UNDERSTANDING THE ROLE OF EMBODIMENT ACROSS COMMUNICATION TECHNOLOGIES IN FACILITATING SOCIAL CONNECTIVITY AND ADDRESSING LONELINESS

By

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(Under the Direction of Jenay M. Beer)

ABSTRACT

***Background:*** In the United States, one in five adults report feeling lonely (Thayer & Anderson, 2018). The experience of loneliness across the lifespan can have severe implications on health and wellbeing. Though our society has become more aware of the challenges and impact of loneliness on the lives of individuals across the lifespan, little support is available to help combat this public health epidemic. Communication technologies have been identified as having the potential to facilitate opportunities for social interaction and serve as tools to enhance access to social connectivity. Particularly technologies which can provide the users with the ability to feel more present through embodiment. Leveraging communication technologies as tools to facilitate social connectivity presents an opportunity for the expansion of resources and intervention development for adults across the lifespan. ***Methods:*** This dissertation implemented three methodologies: (1) systematic review (2) quantitative, and (3) qualitative. The systematic review summarizes the existing literature surrounding the use and implementation of communication technologies to facilitate social connectivity and address the experience across the lifespan. The quantitative study aims implemented bivariate and multivariate analysis (multivariate regression

and logistic regression) to analyze the characteristics contributing to the experience of loneliness across the lifespan. The qualitative study was made up of thirty interviews which aimed to understand the characteristics associated with meaningful social connections and the influence of embodiment level in forming meaningful social connections. ***Results:*** Communication technologies present opportunities in helping bridge the resources gap to facilitate social connections when in person communication is not possible. Leveraging communication technologies across various levels of embodiment present opportunities towards enhancing the sense of connection which can be achieved through technology. ***Discussion:*** Leveraging communication technology presents a range of opportunities in facilitating social connectivity and combating the loneliness epidemic. Research findings indicate that embodiment may be an important factor in facilitating meaningful social connections through technology mediated communication. The lifespan approach of these studies presents new insights surround the potential of technology interventions across each phase of adulthood. Furthermore, this work provides new insights for social work involvement in the areas of gerontology, communication technology, telepresence and embodiment research.

INDEX WORDS: Gerontechnology, Telepresence, Embodiment, Loneliness, Social Connectivity, Lifespan, Older adults

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DEDICATION

To my parents Alexandru and Daniela

&

my sister Alexandra

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I am grateful to my IoG family who provided me with a place I could always call Home.

TABLE OF CONTENTS

Page

CHAPTER 1

# INTRODUCTION

In the United States, two in five adults report feeling lonely (Thayer & Anderson, 2018a). The experience of loneliness across the lifespan can be attributed to various factors and can have severe implications across adulthood. These implications include medical conditions, disabilities, health behaviors, and social connections. The experience of loneliness is often prolonged, as four in ten lonely adults report having felt lonely for more than six years (Qualter et al., 2015). This lengthened experience of loneliness can result in ramifications such as declining physical wellbeing, poor mental health, and the experience of chronic loneliness. Furthermore, the ramifications of loneliness can become exacerbated during an adult's transition through various stages of adulthood.

Before conceptualizing loneliness across the lifespan in more depth, it is important to define phases of adulthood. Erikson's Psychological Stages of Development underline three key stages of adulthood, which include the following: early adulthood, middle adulthood, and late adulthood (Hoare, 2002; Slater, 2003). Early adulthood is characterized by concerns pertaining to intimacy versus isolation. As individuals develop a sense of self through adolescence, they begin to form meaningful social relationships with their peers and share their life with them. However, if unequipped and unable to develop a strong sense of self, individuals may feel lonely or feel emotionally isolated (Hoare, 2002; Malone et al., 2016; Slater, 2003). During middle adulthood, which generally occurs between the time individuals reach their 30's or early 40's through mid 60's, individuals typically seek the social task of generativity versus stagnation.

During this phase, individuals try to find their life's work and contribute to the purpose of serving or helping others; such as volunteering, mentoring, or raising children. Those that do not achieve a sense of purpose through generativity may have fewer connections with others, low interest in self-improvement, and decreased productivity. Later adulthood, which is typically the period of time between mid-60's to end of life, is the period of time which Erikson describes as being characterized by integrity versus despair (Hoare, 2002; Sekhri & Sekhri, 2017). During this phase of adulthood, individuals reflect on their life accomplishments and feel either a sense of accomplishment or a sense of missed opportunity or failure. Erikson's theoretical approach to understanding loneliness within the context of human development helps explain most comprehensibly the implications of loneliness. Furthermore, this theoretical approach is widely cited and utilized to help understand the various transitions an individual may experience across adulthood (Aanstoos, 2019; Hannush, 2006; Rosenthal et al., 2010; Vejar, 2019)

Though our society has become more aware of the challenges and impact of loneliness on the lives of individuals across the lifespan, little support is available to help combat this great public health epidemic. Communities often lack the resources (e.g., support groups, programs, non-profit organization, public transportation) to fulfill the various needs of individuals and provide the support required to sustain healthy aging. The wide array of concerns and social injustices related to the well-being, integration, and social participation of adults presents a significant risk for them as they transition into older adulthood (De Jong Gierveld & Van Tilburg, 1999). Inability to fulfill or achieve the various milestones or key characteristics which enable individuals to transition into the various phases of adulthood can have tremendous impact on how they experience loneliness and its consequences in their day to day life. When trying to understand loneliness, taking into consideration the various phases of development may reveal

how an individual experiences loneliness and the intensity of the phenomenon. Therefore, taking a lifespan approach to conceptualizing and understanding loneliness as a phenomenon can further inform how transitions throughout life are impacted by it. For example, an adult who is not able to form meaningful relationships early on in life may face more difficulties in developing a sense of accomplishment and fulfillment. Therefore, strategies and interventions aimed to address and support individuals across each developmental stage should aim to identify various factors influencing the experience of loneliness.

## Conceptualizing Loneliness through Theoretical Frameworks

Although loneliness has been the topic of narratives, poetry, and philosophical writing throughout human history, this area of research experienced a rapid expansion in the social sciences during the 1970s and has shed light on the implications of loneliness on the health and livelihood of adults throughout the aging process (Cacioppo & Cacioppo, 2018; Hawkley & Cacioppo, 2010a; Hawkley & Kocherginsky, 2018). With an increasingly aged society, the prevalence of isolated and lonely older adults presents a great concern for communities that often lack the necessary resources (e.g., support groups, programs, non-profit organization, financial assistance, public transportation) to support healthy aging. In addition to a lack of resources, the experience of loneliness may amplify the challenges that often accompany longevity across the physical, psychological, and social dimensions of aging. Challenges such as loss of intimate relationships, changing social roles, age-related declines in health, and lack of personal resources further contribute to how the experience of loneliness impacts older adults' wellbeing and the ability to maintain ones health across the lifespan (Cacioppo & Hawkley, 2009; Hawkley & Cacioppo, 2010b; Lykes & Kemmelmeier, 2014; Thurston & Kubzansky, 2009).

Loneliness as a phenomenon has been conceptualized and explained from the perspective of numerous theoretical frameworks. Perlman and Peplau (1982) compiled the first comprehensive sourcebook of loneliness, listing the following theoretical approaches to understanding loneliness: Cognitive (Peplau & Perlman, 1982), Existential (Moustakas, 1961), Interactionist (Weiss, 1973), Phenomenological (Perlman & Peplau, 1982), Privacy (Derlega & Margulis, 1982), Psychodynamic (Fromm-Reichmann, 1959), Sociological (Riesman, 1961), and Systems (Flanders, 1982). Empirical research conducted over the past few decades have narrowed the field to three prevailing theoretical approaches: Social Needs (Psychodynamic), Behavioral, and Cognitive (Balouch et al., 2019; Cacioppo & Cacioppo, 2018, 2018; Hawkley & Cacioppo, 2010b; Hawkley & Kocherginsky, 2018).

**Theoretical Approaches: Definitions**

The three most common theoretical perspectives used to describe loneliness are the Social Needs (Psychodynamic), Behavioral, and Cognitive approaches. These key theoretical frameworks helped shape various definitions of how loneliness is conceptualized and understood. The Social Needs approach defines loneliness as an unpleasant experience which is tied to an inadequate discharge of the need for human relationships (Sullivan, 1953). Furthermore, loneliness is not necessarily caused by being alone but by experiencing a lack of meaningful relationships. Weiss notes that loneliness is also a response "to the absence or provision of meaningful friendship, collegial relations, or other linkage to a coherent community" (Weiss, 1973; p. 17).

The Behavioral theoretical approach links its definition of loneliness to personality traits and social skill as the contributing characteristics of negative or lack of interpersonal interactions. The experience of loneliness is characterized by individuals' unique personality

characteristics and behaviors (Bartels et al., 2008; Boomsma et al., 2005). According to a longitudinal study conducted by (Mund & Neyer, 2016), loneliness has been linked to neuroticism, extraversion, and conscientiousness scores as individuals transition across various phases of adulthood. However, individuals who display personality characteristics and behaviors favored by society show significant decreases in loneliness (Marangoni & Ickes, 1989). Similarly, cross-sectional studies indicate that loneliness has a strong, positive correlation with neuroticism and is negatively correlated with extraversion (Flett et al., 2016; Saklofske et al., 1986; Schermer & Martin, 2019).

The Cognitive theoretical approach, proposed by Perlman & Peplau (1982), defines loneliness as "the unpleasant experience that occurs when a person's network of social relations is deficient in some important way, either quantitatively or qualitatively" (p.31). Loneliness is characterized as the relational difference between an individual's desired and actual form of social relationships. Therefore, an individual who may not seem lonely objectively, may in fact experience feelings of loneliness if their social contact is below that of their desired level (De Jong-Gierveld & Kamphuls, 1985). This definition was expanded by De Jong Gierveld (1989), who noted the following: "Loneliness is a situation experienced by the individuals as one where there is an unpleasant or inadmissible lack of certain relationships. This includes situations in which the number of existing relations is smaller than is considered desirable or admissible, as well as situations where the intimacy one wishes to have, has not been realized. Thus, loneliness is seen to involve the manner in which the person perceives, experiences, and evaluates his or her isolation and lack of communication with others" (p. 74). This definition expanded the Cognitive approach understanding of loneliness from a unidimensional phenomenon to a multidimensional one. However understand the full implications of loneliness as a phenomenon requires a careful

consideration of the epistemologies and assumptions of the three key loneliness theoretical frameworks.

## Theoretical Perspective: Assumptions and Epistemology

***Social Needs Approach*.** The assumptions and epistemology of the Social Needs approach is imbedded in the Psychodynamic theory (Peplau & Perlman, 1982), focusing primarily on the affective aspects of loneliness (p. 124). The psychodynamic perspective prompted the first distinction between loneliness and being lonesome, first drawn by (Zilboorg, 1938). He noted that being lonesome was a normal state of mind while loneliness is a persistent experience, regardless of personal efforts to overcome it. This sense of loneliness is traced by the early psychologists to the crib (Zilboorg, 1938). Sulivan (1953), a key contributor to the conception of the Social Needs approach, supported Zilboorg's perspective, noting that loneliness in later adulthood is rooted in the individual's childhood. He expands on this idea by noting that this creates a driving energy for intimacy. The earliest of such bonds are created between the child and parents. However, if these bonds are unsatisfied due to improper social connections formed between parent and child, they can affect children as they enter preadolescence. During this period, children who lack the social skills necessary to form significant social bonds with other children often lack the ability to meet the need for intimacy which can result in loneliness and manifest later on in life (Sullivan, 1953).

Inspired by the work conducted by Sullivan (1953), Frieda Fromm-Reichmann (1959) helped shift the psychodynamic approach by noting a lack of understanding in the field regarding loneliness as a phenomenon (Berblinger, 1968; Reichmann, 1959). Her work was among the first to recognize loneliness as a pathological state. Similar to Sulivan (1953), Frieda- Fromm-Reichmann (1967) attributed loneliness to early childhood experiences. Linking separation from

parents, lack of physical contact, and lack of loving intimacy as the main contributors to a sense of isolation. These feelings manifest during adulthood as fear of love and intimacy, resulting in feelings of loneliness. The early writings of Sullivan (1953) and Fromm-Reichmann (1967) created a theoretical forerunner for the Social Needs approach, a key theoretical approach in theorizing and conceptualizing loneliness (Marangoni & Ickes, 1989; Sullivan, 1953).

Bowlby's (1969) attachment theory is another theoretical framework that contributed to the exploration of adult attachment and adult loneliness. Bowlby and later attachment theorists, such as Hazan and Shaver (1987), helped propose the links between early childhood relationship formation and development of intimate relationships during late adulthood (Bowlby, 1969; Hazan & Shaver, 1987). Similar to the patterns observed in infant-caretaker attachment, patterns such as security, avoidance, or anxiousness-ambivalence can be observed with adults in romantic relationships (Cavaiola et al., 2015). Although attachment patterns tend to be stable, they are qualitatively different, thus impacting adults' experience of loneliness (Weiss, 1973). For instance, an avoidant type may deny feeling lonely as a protection mechanism. Therefore, the absence of meaningful social relations and feelings of loneliness may persist over extended periods of time.

The works of Sulivan (1953), Frieda Fromm-Reichmann (1959), and Bowlby (1959) paved the way towards a more empirical approach to loneliness research. However, Weiss (1973), was undoubtedly the most influential in stimulating the boom of empirical research in the 1970's and development of the Social Needs approach. Weiss attributed loneliness to six Social Needs: attachment, social integration, nurturance, reassurance of worth, sense of reliable alliance, and guidance in stressful situations (Weiss, 1973). He proposed a classification, which unlike those before him, took a multidimensional approach to understanding loneliness,

including emotional and social loneliness. Emotional loneliness can be described as feelings of anxiety and absence of intimate attachment. Social loneliness, characterized by boredom and aimlessness, stems from the absence of a meaningful network of social relationships or group membership with individuals that share common interests. Weiss noted that different types of social relationships help serve, satisfy, and address the different needs of an individual's social support system. Therefore, various life events, situations, and remedial behaviors aimed to alleviate loneliness, can be linked to specific types of loneliness. For example, the death of a partner or the loss of important relationships are associated with emotional loneliness. In contrast, social loneliness is characterized by individuals being somewhere unfamiliar and in turn serves as a force which motivates individuals to form a social network (Weiss, 1973), while emotional loneliness is characterized by inner feelings that affect the individual at a psychological level.

An individual's social network and the perceived satisfaction with it plays an integral part in their feeling of loneliness. The relationship between social networks and loneliness was first established and scaled through the research developed by Russell et al. (1980). Disruptions in one's social network is considered to be a factor in the creation of feelings related to loneliness. For example, events such as relocation, retirement, divorce, and the empty nest syndrome have been identified as factors which can help distinguish the lonely from non-lonely (Russell et al., 1980). The development of the widely adapted UCLA Loneliness Scale helped indicate that there was a close relationship between loneliness scores and the number of close friends one reported having (Russell et al., 1980).

***Behavioral Approach.*** The Behavioral theoretical approach to understanding loneliness focuses on understanding the behavioral challenges and implications of social skills in forming

meaningful relationships. Research in this area indicates that there are key differences in the behavioral characteristics of lonely and non-lonely individuals. For instance, although lonely older adults are able to form some type of social relationship, they often experience challenges in meeting and introducing themselves to others and lack the ability to form meaningful relationships (Wittenberg & Reis, 1986). Furthermore, in more intimate relationships, lonely individuals often lack the skills recognized as requirements for the formation of meaningful relationships. In the self-disclosure literature, a lack of intimate relationships or meaningful relationships are key contributors to feelings of loneliness (Wheeler et al., 1983). Lonely individuals are less likely to report having a close relationship with a best friend and are less likely to self-disclose to a partner.

