



A More Connected Future: How Social Connection, Interdisciplinary Approaches, and New Technology Will Shape the Affective Science of Loneliness, a Commentary on the Special Issue

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Abstract

The recent Special Issue of *Affective Science* considered “The Future of Affective Science,” offering new directions for the field. One recurring theme was the need to consider the social nature of emotional experiences. In this article, we take an interdisciplinary approach toward studies of social connection that builds upon current theoretical foundations to address an important public health issue – loneliness. Loneliness is an affective state that is characterized by feelings of isolation and has widespread adverse effects on mental and physical health. Recent studies have established links between loneliness, social connection, and well-being, but most of this work has been siloed in separate fields. We bridge these themes, leveraging advances in technology, such as artificial intelligence-based voice assistants (e.g., Alexa), to illuminate new avenues for detecting and intervening against loneliness “in the wild.” Recognizing the power of connection among individuals as social beings and among researchers with shared goals, affective science can advance our understanding of loneliness and provide tangible benefits to society at large.

Keywords Loneliness · Interpersonal emotion regulation · Social connection · Artificial intelligence

The recent Special Issue of *Affective Science* considered “The Future of Affective Science” as a discipline, with articles addressing topics such as our fundamental understanding of emotion and valence, interpersonal emotion regulation, and the need for real-world measurements and applications of affective theory. As acknowledged in the Introduction to the Special Issue (Shiota et al., 2023), one recurring theme is the need to recognize the social nature of emotional experience and to move beyond controlled laboratory experiments that study single individuals in isolation. There was also a strong case made for interdisciplinarity in our scientific approach. In this article, we take

an interdisciplinary approach toward studies of social connection that builds upon current theoretical foundations and recent technological advances, moving to more authentic and impactful research in affective science. The overarching framework, drawing from the fields of psychology, communications, public health, and computer science, will emphasize the importance of a research area that was touched on only briefly in the special issue—loneliness.

Loneliness is an affective state that is characterized by feelings of isolation—regardless of whether one is objectively isolated—that is often accompanied by a longing for greater social connection (Peplau & Perlman, 1982; Weiss, 1975). Much like the experience of physical pain, loneliness can serve as a signal that something is amiss, prompting individuals to seek out greater connection (Macdonald & Leary, 2005). Indeed, loneliness has evolutionary roots in that human survival has historically depended to some extent on cooperation with an interconnected social group (Cacioppo, Hughes et al., 2006). Despite our modern society, which arguably affords greater connectedness than ever before, loneliness has become a more urgent public health concern (Murthy, 2023); a survey conducted across 16 countries found that nearly 60% of young adults reported negative

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effects of feeling lonely (AXA, 2023). Loneliness also has widespread adverse effects on our mental and physical health (Erzen & Çikrikci, 2018; Hawkey & Cacioppo, 2010; Heinrich & Gullone, 2006; Quadt et al., 2020), including accelerating aging (Hawkey & Cacioppo, 2007) and increasing risk for depression (Cacioppo, Hawkey et al., 2006), dementia (Penninkilampi et al., 2018; Sutin et al., 2020), and all-cause mortality (Holt-Lunstad et al., 2015; Luo et al., 2012; Rico-Uribe et al., 2018). Not surprisingly, the National Institutes of Health has listed research on loneliness and social connection among its funding priorities (Simmons et al., 2023). But to date, much of this work has been siloed within domains related to physical health, clinical psychology, aging and development, social psychology, etc. Bridging various domains using modern scientific approaches will advance the affective science of loneliness in a way that can effectively address this public health concern.

One aspect of loneliness research that will benefit from a modern approach to affective theory is identifying the mechanistic link between social connection and affect. Emotion regulation research has historically focused on intrapersonal processes, but recent conceptualizations recognize the social nature of affect and increasingly emphasize interpersonal emotion regulation (IER; Petrova & Gross, 2023). IER is a strategy that relies on interactions with others to help cope with negative emotions (downregulation) or enhance positive emotions (upregulation). A better characterization of how an individual's frequency of and desire for social connection interact with their attempts at emotion regulation is likely to yield new insights into loneliness. Both having strong social connections and being able to effectively use them for emotion regulation are important factors in combating loneliness. This work could also be useful for predicting who is most vulnerable to the negative effects of loneliness, particularly during periods of shared adversity and reduced social connection (Bierman et al., 2021; Dhakal et al., 2023; Harp & Neta, 2023). For example, during the COVID-19 pandemic, we demonstrated that engaging in positive IER and having greater complexity in one's social networks (i.e., having multiple connections in varied domains of one's life—family, friends, coworkers, etc.) protected against increased negativity and loneliness (Haque et al., [revise-resubmit](#); Harp & Neta, 2023). Thus, continuing research into the mechanisms linking IER and social connectedness may be particularly important in mitigating negative impacts of loneliness.

