Socialthy: Tracking *Social* Interactions for A *Healthy* Life

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One of the factors that is significantly changed due to the pandemic, is the way people socialize or interact with each other. With the majority of the businesses running their operations remotely, the individuals working on these jobs are struggling to find a discrete divide between their work and home environments. This has affected people's social interactions. Since social interactions play a key role in the an individual's sense of security, happiness and mental health in general, it is important to be aware of one's social interaction in these pandemic times. We propose *Socialthy* an iOS app that uses semi-automatic tracking to track social interactions. *Socialthy* is designed to facilitate user's self awareness regarding social interactions and to serve as an aide in managing their interactions.

CCS Concepts: • **Human-centered computing → Ubiquitous and mobile computing**.

Additional Key Words and Phrases: social interaction, mobile tracking application, personal health informatics

1 INTRODUCTION AND MOTIVATION

The coronavirus pandemic has disrupted the way in which people work, study, socialize and entertain themselves. It can be said that the pandemic has made fundamental and systemic changes to human life. One of the factors that is significantly changed due to the pandemic, is the way people socialize or interact with each other. With the majority of the businesses running their operations remotely, the individuals working on these jobs are struggling to find a discrete divide between their work and home environments. Anecdotal evidence suggests that people find themselves working for longer hours because of work-from-home setups. This aforementioned scenario coupled with local lockdown laws and a general public opinion of avoiding unnecessary public exposure, leads to individuals spending the majority of their time in their homes. Oftentimes their home space is shared with other family members or roommates. Thus the work-from-home scenario fundamentally alters individuals's social interactions. Thus, the pandemic has directly limited people's social interactions which affect their loneliness levels. Further pandemic induced anxiety about virus' community spread, the subsequent economic instability and lack of individual job security are additional stressors to individuals' lives.

Xiang et al argue that the pandemic directly hinders mental health stability among people working closely with the pandemic [22]. We agree with the authors that mental care support must be provided in these pandemic times, to patients and healthcare workers and further argue that a general preventive mental health support is required for the general public. Social interaction is correlated to one's mental health, happiness levels and sense of safety and belonging [5, 12, 17]. Social interactions provide a sense of security and belonging and meaningful connections in an individual's life [19, 21]. Research suggests that there is an undeniable correlation between social interaction and mental and physical health. [9, 18, 19, 21]. Social interaction is a key facet of human life that has seen significant changes due to the pandemic, and the pandemic induced change of restrictive lifestyles lead to mental stressors such as depression, insecurity and emotional isolation [20]. Since the world is facing a second wave of the coronavirus, with certain European countries reinforcing nationwide lockdowns, and the uncertainty regarding the end of the pandemic, we argue that it is important to tackle the issue of reduced social interactions.

We propose *Socialthy*, an app that understands the importance of social interactions in leading an overall healthy life, and thus helps in tracking of, and reflecting on social interactions. In this paper,

we define social interactions as a user's personal interactions with other people for recreational purposes. We use this as our working definition for social interactions because we hypothesize that interactions which are carried out for recreational reasons constitute a larger impact on one's health, rather than interactions which requires an individual's attendance, such as a work meeting. *Socialthy* is an app that tracks a user's social interactions via manual and automatic tracking. To better inform the user of their interaction patterns, *Socialthy* conveys the tracked data in easy to understand graphics. Further it allows the user to set goals for their desired social interaction behavior.

With this project, our goal is to allow users to create self awareness about their social interactions. Users can use the system to track their social interactions, both virtual and in-person along with the related meta-data. This will help the user gauge their social behavior and apply their findings to the related life aspects of happiness, loneliness and general mental health and well-being.

2 RELATED WORK

While our work focuses on the connection between social interactions and mental health, various research suggests that social interactions have quite the wide range of benefits. Beyond mental health and happiness benefits as mentioned earlier, Anme et. al. finds a positive relation between increased social interactions and reduced mortality [1]. Their analysis shows that this relation holds even after adjusting for various factors such as baseline age, gender, physical function, health status, and ADL. Relatedly, a study by Yanos et. al. found a significant relationship between social interactions and general quality of life (QOL), with negative social interactions relating to lower QOL and more supportive interactions relating to higher QOL [24]. In a more directed study, MacRae finds that in people suffering from Alzheimer's disease, the affected individuals' social interactions provide essential support, cooperation, and encouragement which is what enables them to create meaning in life and sustain their identity [12]. Particularly interesting is the Social Disorganization Theory and its suggestion that social interaction among neighbors can actually control community crime. This assumption is tested and qualified by Bellair wherein he notes the positive effect that getting together with neighbors at least once a year can have on burglary, motor vehicle theft, and robbery [2].