Across genders, there are differences in one's perception of loneliness from a Behavioral theoretical approach. For males, social network density has been positively correlated to one's feeling of loneliness. However, for females, feelings of loneliness are generally positively correlated to a lack of perceived ability to self-disclose to peers. Across both genders, individuals that report being lonely tend to engage in different patterns of self-disclosure than those that report not feeling lonely. These behavioral observations do not only have implications for those that report feeling lonely but also for their interaction partners (Williams & Solano, 1983). Partners and friends of lonely subjects often report that they are not interested in developing future friendships. Research in this area attributes these behaviors to a number of personal behavioral characteristics of lonely individuals. For example, lonely individuals are more likely to be more self-focused, ask questions less frequently, talk less, engage less, lack focus on conversations, and often lack the ability to recall what their conversation partner said (Bell, 1985). Research conducted by Jones, Hobbs, & Hockenbury (1982) indicates that training in

conversational involvement and attention skills have had a significant impact on reducing loneliness (Jones et al., 1982).

The Behavioral theoretical approach also accounts for the personality variables which help contribute to an individual's interpersonal behavioral style. Loneliness literature indicates that personality traits such as shyness, self-consciousness, depression, negative self-concepts, inhibited sociability, and unassertiveness are closely correlated to feelings of loneliness (Qualter & Munn, 2002). In contrast, loneliness has been negatively correlated with individuals who report high self-esteem, exhibit social risk taking, and extraversions (Anderson, 1983; Stokes, 1985). A key aspect of personality traits is that they are inversely correlated to individuals' self-perceptions of their own social skills (Wittenberg & Reis, 1986). Therefore, loneliness is related to a multitude of interpersonal behaviors but not related to specific skills. Most recent research points to the notion that behavior and personality traits of lonely individuals can be both the cause and consequence of their feelings of loneliness. This has been documented as a mechanism through which loneliness manifests and persists over long periods of time, leading to problematic social relationships, and further social isolation.

***Cognitive Approach***. The Cognitive theoretical approach emerged during the 1980's from the research conducted by Peplau and Perlman (1982). The Cognitive approach does not deny the Behavioral and affective component of the Social Needs approach, or the behavioral elements proposed through the Behavioral approach. The focus from this theoretical approach, however, has been on the cognitive processes of perception and evaluating social networks to explain the difference between the actual and desired social relationships (Heinrich & Gullone, 2006; Peplau & Perlman, 1982). The approach puts forth the idea that loneliness is characterized

by distinct differences in perception and ascriptions. For instance, an individual can be alone and not feel alone while another may be surrounded by many people and feel lonely.

The key aspect of the Cognitive approach is its emphasis on cognition as the mediating factor between deficits in sociability and the experience of loneliness. Drawing on attribution theory, Peplau notes that the experience of loneliness can influence the intensity of the experience along with the perceived likelihood that it will persist over time (1982). The Cognitive approach focuses on these subjective perceptions and standards; claiming loneliness, therefore, is affected not only by the person's actual and desired social relationships but also the standard which they use for what they want to have. Hence, loneliness is not determined by the outsider looking in, but rather it is the individual, the insider who determines and evaluates her or his social life. For example, two older adults may have similar social relationships and engage in similar activities however one may feel lonely while the other does not. Loneliness as a construct from the Cognitive approach can be heightened or reduced based on an individual's standards for the relationships they want to have (Marangoni & Ickes, 1989). For example, if an individual has thus far been satisfied with the social relationships they have had throughout their life, but their standards increase, they in turn may start feeling lonely.

An important aspect to consider in one's evaluation of their social relationships is that the standards and judgements one makes regarding their standard of social relationships is not always necessarily explicit or articulated. The two most common ways in which an individual may derive the standard they have for the social relationships are based on past experiences and social comparison. Past experiences help individuals develop ideas and pictures of the type of interactions and relationships one must have in order to achieve satisfaction and happiness. As one develops these ideals, they begin to compare their current circumstances against what their

ideals have become. Evidence of this can be observed in studies conducted by Lowenthal, Thurnjer & Chiriboga (1975) and Townsend (1957) where older adults reported that the concept of "the former self" is a key reference point for evaluating their current experiences (Lowenthal et al., 1976; Townsend, 1955).

Social comparison can have an important influence on the way one self-evaluates. Individuals often assess their interpersonal relations by comparing themselves to those around them. Townsend (1957) noted that older adults can experience multiple types of social isolations based on different types of comparisons which can include other people their own age, younger people, and earlier generations of older adults (Townsend, 1957). The standards one has for their social relationships often shift over time. Some of the factors which may contribute to these changes can be age-related, psychotherapy, and adaptability. Individuals whose social life is going well may expect high level of satisfaction while individuals who are lonely might shrink their standard appraisal of their social situation.

A key Cognitive characteristic associated with individuals who report feeling lonely is low self-esteem. This feature has been linked to higher rates of loneliness amongst children, adolescents, and adults (Galanaki, 2016; Heinrich & Gullone, 2006; Kirova, 2004; McWhirter, 1997; Nurmi et al., 1997; Rubin & Mills, 1988). Longitudinal data support that low self-esteem has been closely tied to feelings of loneliness and also indicates that there is a reciprocal relationship between the two constructs (Bukowski et al., 1999; Peplau & Perlman, 1982). Since social relationships play an important role in the development of an individual's self-conceptions, a lack of satisfactory social relationships can result in lower self-esteem. This, in turn, helps sustain a vicious cycle where poor self-esteem and loneliness reinforce one another (Peplau, Miceli et al 1982). These implications can result in feelings such as inferiority,

worthlessness, unattractiveness, unlovability, and social incompetency (Anderson, 1983; Peplau & Perlman, 1982). Furthermore, research indicates that lonely individuals are more likely to have a greater discrepancy than non-lonely individuals in regards to their actual and ideal self (Kupersmidt et al., 1999).

Loneliness can also be a contributing factor for selective retention of social information and more negative self-conception (Gardner et al., 2000). Research indicates that individuals who report feeling lonely have a heightened degree of self-focus and self-consciousness ((Jones et al., 1981, 1985). Weiss (1973) attributes these factors to the inclination to exaggerate or misinterpret others' intent. Furthermore, lonely individuals are more sensitive to rejection (Curtona, 1982), hold negative views about themselves, and view other people unfavorably (Ernst & Cacioppo, 1999; Peplau & Perlman, 1982). Lonely individuals are more likely to perceive others as less trustworthy, less supportive, less communicatively competent, less attractive, and less socially desirable (Jones, 1981; Jones, Sansone, & Helm, 1983). The self-reported perception of oneself is also impacted by loneliness, as lonely individuals often indicate feeling powerlessness to change their circumstances. Moreover, lonely individuals are also more likely to attribute their interpersonal failures to personal characteristics such as fear of rejection, shyness, and personal traits, rather than more circumstantial characteristics that can be changed or altered (Koening & Abrams, 1999; Renshaw & Brown, 1993). However, they do not attribute interpersonal successes to personal characteristics but rather to luck or external factors (Solano, 1987). Attrition styles employed by individuals who report feeling lonely are often detrimental, associated with pessimism, lower expectation of success, and diminished motivation (Peplau, Miceli et al., 1982).

The Cognitive theoretical perspective presents three key conceptualizing aspects of loneliness as a phenomenon. First, loneliness is associated with emptiness, abandonment, or the absence of feeling attachment. Second, the time component refers to how individuals report feeling about the lonely situation they are in: do they report feeling hopeless or that they are able to change the situation that they are in? The third component to understanding loneliness from a Cognitive theoretical perspective involves different emotional aspects experienced by a lonely individual, feelings such as shame, guilt, sorrow, frustration, and desperation (Shute & Howitt, 1990). Applying these conceptualizations can give insight into the multitude of factors which may contribute to the experience of loneliness across the lifespan.

## Strengths, Limitations, and a Life Course Perspective

The three theoretical approaches present strengths and limitations in their ability to conceptualize loneliness, both generally and in their application towards understanding the experience of loneliness across the lifespan. Key strengths shared by each of the theories–Social Needs approach, Behavioral approach, and Cognitive approach– can be summarized by three areas of agreement. First, loneliness is a result of deficiencies in a person's social relationships. Secondly, the experience of loneliness is subjective, and not the same as social isolation. Thirdly, the experience of loneliness is unpleasant and creates distress. These agreements form an important foundation in understanding loneliness as a phenomenon. Along with these strengths, all of these approaches have a common weakness due to the subjective nature of loneliness and the limitations often encountered when studying a psychological variable. Loneliness as a phenomenon cannot be recreated in a laboratory setting, and therefore the primary sources of data collection has been predominately facilitated through interviews and questionnaires.

The Social Needs approach links individuals' experience to breakdowns of Social Needs that generally happened during childhood, linking back to the child and parent relationship. A key strength of this theory is that it has been supported through empirical research. For example, Hojat and colleagues conducted a series of studies which have indicated that there are correlations between parent-child attachment and higher levels of loneliness, anxiety, low-self-esteem, depression, and feelings of control over one's own life (Hojat, 1998; Hojat et al., 1990; Hojat & Crandall, 1989). More recent studies conducted by Besser & Priel, (2005) and Wiseman, Mayseless, & Sharabany, (2006) indicated that there is a significant correlation between levels of attachment and reports of depression and loneliness (Besser & Priel, 2005; Wiseman et al., 2007).

The social network developed by an adult through their lifetime presents a unique insight into how one may be connected to those around them, as attachments formed over a lifetime contribute to one's ability to form meaningful relationships. For example, Hazan and Shaver's (1987) observation that there are qualitative differences in adults' experience of loneliness helps shed light on how older adults' experience of loneliness is tied to certain behaviors and personality traits. Furthermore, loneliness in older adulthood is closely tied to a lack of friendships or romantic relationship, which are key developmental milestone in early and middle adulthood. The Social Needs approach has a particularly important strength, shared by the Cognitive approach, in its multidimensional description of loneliness which can help explain loneliness as a social and emotional experience. Understanding loneliness as a multidimensional phenomenon helps recognize not only the importance of social connectivity but also how an individual experiences being socially connected. For example, although older adults may be able to engage with the community they live in, they may not be able to engage with individuals of an

interrelated group who share similar interests or activities which may still place them at a risk of feeling lonely. The literature indicates that an overall decrease in engagement in social activities is reported by older adults as a source of loneliness (Qualter et al., 2015).

Although there is a body of literature which has investigated the parent-child attachment and its correlation to feelings of loneliness, it does not necessarily help explain other sources or other forms of loneliness (Hojat, 1998; Hojat et al., 1990). For example, research conducted by Rubenstein and Shaver (1982) indicates that the onset of loneliness can be attributed to moving to a new place or changes in relationships such as breaking up with a partner. Individuals who report feeling lonely often report feelings such as sadness, boredom, self-pity, and longing to be around someone special. Baumeister and colleague's research indicated that changes in the perception of social relations can have an impact of individuals' Cognitive skills (Baumeister et al., 2005). Therefore, the definition of loneliness within the Social Needs approach, which attributes loneliness primarily to a lack of intimacy, is limiting as the phenomenon encompasses such a wider range of factors that are more thoroughly explained through the Cognitive theoretical approach.

Similar to the Social Needs approach, the Cognitive approach looks at loneliness as a Cognitive reaction to changes in social relationships. Peplau and Perlman (1982), state that loneliness should be understood as the discrepancy between the desired and actual relationships one has. However, taking a unidimensional approach to understanding the phenomenon is limiting. Weiss's (1972) proposition from a Social Needs approach, looking at loneliness as a multidimensional phenomenon, helps account for different types of loneliness and gives a better understanding of the experience of loneliness. Having a unidimensional approach limits the ability to account the values, norms, and standard in a person's life and society in which they

live. De Jong Gierveld (1987, 1989, 1998) expanded the Cognitive theoretical approach's definition to describe loneliness as a multidimensional phenomenon. Thus, loneliness encompasses the manner in which the person perceives, experiences, and evaluates his or her isolation and lack of communication with others. This expansion to the understanding of loneliness and the needs one may have, as a multidimensional phenomenon, helped create a greater understanding of the experience of loneliness by older adults and its determinants (Gierveld, 1998; Perlman, 1988).

The behavioral theoretical approach focuses on understanding the behavioral challenges and implications of social skills in forming meaningful relationships and presents an important insight into the experience of loneliness of older adults. This approach helps create a systematic method to differentiate the social skills, behaviors, and personality traits of lonely and non-lonely individuals (Wheeler et al., 1983). Therefore, a key strength of this approach is being able to understand not only how one experiences loneliness, type of loneliness, and how loneliness is perceived but also the key individual factors which may contribute to experiences of loneliness. This is primarily important when studying older adults' experience of loneliness as behavioral and personal traits can help researchers develop interventions which can be customized based on the needs of the user. However, a key weakness of the Behavioral approach is that loneliness is not necessarily discussed as a multidimensional phenomenon. The multidimensional understanding provided by the Social Needs approach and Cognitive approach gives a better, more well-rounded, understanding of the experience of loneliness.

Although most loneliness research relies on individuals to disclose their feeling of loneliness, this is particularly important from a behavioral standpoint. Loneliness is a phenomenon that has often been connected to stigmatization. Thus individuals who experience

loneliness may not always report feeling lonely (Borys & Perlman, 1985; Peplau & Perlman, 1982). Research conducted by Solano, Batten, & Parish (1982) indicates that, overall, the self-disclosure patterns of lonely adults and non-lonely differ. This is particularly important, especially considering the experience of loneliness across the lifespan. Applying, the Behavioral approach helps give insight into behaviors and personality traits which may contribute to the experience of loneliness during older adulthood. Furthermore, components of the Behavioral approach have been adapted in the theoretical frameworks of both the Social Needs approach and Cognitive approach. Perhaps the greatest weakness of the Social Needs approach is that it focuses primarily on the internal factors of the individual's experience of loneliness, and does not consider outside factors such as culture, family structure, and social environment. This key weakness limits this approach's ability to understand loneliness.

The three theoretical approaches, which also happen to form the theoretical underpinnings of the loneliness literature, are limited in their ability to explain loneliness as a phenomenon. There is quite a bit of overlap across theories on how loneliness is explained. However, a more integrated approach to understanding loneliness and its subjective nature would be beneficial in the classification of type of loneliness, how, why, and when someone may be experiencing it. An integrated theoretical approach could help compile the factors which contribute to the experience of loneliness by older adults who are aging in place more comprehensively. Awareness about the negative effects of loneliness during older adulthood has motivated a push towards more empirical research in this area to understand its impact on quality of life and wellbeing. The chosen theoretical framework for the purposes of my research is Cognitive Theory. This theoretical approach provides the strongest explanation of loneliness as a

phenomenon and integrates most of the strengths offered by the Social Needs Approach and Behavioral Theory.

