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This article discusses sociotechnical challenges of technology-based interventions to address loneliness in later life. We bring together participatory and multidisciplinary research conducted in Canada and Australia to explore the limits of digital technologies to help tackle loneliness among frail older people (aged 65+). Drawing on three case studies, we focus on instances when technology-based interventions, such as communication apps, were limiting or failed, seeming to enhance rather than lessen loneliness. We also unpack instances where the technologies being considered did not match participants' social needs and expectations, preventing adoption, use, and the intended outcomes. To better grasp the negative unintended consequences of these technological interventions, we combine a relational sociological approach to loneliness with the *Strong Structuration Theory* developed by sociologist Rob Stones. This combined lens highlights the connection between sociotechnical factors and their agentic and structural contexts, facilitating a rich understanding of why and when technologies fail and limit.

Introduction

"Even after COVID-19 is controlled, loneliness will be the shadow pandemic that remains", forewarned journalist Melody Warnick (2020). During the pandemic, the media drew attention to loneliness as a result of lockdowns, physical distancing, and isolation policies enacted to stop the spread of the virus (Shahahan, 2020; Warnick, 2020). While this public awareness is important, loneliness is not a new or straightforward phenomenon. Loneliness among older people (aged 65+) has been a long-recognised issue in western countries, such as the UK, Canada, and Australia (Neves et al., 2019a). Yet, it is imperative to emphasize that later life does not equal loneliness – among the top factors that enhance older people's vulnerability to loneliness are living alone or in aged-care facilities while experiencing health conditions and circumstances that affect social

interaction (Gardiner et al., 2020; Smith et al., 2019). Prevalence of loneliness in later life varies between 12% to 30%, depending on the country and measurements employed (Neves et al., 2019a). A recent systematic review concludes that the estimated mean prevalence of loneliness in aged-care ranges from 35% to 61%, which is higher than in the community (Gardiner et al., 2020). Loneliness has serious effects, from the anguish that it causes to harmful health and social consequences in later life; for example, loneliness increases social exclusion and the risk of diseases that require long-term care such as dementia (Sutin et al., 2020).

Loneliness entails complex and subjective feelings of lacking companionship, of missing social connections and meaningful relationships (Perlman and Peplau, 1981; Neves et al., 2019a). Consequently, enhancing social connectedness – i.e., meaningful social interaction – is a well-documented method to alleviate and prevent loneliness (O'Rourke et al., 2018; Neves et al., 2019b; Townsend and McWhirter, 2005). Because of the potential of social technologies to afford opportunities for social connectedness, several digital-based interventions to tackle loneliness in later life emerged in the last years: from robots to communication apps (Khosravi et al., 2016; Poscia et al., 2018). We approach these interventions as sociotechnical systems because they are built on a nexus between social and technical features.

The outcomes of these sociotechnical systems to tackle loneliness in later life seem promising, but little is published on negative unintended consequences such as adverse limitations and failures. All sociotechnical systems have limits, from reduced sustained use among different groups to undesired results (Greenhalgh and Stones, 2010; Neves & Mead, 2020; Waycott et al., 2015; Waycott et al., 2016). This has been illustrated by research on the 'promises and pitfalls' of technologies for older people and on general negative consequences of digital health interventions (Coughlin, 2010; Lorenc & Oliver, 2014; McAuley, 2014). Still, the discussion of negative issues regarding technology-based interventions to address loneliness is scarce, even if those issues represent a minority of outcomes. Reporting and understanding negative outcomes would inform better interventions and deeper understandings of loneliness in later life.

Consequently, this article incorporates sociological theory to conceptualise this gap in the literature and then to analyse three case studies that illustrate failures and limitations of technology-based interventions. Within this conceptually-driven analysis of the case studies, we show examples of

technologies that seemed to exacerbate a sense of loneliness due to sociotechnical factors and other contextual dimensions affecting the feasibility of the interventions to facilitate social connectedness. The first case investigates a Canadian communication app to enhance social connectedness with existing ties. The second case focuses on an Australian photo-sharing app to make new connections. The final case takes a meta standpoint and explores the perspectives of older Australians on technological responses to loneliness. These cases involve older groups vulnerable to loneliness: 1) frail older people living in aged-care facilities, and 2) older people living independently (usually alone) in the community but requiring home-based care services. Although these technology-based interventions led to mostly positive outcomes, we explore their negative unintended consequences. We also show that even when based on participatory design (i.e., involving 'end-users'), co-designed interventions are not exempt from negative outcomes. These cases offer diverse sociological insights to advance our understanding of unintended consequences and to refine initiatives to address loneliness.

In the next sections, we articulate the conceptual and applied intersections between a sociological approach to loneliness and technology-based interventions. We combine a relational sociological perspective of loneliness with the Strong Structuration Theory (SST) to tease out the sociotechnical dimensions shaping unintended consequences of technological interventions.