Other tools have also addressed tracking social interactions in different ways. Lahnakoski et. al. focus their tool towards predicting the quality of interactions instead of just simply tracking them; towards that end, they built their system using optical motion sensors validated with wearable IMUs [8]. So unlike our approach, their method includes a noticeable hardware component. In a similar manner, SociTrack presents a way to autonomously track social interactions using a combination of UWB and BLE radio technology [3]. While such approaches lean more towards tracking through additional hardware, Cuttone et. al. present an Android system which relies on data captured through mobile embedded sensors such as GPS and Bluetooth [4]. It is worth noting that this system has a much heavier emphasis on visualization than tracking whereas our app is mostly the opposite. Conversation Moderator focuses on a smaller subset of interactions, but makes use of machine learning in order to provide feedback about the speaking patterns of individuals in a meeting [23]. Additionally, we find that there are trends where individuals will use general PI tools in order to manage their mental conditions [6, 13, 15] but also indications that technology use can also potentially be detrimental to mental health [14].

Apart from these works, we also consider RescueTime, a time and productivity tracker app available for both iOS and Android that is based on its base desktop version. The app tracks screen time and automatically categorizes actions by productivity level. We incorporated RescueTime's idea and system design of automatic tracking of opened applications, into our system's automated

tracking component. *Socialthy*'s automated tracking is guided by our app's goals but we do take inspiration from RescueTime's seamless automated tracking.

3 DESIGN PROBLEM AND TARGET USER GROUP

With the pandemic being our motivating factor, we are of the opinion that there is a strong need for application that supports the general public's mental health. One of the areas that has been affected by the pandemic induced lifestyle and which is a vital component of mental health is social interactions. Hence for this paper, our focus is on social interactions. In this paper, we identify a need to be better aware of our social interactions in current times. As a solution we propose *Socialthy*, a mobile application designed with an understanding of current day social interaction patterns, which helps in tracking one's social interactions. The mobile app's design and feature set is influenced by Nelson and Hayes's work on self-monitoring [7, 16]. The app is designed to make the user aware of their social interactions, help them identify their core inner circle of friends and confidants and lastly to serve as an essential aide in maintaining the user's mental health.

The target user group for this application is characterized in the following three ways:

(1) Any individual whose lifestyle is changed by the coronavirus pandemic.
(2) Any individual who wants to be better aware of their social interactions.

Further, we say that the application does not only cater during the pandemic times, but can be used even when the situation returns to normalcy as it helps users analyze their interactions and provides a way for self reflection.

3.1 Persona

Since our project is motivated by the pandemic, we focused on thinking about people in different walks of life. We are geared towards a somewhat younger audience and do not consider elderly individuals as our targeted audience of this application. The rough age groups we looked at were college freshmen, young adults/graduate students and middle aged individuals who have a stable job and families. Further we looked at common interaction themes followed by individuals prior to COVID-19 and their subsequent alternations in the post-pandemic era. Based on the above considerations we have created primary and secondary personas which aided our feature design process.

3.1.1 Primary persona: Michael. Michael is a 37-year old man who has spent the last two months learning to adapt to his new life and workflow during the pandemic era. His professional, social, and familial life have all experienced extensive changes with mixed results. Prior to the pandemic, Michael had a relatively balanced life; he was well-liked as the regional manager at his office and dedicated himself as an active father and husband. Outside of his responsibilities, Michael enjoyed meeting with friends often and going out to watch sports at his local bar. Recently, his birthday passed and was not able to hold a big celebration like he does every year with family and friends. Much fewer people reached out to him than he would have even conservatively expected. Michael is a creature of habit, and wants nothing more than for things to go back to normal. He can't really put his finger on why, but he does not feel as close to others as he once was. His goals are to maintain his relationships and not lose touch with the people he cares about.