**Technology, Telepresence, Embodiment, and Implications for Social Connectedness**

Perlman (1982) and Gierveld (1989,1998) note that loneliness is closely tied to the deficiencies in one's network of social relations. In today's technologically advanced society, a persons' social relations are comprised of a network that exists both in-person and virtually. The virtual interactions, which individuals often experience, are facilitated by information communication technologies. Communication technologies are tools which help process communication information and aim to keep adults socially connected and engaged (Ledbetter, 2017; Liang & Walther, 2015). Access to these technologies has increased tremendously in the past 20 years due to increased access to internet connectivity. The percent of adults who report having access to the internet has increased from 47% in 2000 to roughly 90% in 2019 (Anderson et al., 2019). However, some of the key challenges that are often associated with limited or no access to internet resources include age, educational attainment, household income, and community type. The spectrum of communication technologies includes a host of communication platforms, comprised of both software (e.g., social media, telepresence technologies) and hardware (e.g., smart displays, virtual and augmented reality hardware, telepresence robots) which aim to support and encourage social connectedness. Social connectedness focusses on the quality of social interactions and helps address the challenges pertaining to loneliness and social isolation (Wong & Waite, 2016). Increased social connectedness has been linked to a reduction in stressors, which can have a positive effect on individuals' perceived quality of life, wellbeing, and overall health (Mollahosseini et al., 2018; Tanaka et al., 2015a; Wainer et al., 2006).

## Role of Embodiment and Implications for Social Connectedness

Leveraging communication technologies has the potential to support heightened levels of social connectedness (Barbosa Neves et al., 2019). Through various technology platforms, social contact can be achieved through text, voice, video, virtual spaces, and motion in remote physical environments. The type and level of perceived presence through a communication medium is often referred to as technology embodiment. Embodiment, is broadly understood across literature as the way in which an individual establishes contact while being in control of one's body (Ciocan, 2015; Haans & IJsselsteijn, 2012; Keshmiri et al., 2019; Luft, 2015; Streeck, 2015; Titchkosky, 2007). Embodiment has been explained and discussed in a variety of fields. Philosophers such as Heidegger (Ciocan, 2015) and Husserl (Husserl & Schuhmann, 1977) have described embodiment as being an active agent in the physical world, pointing to the lived body as the lived center of experience (Taipale, 2014). The Cartesian-Lockian model of embodiment has helped serve in pushing many of the breakthroughs in communication technologies (e.g., video, audio, limited locomotion) allowing for innovative ways to present representational knowledge  though surrogated communication facilitated through a technology medium (Luna Dolezal, 2009; Malpas, 2000).  However, breakthroughs in communication technologies, specifically in the ability to interact with a remote environment and alter it, result in a need to expand this approach to understand how embodiment impacts social connectivity.

Technology embodiment levels range from low embodiment to high embodiment, each facilitating a corresponding sense of social presence. For example, within the context of telepresence, video conferencing software (e.g., Skype) is a low-level embodiment technology, the user's sense of presence is limited to hearing and seeing the person(s) they are communicating with. Telepresence robots (e.g., Beam or Double robot), a high-level

embodiment communication technology, allows the user to not only see and hear the person(s) they are communicating with, but it also enhances the sense of presence through locomotion (e.g., mobility in a remote location), please see Figure 1.1. The increase in the level of embodiment allows the user to interact with a remote environment, closely resembling a face-to-face interaction. These systems often include synchronous two-way video and two-way audio, mobile bases, and a range of sensors to help the remote user navigate in the remote environment.

Given that technology can help create opportunities for social contact, how can it present an opportunity for the inception and enhance meaningful connections across the lifespan? Communication technology hold the potential to foster connectivity between adults, family members, friends, and the community. More specifically, telepresence technologies present an opportunity to create better social connections which may help reduce rates of loneliness and address social injustices (Mollahosseini et al., 2018; Tanaka et al., 2015a; Wainer et al., 2006). Telepresence is defined as the experience of presence in an environment by means of a communication medium (Dolezal, 2009; Kidd & Breazeal, 2004; Kose-Bagci et al., 2009; Steuer, 2000). These technologies help support social connections in remote environments by supporting a sense of embodiment.

Telepresence technology (e.g., video conferencing) and telepresence robots, from companies such as Zoom, Anybots, Revolve Robotics, and Toyota allow people to “be there” from remote locations. “Being there” refers to advanced human-centered interactions achieved through technology systems that help provide a remote user with the ability to feel and sense as if they would be present, close to what it would feel to be physically present (Riva et al., 2003). These types of technologies have been described as “embodied video conferencing” (Tsui et al.,

2014). Telepresence technology offers the sensation of being present at a remote location by simultaneously transferring audio and video in two or more locations.

For telepresence technology and telepresence robots to make an impact in our aging society, further research is needed to understand the design components of the technology that can best support meaningful social connections. Social connection is defined as the "subjective evaluation of the extent to which one has meaningful, close, and constructive relationships with others" (O'Rourke & Sidani, 2017). Telepresence technology and telepresence robots can be thought of as a technological representation of the user – in other words, the technology serves as a medium to represent, or embody, the user in a remote location. Technologies with a higher levels of embodiment, such as telepresence technologies and telepresence robots, present opportunities in not only facilitating social encounters but also supporting meaningful social connections for both senders and receivers of communication messages (Chen et al., 2013; Haans & IJsselsteijn, 2012; Mollahosseini et al., 2018; Richardson & Swan, 2019; Streeck, 2015).

Utilizing higher-level embodied communication technologies, such as telepresence robots can create a heightened sense of "being there" (Cesta et al., 2016; Takayama, 2015). The application of Social Presence Theory can help assist in explaining the role of embodiment in creating meaningful social connections. Social Presence theory explains the degree to which a person is perceived as a "real person" in a technology mediated communication format and the interpersonal emotional connection that is formed between them (Gunawardena, 1995). Social presence theory considers the intimacy and immediacy achieved through communication (Argyle & Dean, 1965; Cobb, 2009; Wiener & Mehrabian, 1968). Although the theory has been used primarily within the online learning literature, it has been used within the robotics literature as

well (Heerink et al., 2008; Schermerhorn et al., n.d.). Previous studies suggest that increased levels of physical presence are related to increased enjoyment, positive communication outcomes, and acceptance to physical embodied agents such as robots (Heerink et al., 2008; Lee et al., 2006). Therefore, utilizing technologies with heighten level of embodiment may hold the potential to create a stronger sense of presence than technologies with a lower level of embodiment. For example, an older adult whose family utilizes a telepresence robot may experience a heightened level of social connectedness, compared to what they may experience using a lower embodiment telepresence technology (e.g., video conferencing). Furthermore, Embodiment Cognition Theory claims that the phenomenon is bounded by characteristics of intelligence and the human mind (Varela et al., 1991). Developing embodied telepresence technology presents an opportunity towards improving social presence, social connectedness, and potentially reducing loneliness.


**Figure 1.1** Telepresence Technology Embodiment Level

Merging both social presence theory along with Embodiment Cognitive Theory (ECT) gives new insight into how enhanced social relationships created through embodied telepresence agents may contribute to the adults' experience of loneliness. Embodiment research indicates that the sense of "being there" facilitated through remote agents (e.g telepresence robots) may feel similar to physical presence (Luna Dolezal, 2009; Takayama, 2015; Tanaka et al., 2015b).

When embodiment is facilitated through communication, such as telepresence software and hardware, the actions of the body become technologically/virtually represented (Meloncon, 2013). Leveraging communication technologies as a tool with the potential to improve social contact and improve a sense of social connectedness, I pose the following question: How can communication technology present an opportunity for the inception of meaningful social connections among individuals? Utilizing communication technology presents opportunities for increased social connections between individuals, family members, friends, and the community at large; in turn reducing rates of loneliness and addressing social injustices (e.g., access to resources, social participation) (Mollahosseini et al., 2018; Tanaka, Nakanishi, & Ishiguro, 2015; Wainer, Feil-Seifer, Shell, & Mataric, 2006). However, the sense of presence and social connectedness achieved through communication technologies can be attributed to various levels of embodiment (Sakamoto et al., 2007; Takayama, 2015).

## Next Steps: What is needed?

Taking a lifespan approach may help enhance the understanding on the role of technology embodiment in facilitating meaningful social connections. However, current literature provides little insight into how access and use of communication technology across the lifespan may affect users' perception of social connectivity and feelings of loneliness. Research aimed to assess the feasibility of communication technologies to facilitate social connectivity can inform the development of strategies and interventions intended to reduce feelings of loneliness across adulthood.

Researchers need to consider that loneliness is a social justice issue which is closely related to one's economic status. Income plays an important role in the access to resources which may help address and reduce rates of loneliness. For instance, 50% percent of adults who earn

less than 25,000 dollars annually report feeling lonely, which is 19% higher than those earning 50,000 dollars or more. Furthermore, income can influence older adults' access to health resources and quality medical services (Crowther et al., 2010). This lack of crucial resources can escalate loneliness among older adults. Individuals who report poor health are 1.6 times more likely to experience loneliness (Thayer & Anderson, 2018b). Furthermore, minority groups are also at a higher risk of experiencing loneliness (Thayer & Anderson, 2018; Victor, Burholt, & Martin, 2012). Investigations into the application of communication technologies across various levels of embodiment need to include the challenges that may be encountered in their application to address loneliness. For example, the complex features of high embodiment technologies can be costly and necessitate a wider range of resources (e.g., broadband internet, fast download speeds, software updates) to function properly. Enhancing the understanding of the role of embodiment towards facilitating social connectivity can inform the development of strategies that aim to educate and advocate for access. Furthermore, development of cost-effective communication technology tools can contribute to the access of resources which can enable individuals to become more social connected.

Current research focusing on the perception of communication technology often aims to understand how individuals adopt and use them (Farrow & Iacovides, 2013; Kim et al., 2018; Kruzan & Won, 2019; Tschacher & Bergomi, 2011). However, research often does not investigate the role of embodiment in facilitating social connections and its influence on the quantity and quality of social relationships attained by users. Current synthetizations of the communication technology literature often do not take into account the role of embodiment in the development, adoption, and application of communication technologies. Very few human-computer interaction and human-robot interaction studies have looked at how various

communication technologies can be utilized to help address loneliness. Furthermore, little is known about how embodiment can contribute to facilitating and supporting meaningful social relationships across various phases of adulthood. However, there is a significant body of literature which has indicated generational differences across technology use (Campbell et al., 2015; Twenge, 2019; Twenge et al., 2019; Twenge & Spitzberg, 2020).

The current gaps pertaining to embodiment within the human-computer interaction, human-robot interaction, social connectivity, and loneliness literature include the following key areas: (1) role of embodiment in facilitating social connectivity at various phases of adulthood, (2) attitudes and perceptions of embodiment across various phases of adulthood, and (3) impact of perceived presence, across embodiment level, on adoption. Addressing these gaps can help inform the development of resources and interventions aimed to help support and maintain social connectivity across the lifespan and potentially address the experience of loneliness.

## Applying Mixed Methods

The goal of this research was to understand the potential of embodied telepresence technologies in facilitating social connectivity and its potential implications in addressing loneliness across various phases of adulthood. When choosing a methodological approach, I considered the multidimensionality of loneliness along with the complexity of experiences (e.g., changing life roles, loss of loved ones, relocation) encountered by adults throughout their lifespan. To enhance the understanding of how embodiment across various technological platforms affects one's sense of being present, I applied a mixed methods approach.

Mixed methods research allows researchers to combine elements of quantitative and qualitative approaches to understand the breadth and depth of the phenomenon being studied (Johnson et al., 2007). The researcher integrates the two approaches and draws interpretations

based on the strengths of both sets of data to hep understand the research problem (Cresswell et al., 2018) . Mixed methods provide advantages such as increased validity due to the triangulation of methods and a more holistic approach to studying the phenomenon of interest (Bronstein & Kovacs, n.d.; Watkins & Gioia, 2015). Combining the data from both qualitative and quantitative methods via a mixed methods approach enables the researcher to have a better understanding of the phenomenon and how the technological embodiment may contribute to the reported level of loneliness.

The development of a mixed methods research question requires the consideration of both the quantitative and qualitative portions of the study. Therefore, the development of research questions for the formative work must consider both the lifespan experience of loneliness along with the impact of embodiment on social connectedness. Furthermore, the design of mixed methods research should aim to maximize the use of both qualitative and quantitative phases of the study. Each portion of the mixed methods approach should have a specific goal that it aims to achieve and should therefore be reflected in the research question. Research questions can be written as method focused or content focused, but an ideal research question should be written to have both a content and method focus (Watkins & Gioia, 2015).

## Structure of Dissertation

The dissertation is divided into five core chapters. The first chapter, the Introduction, provides an overview of the general interests and focuses. Chapters 2, 3, and 4 provide a report of the three studies. Each of the studies include section specific to their content, the sections included in each of the studies include introduction and literature review, methodology (data collection, materials, and analysis plan), results, discussion, implication, and conclusion. Chapter

5 of the dissertation provides the overarching conclusion of the dissertation. References and appendixes are located at the end of each respective chapter. The goals of this research were:

1. Systematically review the current literature focused on the role of communication technologies across various level of embodiment in facilitating social connectivity and addressing loneliness
2. Understand the factors associated with the experience of loneliness and the technologies being utilized across various phases of adulthood, and
3. Understand the feasibility of facilitating meaningful social connectivity through telepresence technologies across various levels of embodiment across the lifespan.

Considering the rapid change in the population demographics ranging from young adults to older adults, taking a lifespan approach can help enhance the understanding of embodiments role in facilitating meaningful social connections. Furthermore, this research can help inform how usability challenges are encountered and interpreted across various age groups. The findings of the three studies can also help enhance researchers' ability to understand the age-related differences in how the users adopt and want to utilize the technology to support social connections. Moreover, this research can help inform consideration for the development and design of embodied communication technologies that aim to meet the various needs of individuals across the lifespan.

**Table 1.1** Mixed Methods Studies

| Study Number | Study Name |
|---|---|
| Study 1 | Understanding the role of Embodiment in Facilitating Social Connectivity to Address Loneliness Across the Lifespan: A Systematic Review |
| Study 2 | Understanding the Relationship Between Communication Technologies and Perceived Loneliness |
| Study 3 | Understanding the Role of Embodiment in Supporting Quality Social Connections |

The research objectives and questions developed for the formative work are listed below in Table 1.2. The goal of these questions is to help address the three key gaps in the current literature: 1. role of embodiment in facilitating social connectivity at various phases of adulthood, 2. attitudes and perceptions of embodiment across various phases of adulthood, and 3. impact of perceived presence on adoption, across embodiment levels. The proposed studies employed a convergent parallel design. In a convergent parallel design, the data are collected concurrently and analyzed separately. However, the data are merged during the interpretation of the results. The key benefits and strengths of this approach is that it creates a clear distinction between qualitative and quantitate data, effectiveness, and time saving. The qualitative and quantitative studies should address the same concepts to help compare the data in a meaningful way (Watkins & Gioia, 2015). Furthermore, the triangulation of these methods not only allows for insights through statistical analysis, but also a rich and thick description of the role that various forms of embodiment have in facilitating social connectivity.

**Table 1.2** Mixed Methods Objectives and Research Questions

| | |
|---|---|
| Systematic Review | • Understand the experience of loneliness across various phases of adulthood<br>• Understand the types of communication technologies adopted and implemented through interventions to assist adults to formulate social connectedness and address loneliness.<br>• Understand how one's sense of social connectedness may be impacted by the level of technology embodiment used. |
| Quantitative | • What are the individual and demographic characteristics contributing to the experience of loneliness across various phases of adulthood?<br>• What are the types of technologies individuals adopt across the lifespan in helping engage in communication?<br>• What are the types of technologies individuals across various phases of adulthood interested in adopting to help support maintenance of meaningful social connections? |
| Qualitative | • What are the key features of a meaningful relationships across phases of adulthood?<br>• How does the level of telepresence embodiment impact social connectedness across the lifespan? |

| | |
|---|---|
| | • What are the key distinctions between different levels of embodiment? |

# References

Aanstoos, C. M. (2019). Erik H. Erikson's ego psychology. In *Salem Press Encyclopedia of Health*. Salem Press. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ers&AN=93871919&site=eds-live

Anderson, C. A. (1983). Motivational and Performance Deficits in Interpersonal Settings: The Effect of Attributional Style. *Journal of Personality & Social Psychology*, *45*(5), 1136–1147. sih.