Context

Understanding loneliness sociologically

Reviews of technology-based interventions to address loneliness note that a theoretical basis is often lacking, affecting the quality of interventions (Khosravi et al., 2016; Poscia et al., 2018). Herein we present a sociological conceptualisation of loneliness that can guide interventions and help understand why technologies can fail or limit positive outcomes. Loneliness is frequently defined as a subjective experience of lacking quality relationships and companionship (Neves et al., 2019a). Psychological definitions (and typologies, e.g., Weiss, 1973) abound and are widely used by researchers, policy-makers, and practitioners (Campaign to End Loneliness, 2020). The common definition of loneliness draws on a "discrepancy between one's desired and achieved levels of social relations" (Perlman and Peplau, 1981, p. 32). Although often conflated, loneliness

is different from social isolation: social isolation relates to low/non-existent social support and participation as well as decreased quantity and quality of social relationships (Cloutier-Fisher et al., 2011). Loneliness and social isolation can intersect, but one can feel lonely and not be socially isolated and vice versa (Smith et al., 2019).

While loneliness is mostly approached as an individual feeling, it is shaped – regardless of the definition – by social dimensions. In fact, all definitions focus on a shared dimension: social relationships. An emergent psychological movement frames loneliness within an epidemic of mental health issues or 'behavioural epidemics' (Jeste et al., 2020). This pathologizing can place loneliness as an individual problem that must be managed with individuality, by training people to be more individually positive and resilient (Campaign to End Loneliness, 2020). Despite the social nature of loneliness, the 'social' is overlooked or brushed aside as a minor dimension that the individual has power to fully change or counter-act.

We approach loneliness sociologically, as both personal and social. The *personal* relates to emotional feelings and its consequences, and the *social* to social structures, networks, contexts, and practices that not only produce and mould the experience of loneliness but also its perception and expression. Arlie Hochschild (1979) demonstrates the links between emotions and social structures through 'emotion work' and 'feeling rules' – emotion work pertains to efforts to change or manage an emotion or feeling to respond to social situations and practices; feeling rules relate to social scripts and norms about feelings (e.g., 'what I should feel') and their display (Hochschild, 1979, p. 565). Loneliness should be understood from a dynamic interaction between human agency (e.g., one's conscious emotion work, actions, and choices) and social structures (e.g., norms, social institutions, etc.). Drawing on a relational sociological perspective that positions loneliness within the broader social milieu, we bridge the personal and the social by considering how one's loneliness shapes and is shaped by social dimensions, such as living settings, sociocultural norms and practices, socioeconomic status, and contextual elements.

This relational perspective looks at the networks of relationships and interactions between agents (Crossley, 2010), overcoming the traditional agency/structure dichotomy and allowing us to situate multiple agentic and structural contexts within the personal and the social dimensions of

loneliness. For example, in our research with frail older people living in care homes (Neves et al., 2019a), we found that loneliness was perceived as relational (connected to family loss and lack of meaningful relationships) and linked to an ageing process that participants associated with dependency, ageism, and institutionalisation. But loneliness was also defined as an individual sickness and one's fault or choice, situating it as a construct of personal agency. Additionally, the expression of loneliness was constrained by their living settings and by how staff, family, and other residents dismissed it, suggesting a structural constraint or rejection.

By employing a relational lens towards loneliness, we can highlight those personal and social dimensions, their agentic and structural relationships, and point to their intersections with sociotechnical systems such as technology-based interventions. Our approach to both loneliness and technology is relational – these phenomena operate in relation to the social, to the interaction between different agents, to the affordances that are inscribed in and emerge from the relationships between people, technologies, and contexts. We, thus, also apply a sociological approach to technology-based initiatives to tackle loneliness. We turn to this in the next section.

Understanding technology-based interventions sociologically

In the last decade, several technology-based interventions to address loneliness in later life emerged based on the potential of new information and communication technologies to create opportunities for *social connectedness* (Masi et al., 2011; Poscia et al., 2018). Social connectedness – meaningful social interaction – is a foundational element of most technology-based interventions targeting loneliness (O'Rourke et al., 2018) and of our three case studies. Technology-based interventions to address loneliness have included general Internet use, apps, social media, virtual reality, robotic companions, and digital literacy training (Khosravi et al., 2016; Poscia et al., 2018; Stojanovic et al., 2017; Yu et al., 2021). Research shows that these interventions can alleviate loneliness in later life – however, their efficacy could be improved by technology that matches the diverse needs, capabilities, and circumstances of older people (Poscia et al., 2018). This demonstrates the need for a theoretical framework that conceptualises loneliness across personal and social elements and provides insights into its agentic and structural contexts,

as noted in the prior section. We argue that the same is required to fully understand the outcomes of technological interventions.

Furthermore, we lack evidence on the long-term impact and sustainability of such interventions (Cattan et al., 2005; Poscia et al., 2018). While an intervention may experience successful outcomes initially, these may be difficult to sustain over time. We need more longitudinal and varied methods to study those aspects. Until recently, randomized controlled trials were the gold standard for evaluating interventions. However, because of their limitations (e.g., ecological validity or ability to deal with complex interventions, Marchal et al., 2013), we see a new call for high-quality qualitative and mixed methods research to enable a comprehensive grasp of in-situ and 'out-of-the-lab' contexts (Poscia et al., 2018). These new directions are promising to help tease out when and why technologies have unintended consequences.

