HCI Solutions for Reducing Loneliness

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Fig. 1. Boy in a Barcelona art gallery. Photograph by Aaina Sharma (https://unsplash.com/@aaina)

Despite an increase of communication channels, loneliness is a growing problem in our society. The use of computer mediated communication (CMC) has been shown to be correlated with increased loneliness, however, causation is not proven. Some research projects in HCI are investigating solutions for loneliness, but there is a lack of perspicuous descriptions of the current research. This review provides an overview of HCI solutions tackling loneliness, with a focus on identifying promising concepts for further research. Some smaller studies have shown promising results in fields of social robotics and use of novel modalities. The findings of this study suggest that the inclusion of touch, through the use of tangibles or haptics, and the use of social robotics can reduce feelings of loneliness in users. Further research in these fields is deemed necessary.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**.

Additional Key Words and Phrases: loneliness, CMC, HCI, social robots

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1 INTRODUCTION

The American Psychological Association defines loneliness in cognitive psychology as the "unpleasant and unsettling experience that results from a perceived discrepancy[...] between an individual's desired and actual social relationships" [2]. Similar definitions are common when discussing loneliness in the context of health [26]. It is a definition that emphasises the experiential aspect of loneliness. By this rendering, loneliness is subjective in its nature, depending on the discrepancy in how much social contact the person has versus how much they want. This definition is reflected

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in how loneliness is commonly measured. In the University of California (UCLA) three point scale for measuring loneliness, participants are asked to answer three questions, all worded subjectively, relating to how the participant feels about their social life. So is the UCLA 20-point scale[23], and the De Jong Gierveld scales[11].

Many studies have linked loneliness to adverse health effects. In one study by Wilson et al., loneliness was linked to both cognitive decline and the development of Alzheimer's [30]. Participants in the study were twice as likely to develop Alzheimer's if they experienced higher levels of loneliness than if they did not. There is also a link between loneliness and depressive symptoms. VanderWeele et al. argues that if interventions are made to reduce long term loneliness, depressive symptoms can drop significantly over time [27]. Loneliness has also been shown to correlate to increased stress markers [12] and coronary heart disease [25] in women. A six year long study in the U.S. showed that loneliness is correlated to higher mortality in the elderly. The increase in mortality was not connected to the participants' social life or whether they had healthier lifestyles, pointing to the fact that loneliness in itself can increase the risk of death[16]. Since more and more people are affected by loneliness every year[6], we can expect to see a rise in these negative health effects associated with loneliness.

There is a correlation between increased use of computer mediated communication (CMC) and loneliness in certain age groups[4], leading to the possibility that increased use of CMC is contributing to loneliness. Considering the use of CMCs such as social media is most prevalent with the younger generations[14], if there is a causation relationship between the two we can expect the problem of loneliness to rise even more in the years to come.

Efforts have been made in the human computer interaction (HCI) field to find solutions to lessen experienced loneliness by technology users, such as the *In Touch* prototype by Baecker et al.[3]. However, many of these efforts are highly focused and specialized for a specific target group or application, such as the aforementioned study where seniors in nursing homes were the target audience. A more general overview of potential HCI solutions to loneliness is needed, both for understanding the current state of research in the field and for the possibility to explore areas where more work could be done.

This literature review aims to compile findings on the effects of CMC on experienced loneliness and to explore previous research on HCI solutions which have a potential to be used to lessen experienced loneliness, with the intent of answering the following research questions:

What are the effects of CMC usage on the experience of loneliness?

Which methods and innovations in the field of HCI can be used to reduce/positively affect feelings of loneliness?

Which HCI technologies and concepts are most relevant to further research solutions to loneliness?

2 METHOD

Relevant studies were identified using the databases ACM Digital library, IEEE Xplore, and Google Scholar. The search terms for CMC effects on loneliness initially included "CMC"/"computer mediated communication" and "loneliness". They were later expanded to include "social media" and "internet use" based on the results of the previous query. HCI research on loneliness was identified using the search terms "loneliness", "social robots", "human-robot interaction"/"HRI", "HCI"/"human computer interaction, "interaction", and later expanded to include "mental health". Further references were identified using the reference lists of relevant research.

The material was screened for relevance, focusing on the topics of CMC's effects on feelings of loneliness and HCI solutions/concepts developed for enhancing social interactions or reducing loneliness. Due to limited material focusing on the population in general, studies with a specific target age/living situation were included in the review.

The initial body of works was screened, leaving 21 papers possibly relevant to the review, 7 papers addressing CMC effects on loneliness, and 14 on HCI research mentioning loneliness. 4 papers on HCI research and loneliness were discarded due to irrelevance or insufficiencies in the paper in regards to the factor of loneliness, and one paper due to a lack of access to the paper in English, leaving 16 studies in the final review.