3.1.2 Secondary persona: Amy. Amy is a graduate student at the University of Maryland. She lives a few miles away from campus with her mother, who works a 9 to 5 job every weekday. Amy is taking a rigorous and challenging course load for the semester, yet she manages to also work part time as a software developer. Amy's work and education are done virtually, whereas her mother must go to work at her workplace. Amy spends most of her day glued at her laptop either attending

classes, working, or studying. Since she lives at some distance from campus, there aren't many other university students around her, and most of her friends, who she met during her time on campus, live around the campus vicinity. Before the pandemic, when classes were still held in-person, Amy used to be on campus from 9am to 6pm – attending lectures, studying, socializing with her friends and colleagues or working on campus. Campus essentially served as a medium for Amy to meet new people, form friendships and socialize with friends and acquaintances. Amy has become quite secluded due to work-from-home and online classes. She cannot meet her friends as she lives away from campus. Further she is alone at home for the majority of the time. Amy's primary goal is to bring back social interaction into her daily life.

3.2 Storyboard

To get a better idea of a user-case scenario, we developed a narrative storyboard featuring our primary persona, Michael. In the storyboard [Fig. 1], Michael is looking over his work-filled schedule for the week, and then realizes that he hasn't talked with those he used to often socialize with in a while. From that realization, he decides to get a better idea of just how different his interactions are by tracking it, in which he finds our app, *Socialthy*, and downloads it. He sets up the automatic tracking settings and then proceeds to video call his friend, allowing the app to track his interaction.

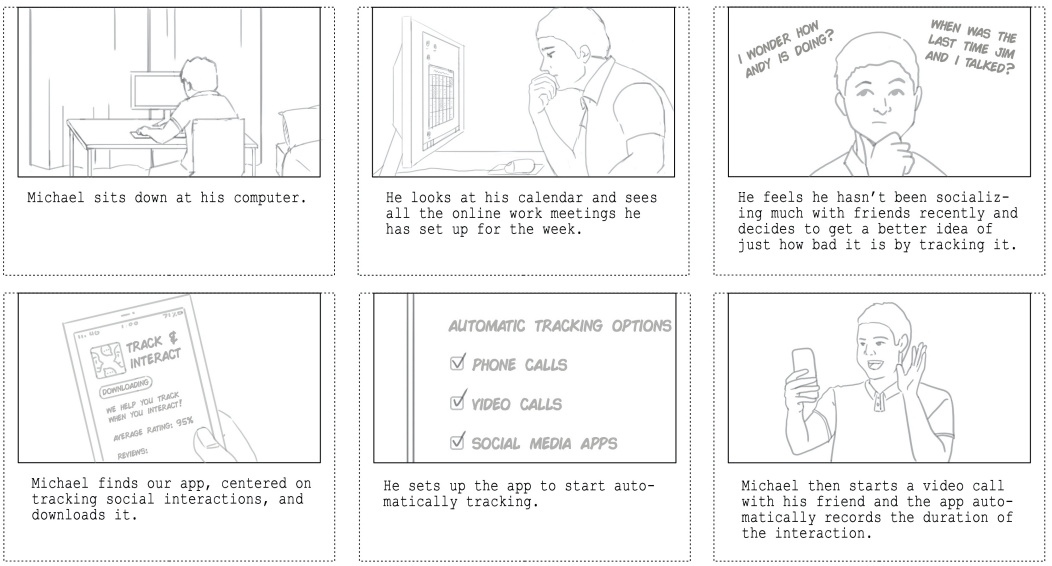

Fig. 1. Storyboard featuring the Michael persona. Illustrated by Diana Chou in Adobe Photoshop.

4 DESIGN REQUIREMENTS AND RATIONALE

Motivated by the problem we identified, we designed *Socialthy*. In this section, we describe *Socialthy*'s design goal and the corresponding rationale. We further detail the application system along with its user interface. With *Socialthy*, we aimed to address the following goals:

G1: Allow the user to be better aware of their social interactions.
G2: Serve as an aide to the user's self awareness of their interactions and greater mental health.