As noted by Robert K. Merton (1936), purposive social actions – from policy to interventions – can have both intended and unintended consequences. Not all unintended consequences are negative, since they also refer to positive outcomes that were not intended or anticipated by purposive social action. Merton (1936) distinguishes between unexpected benefits, drawbacks, and perverse results. The first relates to positive consequences or outcomes of a given purposive action, the second to adverse limitations or damages occurring alongside the expected positive outcomes, and the third to outcomes or effects that are contrary to the intended results (Merton, 1936). The so-called 'positive-results bias' has led to few accounts of negative results and of drawbacks or perverse effects (Mlinarić et al., 2017). This underreporting is problematic, providing an erroneous state-of-the-art, discarding scientific knowledge, and having ethical implications (Ekmekci, 2017; Mlinarić et al., 2017; Neves & Baecker, 2020). Therefore, we must encourage publication of negative findings and unexpected results (Mlinarić et al., 2017; Waycott et al., 2016). This article responds to this call by exploring negative unintended consequences, drawbacks and perverse effects, limitations and failures, misalignments between the aims of three initiatives that we conducted to address loneliness and their outcomes.

To guide the analysis of our case studies, we combined a relational sociological approach to loneliness and technology with a Strong Structuration Theory (SST). A relational approach provides the analytical framework to consider the personal and social dimensions of loneliness and

responses to it; the SST allows us to analyse sociotechnical interventions by mapping agentic and structural elements, their interrelation, and the corresponding outcomes of such interventions.

SST, as developed by Rob Stones (2005), refines Anthony Giddens' structuration theory (1984) by grounding the "duality of structure" (i.e., the relationship between agency and structure) in specific contexts and agents. For Giddens, one ascertains the relationship between agency (e.g., one's actions and choices) and structure (e.g., norms, social institutions, etc.) by conceptualizing structures as an internalization of what people know and how they perceive the world (1984). Criticisms levelled at the theory stress that structures are external to people, and that structures are simultaneously the medium and the result of social practice (Greenhalgh and Stones, 2010). To overcome these criticisms, SST draws on a quadripartite model (Stones, 2005) including:

1. External structures (conditions of action and practice),
2. Internal structures (one's general worldview, knowledge, and capabilities),
3. Active agency (individual action and response),
4. Outcomes (intended/unintended impacts on structures – are outcomes replicating or amending the social structure that provided the circumstances for one's practice?).

This model integrates personal and social elements, but also a technological dimension, which was later incorporated by Greenhalgh and Stones (2010) into SST's internal structures. This acknowledges "the material properties of technology within interaction" and "inscribed socio-cultural structures" (Greenhalgh and Stones, 2010, p. 1290). SST provides a comprehensive theorization of the relationships between humans and technology, without underplaying the technical or the social dimensions. The SST model includes "actants" – that is, human agents/actors and forms of technology/artefacts – but recognizes that human and non-human agents act differently. Actants are placed into internal structures, internalizing those structures through material properties and functional relations (Greenhalgh and Stones, 2010).

SST offers a rich framework to study unintended outcomes of technology-based interventions to tackle loneliness by shedding light on the agentic and structural dimensions that shape and are shaped by sociotechnical systems. This approach also resonates with our conceptualisation of loneliness from a relational standpoint, as personal and social – to which we include a

technological dimension inscribed with the aim of facilitating social connectedness. We employed these joint lenses to analyse three case studies on negative unintended consequences of interventions, as explored next.

Case Studies: When technology limits and fails

We illustrate Merton's 'drawbacks' and 'perverse effects' (1936) by presenting limitations and failures from three studies on technology-based initiatives to address loneliness in later life. These initiatives, conducted by the first and second author, were not designed as simple 'solutions' to loneliness, rather as opportunities to complement other necessary strategies. Avoiding 'solutionism' also meant focusing on the *feasibility* of technology within particular contexts of action. The first intervention trialled a communication app in Canadian aged care homes, aiming to enhance social connectedness between older people and their families and friends (Neves et al., 2015; Neves et al., 2018; Neves et al., 2019b). The second intervention tested a photo-sharing app to develop new social networks with older Australians living independently but requiring home-based care services (Waycott et al., 2012; Waycott et al., 2013; Waycott et al., 2014). These studies were conducted independently of each other. Drawing on these studies' conclusions, the third case explored responses to loneliness interventions by frail older people living in Australian care homes (Neves et al., 2019a). While general findings from these three studies have been reported separately in the literature, we now focus on negative unintended consequences, which have not been discussed or properly developed in prior publications. We re-examined the three cases for the purpose of this paper and used SST's quadripartite model (internal and external structures, active agency, and outcomes) and our relational approach to loneliness (as personal and social) to guide the analysis of drawbacks and perverse effects. Combining these cases allowed us to map similarities and differences across technologies and contexts. All studies were approved by our Universities' ethics committees, and we ensured procedural and ethics-in-practice, combining written with continuous verbal consent. Pseudonyms are used throughout.

Case 1: An accessible communication app to enhance social connectedness

This project evaluated an accessible tablet-based communication app (Baecker et al., 2014), which was co-designed with frail older adults living in aged-care facilities and desiring more social connection with family and friends due to experiences of loneliness (2014-2019). The app allowed for asynchronous multimedia communication: users could send and receive text, video, audio, and picture messages (see Figure 1). The text messages were pre-set since our participants had motor impairments, such as hand tremors affecting their capacity to type. The app's interface comprised large non-textual touch icons, affording swiping and tapping, and accommodating users with visual impairments.