Argyle, M., & Dean, J. (1965). Eye-contact, distance and affiliation. *Sociometry*, *28*(3), 289–304. https://doi.org/10.2307/2786027

Balouch, S., Rifaat, E., Chen, H. L., & Tabet, N. (2019). Social networks and loneliness in people with Alzheimer's dementia. *International Journal of Geriatric Psychiatry*, *34*(5), 666–673. cin20. https://doi.org/10.1002/gps.5065

Barbosa Neves, B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019). Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study. *Journal of Applied Gerontology*, *38*(1), 49–72. cin20. https://doi.org/10.1177/0733464817741369

Bartels, M., Cacioppo, J. T., Hudziak, J. J., & Boomsma, D. I. (2008). Genetic and environmental contributions to stability in loneliness throughout childhood. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *147B*(3), 385–391. https://doi.org/10.1002/ajmg.b.30608

Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Twenge, J. M. (2005). Social exclusion impairs self-regulation. *Journal of Personality and Social Psychology*, *88*(4), 589–604. https://doi.org/10.1037/0022-3514.88.4.589

Bell, R. A. (1985). Conversational involvement and loneliness. *Communication Monographs*, *52*(3), 218–235. https://doi.org/10.1080/03637758509376107

Berblinger, K. W. (1968). A Psychiatrist Looks at Loneliness. *Psychosomatics*, *9*(2), 96–102. https://doi.org/10.1016/S0033-3182(68)71881-8

Besser, A., & Priel, B. (2005). The apple does not fall far from the tree: Attachment styles and personality vulnerabilities to depression in three generations of women. *Personality & Social Psychology Bulletin*, *31*(8), 1052–1073. https://doi.org/10.1177/0146167204274082

Boomsma, D., Willemsen, G., Dolan, C. V., Hawkley, L. C., & Cacioppo, J. T. (2005). Genetic and Environmental Contributions to Loneliness in Adults: The Netherlands Twin Register Study. *Behavior Genetics*, *35*(6), 745–752. https://doi.org/10.1007/s10519-005-6040-8

Borys, S., & Perlman, D. (1985). Gender Differences in Loneliness. *Personality and Social Psychology Bulletin*, *11*(1), 63–74. https://doi.org/10.1177/0146167285111006

Bowlby, J. (1969). *Attachment and Loss, Vol. 1: Attachment*. Basic Books.

Bronstein, L. R., & Kovacs, P. J. (n.d.). *Research Article Writing a Mixed Methods Report in Social Work Research*.

Bukowski, W. M., Sippola, L. K., & Hoza, B. (1999). Same and Other: Interdependency Between Participation in Same- and Other-Sex Friendships. *Journal of Youth and Adolescence*, *28*(4), 439–459. https://doi.org/10.1023/A:1021664923911

Cacioppo, J. T., & Cacioppo, S. (2018). Chapter Three - Loneliness in the Modern Age: An Evolutionary Theory of Loneliness (ETL). In J. M. Olson (Ed.), *Advances in Experimental Social Psychology* (Vol. 58, pp. 127–197). Academic Press. https://doi.org/10.1016/bs.aesp.2018.03.003

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences*, *13*(10), 447–454. https://doi.org/10.1016/j.tics.2009.06.005

Campbell, W. K., Campbell, S. M., Siedor, L. E., & Twenge, J. M. (2015). Generational Differences Are Real and Useful. *Industrial and Organizational Psychology*, *8*(3), 324–331. https://doi.org/10.1017/iop.2015.43

Cavaiola, A. A., Fulmer, B. A., & Stout, D. (2015). The Impact of Social Support and Attachment Style on Quality of Life and Readiness to Change in a Sample of Individuals Receiving Medication-Assisted Treatment for Opioid Dependence. *Substance Abuse*, *36*(2), 183–191. https://doi.org/10.1080/08897077.2015.1019662

Cesta, A., Cortellessa, G., Orlandini, A., & Tiberio, L. (2016). Long-Term Evaluation of a Telepresence Robot for the Elderly: Methodology and Ecological Case Study. *International Journal of Social Robotics*, *8*(3), 421–441. https://doi.org/10.1007/s12369-016-0337-z

Chen, Y.-S., Hsu, Y.-L., & Lu, J.-M. (2013). TRiC(mini)(+)—A Telepresence Robot for Interpersonal Communication for Older Adults. *JOURNAL OF THE CHINESE SOCIETY OF MECHANICAL ENGINEERS*, *34*(2), 121–127.

Ciocan, C. (2015). Heidegger's phenomenology of embodiment in the Zollikon Seminars. *Continental Philosophy Review*, *48*. https://doi.org/10.1007/s11007-015-9347-z

Cobb, S. C. (2009). Social Presence and Online Learning: A Current View from a Research Perspective. *Journal of Interactive Online Learning*, *8*(3), 241–254.

Cresswell, K., Cunningham-Burley, S., & Sheikh, A. (2018). Health Care Robotics: Qualitative Exploration of Key Challenges and Future Directions. *Journal of Medical Internet Research*, *20*(7), Article 7. https://doi.org/10.2196/10410

Crowther, M., Scogin, F., & Norton, M. J. (2010). Treating the aged in rural communities: The application of cognitive-behavioral therapy for depression. *Journal of Clinical Psychology*. https://doi.org/10.1002/jclp.20678

De Jong Gierveld, J., & Van Tilburg, T. (1999). Living arrangements of older adults in the Netherlands and Italy: Coresidence values and behaviour and their consequences for loneliness. *JOURNAL OF CROSS CULTURAL GERONTOLOGY*, *1*, 1.

de Jong-Gierveld, J., & Kamphuls, F. (1985). The Development of a Rasch-Type Loneliness Scale. *Applied Psychological Measurement*, *9*(3), 289–299. https://doi.org/10.1177/014662168500900307

Dolezal, L. (2009). *The Remote Body: The Phenomenology of Telepresence and Re-Embodiment*. https://doi.org/10.17011/ht/urn.200911234471

Ernst, J. M., & Cacioppo, J. T. (1999). Lonely hearts: Psychological perspectives on loneliness. *Applied & Preventive Psychology*, *8*(1), 1–22. https://doi.org/10.1016/S0962-1849(99)80008-0

Farrow, R., & Iacovides, I. (2013). Gaming and the limits of digital embodiment. *Philosophy & Technology*, *27*. https://doi.org/10.1007/s13347-013-0111-1

Flett, G. L., Goldstein, A. L., Pechenkov, I. G., Nepon, T., & Wekerle, C. (2016). Antecedents, correlates, and consequences of feeling like you don’t matter: Associations with

maltreatment, loneliness, social anxiety, and the five-factor model. *Personality and Individual Differences*, *92*, 52–56. https://doi.org/10.1016/j.paid.2015.12.014

Galanaki, E. (2016). Are children able to distinguish among the concepts of aloneness, loneliness, and solitude?: *International Journal of Behavioral Development*. https://doi.org/10.1080/01650250444000153

Gardner, W. L., Pickett, C. L., & Brewer, M. B. (2000). Social exclusion and selective memory: How the need to belong influences memory for social events. *Personality and Social Psychology Bulletin*, *26*(4), 486–496. https://doi.org/10.1177/0146167200266007

Gierveld, J. de J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology*, *8*(1), 73–80. https://doi.org/10.1017/S0959259898008090

Gunawardena, C. N. (1995). Social Presence Theory and Implications for Interaction and Collaborative Learning in Computer Conferences. *International Journal of Educational Telecommunications*, *1*(2), 147–166.

Haans, A., & IJsselsteijn, W. A. (2012). Embodiment and telepresence: Toward a comprehensive theoretical framework. *Interacting with Computers*, *24*(4), 211–218. https://doi.org/10.1016/j.intcom.2012.04.010

Hannush, M. J. (2006). Erikson on Development in Adulthood: New Insights from Unpublished Papers. *Journal of Phenomenological Psychology*, *1*, 115.

Hawkley, L. C., & Cacioppo, J. T. (2010a). Loneliness Matters: A Theoretical and Empirical Review of Consequences and Mechanisms. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine*, *40*(2). https://doi.org/10.1007/s12160-010-9210-8

Hawkley, L. C., & Cacioppo, J. T. (2010b). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *40*(2), 218–227. https://doi.org/10.1007/s12160-010-9210-8

Hawkley, L. C., & Kocherginsky, M. (2018). Transitions in Loneliness Among Older Adults: A 5-Year Follow-Up in the National Social Life, Health, and Aging Project. *Research on Aging*, *40*(4), 365–387. https://doi.org/10.1177/0164027517698965

Hazan, C., & Shaver, P. (1987). Romantic love conceptualized as an attachment process. *Journal of Personality and Social Psychology*, *52*(3), 511–524. https://doi.org/10.1037/0022-3514.52.3.511

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2008). The influence of social presence on acceptance of a companion robot by older people. *Journal of Physical Agents (JoPha)*, *2*(2), 33–40. https://doi.org/10.14198/JoPha.2008.2.2.05

Heinrich, L. M., & Gullone, E. (2006). The clinical significance of loneliness: A literature review. *Clinical Psychology Review*, *26*(6), 695–718. https://doi.org/10.1016/j.cpr.2006.04.002

Hoare, C. H. (2002). *Erikson on Development in Adulthood: New Insights From the Unpublished Papers*. Oxford University Press. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=129711&site=eds-live

Hojat, M. (1998). Satisfaction With Early Relationships With Parents and Psychosocial Attributes in Adulthood: Which Parent Contributes More? *The Journal of Genetic Psychology*, *159*(2), 203–220. https://doi.org/10.1080/00221329809596146

Hojat, M., Borenstein, B. D., & Shapurian, R. (1990). Perception of childhood dissatisfaction with parents and selected personality traits in adulthood. *Journal of General Psychology*, *117*(3), 241–253.

Hojat, M., & Crandall, R. (1989). *Loneliness: Theory, research, and applications*. Sage Publications.

Husserl, E., & Schuhmann, K. (1977). *Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie: Erstes Buch: Allgemeine Einführung in die reine Phänomenologie* (1995 edition). Springer.

Jones, W. H., Cavert, C. W., Snider, R. L., & Bruce, T. (1985). Relational stress: An analysis of situations and events associated with loneliness. In *Understanding personal relationships: An interdisciplinary approach* (pp. 221–242). Sage Publications, Inc.

Jones, W. H., Freemon, J. E., & Goswick, R. A. (1981). The persistence of loneliness: Self and other determinants1. *Journal of Personality*, *49*(1), 27–48. https://doi.org/10.1111/j.1467-6494.1981.tb00844.x

Jones, W. H., Hobbs, S. A., & Hockenbury, D. (1982). Loneliness and social skill deficits. *Journal of Personality and Social Psychology*, *42*(4), 682–689. https://doi.org/10.1037/0022-3514.42.4.682

Keshmiri, S., Sumioka, H., Yamazaki, R., & Ishiguro, H. (2019). Differential Effect of the Physical Embodiment on the Prefrontal Cortex Activity as Quantified by Its Entropy. *Entropy*, *21*(9), 875.

Kidd, C., & Breazeal, C. (2004). *Effect of a robot on user perceptions*. *4*, 3559–3564 vol.4. https://doi.org/10.1109/IROS.2004.1389967

Kim, K., Boelling, L., Haesler, S., Bailenson, J., Bruder, G., & Welch, G. F. (2018). Does a Digital Assistant Need a Body? The Influence of Visual Embodiment and Social Behavior on the Perception of Intelligent Virtual Agents in AR. *2018 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, 105–114. https://doi.org/10.1109/ISMAR.2018.00039

Kirova, A. (2004). Lonely or bored: Children's lived experiences reveal the difference. *Interchange*, *35*(2), 243–268. https://doi.org/10.1007/BF02698852

Kose-Bagci, H., Ferrari, E., Dautenhahn, K., Syrdal, D. S., & Nehaniv, C. L. (2009). Effects of Embodiment and Gestures on Social Interaction in Drumming Games with a Humanoid Robot. *Advanced Robotics*, *23*(14), 1951–1996. https://doi.org/10.1163/016918609X12518783330360

Kruzan, K. P., & Won, A. S. (2019). Embodied well-being through two media technologies: Virtual reality and social media. *New Media & Society*, *21*(8), 1734–1749. https://doi.org/10.1177/1461444819829873

Kupersmidt, J. B., Sigda, K. B., Sedikides, C., & Voegler, M. E. (1999). *Social Self-Discrepancy Theory and Loneliness During Childhood and Adolescence*. 9.

Ledbetter, A. M. (2017). Communication Technology and Interpersonal Relationships. *Oxford Research Encyclopedia of Communication*. https://doi.org/10.1093/acrefore/9780190228613.013.497

Lee, K. M., Jung, Y., Kim, J., & Kim, S. R. (2006). Are physically embodied social agents better than disembodied social agents?: The effects of physical embodiment, tactile interaction, and people's loneliness in human–robot interaction. *International Journal of Human-Computer Studies*, *64*(10), 962–973. https://doi.org/10.1016/j.ijhcs.2006.05.002

Liang, Y. (Jake), & Walther, J. B. (2015). Computer Mediated Communication. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* (pp. 504–509). Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.95090-6

Lowenthal, M. F., Thurnher, M., & Chiriboga, D. (1976). *Four Stages of Life*. Jossey-Bass.

Luft, S. (2015). Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity. *Review of Metaphysics*, *69*(2), 415–418.

Luna Dolezal. (2009). The Remote Body: The Phenomenology of Telepresence and Re-Embodiment. *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, Vol 5, Iss 2, Pp 208-226 (2009)*, *2*, 208. https://doi.org/10.17011/ht/urn.200911234471

Lykes, V. A., & Kemmelmeier, M. (2014). What predicts loneliness? Cultural difference between individualistic and collectivistic societies in Europe. *Journal of Cross-Cultural Psychology*, *45*(3), 468–490. https://doi.org/10.1177/0022022113509881

Malone, J. C., Liu, S. R., Vaillant, G. E., Rentz, D. M., & Waldinger, R. J. (2016). Midlife Eriksonian Psychosocial Development: Setting the Stage for Cognitive and Emotional Health in Late Life. *Developmental Psychology*, *52*(3), 496–508. https://doi.org/10.1037/a0039875

Malpas, J. (2000). *Acting at a distance and knowing from afar: Agency and knowledge on the Internet*. https://doi.org/10.7551/mitpress/5980.003.0010

Marangoni, C., & Ickes, W. (1989). Loneliness: A Theoretical Review with Implications for Measurement. *Journal of Social and Personal Relationships*, *6*(1), 93–128. https://doi.org/10.1177/026540758900600107

McWhirter, B. T. (1997). Loneliness, Learned Resourcefulness, and Self-Esteem in College Students. *Journal of Counseling & Development*, *75*(6), 460–469. https://doi.org/10.1002/j.1556-6676.1997.tb02362.x

Meloncon, L. (2013). Toward a Theory of Technological Embodiment. In L. Meloncon (Ed.), *Rhetorical Accessability: At the Intersection of Technical Communication and Disability Studies*. Baywood Publishing Company, Inc. https://doi.org/10.2190/RAAC3

Mollahosseini, A., Abdollahi, H., Sweeny, T. D., Cole, R., & Mahoor, M. H. (2018). Role of embodiment and presence in human perception of robots' facial cues. *International Journal of Human-Computer Studies*, *116*, 25–39. https://doi.org/10.1016/j.ijhcs.2018.04.005

Mund, M., & Neyer, F. J. (2016). Rising High or Falling Deep? Pathways of Self-Esteem in a Representative German Sample. *European Journal of Personality*, *30*(4), 341–357. https://doi.org/10.1002/per.2063

Nurmi, J. E., Toivonen, S., Salmela-Aro, K., & Eronen, S. (1997). Social strategies and loneliness. *The Journal of Social Psychology*, *137*(6), 764–777. https://doi.org/10.1080/00224549709595497

O'Rourke, H. M., & Sidani, S. (2017). Definition, Determinants, and Outcomes of Social Connectedness for Older Adults: A Scoping Review. *Journal of Gerontological Nursing; Thorofare*, *43*(07), 43–52. http://dx.doi.org.proxy-remote.galib.uga.edu/10.3928/00989134-20170223-03

Peplau, L. A., & Perlman, D. (1982). *Loneliness: A sourcebook of current theory, research, and therapy* (Main 6th floor BF575 .L7). New York : Wiley, ©1982.