G3: Create a tool that can be seamlessly integrated into one's life and hence does not require a lot of tracking burden.

Because of the ubiquity of mobile phones and how they have become an integral part of many people's lives, we wanted to build a tool that can leverage this fact to enable more seamless integration into users' lives. With this in mind, we focus our efforts to design *Socialthy* as a mobile app and currently do not support a desktop version. When approaching the problem of how our app would track social interactions, we consider both manual and automatic tracking approaches. While manual tracking offers the benefits of increased engagement and greater user awareness, it also serves as a chore with high tracking burden [7] and potentially detrimental effects on mental health [14]. On the other hand, fully automatic tracking reduces user awareness [11] but mitigates some of the negative effects of manual tracking. Based on our goals, we wanted to somehow keep the benefits of both approaches while simultaneously reducing the drawbacks of both. Without a clear way to design a method that can satisfy both requirements, we decided to support both approaches so that users can enjoy the benefits of both while having the benefits of one approach also counteract the drawbacks of the other.

The *Socialthy* app consists of the three core pages: Interactions, Analysis, and Goals. A navigation bar will be present to enable smooth transitions between those pages and the Settings page. The interactions page lists all the recorded interactions and is also how users can get to the manual tracking feature. The analysis page is where the collected data is aggregated to display easy visualizations for the user. The goals page allows for setting social interaction goals. Additionally, our app adopts a Launch-to-Action approach with the Interactions tab as the first tab a user sees when starting the app. As opposed to the others, the Interactions tab, which contains all of the user's recorded interactions, is the most direct representation of the stated purpose of our app, which is why we decided to make it our "home" page. Below we describe each core component of the app in detail.

4.1 Key Functionality

4.1.1 Tracking. Being a semi-automated tracking application, we aimed to provide comparable support for both the manual and automatic tracking aspects of our app. We first discuss automatic tracking functionality and then the manual tracking.

In order to reduce the burden for the user in automatic tracking mode, we designed *Socialthy* to leverage the devices' underlying OS APIs (G3). With these APIs, *Socialthy* can track the users' actions in external apps, so when an instance of social interaction is detected, *Socialthy* will extract and record the necessary data into the Interactions page. *Socialthy* applies a heuristic algorithm to determine what actions should be considered social interactions. In this way, there is very little action required on the part of the user when recording their interactions in this mode. Details of the algorithm and when additional user action is required is discussed in more detail in section 4.2.3. Users will always have the ability to edit or remove any of the automatically recorded interactions at any time. When editing, users can adjust any of the fields already populated by the automatic tracking while also adding additional information through the description, pictures, and rating.

Users access the manual input function through the '+' button on the Interactions page, which will bring up a form with various spaces for the user to fill in. We require the user to include who they interacted with, when the interaction took place (both the start time and end time), and what method/platform the interaction was through (i.e. face-to-face, call, text, etc.). These requirements are included to help the user to understand and be aware of their interactions (G1). Moreover the metadata leads to richer visualizations. Users will also have the option to include a description, pictures, and a rating of the interaction. These areas are included mainly to support

increased personalization. And just like with automatic tracking, users can edit and delete recorded interactions at any time.

4.1.2 Interactions. The Interactions page will contain all the instances of social interactions, both automatic and manual tracking, that have been recorded. Users should be able to easily distinguish between automatically tracked and manually tracked entries based on the different colors the entries will have, depending on what approach was used to track them. Clicking on any entry will allow users to edit the information of that interaction while swiping an entry enables deletion of that entry. Pending interaction entries (discussed in more detail in section 4.2.3) will also be accessible from this page. There will also be the option to filter the recorded interactions by various measures, whether that be tracking method, name of person the interaction was with and interaction method (phone/messaging/etc.). The ability to view interactions from different perspectives and only keep the instances which the user feels are meaningful to them should help with developing increased awareness of different trends in their interactions (G1).