Figure 1. App with wave (pre-defined text), audio, picture and video messaging options.

To evaluate the app's feasibility to enhance social connectedness among existing ties, we deployed it in two Canadian care homes (2015-2016). The first study was conducted in a long-term care facility for two months with 'oldest old' people (aged 80+); the sample included 5 older Chinese Canadians and 5 study partners (relative or friend). The second in a retirement home with 12 residents (aged 65+) with diverse cultural backgrounds and their study partners for three months (total n=23). The research drew on a long-term mixed methods design with three stages: pre-, mid-,

and post-deployment. Methods included semi-structured interviews, psychometric scales, usability and accessibility tests, field observations, and log analysis. In this article, we explore the qualitative data, namely semi-structured interviews and field observations analysed with thematic analysis. Thematic analysis was used to identify codes and themes within and across cases; we employed a mixed (inductive and deductive) approach, identifying themes from the data (e.g., unintended outcomes) but also considering a priori categories, such as technology-related codes regarding feasibility, usability, etc. (Guest et al., 2012).

While general findings showed that the app was a feasible tool to enhance social connectedness, matching the study's goals (Neves et al., 2019b; Neves & Baecker, 2020), we found unintended consequences in both research locales. Some were positive (e.g., increased subjective well-being and self-efficacy with technology), but others were not. We then grouped these negative findings into drawbacks and perverse effects. Three themes, emerging from the conceptually-driven analysis, capture drawbacks: 1) increased awareness of health conditions, 2) family tensions, and 3) enhanced consciousness of institutional and restrictive contexts. These drawbacks intertwine with agentic and structural dimensions that can shape experiences and expressions of loneliness as well as the outcomes of interventions.

Firstly, while the app was accessible and co-designed with frail people, the intervention made at least three participants more visibly conscious of their poor health. They reported how "inadequate" and "limited" they felt. For Ike (aged 74), the technology made his "Parkinson's battles" more noticeable, from eyesight problems to "losing cognitive abilities" when he forgot about some app's "features". The technology emphasized his health status and a compromised sense of personhood and identity: "I was not like this before", he told us. This affected personhood also interacts with loneliness, connecting ageing with meanings of loneliness. In this way, using SST's model, the technology emphasises internal structures through capabilities and a reduced sense of agency.

Secondly, for some participants, the intervention strained their social context due to various sociotechnical elements. Six participants verbalized that the technology created family tensions – and while these were minor, for some it represented a reminder of dissimilar generations and values. For example, we found different intergenerational norms and expectations regarding

communication: our older people preferred asynchronous communication, to send audio messages, and to receive text messages, but family preferred synchronous communication and video and photo messages. Participants were "disappointed" with relatives that instead of replying to their messages via the app called them on the telephone. Sometimes this lack of engagement was due to a preference for alternative media, such as the telephone; other times, relatives did not know how to use email. These sociotechnical dimensions (e.g., uptake of the app, technological expectations) and their agentic and structural contexts can affect the feasibility of interventions.

Thirdly, the intervention made five participants more aware of their institutionalized settings. They reported feeling more observant of their lack of privacy when using the app in shared units or in communal spaces. They also mentioned that the care home did not afford "nice" pictures or videos to share via the app. For instance, David (84), in the first locale, did not record many videos because "things around my bed are always the same". This contrasted with his wishes to send more videos to his family in China. Likewise, Lily (83), in the second locale, explained: "the surroundings aren't very conducive to video". These external structures can also influence loneliness and the success of responses to it. Together, these three drawbacks represent the limitations and damages that can happen simultaneously to positive outcomes of an intervention (Merton, 1936).

Regarding 'perverse effects', we found an enhanced awareness of loneliness for two participants, which demonstrates how interventions can fail, having outcomes opposite to intended results (Merton, 1936). In the first care home, Chris (88), had one son, a wife living apart, and the remaining family in China. He was the least frequent user in this facility: he used the app twice every two weeks. While he sent messages to family through the app, the replies were minimal and ceased as the study progressed. Chris' usage sharply declined in the last weeks of the study. In the first month of the study, Chris thought the app was useful for keeping in touch with family. In the post-deployment interview, he mentioned not needing the app since "just waiting for my own funeral. My birthday has just passed, just a few days ago". When we interviewed Chris' son, he explained that the telephone worked better for them and that his mother did not use email. Our team monitored Chris closely to prevent or alleviate any negative issues with the study, including asking if he wanted to withdraw or add new contacts to which he declined. As the study evolved, staff indicated that Chris had very limited contact with his family, despite the son's reports of

frequent telephone and face-to-face contact. These narrative asymmetries of family contact and of technological usefulness can also lead to or result from contexts of loneliness.

In the second care home, we found similar insights with Jen, a former librarian in her 80s who was single and had no children. She described fraught family relationships because of her religiosity: "I think one of the main reasons is because…they are not believers, and I am…Families can really bug you." Jen had a nephew and friends from her church that she was in contact with. However, the nephew infrequently replied to her messages via the app; the parishioners were uninterested in communicating digitally. While we were monitoring her emotional state with staff help, Jen confided that she was a "loner now…that's life now". As with Chris, if existing social structures are not encouraging of social connectedness, technology-based interventions to enhance it can fail and have opposite outcomes.