Perlman, D. (1988). Loneliness: A life-span, family perspective. In *Families and social networks* (pp. 190–220). Sage Publications, Inc.

Qualter, P., & Munn, P. (2002). The separateness of social and emotional loneliness in childhood. *Journal of Child Psychology and Psychiatry*, *43*(2), 233–244. https://doi.org/10.1111/1469-7610.00016

Qualter, P., Vanhalst, J., Harris, R., Roekel, E. van, Lodder, G. M. A., Bangee, M., Maes, M., & Verhagen, M. (2015). Loneliness across the life span. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science*, *10*(2), 250–264. https://doi.org/10.1177/1745691615568999

Reichmann, F. F. (1959). Loneliness. *Psychiatry*, *22*(1), 1–15. https://doi.org/10.1080/00332747.1959.11023153

Richardson, J. C., & Swan, K. (2019). EXAMINING SOCIAL PRESENCE IN ONLINE COURSES IN RELATION TO STUDENTS' PERCEIVED LEARNING AND SATISFACTION. *Online Learning*, *7*(1). https://doi.org/10.24059/olj.v7i1.1864

Riva, G., Davide, F., Ijsselsteijn (eds, W. A., Waterworth, E. L., & Waterworth, J. A. (2003). *Being There: Concepts, effects and measurement of user presence in [35] synthetic environments*.

Rosenthal, Doreen. A., Gurney, Ross. M., Moore, Susan. M., Schwartz, S. J., Zamboanga, B. L., Weisskirch, R. S., & Wang, S. C. (2010). Erikson Psychosocial Stage Inventory. *The Relationships of Personal and Cultural Identity to Adaptive and Maladaptive Psychosocial Functioning in Emerging Adults*, *150*(1), 1–33.

Rubin, K. H., & Mills, R. S. (1988). The many faces of social isolation in childhood. *Journal of Consulting and Clinical Psychology*, *56*(6), 916–924. https://doi.org/10.1037//0022-006x.56.6.916

Russell, D., Peplau, L. A., & Cutrona, C. E. (1980). The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *Journal of Personality and Social Psychology*, *39*(3), 472–480. https://doi.org/10.1037//0022-3514.39.3.472

Saklofske, D. H., Yackulic, R. A., & Kelly, I. W. (1986). Personality and loneliness. *Personality and Individual Differences*, *7*(6), 899–901. https://doi.org/10.1016/0191-8869(86)90091-7

Schermer, J. A., & Martin, N. G. (2019). A behavior genetic analysis of personality and loneliness. *Journal of Research in Personality*, *78*, 133–137. https://doi.org/10.1016/j.jrp.2018.11.011

Schermerhorn, P., Scheutz, M., & Crowell, C. R. (n.d.). *Robot Social Presence and Gender: Do Females View Robots Differently than Males?* 8.

Sekhri, R., & Sekhri, A. (2017). Psychological consequences of anxiety on loneliness and suicide ideation among retirees: A psycho-social review. *Indian Journal of Health & Wellbeing*, *8*(1), 38–40.

Slater, C. L. (2003). Generativity Versus Stagnation: An Elaboration of Erikson's Adult Stage of Human Development. *Journal of Adult Development*, *10*(1), 53–65. https://doi.org/10.1023/A:1020790820868

Steuer, J. (2000). Defining Virtual Reality: Dimensions Determining Telepresence. *Journal of Communication*, *42*. https://doi.org/10.1111/j.1460-2466.1992.tb00812.x

Stokes, J. P. (1985). The relation of social network and individual difference variables to loneliness. *Journal of Personality and Social Psychology*, *48*(4), 981–990. https://doi.org/10.1037/0022-3514.48.4.981

Streeck, J. (2015). Embodiment in Human Communication. *Annual Review of Anthropology*, *44*(1), 419–438. https://doi.org/10.1146/annurev-anthro-102214-014045

Sullivan, H. S. (1953). *The interpersonal theory of psychiatry* (pp. xviii, 393). W W Norton & Co.

Taipale, J. (2014). *Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity*. Northwestern University Press.

Takayama, L. (2015). Telepresence and Apparent Agency in Human–Robot Interaction. In *The Handbook of the Psychology of Communication Technology* (pp. 160–175). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118426456.ch7

Tanaka, K., Nakanishi, H., & Ishiguro, H. (2015a). Physical Embodiment Can Produce Robot Operator's Pseudo Presence. *Frontiers in ICT*, *2*. https://doi.org/10.3389/fict.2015.00008

Tanaka, K., Nakanishi, H., & Ishiguro, H. (2015b). Physical Embodiment Can Produce Robot Operator's Pseudo Presence. *Frontiers in ICT*, *2*. https://doi.org/10.3389/fict.2015.00008

Thayer, C., & Anderson, G. O. (2018a). *Loneliness and Social Connections: A National Survey of Adults 45 and Older*. AARP Research. https://doi.org/10.26419/res.00246.001

Thayer, C., & Anderson, G. O. (2018b). *Loneliness and Social Connections: A National Survey of Adults 45 and Older*. AARP Research. https://doi.org/10.26419/res.00246.001

Thurston, R. C., & Kubzansky, L. D. (2009). Women, loneliness, and incident coronary heart disease. *Psychosomatic Medicine*, *71*(8), 836–842. https://doi.org/10.1097/PSY.0b013e3181b40efc

Titchkosky, T. (2007). *Reading and writing disability differently: The textured life of embodiment*. University of Toronto Press.

Townsend, P. (1955). The Family Life of Old People: An Investigation in East London. *The Sociological Review*, *3*(2), 175–195. https://doi.org/10.1111/j.1467-954X.1955.tb01052.x

Townsend, P. (1957). *The family life of old people; an inquiry in East London* (Off-site Storage--Sign in to request HQ1064 .G7). Routledge & K. Paul.

Tschacher, W., & Bergomi, C. (2011). *The implications of embodiment: Cognition and communication*.

Tsui, K., McCann, E., McHugh, A., Medvedev, M., Yanco, H., Kontak, D., & Drury, J. (2014). Towards designing telepresence robot navigation for people with disabilities. *International Journal of Intelligent Computing and Cybernetics*, *7*, 307–344. https://doi.org/10.1108/IJICC-10-2013-0044

Twenge, J. M. (2019). More Time on Technology, Less Happiness? Associations Between Digital-Media Use and Psychological Well-Being. *Current Directions in Psychological Science*, *28*(4), 372–379. https://doi.org/10.1177/0963721419838244

Twenge, J. M., & Spitzberg, B. H. (2020). Declines in non-digital social interaction among Americans, 2003–2017. *Journal of Applied Social Psychology*, *50*(6), 363–367. https://doi.org/10.1111/jasp.12665

Twenge, J. M., Spitzberg, B. H., & Campbell, W. K. (2019). Less in-person social interaction with peers among U.S. adolescents in the 21st century and links to loneliness. *Journal of Social & Personal Relationships*, *36*(6), 1892–1913. cin20. https://doi.org/10.1177/0265407519836170

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. The MIT Press.

Vejar, C. (2019). Effects of Retirement. In *Salem Press Encyclopedia*. Great Neck Publishing. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ers&AN=89185449&site=eds-live

Wainer, J., Feil-seifer, D., Shell, D., & Mataric, M. (2006). The role of physical embodiment in human-robot interaction. *ROMAN 2006 - The 15th IEEE International Symposium on Robot and Human Interactive Communication*, 117–122. https://doi.org/10.1109/ROMAN.2006.314404

Watkins, D., & Gioia, D. (2015). *Mixed Methods Research*. Oxford University Press.

Weiss, R. S. (1973a). Loneliness: The Experience of Emotional & Social Isolation. *Loneliness: The Experience of Emotional & Social Isolation*.

Weiss, R. S. (1973b). *Loneliness: The experience of emotional and social isolation* (pp. xxii, 236). The MIT Press.

Wheeler, L., Reis, H., & Nezlek, J. (1983). Loneliness, social interaction, and sex roles. *Journal of Personality and Social Psychology*, *45*(4), 943–953.

Wiener, M., & Mehrabian, A. (1968). *Language Within Language: Immediacy, a Channel in Verbal Communication*. Ardent Media.

Williams, J. G., & Solano, C. H. (1983). The social reality of feeling lonely: Friendship and reciprocation. *Personality and Social Psychology Bulletin*, *9*(2), 237–242. https://doi.org/10.1177/0146167283092007

Wiseman, H., Raz, A., & Sharabany, R. (2007). Depressive personality styles and interpersonal problems in young adults with difficulties in establishing long-term romantic relationships. *The Israel Journal of Psychiatry and Related Sciences*, *44*(4), 280–291.

Wittenberg, M. T., & Reis, H. T. (1986). Loneliness, social skills, and social perception. *Personality and Social Psychology Bulletin*, *12*(1), 121–130. https://doi.org/10.1177/0146167286121012

Wong, J. S., & Waite, L. J. (2016). Theories of social connectedness and aging. *Handbook of Theories of Aging*, 349–363.

Zilboorg, G. (1938). Loneliness. *The Atlantnic Monthly*. https://www.unz.com/print/AtlanticMonthly-1938jan-00045/

# CHAPTER 2

# UNDERSTANDING THE ROLE OF TECHNOLOGY EMBODIMENT IN FACILITATING SOCIAL CONNECTIVITY TO ADRESS LONELINESS ACROSS THE LIFESPAN: A SYSTEMATIC REVIEW

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Abstract

***Background:*** Loneliness is an emerging societal epidemic which is affecting adults across all ages. The experience of loneliness can have implication on the wellbeing overall quality of life. Social connectivity is an important component in help address the experience of loneliness, however limited resources can often create challenges for individuals to maintain and support meaningful relationships. Current literature provides little insights pertaining to the role of communication technologies and how technology embodiment may present opportunities in helping enhance the experience of connectivity by adults across the lifespan. ***Objective:*** The purpose of this study was to the experience of loneliness across the lifespan, communication technology adoption, and implication of technology embodiment in facilitating social connectivity. ***Methodology:*** This review was conducted utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews (Liberati et al., 2009). After systematically reviewing the current literature a total 15 studies met the inclusion criteria. **Results:** Communication technologies present opportunities in helping bridge the resources gap to facilitate social connections when in person communication is not possible. Technologies range in capabilities and functions, representing a continuum of embodiment. ***Conclusion:*** Our findings communication technology presents a range of opportunities in facilitating social connectivity. Technologies with higher levels of embodiment hold opportunities in expanding the sense of social connectivity achieved by the use

INDEX WORDS: Gerontechnology, Telepresence, Embodiment, Loneliness, Social Connectivity, Lifespan, Older adults

## Introduction

Loneliness is an emerging societal epidemic that has tremendous ramifications for adults across all ages. Loneliness is commonly defined as the difference in one's desired and actual quality and number of social relationships (De Jong Gierveld & Van Tilburg, 1999; Hawkley & Cacioppo, 2007; Peplau & Perlman, 1982). In the United States, two in five adults (aged 18+) report feeling isolated and a lack of meaningful relationships (*Cigna U.S. Loneliness Index*, 2018). In a study conducted by the American Association of Retired Persons (AARP) more than 35% of participants aged 45 and over reported feeling lonely (Anderson, Oscar, & Thayer, 2018). Across various stages of adulthood, as highlighted in Erikson's developmental framework, the experience of loneliness varies based on an individual's ability to achieve intimacy, generativity, and integrity (Malone et al., 2016; Ryff, 1982; Slater, 2003). Furthermore, the understanding of the factors that impact the experience of loneliness is expanded by the cognitive and attachment theories of loneliness. These theoretical frameworks highlight factors such as attachment styles, anxiety, self-esteem, depression, and feeling of control over one's own life as key influences in the experience of loneliness (Besser & Priel, 2005; Hojat et al., 1990; Wiseman et al., 2007). The cognitive reaction to changing social relationships helps inform how individuals perceive, experience, and evaluate loneliness as a phenomenon (Gierveld, 1998; Peplau & Perlman, 1982).

The social network developed over the course of an adult individual's life presents unique insights into how individuals form and support meaningful and quality relationships. Careful attention must also be placed on how shifts and changes impact an individual's sense of social connectivity. For example, changes in the structure of networks and loss of support facilitated by meaningful relationships can negatively impact one's sense of social

connectedness, contributing to a stronger sense of loneliness. Previous work has indicated that strategies aimed to enhance social engagement and promote social connectivity can have beneficial outcomes on participants' wellbeing and have resulted in a reduction in loneliness (Antoci et al., 2014; Hua Wang & Wellman, 2010; Poscia et al., 2018).

Yet, interventions aimed to promote social connectivity can often be limited by both organizational and individual resources, making their effectiveness limited. To address this limitation, communication technologies have been proposed as having the potential to help improve access to opportunities to increase connectivity (Berg et al., 2017; Campos Antunes et al., 2019; Fang et al., 2019).

**Communication Technologies and the Role of Embodiment**

Communication technologies include a variety of online platforms, software, and hardware through which individuals can communicate electronically. The userbase of these technologies is continually growing, as more adults are adopting them to engage with others and to facilitate communication. However, the types of these technologies vary considerably, from social media platforms to telepresence robots, thus offering consumers a wide range of device types to choose from.

Social media platforms such as Facebook, Instagram, and Twitter can allow individuals to share short messages and photos with their followers. The user base of these platforms is rapidly increasing among middle to late aged adults: the number of social media users aged 18-29 increased from 79% in 2011 to roughly 90% in 2018, and the number of older adults aged 65+ increased from 14% in 2011 to roughly 37% in 2018 (Pew Research Center, 2018b).

The use of mobile communication hardware, such as smartphones and tablet computers (e.g., iPad, Galaxy Tab) also continues to grow among adults in the US (Pew Research Center,

2018a). These devices not only allow users to engage via voice calls and text messages but also provide the opportunity to access telepresence software (e.g., Zoom, Skype), where users are equipped with the ability to engage with each other through face-to-face video interaction. The term telepresence is defined as the experience of presence in an environment facilitated through a communication medium (Dolezal, 2009; Kidd & Breazeal, 2004; Kose-Bagci et al., 2009; Steuer, 1995). More advanced communication technologies, such as smart displays (e.g., Google Home, Echo Show, Facebook Portal) and telepresence robots (e.g., Toyota Telepresence Robot, AVA Telepresence Robot), are providing users with a more immersive synchronous communication experience through the ability to pan and tilt the remote display and/or actually navigate around the remote environment.