3 ANALYSIS OF REVIEWED WORK

3.1 The impact of CMC on loneliness

The causation of CMC usage on increased experienced loneliness is yet not established, however, there is evidence for correlation [4]. Some uses of CMC in the form of social media has proven to lessen experienced loneliness. Picture based social media, such as Instagram, has shown to have a negative correlation with loneliness [21]. Active Facebook usage, where users interact with other Facebook users to a greater extent, leads to increased feelings of a social support network, whereas passive Facebook usage, where users spend more time viewing content instead of interacting with it, reduced feelings of friend support and was connected to higher feelings of loneliness [9]. On the other hand, a study on undergrad students by Pittman showed an inverse correlation between affinity for social media platforms Instagram and Twitter, and reported loneliness [20]. This could indicate that there is a correlation between the users' attitudes towards a CMC and their feelings of loneliness.

Other research has found that reducing social media usage on mobile phones reduced signs of loneliness and depression [13], and that there is a correlation between loneliness and daily use of CMC in adolescents [24].

A 2021 survey conducted by Cauberghe et al. aimed to investigate how adolescence used social media during the COVID-19 pandemic concluded that social media usage can work as a coping strategy for anxiety. Even though adolescence who reported feelings of loneliness were more likely to use social media, it had no significant impact on their perceived happiness[5].

3.2 HCI Research on Loneliness

Few studies and research projects have been done directly on HCI solutions to mitigate loneliness, but many studies touch on loneliness when exploring subjects such as connectedness and empathic relations.

3.2.1 Social Robots. Ananto and Young argue in their 2021 short paper [1] that there is potential for social robots to be tested and used more extensively for reducing experienced loneliness. There is evidence showing that people who feel lonely tend to anthropomorphize (ascribe human attributes to) robots to a greater extent than humans who do not feel lonely[8]. This could be related to a need in human form social bonds, which when lacking is expressed as a social bond to inanimate objects or animals, a theory supported by the fact that the same effect is seen in relation to pets[18]. Some projects revolve around the use of social robots and their relationships with humans, such as the study by deGraaf et al. who explored the factors necessary for people to accept robots into their homes. Their findings indicated that both social interactions and utilitarian factors are of importance when designing social robots for peoples' homes[7]. The subject of accepting and connecting to social robots is important for exploring solutions to lessen feelings of loneliness, however, it is not directly translateable. This ties in with a study by Odekerken-Schröder et al., describing three different roles a social robot can play in a users life. The first is the "personal assistant", a robot that the user interacts with for a utilitarian purpose, such as information gathering. For this sort of robot the utalitarian goals are the most important, as

it is the reason for the robot to be in the user's life. The second is the "relational peer", a robot that a user interacts with in less productive, goal driven ways, e.g. playing games or joking. The third is the "intimate buddy", a robot that the user ascribes a deeper value to, forming a more intimate connection with[17].
Pirhonen et al. describe several different possibilities for the social robots' ability for reducing feelings of loneliness in the lives of the elderly, in particular ones in assisted living[19]. Some of the possibilities described include humanoid robots, which can remedy loneliness by "creating conversational opportunities", telepresence robots, which can give users the possibility to communicate with loved ones from a distance, and pet robots, which can act as a subject of affection and open up for communication with visiting family.

3.2.2 Exploring Modalities. Baecker et al. list some implications of technology for lessening social isolation and loneliness, derived from user studies with elders. Some implications include the use of tangible objects, to allow for richer media such as photos and audio, and to design with existing information and technology infrastructure in mind [3] The use of tangibles was supported by a study testing a picture frame that sent messages to the users' family when it was held, letting them know that the user was thinking of them. Many studies try to solve chronic loneliness, where the person has a constant lack of sufficient social support. Lawson et al. argue that for more transient forms of loneliness, it is important to include support for empathy and trust in the design [15]. This transient loneliness is also addressed in a study performed by Vetere et al., that investigated the mediation of intimacy between established long term couples. Based on these findings, some design ideas are proposed, two of which include tangible/haptic elements[29]. This gives further support that for the idea that touch can mediate intimacy, which could potentially mitigate feelings of loneliness.
Veldmeijer et al. explored the use of virtual reality (VR) to reduce feelings of loneliness in the elder, by presenting tools for remembering and reflecting over old memories. The VR environment used artifact such as photographs of family members to awaken memories. The results were promising, as the participants felt that this has helped their well-being. The authors highlight that this was not a solution to users' loneliness, but that is works as a tool to discover more deeply the root of loneliness, and that allowing users' into the design process by using participatory design had meaning on the effectiveness of improving well-being[28].