The SST lens shows how external structures (e.g., restrictive and institutionalized settings, intergenerational differences in technology use that can lead to family tensions) interact with internal structures (health conditions affecting capabilities, affordances of the technology) and active agency (communication choices and responses) to influence intended and unintended outcomes (Greenhalgh and Stones, 2010). In turn, these outcomes interplay with the relationality of loneliness, illuminating its network of personal and social dimensions.

Case 2: A photo-sharing app to build new social networks

This project (2012-2015) aimed to understand how social technologies could help alleviate older people's social isolation (Waycott et al., 2012; Waycott et al., 2013; Waycott et al., 2014). The project initially targeted social isolation, but as it progressed it became apparent that we needed to address people's loneliness. This illustrates some experiential interconnectedness of social isolation with loneliness, but also their distinction. Those who were isolated but not lonely tended to be uninterested in the project, while those who felt lonely were more open to using technology to connect with others.

We focused on older adults living independently who were clients of an aged-care organisation providing home-based services. The organisation's care managers identified clients who they

believed were lonely or desired greater social contact, and we enrolled those interested in the study. Sixteen older adults (aged 67 to 93) took part in one or more field studies lasting from three to twelve months. Each field study involved trialling a photo- and message-sharing app to communicate with others taking part in the project. We interviewed participants at the start and end of each field study, and met with participants at face-to-face social events, held monthly to give them the opportunity to meet each other in person, to learn more about the technology, and to provide feedback about the project. We conducted inductive thematic analysis, using an iterative process to identify key findings in relation to research questions on the benefits for older adults of photo sharing for social connectedness and the role of staff in supporting the intervention.

The social networking tool used was a purpose-built iPad app to create and send photographs and messages (See Figure 2). Using the inbuilt camera and onscreen keyboard, participants could use the app to take and share: 1) photographs, 2) photographs with captions, or 3) messages. Once created, these objects were sent to a server used to populate the app's display. Once connected on the app, participants could see each other's photographs and messages floating down the screen in a cascading motion. Objects appeared in a semi-random fashion and, unlike typical social media apps, would appear in the same order for all users, so that each would see the same version of the display at the same time. Participants could interact with the display using the touch-screen interface (e.g., by moving or changing an object), and these interactions were visible to others viewing the display at that time.



Figure 2. iPad photo-sharing app

A key element of this project was facilitating *new social connections*, rather than communication with existing ties such as family. Participants used the app to communicate with each other but did not know each other prior to the project. The first three-month field study found that the photo-sharing app offered a creative way for participants to share personal interests and build new social connections. The subsequent field studies, which ran for six months and twelve months, revealed that while photo-sharing continued to provide new opportunities for social connectedness, there were challenges involved in creating social cohesion among older adults who did not previously know each other. To unpack these challenges, we focus on drawbacks based on the sociotechnical limitations of the intervention and on perverse effects regarding social connectedness outcomes.

Drawbacks encompassed three main themes: 1) lack of common interests, 2) invisibility of social responsiveness/engagement, and 3) impacts of incompatible personalities and related social dynamics. Linked to the first two drawbacks are also perverse effects, namely limitations of the intervention in addressing loneliness and, for some participants, increasing awareness of their loneliness. Common to these themes are sociotechnical elements shaped by the agentic and structural dimensions defined in the SST's model, as explored next.

The first and second drawbacks are discussed below in reference to post-trial interviews conducted after the second field study; the third relates to an encounter during an in-person social gathering at the start of the third study, captured in the fieldnotes.

Lack of common interests

Finding common interests is important for building social connections. During the post-trial interviews, participants were asked what sort of content they enjoyed and did not enjoy on the app. Some participants said they enjoyed seeing whatever others chose to share, while others were less positive and talked about their disinterest in other people's lives. As Louisa (in her 90s) noted, "It's pretty hard to get a group of people to have the same interests, isn't it?"

Harry and Ron expressed disappointment with other people's contributions. For Ron (aged 80), the app's display contained "a lot of rubbish", including photographs of television, which he saw as "a waste of time". He also found it challenging to share information with strangers: "It would have worked better if we all knew each other. You've got to put a face to a name, otherwise you're talking to a brick wall."

Harry (aged 94) felt there was nobody in the group who shared his interests ("I haven't struck anybody on this that'd show the slightest whip of interest in mechanical things"), and was uninterested in viewing photographs of other people's domestic spaces:

> A lot of the participants in this group are elderly, like me, but a lot of them are not as mobile as I am, so the pictures you'd get are pictures of where they are, pictures of the furniture, the lounge room, the fireplace, and that's all. And that doesn't interest me very much at all (…) I mean you get a picture of Louisa's garden, which is all very pretty, and I think Jill's got a couple of garden pictures in it, yes they're all very nice, but they don't interest me very much. [...] I notice that Ron is keen on fish, he has fish tanks, and he has a fishpond I think, and that sort of thing would interest some people, but it doesn't interest me. I mean it's an interesting picture, what he photographed, but it won't evoke a response from me.