4.1.3 Analysis. This page contains visualizations along with certain aggregate measures and statistics of the user's interactions. The user can use this to get a better understanding about the various trends in their interaction habits (G1, G2). This page breaks down the user's total interaction time into manually tracked interactions and automatically tracked interactions. It also displays the connections that the user frequently interacts with and the frequently used apps for these interactions. Further the bubble plot displays the user's emotions while interacting with their connections. Lastly, these visualizations are displayed for the day, week and year time granularity levels. Thus, with this page, the user can better understand their social interactions, the time spent interacting with others, who they most interact with and their feelings after interacting with their connections. This data is shown in easy to understand plots, which follow the iOS health app's structure. Thus, we are able to fulfill G1, G2 and G3 with the information conveyed by the easy to understand visualizations in this tab.

4.1.4 Goals. In this work, we did not conduct preliminary interviews with our target audience to understand what type of goals would users like to set in the context of social interaction. Hence, in our design we wanted to allow setting various types of goals. We hypothesize goals to have the following characteristics:

(1) Goals can require one interaction to complete the goal or multiple interactions. For example, a goal such as 'Meet up with Bob before he moves to France' requires one interaction with Bob in order to accomplish the goal. On the other day, a goal such as 'Talk to Andy 10 times' requires 10 interactions with Andy for the goal to be considered completed.
(2) Goals that are periodic in nature. Such goals represent a behavior that the user wants to repeat every period of time. For example, a goal such as 'Call mom twice a week' requires two interactions a week to accomplish the goal for that week. Further, such a goal resets every week.

We designed the goals page to allow the user maximum flexibility in choosing the types of goals for themselves. The 'Reset' option allows for setting periodic goals. The 'Number of Times' option allows for setting the required number of interactions for this goal. Further, goals can be tracked either automatically or manually (G3). Users can select which option they would like to use. Automatically tracked goals are updated on their progress based on the interactions recorded on the interactions page. Manually tracked goals can be updated by clicking on the progress bar. The app can also be configured to send reminders via notifications for progressing towards the user created goals. Notifications provide a way to maintain user engagement as people may be disengaged or forget to track [10] and help reduce some of the tracking burden (G3). All goals

can be deleted by holding down the progress bar. Goals page does not directly support G1 and G2, however they serve as a vital functionality for managing social interactions. Thus, the goals functionality enhances the app's usefulness towards G2.

4.2 Additional Functionality and Design

4.2.1 Settings. Users can control certain aspects of the app through the settings page. These adjustable aspects were designed with the intention that users would need to consider what it means to them for a social interaction to have meaning (G1). While some users may place heavy emphasis on interacting through social media, others may only find meaning in actively interacting with others through calls or FaceTime. One of these adjustable features is the apps which *Socialthy* will automatically track. *Socialthy* keeps a running list of external apps which are currently being automatically tracked or have been in some time in the past. For each of these apps, users have the ability to enable or disable the automatic tracking feature for the app as well as specify the minimum duration an action on that app must last before it can be considered a social interaction. Users can add and remove apps from this list at any time, where adding an app will introduce the possibility of automatic tracking and removing an app will just disconnect the app from *Socialthy*, completely disabling the automatic tracking option. There is also an option to enable notifications, the effects of which are described in more detail below.

4.2.2 Notifications. Socialthy supports notifications to serve as a supplementary feature for increasing user awareness (G1, G2). *Socialthy* sends three notifications daily, in the morning, late afternoon and night. At the start of the day, a notification of the form 'Hi <user's name>! You have some pending reports to check out.' In the afternoon, if the level of interactions recorded are too low, then the app sends a reminder of the form 'Just checking in, did you have a meaningful interaction today?'. In the case that there are interactions recorded, the app sends in an educational tip such as 'Talking to a friend for 10 minutes can greatly improve your mood'. At the end of the day, the app reminds the user to log their interactions and go through the pending activity (from the automatic tracking component). The notification text used is 'Have you logged your social interactions for the day?'.

4.2.3 Automatic Tracking Mechanism. As introduced in section 4.1.1, *Socialthy* relies on a heuristic algorithm in automatic tracking mode to help determine when to record instances of social interactions happening on external apps. This algorithm is based on instances of social interactions on external apps being characterized as either sending something or forming an active connection with another party. This design rests on the premise that there would be reasonable expectation in those two kinds of situations that the user is actively soliciting interactions or actively interacting with another party. In other words, we believe it is reasonable to assume that when a user is performing one of those two interactions, a user is trying to interact or is actively interacting with someone. Respective examples would be sending text messages in iMessage or being on a call in the Phone app. In the case where an action falls in the first category, *Socialthy* will consider the entire time it takes from when the send-out is first composed to when the send-out is actually sent out as the social interaction and thus record the entire interval. For actions which fall into the second category, *Socialthy* will consider the entire time the connection is active as the social interaction and thus record that interval.