The sense of presence which an individual can achieve through technology-mediated communication can be best described as a form of embodiment. Embodiment as a phenomenon has been explained and discussed in a variety of fields. Philosophers such as Heidegger (Ciocan, 2015) and Husserl (Husserl & Schuhmann, 1977) have described embodiment as being an active agent in the physical world, pointing to the lived body as the lived center of experience (Taipale, 2014). The Cartesian-Lockean model of embodiment points that many breakthroughs in communication technologies have been achieved, allowing for innovative ways to present representational knowledge (Luna Dolezal, 2009; Malpas, 2000). Recent breakthroughs in communication technologies, more specifically one's ability to interact with a remote environment and alter them through technology, resulted in the need to expand the current understanding of the phenomenon and its connection to what it means to be present. The varying embodied levels achieved through communication technologies affects the sender's and receiver's perceptions and sense of "being there." For example, the communication achieved

through social media is generally limited to one-way communication. However, high-level embodied communication technologies, such as telepresence robots, can create a heightened sense of "being there" (e.g., through pan/tilt or moving around the remote environment), thus potentially supporting the individuals' sense of social connectedness (Sakamoto et al., 2007; Takayama, 2015).

Current systematic reviews have aimed to describe how technology may serve the role of facilitating communication (Barr et al., 2019; Ibarra et al., 2020; Shah et al., 2019). These reviews have supported technology may hold opportunities in the expansion of resources and tools needed to help facilitate social connectivity. However, there are significant gaps in the understanding due limited significant findings related to the application of digital technology interventions capable of addressing the experience of loneliness. Current systematic reviews focus on specific age groups (e.g., young adults, older adults) and subsets of communication technologies (e.g., social media, cellphone, videoconferencing). Furthermore, there are limited reviews that identify the role of embodiment concerning social connectivity as an intervention aimed to address loneliness across various stages of adulthood (Banbury et al., 2018a; Bemelmans et al., 2012; Bessaha et al., 2020). Addressing these gaps can help clarify the types of technologies being used by adults across the lifespan and how technology functionalities may help serve a role if facilitating more meaningful relationships.

## Aim and Objectives

This systematic review helps address a gap in the current research, as I aimed to map the various technologies used and the role of embodiment in facilitating opportunities for social connectivity. Unlike previous work, this study aims to understand the role of communication technologies in facilitating social connectivity across the lifespan (Bessaha et al.,

2020; Poscia et al., 2018). The purpose of this systematic review is to further the understanding of communication technology's role in facilitating social connectivity across the lifespan and its role in helping address the current loneliness epidemic. I aimed to synthesize the current literature and map the various technology embodiment levels and their implications for creating social connections. Below I identified three objectives that aim to address three key goals: guide the development of interventions, inform future research, and provide elements for the organization of current communications technologies.

Objectives:

- Understand the experience of loneliness across various phases of adulthood
- Understand the types of communication technologies adopted and implemented through interventions to assist adults to formulate social connectedness and address loneliness.
- Understand how one's sense of social connectedness may be impacted by the level of technology embodiment used.

## Methods

### Study Selection and Eligibility Criteria

The studies included in this review had to meet the initial set of predefined criteria for inclusion, described in Table 2.1. The studies included span across a period of ten years, nested between January 1, 2009, and January 2020. This time frame denotes a crucial shift in accessibility to mobile defines that support synchronous video communication. Studies were included if participants were aged 18+, reported experiencing a form of social isolation and/or loneliness, and were asked about technology use or part of a technology intervention. All studies addressed or provided a clear explanation or conceptualized loneliness as a construct. All studies

either implemented a technology intervention or aimed to understand how the use of communication technologies impacted the users' sense of social connectedness.

**Table 2.1** Inclusion Criteria

| Condition | Criteria |
|---|---|
| Publication Dates | January 1, 2009- January 2020 |
| Publication Types | Primary Research Articles (Journal Articles) |
| Study Types | Cross-sectional, Longitudinal, Qualitative, Quantitative, Mixed Methods |
| Age Groups | Adults (18+) |
| Outcomes | Loneliness/Social Isolation |
| Language | English |
| Geographic Location | All countries |
| Settings | Residential, Community, Health facilities, and Institutionalized Care |

**Data Source**

This review was conducted utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews (Liberati et al., 2009). Two researchers systematically searched for articles published in 8 large and widely used online databases (see Table 2.2). These databases covered fields such as sociology, engineering, medicine, psychology, nursing, health technology, healthcare, social work, and public health. The literature search covered a publication period of 10 years and 2 months, ranging from 1 January 2009 to 1 January 2020.

**Table 2.2** Online Databases

| | Databases |
|---|---|
| 1 | Abstracts in Social Gerontology |
| 2 | American Psychological Association (APA) Psych Info |
| 3 | Cumulative Index of Nursing and Allied Health Literature (CINAHL) |
| 4 | Institute of Electrical and Electronics Engineers (IEEE) |
| 5 | Medline |

| | |
|---|---|
| 6 | ProQuest |
| 7 | Web of Science: Science Citation Index (SCI) |
| 8 | SocINDEX with Full Text |

**Search Strategy**

Systematic literature searches were undertaken in each of the eight online databases. Pre-identified search terms and subject headings were identified through careful consideration of the literature, theoretical frameworks (e.g., Cognitive Theory of Loneliness, Social Presence Theory, Erikson's stages of development), and with the help of a research librarian (see Table 2.3). The technologies terms identified in this review were adapted from communication technology terms identified by previous systematic reviews (Best et al., 2014; Campos Antunes et al., 2019; Chen & Schulz, 2016; Liberati et al., 2009). The literature was investigated using both keywords and subject headings in the "title" and "abstract" search fields of the identified online databases. Searches will be filtered by applying the search criteria outlined in Table 2.3 and through the use of Boolean operators such as "AND" and "OR" as reported in Appendix 1.

**Table 2.3** Key Words and Subject Headings

| Condition/ Challenge | Strategy | Communication Technology |
|---|---|---|
| Loneliness [2] | Social Connectedness [2] | Tele technology [1] |
| Isolation [1] | Social Communication | Robot* |
| Isolated [1] | *Communication[2] | Technology [1] |
| Isolating [1] | Communi*[2] | Telepresence [1] |
| Social Deprivation [2] | Social Communities | Embodiment[2] |
| | Social Connect* | Social Media[1] |
| | Social Support [2] | Video communication[2] |
| | Social Prescribing [2] | Information and communication[1] |
| | Social Presence [2] | Information technology[1] |
| | Interpersonal Interaction [2] | Videoconference [1] |
| | | Twitter[1] |
| | Online Social Networks [1] | Facebook[1] |
| | | Instagram[1] |
| | | Snapchat[1] |

| | |
|---|---|
| | Telecommunication[1] |
| | Teleconferencing[1] |
| | Information Seeking Behavior [1] |
| | Communication |
| | Social Networking[1] |

- * Boolean phrase – allows for all varying forms of the word
- [1] Item identified based on previous literature
- [2] Item identified based on Theoretical Frameworks

**Study Selection**

The process of study selection was conducted by a group of two researchers. All records found in searches were downloaded and exported utilizing Zotero (Zotero, 2020). Zotero is a citation manager that allows users to organize bibliographic records and citations. The first screening phase, which screened article titles and details relevant items highlighted in Table 2.2 was conducted by one researcher. The second screening phase consisted of both researchers reviewing study abstracts. Following the completion of the second phase, both researchers reviewed the full papers of all relevant articles to assess eligibility. Following the completion of the review, discrepancies in the selection of studies were discussed amongst the two researchers until consensus was reached.

**Data Extraction Procedures**

Two reviewers completed the synthesis and data extraction of the final articles. To eliminate bias and reduce errors, the reviewers compared their findings and discussed any differences or discrepancies in the data collected. Following the review agreement, a final data extraction form was created to reflect these changes. The data extraction form focused on three primary areas of interest: loneliness, social connectedness, and communication technologies. These areas of interest were focused on the understanding of how communication technologies are being utilized across the lifespan to facilitate social connectedness to address loneliness. The

data collected included: study aim, research questions, demographics of study sample, and findings related to technology, social connectivity, loneliness and wellbeing.

### Quality of Studies

The studies were assessed using the Quality Assessment Tool for Quantitative Studies (EPHPP, 2009) and Qualitative assessments for interpretive validity and each reviewer attributed a rating for each criterion and then assigned a final score was that attributed to each study. Following the completion of the quality of studies by the two reviewers, they compared their final scores and discussed any discrepancies. Following agreement, the two assigned a final global score for each study. To help support and facilitate consistency for scoring across varying methodological approaches, scoring and language were adapted based on the EPHPP instrument.

## Results

### Study Selection

The total number of articles downloaded before duplicate removal was 3654. Two investigators identified all duplicates through manual review and using the Zotero (*Zotero | Your Personal Research Assistant*, 2020) duplicate identifier tool. Upon removal of all duplicates, the search concluded with 2799 records. During the first screening phase, articles' titles were reviewed. Articles were excluded if they were not primary research and/or did not discuss loneliness, social connectedness, or technology. It's important to note that if the researcher was not able to make an informed decision based on the title of the article, the abstract was screened for clarification. Following the initial screening phase of the article titles, 332 articles remained.

During the second screening phase, articles were screened for the complete screening criteria outline in Table 3.1 Two researchers reviewed the 332 articles abstract arriving at a total of 119 articles. During the third stage of review, the full text of the remaining 119 articles was

reviewed by two researchers narrowing the total number of articles eligible for this systematic review to a total of 15 articles, please see Figure 2.1. The included studies analyzed the role technologies, across varying levels of embodiment, and their role in facilitating social connectivity and addressing loneliness.

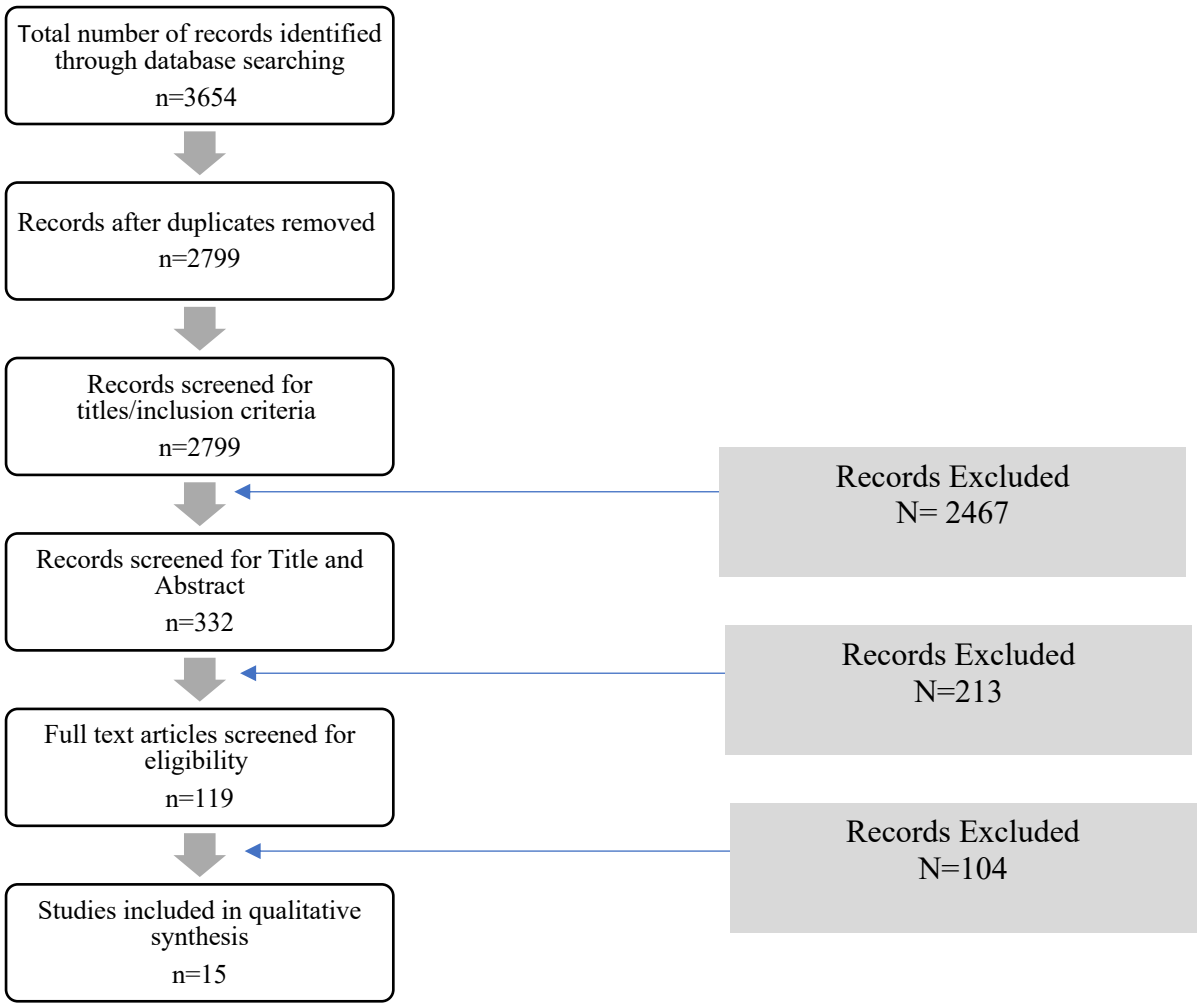


**Figure 2.1** PRISMA Flowchart of the Literature Review

**Features of Studies Included**

The 15 studies selected were published between January 2009 and January 2020. These studies were conducted across 8 different countries and include United States (5 Studies), China

(3 Studies), United Kingdom (2 Studies), Canada (1 Study), Netherlands (1 Study), New Zealand (1 Study), and Portugal (1 Study).

**Study Design**

All the studies identified implemented a cross-sectional design thus providing a single snapshot of the technology's role in the facilitation of social connectivity and the experience of loneliness. The studies implemented quantitative (10), mixed (4), and qualitative (1) methodological approaches.

**Quality of Studies**

Of the studies included 6 studies received a strong quality score (2,3,5,8,13,14) and 9 studies (1,3,5,6,9,10,11,12,15) received moderate scores. The range of quality of ratings for both qualitative and quantitative studies has been mapped and displayed in Figures 2.2 & Figure 2.3 respectively. Studies which had moderate scores had at least one weak sub-quality rating, but the majority of sub-quality ratings were moderate. The studies which were identified as strong had no low-quality sub ratings and a majority of high-quality sub ratings.