Using SST's model, we can see that these social contexts as external structures intertwine with internal structures (personal interests and affordances of the technology) and active agency (choices/responses), shaping interventions' drawbacks or limitations. While Harry and Ron felt

there weren't like-minded people in the group, they actually shared similarities, including an interest in building and woodwork. This highlights one of the limitations in creating new social connections through lightweight photo- and message-sharing: common interests may exist but remain difficult to find. Furthermore, as absence of shared interests become more perceptible to some participants, we are unintendedly emphasising lack of social connectedness and, thus, loneliness.

Invisibility of social responsiveness/engagement

Many photographs and messages sent to the display did not attract any response from participants. This limited the app's feasibility for building social connections: "The idea was to try and get old people to get together and sort of converse with each other. Well, as far as I'm concerned that hasn't happened" (Harry).

Harry and Ron shared messages trying to incite a response, illustrating the difficulties encountered in gaining a sense of social connection through the app:

> Would somebody please respond to this? It gets very lonely just looking at this screen and seeing nothing new day after day. Let's make this Uni project a success for the sake of the team who set it up. They have gone to a lot of trouble to alleviate the isolation which is the lot of most of us Oldies and it looks as though it is not working as they expected. Having said all that I sincerely hope that this new year proves to be a good one for everybody. (Harry)

> Is there anybody out there. I feel like I'm talking to myself. Please help me by answering me. I hate talking to myself. (Ron)

Insufficient responses also meant that participants had no way of knowing whether the content they created had reached an audience, taking away some of the enjoyment from creating and sharing content: "Very few people responded to my thoughts of the day. There was nobody. There was no reply, or no acknowledgement that they were appreciated." (Louisa)

This identified a need for the app's users to be more visible, especially since most participants regularly checked for new content and seemed to enjoy viewing other people's contributions. A

lack of response did not necessarily mean a lack of appreciation for the content others had created, suggesting a sociotechnical need to legitimise viewing/reading and make it more visible to others. One of the modifications made to the app before the next field study was to add a 'heart' icon so that people could show appreciation for a photograph or message, similar to the standard 'like' button on social media. This adjustment, however, was unlikely to address the need shown by Harry and Ron for more communication and connection. The lack of response to their messages may have exacerbated, rather than alleviated, their sense of loneliness, representing a perverse effect or outcome of this intervention.

Impacts of incompatible personalities and related social dynamics

At the beginning of the third field study, we held a social gathering for a new group of clients interested in joining the project. Three clients attended, along with two informal carers (a spouse and a neighbour), a care assistant, and one of the organisation's care managers. One of the clients had a 'dominating personality' that contrasted with the quieter nature of the other attendees. The difficulties encountered at this event raised concerns about creating connections between people who have little in common, apart from being in a similar age group. The reflections below are drawn from field notes recorded after the event by the second author and focus on the behaviour and impact of David, the client with the dominating personality.

David attended the event with his wife, who was his carer. In his 70s, David had a mobility impairment and health issues causing chronic pain. Throughout the event, David presented himself in a way that made others feel uncomfortable. He was very loud and took over when we were doing the roundtable introductions; it was difficult to keep him on track and he gave far more detail than appropriate. He fully described his ailments and talked about the impact previous jobs had had on his health. He described a work history that seemed fanciful. Later, David's care manager (who did not attend the event) said that much of what David says about his life is unlikely to be true. David also spoke about his family, saying that he was estranged from his children, who he described in an unflattering light, referring to their drug addictions and incarceration.

At the end of the event, one of the clients in attendance noted she was not interested in the project. Another client initially said he would take part in the project but did not want to be connected to David. Similarly, the care manager who attended (not responsible for David's care), initially said

she would be happy to be connected to all clients on the app, but then asked to be disconnected from David.

Attendees' responses to David raised an ethical issue. The app was designed to be used by small groups of people in closed social networks; clients who attended the event were told that if they chose to participate they would use the app to communicate with other clients from the organisation. It would be unethical, however, to connect participants to people they did not want to communicate with. And how would we explain to David that other participants did not want to be connected to him? According to David's care manager, his behaviour was a recurrent problem. She said she had hesitated about nominating him for the project but thought it would not be right to pick the 'easy' clients. Ultimately, David was unable to participate because of health problems. Nevertheless, this example illustrates personal and social drawbacks involved in deploying a social intervention.

Taken together, these themes further highlight the role of SST's elements and their interconnections: structures (internal and external) and active agency shape each other and the outcomes of interventions. The themes identified – shared interests, type of social responsiveness afforded by sociotechnical factors, and the impacts of different personalities and social dynamics – not only link to the relationality of loneliness (i.e., personal and social dimensions) but influence the successful design and implementation of technology-based interventions focused on social connectedness.

Case 3: Older people's perspectives on technology-based interventions

This project studied experiences and prevalence of loneliness in later life (2017-2019), including a six-month qualitative study in two aged-care facilities in Victoria, Australia. The qualitative component explored lived experiences and responses to loneliness, combining participant observation of daily life in the care homes (n= 177 residents) with 22 interviews with frail residents experiencing or at risk of prolonged loneliness. Data were analysed with thematic analysis, as in Case 1. Interviewees included sixteen women and six men from diverse cultural backgrounds, ages ranging from 65 to 95.