Socialthy also takes certain steps in automatic tracking mode to prevent fully recording certain instances of social interaction where there is reasonable doubt as to the importance of an instance to the user. This is mainly done when either 1) an interaction does not reach the duration threshold specified for the given external app in the settings or 2) the party the interaction was with is not clearly defined. Examples of these cases would be a phone call that lasts for less than a minute

with a duration threshold setting of one minute for the Phone app and a phone call with a number not associated with a name. In these cases, *Socialthy* will still record the relevant information and create an entry in the Interactions page, but instead of adding it directly to the list with all the other instances, these will remain in the pending tab until the user confirms/rejects its inclusion into the permanent list. These cases are when additional user input would be required in the automatic tracking mode.

5 LOW-FIDELITY PROTOTYPE

After further development of our app's key features and functionalities, we designed a low-fidelity (low-fi) prototype using the web-based prototyping tool, Figma. The low-fi prototype [Fig. 2] demonstrates how each screen would look like after pressing each icon in the navigation bar, which is always present on the bottom of the screen, and covers key elements of the interface, layout, and user flow.

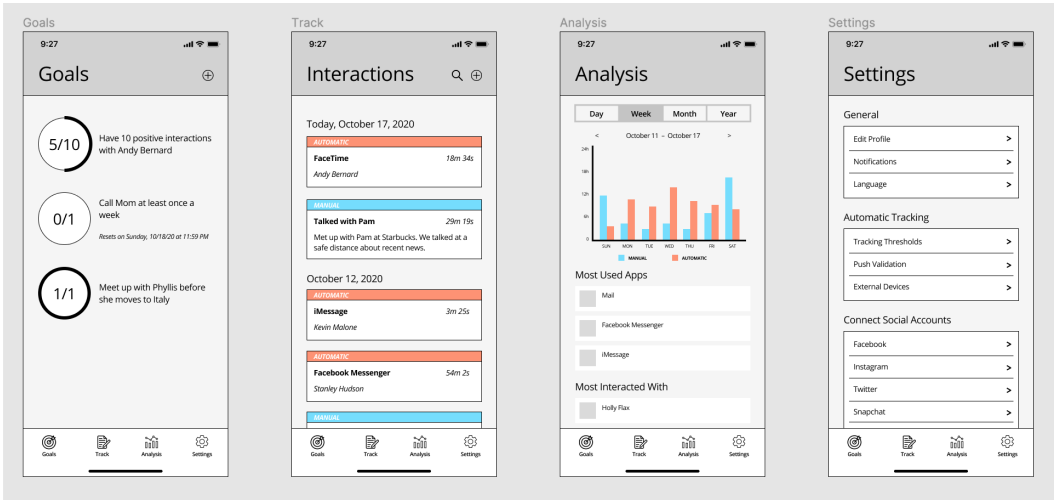

Fig. 2. Screens showing the Goals, Track, Analysis, and Settings pages from the low-fidelity prototype. Created in Figma.

6 HIGH FIDELITY PROTOTYPE

The high fidelity prototype and a video of the prototype interaction is attached along with this paper submission.

7 DISCUSSION

We acknowledge that the method with which our automatic tracking algorithm identifies social interactions leaves some improvements to be desired. Mainly concerning how our approach would characterize actions in which something is being sent out as social interactions, we grant that there will definitely be instances that our app would record actions that would probably not be a social interaction. Some examples of this could be sending out mass emails or posting status updates to social media. In such cases, while there is definitely the possibility that the actions in question are directed towards soliciting interactions from others, it could just as likely not. However, we maintain this over-tracking concern does not detract from the value of our design as we believe

that to truly support G1 and G2, it is imperative that our app can handle recording all actions that would likely have some impact towards those ends. In this way, over-tracking would ensure this quality, whereas a more conservative algorithm could very easily overlook potentially highly important interactions. Additionally, it is much easier for a user to simply remove the recorded instances that don't end up have much meaning than try and remember the relevant details of one that holds high importance.