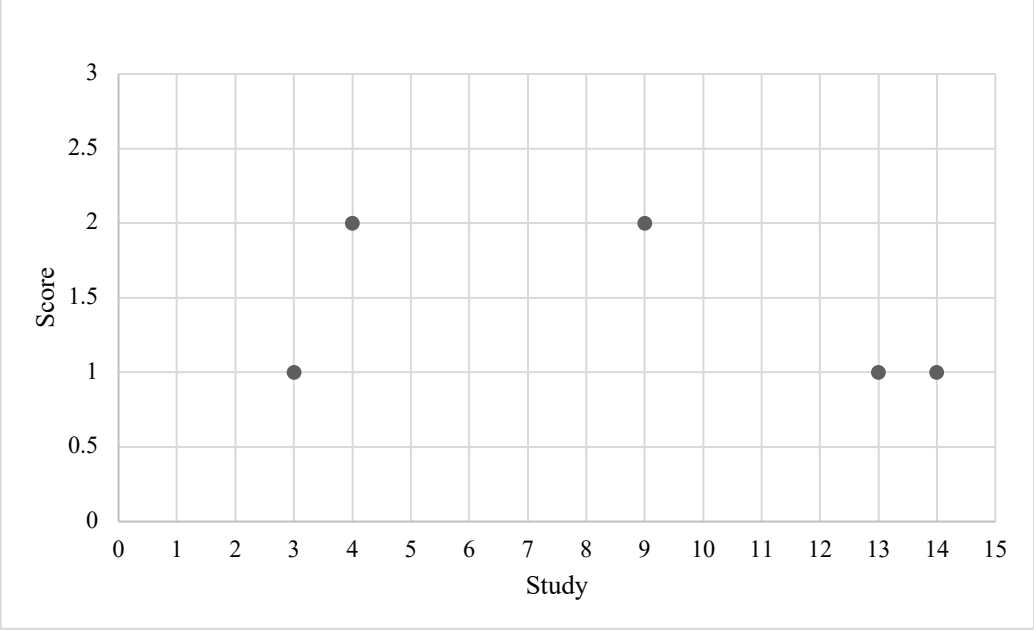


**Figure 2.2** Quality of Qualitative studies

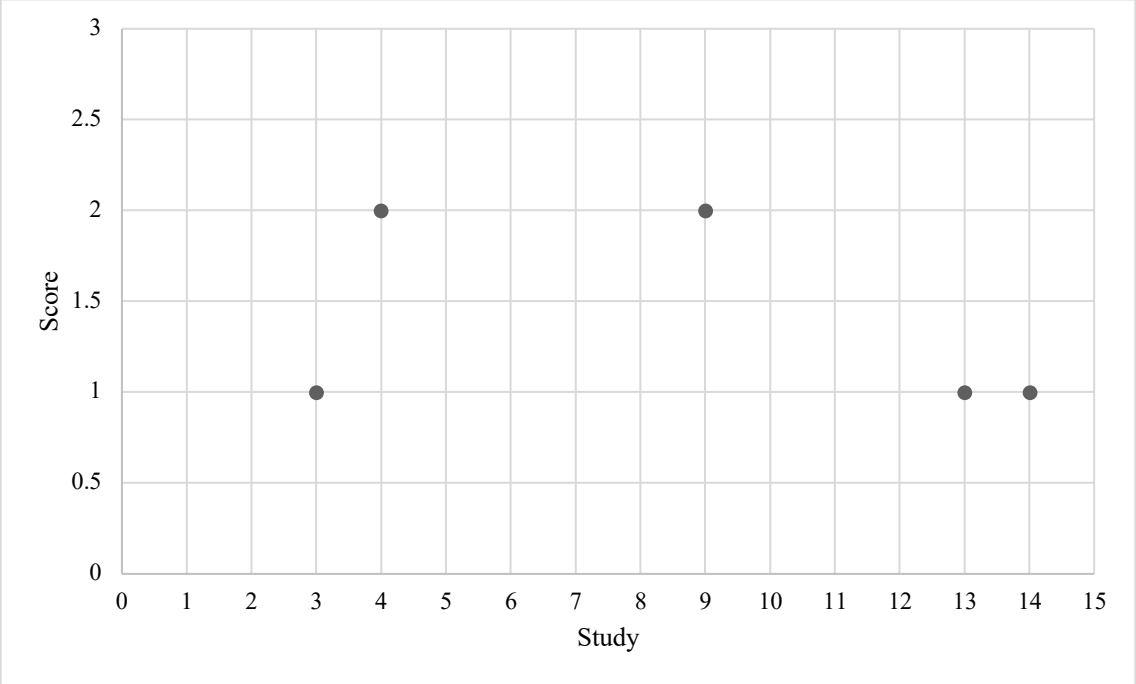


**Figure 2.3** Quality of Quantitative Studies

**Study Participants**

Participants across studies included a range of various adult age groups, including young adults (age 18-34) 6 studies, middle-age adults (age 35-64) 2 studies, and older adults (age 65+) 8 studies. The mean age across studies ranged from 19 to 82, with a mean age of 52, SD 24.74 across all studies. The sample size ranged between 12 to 1787, the mean sample size across studies was 523 SD 554.36. The participants across all studies were predominantly female. For a full overview of study participants please see Appendix (1.1)

**Measuring Loneliness**

Across studies, a total of six loneliness scales were implemented. These included the following: The Emotional and Social Loneliness Scale (ESLS, Wittenberg et al., 1986), USL-4 UCLA Loneliness scale and Social support scale (Russell et al., 1980) & (Haslam et al., 2005), Short Revised UCLA loneliness scale (Hughes, Waite, Hawkley and Cacioppo, 2004),

Brief measure of social support (Sarason, Sarason, Shearin, and Pierce, 1987), De Jong Gierveld Loneliness Scale for Loneliness (Gierveld and Tilburg, 2006), and Hughes et al.'s (2004) shortened 3-item loneliness scale. These scales are summarized in Table 2.4.

**Table 2.4** Loneliness Scales Utilized Across Literature

| Studies | | Loneliness Measures | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | The Emotional and Social Loneliness Scale | UCLA Loneliness Scale | Brief Measure of Social Support | De Jong Gierveld Loneliness Scale for Loneliness | Shortened 3 item UCLA Loneliness Scale | PROMIS Social Isolation | Qualitative Interviews |
| 1 | (Lin et al., 2020) | x | | | | | | |
| 2 | (Lima et al., 2017) | | x* | | | | | |
| 3 | (Neves et al., 2017) | | | | | x | | |
| 4 | (Banbury et al., 2016) | | | | | | | x |
| 5 | (Ye & Lin., 2015) | | x | | | | | |
| 6 | (Zhou, 2018) | | x | | | | | |
| 7 | (Czaja et al., 2016) | | x | | | | | |
| 8 | (Szabo et al., 2018) | | | | x | | | |
| 9 | (Pittman & Reich, 2015) | | | | | x | | |
| 10 | (Primack et al., 2017) | | | | | | x | |
| 11 | (Thomas et al., 2019) | | x | | | | | |
| 12 | (Yu et al., 2016) | | x | | | | | |
| 13 | (Zamir et al., 2018) | | | | | | | x |
| 14 | (Bruggencate et al., 2018) | | | | x | | | |
| 15 | (Hu, 2009) | | x | | | | | |

*Sections of the scale were included in a battery of questions.

## Technology Types

The studies described the use of social networking sites (Lin et al., 2020, Lima et al., 2017, Ye & Lin., 2015, Zhou, 2018, Pittman & Reich, 2015, Primack et al., 2017, Thomas et al., 2019, Yu et al., 2016), tablet-based application (1) (Neves et al., 2017), videoconferencing (2)

(Banbury et al., 2016, Zamir et al., 2018), Personal Reminder Information and Social Management System (1) (Czaja et al., 2016), and Internet-based Social Technologies (3) (Szabo et al., 2018, Bruggencate et al., 2018, Hu, 2009), please see table 2.5 for a complete overview of various technology types. The technologies researched across the identified studies ranged in features representing varying levels of embodiment. For example, technologies with features such as video and mobility can enable users a stronger sense of presense. The types of technologies researched varied across age groups. Studies that included in their sample older adults had the widest range of technologies (see Table 2.5). Studies that focused on young adults and middle-age adults had the least variation in technology type, with one and two types of technologies respectively.

**Table 2.5** Overview of Technology Types and Technology Embodiment Features

| | | Technology Embodiment Features | | | | |
|---|---|---|---|---|---|---|
| Technology Type | Study | Text | Image | Voice | Video | Mobility |
| SNS | (Lin et al., 2020) | x | | | | |
| | (Lima et al., 2017) | x | | | | |
| | (Ye & Lin., 2015) | x | | | | |
| | (Zhou, 2018) | x | | | | |
| | (Pittman & Reich, 2015) | x | x | | | |
| | (Primack et al., 2017) | x | | | | |
| | (Thomas et al., 2019) | x | | | | |
| | (Yu et al., 2016) | x | | | | |
| Tablet and App Intervention | (Neves et al., 2017) | x | x | x | x | |
| Videoconferencing | (Banbury et al., 2016) | | | x | x | |
| | (Zamir et al., 2018) | | | x | x | x |
| Personal Reminder Information and Social Management System | (Czaja et al., 2016) | x | x | x | x | |
| Internet based Social Technologies | (Szabo et al., 2018) | x | | | | |
| | (Bruggencate et al., 2018) | x | | | | |
| | (Hu, 2009) | x | | | | |

**Social Networking Sites**

Across the studies included in this systematic review, 8 papers focused on the use of social networking sites, making it the most predominant researched type of communication technology. Furthermore, social networking sites were the only types of technology that was investigated across phases of adulthood. However, the benefits of its application and use varied for individuals across the lifespan. Active use of social networking sites was associated with a decrease in feelings of loneliness, social connectivity, social support, maintenance of relationships, and self-efficacy (Lin et al., 2020; Primack et al., 2017; Thomas et al., 2020; Yu et al., 2016; Zhou, 2018). However, the overuse of social media was associated with the possibility of displacing the time one may have to interact in face-to-face communication (Lima et al., 2017; Primack et al., 2017). Furthermore, communication facilitated through social networking sites was associated with bridging capital and helped enable connections with non-family members (Lima et al., 2017; Yu et al., 2016). The embodiment features enabled through social networking platforms had an influence on the directionality of the users' sense of loneliness. For example, when comparing the experiences of users of text-based social networking sites to that of image-based platforms, the users of image-based social media platforms reported lower rates of loneliness (Pittman & Reich, 2016).

**Tablet and App Intervention**

One study (Neves et al., 2017), focused on the implementation of a tablet-based communication application that aimed to enhance social connectedness among older adults living in a residential care setting. Users were able to send and receive audio, text, photo, and video messages. Study findings indicate high acceptance of technologies, however, providing training that meets the users' comfort level was important. The increase in technology

embodiment features may require additional training, support, and engagement from those with whom individuals have meaningful relationships with. Study findings indicate that participants whose relatives were actively engaged in communicating through technology were more likely to find it easier to use the application. Findings also reinforced the social capital theory of social connectivity which indicates that the quality of relationships one can achieve is more important than the quantity of relationships one has.

**Video Conferencing**

Two studies (Banbury et al., 2017; Zamir et al., 2018) focused on the use of video conferencing. These studies indicate that video conferencing had a positive impact on reduce feelings of loneliness. Participants (Banbury et al., 2017; Zamir et al., 2018) reported the use of video conferencing as beneficial and made them feel more connected. Furthermore, some participants reported that video conferencing made them feel more emotional support and an enhanced sense of connectivity compared to a voice call (Banbury et al., 2017). Video conferencing was identified as a useful tool to develop a social support network and facilitate opportunities for new social connections. Visual cues provided through video conferencing were identified as an important factor in helping enhance social contact (Banbury et al., 2017). Communication facilitated through video conferencing provides the users with additional features such synchronous video and voice, enabling a stronger sense of embodiment. The main challenges influencing the use of video conferencing by participants included family commitment to participate in video calls and lack of customizability to meet the users' preferences (Zamir et al., 2018).

**Personal Reminder Information and Social Management System**

One study (Czaja et al., 2016) utilized a reminder and information and social management system to provide the user with the ability to engage and connect with family and friends easier. Personal Reminder Information and Social Management System is a easy to use computer based system designed to facilitate social interaction and increase access to community resources (Czaja et al., 2018) The findings of this study indicate that the application of information communication technologies can have an important value in reducing the barriers which may create risks of social isolation and foster opportunities for social connectivity.

**Internet-based Communication**

Three studies (M. Hu, 2009; Szabo et al., 2017; Ten Bruggencate et al., 2018) had a focus on trying to understand the role of internet-based communication to help facilitate social connectivity and its impact on feelings of loneliness. Findings indicate the use of social internet predicted an increase in feelings of well-being and lower rates of loneliness. Social internet use predicted greater wellbeing and reduced loneliness over time (Szabo et al., 2017). One study (M. Hu, 2009) indicated that the use of online chatting is less effective at addressing feelings and coping with feelings of loneliness than face-to-face communication. Among individuals who experienced chronic loneliness, the mood loneliness in computer-mediated communication was significantly higher when compared with face-to-face communication. However, the interaction conducted in this study was conducted among strangers and not with individuals whom the participants had previously developed meaningful social connections. Lack of resources, perceived usefulness, cost, concerns regarding overuse, privacy, and misuse were identified as the key challenges in the adoption and application of internet-based communication technologies (Szabo et al., 2017; Ten Bruggencate et al., 2018).

**Loneliness Across Adulthood and Communication Technology Use**

The experience of loneliness across adulthood has been discussed and explored concerning technology use and adoption. This systematic review provides context for the experience of loneliness across the various phases of adulthood. Of the studies included six studies explored the experience of loneliness across young adulthood. Two of the studies explored the experience of loneliness across middle adulthood. Eight studies explored the experience of loneliness across older adulthood.

**Young adults**. The experience of loneliness in early adulthood has been predominantly linked to factors such as social support, self-esteem (Lin et al., 2020), locus of control, personal relationships, individual's wellbeing (Ye & Lin, 2015), communication medium (M. Hu, 2009; Pittman & Reich, 2016), connectivity (Primack et al., 2017), sense of community, and social isolation (Thomas et al., 2020). The predominant technology type explored among young adults included social networking sites (e.g., Facebook, Instagram, Twitter) and internet-based communication platforms (e.g., online chatting, forums). The use of social networking sites has been identified as having the potential to maintain, facilitate, and bridge social connections (Primack et al., 2017; Thomas et al., 2020). The use of social media has been linked to serving an important role in facilitating and providing opportunities for offline relationships (Thomas et al., 2020) and facilitate social interaction for individuals with physical limitations (Primack et al., 2017). However, young adult users whom report feeling lonely are more likely to report preference of online interactions than those in-person (Ye & Lin, 2015). Furthermore, the type of social networking site and it's capabilities can have various implications on the experience of loneliness and social connectivity among young adults. One article identified that the users of image-base social networking sites are more likely to report feeling happy and satisfied with one's own life, and report feeling less lonely (Pittman & Reich, 2016). Young adults indicated

that there is a difference in the level of intimacy which can be achieved across a text-based social networking site as it lacks the intimacy which is achieved in that of face-to-face communication (Pittman & Reich, 2016).

**Middle-age adults**. Loneliness among middle-age adults has been predominantly attributed to their perceived sense of support, friendships, quality of relationships, health, and bridging and bonding social capital (Lima et al., 2017; Yu et al., 2016). Across the studies which included a middle-age adult sample, social networking sites were the only communication technologies explored. When comparing the impact of one's health of face-to-face friendships and online friendships, only face-to-face connections had a clear direct link to well-being. Face-to-face communication was identified as providing the individual to form a more intimate and supportive link through bonding and increase social bridging through social integration (Lima et al., 2017). Online relationships, such as Facebook friends, have been linked to bridging social capital but not bonding social capital. Among middle-age adults, perception and use behaviors of social media platforms can vary across various segments of this population. It is important to note that middle age adults were the least researched age group across the existing literature, only two studies included a middle age sample. However, unlike studies geared towards the young adult and older adult population, there were no studies aimed directly at understanding the experience of loneliness and use of technology to facilitate social connectedness by middle age adults.