We use this case study to tease out potential limitations and failures of interventions (drawbacks and perverse effects) through how a sample of frail older people living in aged-care facilities manages their loneliness and their perspectives on interventions. We rely on interview data and field notes. By linking their strategies – and how those are received in their contexts – with their viewpoints on interventions, we show the multidimensionality of loneliness and its agentic and structural facets.

While interviewees felt "weakened" by loneliness, leading to inaction and lethargy, most had pre-defined responses or management strategies in place. These strategies were social and individual, and the perceived success of its outcomes depended on various factors. The individual strategies encompassed activities to distract oneself, such as arts and crafts, watching TV, reading, praying, going for a walk. As noted by Artie (aged 91), you can't "sit there like a pound of grapes...you gotta occupy your mind". Although these individual strategies were used to distract from one's loneliness, interviewees reported that they were narrow in their long-term impact and some days more successful than others due factors such as the weather or their health. These strategies were also influenced by the social environment of the care home, i.e., if they received visitors, if other residents received visitors, social events, etc.

The social strategies involved efforts to facilitate social connectedness, with residents, staff, and family/visitors beyond 'small talk'. This included approaching others and enrolling in internal social activities for conversational opportunities. Bill (aged 94) explained: "you get in there. Speak to different people you know". These strategies seemed more fruitful for participants than individual strategies, but their success was also context-dependent. For example, interviewees mentioned that it was hard to converse with other residents, since many had dementia or did not speak English. In both settings, we observed low interaction between residents, including during social activities. Kid (aged 74) told us that frequently: "I'll start a conversation in my head!". Most interviewees were in contact with relatives, yet felt that the level of contact was insufficient. Not wanting to impose on their families and acknowledging that they had "their own lives" was a common response.

Critical to these strategies were additional efforts by participants. Their social needs were self-regulated so as: i) not to burden others, ii) to cope with the stigma of admitting to others that they

were lonely, and iii) to handle an environment that did not seem fully conducive to social connectedness despite its social nature, as well as reactions that dismissed their emotions. We observed how family and staff would re-direct conversations to more 'positive' topics such as the garden or friends at the care home, every time a resident would verbally convey loneliness. As emphasized by Gurney (aged 90), "no one wants to hear about it…really, no one". We can see here how their strategies combine personal and social approaches, while being dynamically shaped by agentic and structural contexts.

When asked about interventions, interviewees were unanimous on the detrimental consequences of the one-size-fits-all approach; it assumes 'we are all the same' and 'all want the same things'. As clarified by Isabelle (aged 92): "Everybody's different, I mean what would satisfy some people would be purgatory for another… No, I think the only way, is that you'd have to have a couple of choices, let people pick what they think would fill their requirements." To facilitate a many-sizes-fits-many approach, interviewees offered recommendations that would need to acknowledge two important elements: first, destigmatize loneliness, making it "OK to talk about it" (Elsie, 86) and not more stigmatizing; second, ensure that interventions don't heighten an already compromised sense of personhood and lack of independence. Ella (85) noted that she "never anticipated ending up in a place like this" – she doesn't need "constant reminders" that she is dependent. It is, thus, crucial that technology-based interventions challenge structural 'rejections' of loneliness that relate to stigma, whilst not exacerbating a reduced sense of agency for participants, as also shown in Case 1.

Three overarching themes encapsulate their recommendations to curb the limitations and failures of loneliness interventions: 1) Understand interests and backgrounds to identify interventions, 2) Provide a list of options for people to choose from and experiment with, 3) Ensure activities entail active involvement and afford opportunities for meaningful interaction within and across generations. The first two themes are based on the need for personalizing and matching needs and interests, as emphasized by Charlie (aged 86): "Give it individual attention". These also match the findings described in Case 2. The final theme links to social connectedness. Interviewees suggested activities that would require active participation (and "not just watching") from online and offline reading groups to high tea with discussion of topics and multimedia storytelling sessions. Participation could be further encouraged by adding a playful component, such as games.

Activities that could provide a sense of leaving the facility were also proposed. A core element of the activities would be intergenerational involvement – for example, including grandchildren with the help of technology. As explained by Shoodo (aged 85), "with loneliness, you can't do it alone".

These recommendations demonstrate the importance of considering the relationality of loneliness and SST's agentic and structural dimensions to fully approach interventions capable of attaining their intended goals while reducing unintended consequences. The three cases complement our understanding of multiple facets of loneliness and of when and why interventions can limit and fail.

Discussion and Conclusion

While technology-based interventions are becoming a popular way to enhance social connectedness and help address loneliness, we still lack accounts of their failures and limits. We show a range of negative unintended consequences of interventions, such as increasing awareness of loneliness rather than its alleviation. Digital technologies can facilitate social connectedness and lessen loneliness in later life (Khosravi et al., 2016; Poscia et al., 2018; Stojanovic et al., 2017) if several factors are considered, from contexts to ties. If there is no meaningful interaction with social ties or if they do not respond to interaction, technologies can be limiting and have undesired effects. Loneliness and interventions do not operate in isolation. The interventions presented in this article occurred in different contexts (aged-care homes and community), with different technologies, and had diverse goals, namely enhancing social connectedness among existing ties or forming new ones. The examples of drawbacks and perverse results provide rich insights into the complex contexts of loneliness in later life – the three cases display similarities but also differences because of those contexts.