We find there is a dearth of academic work focusing on mobile apps to track social development, despite the abundance focusing on tracking in some other manner. We surmise this is at least in part due to the existence of products that build on relevant work that are directed at addressing a similar problem as ours, with RescueTime being a prime example. But regardless of the underlying reason, we still argue for the value that a detailed investigation on this specific topic can afford to people.

8 FUTURE WORK

A major aspect of our product that can be improved is the algorithm used in automatic tracking to identify instances of social interactions. While simply adjusting the working characterization of social interactions employed by the algorithm is worth considering, we believe such an approach would be hard-pressed to truly address the inability to accurately characterize social interactions. A separate approach that offers promise draws inspiration from Conversation Moderator and its use of machine learning. With ML, we believe it may be possible to train some network to develop a pretty comprehensive set of what actions to consider as social interactions, in which case our automatic tracking algorithm could become much more accurate in its identifications of actions to consider as social interactions.

In our current design, the automatic and manual tracking components are relatively distinct from one another, with little overlap. The lack of a connection could potentially reduce the effectiveness of the overall tracking experience as the benefits of each is balanced out by its own disadvantages given that each approach likely takes little of the advantages from the other. To remedy this, we believe there is the opportunity to support a more mixed approach. Specifically, an option for users to specify whether they would like to verify or reject all automatically tracked interaction immediately after the fact may provide users a sense of increased engagement that comes with manual tracking in the automatic tracking mode.

9 CONCLUSION

We present *Socialthy*, an app to help users track their social interactions. The app is designed to increase users' self-awareness about their social interactions at a time when when the pandemic has significantly altered how many people interact with each other. *Socialthy* supports both automatic and manual tracking of interactions, presents recorded interactions in an easy to understand fashion, supports adjustable features to personalize the user experience, and offers goal setting to let users take charge of their own interactions. We examine how each aspect of the app supports a stated goal while describing the general way a user may use each of those functionalities. We also provide a brief demonstration of our app in question before offering some final additional remarks on specifics of the study.

REFERENCES

[1] Tokie Anme, Ryoji Shinohara, Yuka Sugisawa, and Sumio Itoh. 2006. Social interaction and mortality: a seven-year longitudinal study of elderly people. *[Nihon koshu eisei zasshi] Japanese journal of public health* 53, 9 (2006), 681–687.

[2] Paul E Bellair. 1997. Social interaction and community crime: Examining the importance of neighbor networks. *Criminology* 35, 4 (1997), 677–704.

[3] Andreas Biri, Neal Jackson, Lothar Thiele, Pat Pannuto, and Prabal Dutta. 2020. SociTrack: Infrastructure-free interaction tracking through mobile sensor networks. In *Proceedings of the 26th Annual International Conference on Mobile Computing and Networking*. 1–14.

[4] Andrea Cuttone, Sune Lehmann, and Jakob Eg Larsen. 2013. A mobile personal informatics system with interactive visualizations of mobility and social interactions. In *Proceedings of the 1st ACM international workshop on Personal data meets distributed multimedia*. 27–30.

[5] Marshall J Graney. 1975. Happiness and social participation in aging. *Journal of gerontology* 30, 6 (1975), 701–706.

[6] Christina Kelley, Bongshin Lee, and Lauren Wilcox. 2017. Self-tracking for mental wellness: understanding expert perspectives and student experiences. In *Proceedings of the 2017 CHI conference on human factors in computing systems*. 629–641.

[7] William J Korotitsch and Rosemery O Nelson-Gray. 1999. An overview of self-monitoring research in assessment and treatment. *Psychological Assessment* 11, 4 (1999), 415.

[8] Juha M Lahnakoski, Paul AG Forbes, Cade McCall, and Leonhard Schilbach. 2020. Unobtrusive tracking of interpersonal orienting and distance predicts the subjective quality of social interactions. *Royal Society open science* 7, 8 (2020), 191815.