4 DISCUSSION

There is no clear conclusion of how much CMC affects loneliness, however, the existing data indicates that certain CMC usage can affect loneliness. This appears to be the case either when increased use of CMC is connected with decreased non-computer mediated technology, or when the technology is used to consume content made by others instead of producing content and interacting. From this, it can be argued that CMC for reducing feelings of loneliness should encourage active interaction and creation over passive consumption.
Many studies on the subject are observational, which can show a correlation but make it difficult to prove a direct causation[22]. In this context, this raises the question of whether CMC and social media makes people lonely, or if lonely people use these tools as replacement for an already existing discrepancy in their desired social connections. The exception to this is the study by Hunt et al.[13], where reduced usage of social media on the phone reduced signs of loneliness. However, the positive effect on anxiety were shown in both those who reduced their time on social media and those who did not. They authors argue that this is due to the participants being reminded of their phone usage, and that mindful usage can lead to positive effect. From this, there is a possibility that allowing for greater understanding

and conceptualization of your CMC usage can lead to solutions which have a lesser negative effect on loneliness.

Most studies on HCI solutions to loneliness included in this review are short, with the longest study being 7 weeks long[3], meaning long term effect might not be captured in the results. It is of great interest to perform longer studies, both on possible HCI solution, but also on the effects of CMC on loneliness. In addition, there are not many studies directly targeting the subject loneliness. The general consensus in the research community appears to be that there is potential in using HCI to lessen loneliness, and considering the smaller studies with promising result, it warrants more investigation. This could be done by exploring which aspects of an interaction reduces feelings of loneliness, which in turn could produce guidelines or frameworks for design against loneliness. By making the factors determining loneliness in CMC clear, it will be easier to include them in future designs for evaluation of design ideas at an earlier stage.

Considering previous research, there is reason to believe that including more modalities than text-based communication can have reduce feelings of loneliness. The use of visuals such as video calls are already common, but there is also an incentive to further explore tactile interfaces for communication, based on the body of previous research. There is certainly a logic to using touch to reduce feelings of loneliness, as touch has been a modality reserved for more intimate experiences due to the constraints in distance.

Social robots are an interesting field for combating feelings of loneliness. Both telepresence robots and autonomous robots could be used in different applications, and it would be of interest to further explore the effects of feelings of loneliness when interacting with both kinds of robot. There is a gap in research on how loneliness can be affected by the use of "relational peer"/"intimate buddy" robots, social robots which do not serve obvious utilitarian purposes. This can be partially attributed to a lack of sufficient artificial intelligence (AI) systems, resulting in robots which are simply not good enough to serve as purely social company. The robot seal Paro is a social robot which has shown promising result for acting as purely a social, and not utilitarian, robot. Interacting with Paro can improve the users mood and affect oxytocin levels, showing that the interaction has a real, physiological, response[10]. It is possible that similar physiological reactions could have an effect on the body to counteract the factors which affect health negatively when experiencing loneliness.

There is a discussion to be held on whether using computer technology is the appropriate measure for counteracting a problem which could have been caused by computers. An argument would be that simply decreasing the amount of CMC compared to real life human interaction should mitigate the negative effects CMC has on loneliness. Since efforts to reduce CMCs in the form of social media on mobile applications have shown positive results, there is some evidence that this approach is valid. However, it is unlikely that we will see any significant reduction in the usage of CMCs such as social media in the near future. A 2021 survey concluded that nearly all internet users in Sweden over the age of 8, and 89% of the population in general over the age of 16 have used social media at least once in the last year [14]. The usage of both internet and social media is highest within the younger ages, meaning social media usage will likely rise in time. Therefore, finding ways to assure that the future of CMC and HCI does more to reduce risks of increasing experienced loneliness is relevant to the future of the scientific community.

To summarize, the effects of loneliness on health are alarming. The link between CMC usage and loneliness warrants further research, to examine whether any correlation is causational or not. Nevertheless, it is vital for HCI research to address loneliness in design. Viewing the research done indicates that the use of touch interfaces can be useful in reducing loneliness in users. There is also promising results in the use of social robots, and subject of how different robot-human relationships affect experienced loneliness are worthy of investigation. It is also necessary to emphasise

the importance of designing against loneliness in CMC. This can be done by determining systematic methods for evaluation of designs on how they affect loneliness in the user.

5 CONCLUSION

It is clear that there is reason to invest resources on further research in the topic of reducing loneliness and mediating meaningful communication in HCI. Based on the results of previous research, the following topics are strongly suggested to be researched further:

- How the use of CMC technology allowing for interactions using touch can affect feelings of loneliness, both in the form of tactile/haptic feedback and tangibles.
- The effects of long term interactions and cohabitation with social robots, in order to build upon the predominantly short studies already performed. Both social robots with utilitarian uses, and those without, should be investigated.
- Systematic ways to evaluate novel designs in HCI on how they can support feelings of connectedness between users, turning design against loneliness into a more quantifiable goal.

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