To understand unintended consequences of interventions, we argued that a sociological approach considering agency and structure is critical. The *Strong Structuration Theory* (SST) helped explore those dimensions in a relational and situational perspective. We applied SST's quadripartite model

(external structures, internal structures, active agency, and outcomes) to analyse our case studies. The combined findings are discussed here in relation to each category.

External structures included social contexts and related practical and symbolic circumstances, such as the institutional and restrictive settings of aged-care facilities (Case 1 and 3) that frame experiences, perceptions, and expressions of loneliness and technology-based responses to it. Our research shows that existing levels of social interaction, stigma, ageism, social trust, and sense of privacy can shape the success of interventions. The influence of social contexts was also evident in Case 2, which focused on community-dwelling older people. The responsiveness of the audience (and quality of that response) to the photo-sharing app moulded the ability to establish new relationships and highlighted diverse interests and social dynamics. For instance, a number of pictures shared were of domestic environments (because of mobility issues of some participants) or of motifs that did not interest other participants. This meant that many pictures did not elicit a response, which in turn reduced the opportunities to form meaningful relationships. A similar challenge was identified in Case 1: the type of messages sent through the app was constrained by participants' living settings, curbing quantity of picture and video messages sent, which were the preferred type for family and friends. This contextual disconnection is intensified by different intergenerational norms or narrative asymmetries between social actors (e.g., family vs. participant) – in fact, one of the current limitations of most technology-based interventions is a focus on the direct end-user, rather than on all involved social actors, including family and staff. As participants in Case 3 reported the need for intergenerational initiatives to tackle loneliness, we must ensure the active involvement of different social actors and identify procedures to bridge contrasting practices and expectations.

Regarding internal structures, participants' capabilities and interests, health status, digital literacy, and the app were important dimensions shaping the nexus of personal, social, and technological milieus. We observed the links between internal structures and the interventions' outcomes – for instance, the technology's affordances emphasizing internal structures (e.g., particular capacities) while also heightening a reduced sense of agency. The critique advanced by Case 3 participants on the 'one-size-fits-all' of technology-based interventions to tackle loneliness and their recommendation draws primarily on these internal structures, which also impact agentic dynamics.

Considering active agency, this dimension included personal coping or management strategies of older people experiencing loneliness, their communication approaches, and how they used and adopted technology to meet their social needs. These agentic dimensions are vital in our understanding of loneliness and on interventions' limits or failures, but regularly underexplored due to preconceptions about the autonomy of frail older people (Neves et al., 2019a).

The combination of these structural and agentic dimensions – and their co-constitution, as they seem to intimately shape each other – leads us to SST's final dimension: outcomes. Although our technology-based projects had mainly positive outcomes, intersecting them were negative unintended consequences, from increased awareness of loneliness and health issues to family and social tensions. These consequences represented failures and limitations, entailing scripts and praxis that require reflection. Despite our critical approach to the topic and social group, an 'imagined user/community' still proliferates in our approaches and in participants' narratives. Both apps were developed with and for older people through co-design processes, but we are still dealing with aspirational ideas of what might work based on internalized scripts of 'old age', social connection, technological models, and loneliness. This coupled with an inadvertent tendency to sometimes idealize participants (and scripted assumptions about later life) originates an unintentional homogenization of experiences and even personalities (see also Cook, 2018).

The reported unintended outcomes are the result of multifaceted socio-material assemblages and add to them. By recognizing negative outcomes, we provide a more truthful and ethical picture of interventions but also of loneliness in later life – loneliness and responses to it are situated within an interacting multitude of structures and agencies. Greenhalgh and Rob Stones (2010) ask us to consider if this SST 'outcomes' dimension is replicating or amending the social structure that offers the circumstances for one's practice. Our combined research shows that it is doing both: on the one hand, reinforces social structures (e.g., nature of living settings, social stigma of loneliness), on the other, it adjusts them to personal actions (e.g., coping mechanisms, perceptions).

These socio-material assemblages also highlight the value of a relational sociological approach to loneliness – loneliness emerges and is expressed within a network of personal and social dimensions that constantly interact. Individualistic approaches to loneliness are not only limited to

grasp its complex meanings and experiences but can limit the success of interventions to tackle it. Individualism is highly valued in the societies where our case studies come from, despite all cases including culturally and linguistically diverse participants. Thus, this western ideology frames societal understandings of loneliness and how we respond to it. If the social stigma of loneliness is not addressed or if individual contexts continue to be considered in a vacuum, failing interventions are likely to occur.

Failure is an essential element of social life and should be a central topic of sociological inquiry (Malpas and Wickham, 1995). Failures of sociotechnical systems are an impactful area that could gain from sociological perspectives; likewise, a comprehensive approach to loneliness requires sociological lenses that can bridge personal and social dimensions. The SST lens, for example, provides dimensions to explain failures but also to map the relationality of loneliness and interventions, overcoming individualistic notions of these social phenomena (common in some psychological approaches). While the field is dominated by psychology and computer science, we advance theoretical, empirical, and applied contributions demonstrating the relevance of sociological research in these areas. This research is critical to inform in-depth understandings and responses to loneliness, particularly in the context of a growing reliance on digital technology and its promises, as seen during the COVID-19 pandemic.

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