[9] Admassu N. Lamu and Jan Abel Olsen. 2016. The relative importance of health, income and social relations for subjective well-being: An integrative analysis. *Social Science Medicine* 152 (2016), 176 – 185. https://doi.org/10.1016/j.socscimed.2016.01.046

[10] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A Stage-Based Model of Personal Informatics Systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA) *(CHI '10)*. Association for Computing Machinery, New York, NY, USA, 557–566. https://doi.org/10.1145/1753326.1753409

[11] Ian Li, Anind K. Dey, and Jodi Forlizzi. 2012. Using Context to Reveal Factors That Affect Physical Activity. *ACM Trans. Comput.-Hum. Interact.* 19, 1, Article 7 (May 2012), 21 pages. https://doi.org/10.1145/2147783.2147790

[12] Hazel MacRae. 2011. Self and other: The importance of social interaction and social relationships in shaping the experience of early-stage Alzheimer's disease. *Journal of Aging Studies* 25, 4 (2011), 445–456.

[13] Mark Matthews, Elizabeth Murnane, and Jaime Snyder. 2017. Quantifying the Changeable Self: The role of self-tracking in coming to terms with and managing bipolar disorder. *Human–Computer Interaction* 32, 5-6 (2017), 413–446.

[14] Mark Matthews, Elizabeth Murnane, Jaime Snyder, Shion Guha, Pamara Chang, Gavin Doherty, and Geri Gay. 2017. The double-edged sword: A mixed methods study of the interplay between bipolar disorder and technology use. *Computers in Human Behavior* 75 (2017), 288–300.

[15] Elizabeth L Murnane, Dan Cosley, Pamara Chang, Shion Guha, Ellen Frank, Geri Gay, and Mark Matthews. 2016. Self-monitoring practices, attitudes, and needs of individuals with bipolar disorder: implications for the design of technologies to manage mental health. *Journal of the American Medical Informatics Association* 23, 3 (2016), 477–484.

[16] Rosemery O Nelson and Steven C Hayes. 1981. Theoretical explanations for reactivity in self-monitoring. *Behavior Modification* 5, 1 (1981), 3–14.

[17] E. Ono, T. Nozawa, T. Ogata, M. Motohashi, N. Higo, T. Kobayashi, K. Ishikawa, K. Ara, K. Yano, and Y. Miyake. 2011. Relationship between social interaction and mental health. In *2011 IEEE/SICE International Symposium on System Integration (SII)*. 246–249. https://doi.org/10.1109/SII.2011.6147454

[18] Esteban Ortiz-Ospina. 2020. Loneliness and Social Connections. *Our World in Data* (2020). https://ourworldindata.org/social-connections-and-loneliness.

[19] Esteban Ortiz-Ospina and Max Roser. 2020. Loneliness and Social Connections. *Our World in Data* (2020).

[20] Betty Pfefferbaum and Carol S North. 2020. Mental health and the Covid-19 pandemic. *New England Journal of Medicine* (2020).

[21] Michele G. Sullivan. 2020. Researchers examine lifestyle changes to reduce risk of dementia: Evidence indicates that exercise, a good diet, and social interaction are good for physical and cognitive health. *Neurology Reviews* 28, 2 (2020), 14 – 15. http://search.ebscohost.com.proxy-um.researchport.umd.edu/login.aspx?direct=true&db=asn&AN=141939263&site=ehost-live

[22] Yu-Tao Xiang, Yuan Yang, Wen Li, Ling Zhang, Qinge Zhang, Teris Cheung, and Chee H Ng. 2020. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *The Lancet Psychiatry* 7, 3 (2020), 228–229.

[23] Ting Xiao, Thasina Tabashum, Bassam Metwally, Mark Albert, Albert Du, Rejoice Jebamalaidass, Marcos Leal, and Edgard Oliviera. 2020. Conversation Moderator: A Mobile App for Tracking Individual Speaking in Group Conversations. In *2020 IEEE 14th International Conference on Semantic Computing (ICSC)*. IEEE, 430–433.

[24] Philip T Yanos, Sarah Rosenfield, and Allan V Horwitz. 2001. Negative and supportive social interactions and quality of life among persons diagnosed with severe mental illness. *Community Mental Health Journal* 37, 5 (2001), 405–419.