Another aspect of loneliness research that will benefit from modern approaches is the shift from lab-based measures to real-world outcomes. Most existing work on loneliness has relied on self-report measures, such as the UCLA Loneliness Scale (Russell, 1996; see Buecker et al., 2021 for a meta-analysis), which may fail to capture the full range or variability of lived experiences. Studying emotions “in the

wild” offers greater opportunities to examine how the myriad contexts of daily life influence experiences of emotion (Hoe-mann et al., 2023). Critically, recent advances in technology offer better means of capturing real-world affective experiences, including for experiences of loneliness. Smartphones allow for measurements of dynamic emotional states (i.e., ecological momentary assessments) that can be compared to lab-based measures of affect (e.g., Johnson et al., 2024; Kuczynski et al., 2024; Puccetti et al., 2023). The increasing use of other devices, such as artificial intelligence (AI) voice assistants (e.g., Alexa), also creates new opportunities for research on real-world affect. For example, improved loneliness detection in speech may soon be possible via vocal biomarkers that can be integrated with these at-home AI systems. Additionally, certain linguistic features (e.g., first-person plural pronouns, sentiment, sentence complexity, and similarity) are associated with loneliness and social support and natural language processing techniques can be used on text data to predict loneliness (Badal, Graham et al., 2021; Badal, Nebeker et al., 2021). Automatically mapping the occurrence or intensity of loneliness in daily life in this manner could assist in identifying individuals who may be in need of additional social or emotional support that may be missed by self-report measures alone.

In addition to supporting loneliness detection in the real world, AI technology can also contribute to interventions that reduce or prevent the negative effects of loneliness. In an example from the field of health communication, we demonstrated that AI voice assistants can alleviate feelings of loneliness in older adults living alone via time spent on simple conversational interactions (Jones et al., 2021; Yan et al., 2024). This research suggests that interacting in specific ways with AI assistants can increase feelings of social support, and that engaging with video-based AI assistants has a greater effect on loneliness and social support than audio-based assistants (Jones et al., 2024). Such interactions may constitute a unique emotion regulation tactic that complements genuine IER in alleviating loneliness. Through collaborations with health communication, gerontology, audiology, computer science, and nursing, we are exploring how engaging with an ever-smarter Alexa may become a useful measure of loneliness detection, prediction, and intervention “in the wild” (Chen, 2024).

These examples of successful technology-driven real-world applications of affective science argue for more use-based interdisciplinary work (Wilson-Mendenhall & Holmes, 2023) that allows researchers to better connect with each other and with the public. Technology fosters collaborative approaches that promote innovative methods, and it offers opportunities to connect with harder-to-reach participants (e.g., rural communities) that are underrepresented in existing studies (Shiota et al., 2023). Taking advantage of the growing accessibility of internet-connected devices in

homes, researchers could remotely administer online affective tasks in parallel with enabling automatic emotion detection in daily life via Alexa. For example, our measure of valence bias (i.e., the tendency to appraise emotional ambiguity as positive or negative; Neta et al., 2009) could be combined with practical AI-based interventions that target feelings of loneliness and social connectedness. Given that valence bias is a stable but modifiable measure (Neta, 2024) and is associated with mental health symptoms (Harp et al., 2023; Neta & Brock, 2021), it could be used to better detect outcomes of loneliness interventions in a way that complements self-report. If AI proves useful for upregulating positive emotion and reducing loneliness, we would expect to see associated shifts toward a more positive valence bias and greater well-being. Leveraging established laboratory tasks of affect in conjunction with real-world AI applications for addressing loneliness in this manner would help link existing knowledge with new cutting-edge insights.

As technology expands our scientific reach and the field progresses, new improvements to affective computing will increase the quality of how AI models and responds to human emotions (Kappas & Gratch, 2023), thus advancing its efficacy in numerous domains. For example, social media offers a rich context for exploring affective human interactions in the digital world—that researchers soon may be able to better quantify (Rocklin et al., 2023). Social media use has increased dramatically in recent years, offering new and varied means of connecting with peers. At the same time, feelings of loneliness are soaring and there are widespread concerns about the impact of social media on mental health, particularly for children and adolescents (Hollis et al., 2020; Keles et al., 2020). More research, perhaps using AI models of online emotional experiences, is needed to better understand how social media use may contribute to the loneliness epidemic, and how more authentic online engagement could create meaningful, positive social connection (e.g., IER upregulation). Utilizing AI models to understand how people use and are impacted by social media will allow researchers to advise the public on guidelines for healthy social media use in order to foster social connection and curb negative effects of loneliness.

While we focus here on the loneliness epidemic, these approaches can be extended to other public health concerns. For example, as with loneliness, automated detection of depression, suicidality, anxiety, or moral outrage from speech or online posts could help identify individuals that pose a risk to themselves or others (Babu & Kanaga, 2022; Carpenter et al., 2021; Deshpande & Rao, 2017; Surana et al., 2024) and offer appropriate AI-mediated responses or links to mental health resources. Advances in technology such as smart watches or similar wearable devices could also support the development of improved stress management tools that monitor physiological signals and assess the

efficacy of personalized stress reduction techniques (Jesmin et al., 2020; Mentis et al., 2023). Furthermore, creating new tools for identifying threats to affective well-being from online task-based measures could improve detection and intervention across diverse communities. For example, our valence bias task could be used to remotely assess implicit emotion appraisal problems that may be masked in self-reports. Working toward this type of improved detection and access to treatment for a broad range of mental health symptoms, assisted by AI technology and modern conceptualizations of affective dynamics, will lead to a better quality of life for affected individuals and a reduced burden on health care systems.

In conclusion, the articles in the Special Issue provide a useful map for venturing into the future of the affective science of loneliness. Many promising avenues emerge that highlight the importance of an interdisciplinary perspective that builds on modern approaches to affective theory, such as assessing interpersonal emotion regulation, and technological advancements, including real-world assessments of emotions and AI-driven interventions. Here, we bring together these important themes to demonstrate how they can be leveraged to address the growing public health concern of loneliness, as well as offering suggestions on how they may be extended to other domains. Recognizing the power of connection among individuals as social beings and among researchers with shared goals, affective science can continue advancing our understanding of emotions and providing tangible benefits to society at large.

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