**Older adults.** The experience of loneliness among older adults has been predominately attributed to social capital, social connectedness, quality of relationships (Banbury et al., 2017; Barbosa Neves et al., 2019; Ten Bruggencate et al., 2018), self-efficacy, social support (Yu et al., 2016; Zamir et al., 2018; Zhou, 2018), relationship-type (Czaja et al., 2018), community

engagement, activities (Szabo et al., 2017), and resources (Ten Bruggencate et al., 2018). Studies that included older adults had the most diverse set of communication platforms. These platforms included social networking sites, tablet and app interventions, video conferencing, personal reminder information and social management system, and internet-based communication platforms (e.g., chat room). Among older adults, the use of social networking sites was associated with improvements in self-efficacy, reduced sense of loneliness and social isolation, and improved sense of social support (Ten Bruggencate et al., 2018; Yu et al., 2016; Zhou, 2018). Older adults are more likely to experience a stronger sense of connectedness through the use social networking site when compared to middle-age adults (Yu et al., 2016). However, connections achieved through social networking sites were primarily perceived as beneficial with friends and least effective in connecting with immediate family members. Older adults were the only segment of the adult population with whom video conferencing, personal reminder systems, and tablet and intervention were conducted across the literature.

## Discussion

This systematic review is the first with the aim of helping identify the various types of communication technologies across various levels of embodiment and their relationships in facilitating social connectivity and addressing loneliness. The current literature base provides limited insight into the experience of loneliness across the lifespan and the use of diverse communication technologies to facilitate social connectivity. Loneliness has become a worldwide epidemic that has significant ramifications across the physiological, psychological, and social wellbeing across various phases of adulthood. Understanding the experience of loneliness and how it may be best addressed across each phase of adulthood is an important component in helping promote wellbeing and healthy aging. This systematic review aims to

provide an overview of the current knowledge base and gives future research a structured perspective on the application and implementation of communication technologies across various levels of embodiment to facilitate social connectivity.

**Understand the experience of loneliness across various phases of adulthood**

Across the articles included in this systematic review the experience of loneliness across various phases of adulthood has been predominantly attributed to similar factor although some distinct factors were noted across each phase. The experience of loneliness in early adulthood was linked predominantly to social support, self-esteem, locus of control, formation of personal relationships, connectivity, sense of community, and the experience of social isolation (S. S. Hu et al., 2010; Lima et al., 2017; Lin et al., 2020; Pittman & Reich, 2016; Primack et al., 2017; Thomas et al., 2020; Ye & Lin, 2015). Loneliness across middle age adults was attributed to the perceived sense of support, friendships, perceived quality of relationships, health, and bridging and social capital (Lima et al., 2017; Yu et al., 2016). Among older adults the experience of loneliness was mostly attributed to sense of social capital, social connectivity, quality of relationships, self-efficacy, sense of social support, relationship types, and resource accessibility (Banbury et al., 2017; Barbosa Neves et al., 2019; Czaja et al., 2018; Szabo et al., 2017; Ten Bruggencate et al., 2018).

Across adulthood the ability to support social connectivity and quality relationships was associated with lower rates of loneliness. This review indicates that decreases in the social capital was noted as a key factor in the experience of loneliness by middle age adults and older adults. In previous research individuals with a strong social capital were more likely to form quality relationships (Neves et al., 2019). This is particularly interesting as previous research indicates that early adulthood serves as an important period in the development and expansion of

one's social capital (Neves et al., 2019). Furthermore, this findings indicate that social connections were closely associated with lower rates of loneliness among young adults. The ability to be connected with a larger number of individuals may serve as a protector against the experience of loneliness during early adulthood (Nicolaisen & Thorsen, 2017; Victor & Yang, 2012). This review of the literature indicates that young adults and older adults are at the highest risk of reporting social isolation and feelings of loneliness. However, these findings are limited as the samples of the studies included which were predominantly representative of young adults and older adults. Across the studies included in this review six studies included young adults, two studies included middle age adults, and eight studies included older adults.

**Understand the types of communication technologies adopted and implemented through interventions to assist adults to formulate social connectedness and address loneliness.**

The literature included in this systematic review presents a moderate range of existing technologies. The technologies identified in this review included social media (Lima et al., 2017; Lin et al., 2020; Pittman & Reich, 2016; Primack et al., 2017; Thomas et al., 2020, 2020; Ye & Lin, 2015; Yu et al., 2016), video conferencing (Banbury et al., 2017; Das Neves Cavaco et al., 2017; Zamir et al., 2018), and internet based communication technologies (e.g., chatrooms, online forums) (M. Hu, 2009; Szabo et al., 2017; Ten Bruggencate et al., 2018), and a personal reminder and social management system (Czaja, 2016).

The most prevalent technology identified in this review was social media, which was the only technology studied across adulthood. Findings indicate that social media use was associated with a decrease in feelings of loneliness, social connectivity, social support, maintenance of relationships, and self-efficacy (Lin et al., 2020; Primack et al., 2017; Thomas et al., 2020; Yu et al., 2016; Zhou, 2018). However, overuse of social media was associate with decreases in face-

to-face interactions (Lima et al., 2017; Primack et al., 2017). An explanation for these findings could be related to the use behaviors of those engaging on social media (Boulianne, 2015). For example, users who utilize social media to facilitate opportunities for face to face interactions may report feeling less loneliness (Pittman & Reich, 2016). However, some research has indicated that those who report feel more lonely are often more like to resort to online social interactions, through social media or internet based communication technologies (M. Hu, 2009; Ye & Lin, 2015). These findings indicate that the use of communication technologies such as social media and internet-based communication may present some challenges for those whom may report lonely, and may decrease opportunities for meaningful social connections.

In this review, studies which leveraged technologies with an increased number of technology embodiment features such tablet-based communication applications (Neves et al., 2017) and video conferencing(Banbury et al., 2017; Zamir et al., 2018) presented promising opportunities towards facilitating social connections. Findings indicated high acceptance and a positive impact on helping promote meaningful social connections and reducing feelings of loneliness. Furthermore, video conferencing was identified as a useful tool in developing social support and strengthen social ties (Banbury et al., 2017). Findings indicate that leveraging technologies with more embodiment features can present opportunities for engagement and social connections. However, a key challenge that is often associated with video conferencing is the commitment of family members and friends to participate in the call (Banbury et al., 2017). This indicates that in order to effectively leverage videoconferencing and telepresence technologies may require additional resources that aim to facilitate new social connections and development of meaningful.

Current research provides very little insight into how communication technologies with a more diverse set of functions, such as video conferencing (Banbury et al., 2017; Zamir et al., 2018) and telepresence robots (Bevilacqua et al., 2014; Boissy et al., 2007; Casiddu et al., 2015) may be influencing one's sense of social connectivity and experience of loneliness across adulthood. For example, none of the studies in this review or current literature have investigated technology adoption and use across various phases of adulthood to facilitate social connectivity and address loneliness. Considering a rapidly growing older adult population, the lack of research aimed at understanding the use and application of technologies during middle adulthood raises concerns about a considerable gap in current literature. Addressing this literature gap could help inform the development of interventions and preventative strategies to support social connectivity into the transition of older adulthood.

**Understand how one's sense of social connectedness may be impacted by the level of technology embodiment used**

This review provides indicates that communication technologies do not always provide the users with similar functions and capabilities. For example, among social networking sites, their use and application impacted user's perception of social connection and experience of loneliness. Although there is very little support, findings indicate that there be noted difference between social networking sites that enable users to share images (Pittman & Reich, 2016). Findings indicate that social networking sites have a diverse set of functions that serve various roles, including but not limited to communication, opportunities for social interactions, sharing information, and supporting relationships (Aarts, 2018; Antoci et al., 2014; Appel et al., 2020; Batinic & Göritz, 2009). However, it is often unclear as to what is the most common use, how individuals across the lifespan are using these platforms, and what functions users perceive as

most beneficial in forming meaningful social interactions. This suggests, that the inconsistency across literature pertaining to the usefulness of social media in facilitating meaningful relationships may be closely tied to a lack of insights pertaining to how participants use and leverage social media form meaningful social connections.

In studies conducted with older adults, particularly those focused on video conferencing (4,13) and interventions aimed to support social connectivity (3,7), the experiences reported by participants indicate an improved sense of connectivity. These types of technologies have a more diverse set of functions and capabilities when compared to social networking sites, expanding the ability to communicate through image sharing, video, and synchronous communication (BALSAMO, 1995; Luna Dolezal, 2009). Human communication is made up of three core components: verbal communication, non-verbal communication, and paraverbal communication. The ability to engage through communication technologies that allow individuals to share and receive messages which most closely resembles that of in-person communication may be beneficial in helping support a stronger sense of connectivity and allow them to feel embodied through the communication medium. Research indicates that social connectivity is a core component that has been linked to lower rates of loneliness. Across the research, opportunities for meaningful social connections are often reported to be more important than the number of social interactions an individual may experience (Fairchild et al., 2017; Ortiz-Ospina & Roser, 2020; Thayer & Anderson, 2018). Therefore, creating an experience for the user of the technology which allows for an immersion that closely resembles that of in-person communication not only takes the focus from interacting with a multitude of individuals but allows the user to focus on communicating with the individuals that matter most to them. Furthermore, engaging through a communication medium that allows for individuals to interact

in communication that closely resembles that of in-person, helps create a stronger sense of intimacy (Berg et al., 2017; Chevalier et al., 2015).

**Limitation of the Studies Included**

The assessment of the quality of studies showed that most studies were of moderate quality, had limited sample diversity, and moderate generalizability. Most studies provided an overview of participant demographics; however, representativeness of age and demographics was limited. Most studies focused on the use of social networking sites, and there was limited exploring the potential of emerging communication technologies, such as smart displays, telepresence robots, virtual reality, and gamification of social interactions. However, this may be due to fact that technologies such as smart displays and telepresence robots, which incorporate video conferencing, locomotion, and advanced sensors are not widely available and accessible. Increased adoption of these technologies will help bridge the current gap in the literature and advance the field understanding of how their implementation to serve as mediums of communication can help facilitate meaningful social connection.

Current research also is limited in providing longitudinal data on the long term adoption of technology (Davis, 1989). Previous research indicated that exposure and use of technology across time may influence comfort level and adoption. Furthermore, longitudinal data may help give insights into how individuals across the lifespan adopt and use communication technologies to help cope with feelings of loneliness and help facilitate social connectivity. The lack of emphasis on studying the role of communication technologies among middle-age adults presents a major limitation in understanding how individuals amongst this age group adopt and implement technologies. With the Baby Boomer generation approaching the transition into older adulthood, understanding the technological preferences and use patterns of middle-age adults

may be beneficial in developing technologies aimed to cater and meet their needs, and help facilitate stronger social connections as they age.

**Limitations and Strengths of the Systematic Review**

The current systematic review provides an overview of the current state of the literature on the use and application of communication technologies and their use in facilitating social connectivity across various phases of adulthood. An underlying limitation of this review is the moderate quality of the studies included and limited research exploring the role of communication technology in addressing loneliness. Moreover, the current literature provides very minimal insights on the use and application of communication across each phase of adulthood. The inclusion of English-only articles may have increased the chance of language bias and limited inclusion of articles.

The process for study selection, inclusion criteria and quality rating have standardized, however it is important to consider that these were subjective judgements made by two researchers. Increasing the number of study reviewers may have been beneficial in reducing bias and errors. Furthermore, while conducting study reviews, the reviewers were not blinded to the identifying information of the studies (e.g., authors' names, journal, institution).

The systematic review was conducted using the PRISM guidelines and the studies included were assessed for quality using the Effective Public Health Practice Project (EPHPP) tool ("EPHPP," 2018). Furthermore, I provide a clear outline for study search, management, and inclusion to order to help ensure transparency and reproducibility.

**Implication for Future Research and Practice**

The technologies identified in this review represent a small portion of the types of communication technologies individuals use to engage in communication and adapt to changing

societal norms. Furthermore, the types of technologies that are often used by adults change as new technologies emerge on the market older ones often become obsolete (Nowland et al., 2018).With the emergence and access to the internet adults across all age groups are using communication technologies at higher rate than ever before (Anderson et al., 2019). The role and purpose of communication technologies can vary for individuals along with how they are being used and implement to support the needs of their users (Freeman et al., 2020; Rama et al., 2001). Research in these areas is needed to help understand the types of communication technologies young and middle age adults are using and implementing to support meaningful connections. Furthermore, an understanding of the social technologies used by adults serves an important role in the development of interventions and development of community programs aimed at addressing the experience of loneliness.

Translation of research focused on the application of communication technology is an important step towards real world resource development (Mois & Fortuna, 2020). Partnerships facilitated between researchers and practitioners can promote discussions surround the opportunities and challenges of technology facilitate communications (Sebastian et al., 2018). Furthermore, understanding the needs, challenges, and concerns of community members surrounding accessibility and application of technology can inform the development of technology platforms which are more attentive to user needs.

## Conclusion

This systematic review presents the current state of the literature related to the range of communication technologies being used and implemented through interventions to support social connectivity and address the experience of loneliness. Findings indicate that communication technologies hold the potential in helping facilitate social connections. Technology embodiment

functions presents an important role in how social connections are mediated through communication technology. However, there is limited understanding surrounding the application of higher level embodiment technologies in the lives of young and middle age adults (Bevilacqua et al., 2014; Casiddu et al., 2015). Future research should aim to capture the use and application of communication technologies to facilitate of social connections in the lives of individuals across the lifespan. Furthermore, research needs to consider how short- and long-term use of communication technologies impact humans' sense of social connectivity as they transition across various phases of adulthood.

# References

Aarts, S. (2018). Social media and loneliness among community-dwelling older adults. *International Journal of Geriatric Psychiatry*, *33*(3), 554–555. https://doi.org/10.1002/gps.4769

Anderson, M., Perrin, A., Jiang, J., & Kumar, M. (2019). 10% of Americans don't use the internet. Who are they? *Pew Research Center*. https://www.pewresearch.org/fact-tank/2019/04/22/some-americans-dont-use-the-internet-who-are-they/

Antoci, A., Sabatini, F., & Sodini, M. (2014). Bowling alone but tweeting together: The evolution of human interaction in the social networking era. *Quality & Quantity*, *48*(4), 1911–1927. https://doi.org/10.1007/s11135-013-9863-z

Appel, M., Marker, C., & Gnambs, T. (2020). Are Social Media Ruining Our Lives? A Review of Meta-Analytic Evidence. *Review of General Psychology*, *24*(1), 60–74. cin20. https://doi.org/10.1177/1089268019880891

BALSAMO, A. (1995). Forms of Technological Embodiment: Reading the Body in Contemporary Culture. *Body & Society*, *1*(3–4), 215–237. https://doi.org/10.1177/1357034X95001003013

Bamoallem, B. S. (2017). *MobiBot: Personifying telepresence communication*.

Banbury, A., Chamberlain, D., Nancarrow, S., Dart, J., Gray, L., & Parkinson, L. (2017). Can videoconferencing affect older people's engagement and perception of their social support in long-term conditions management: A social network analysis from the Telehealth Literacy Project. *Health & Social Care in the Community*, *25*(3), 938–950. https://doi.org/10.1111/hsc.12382

Banbury, A., Nancarrow, S., Dart, J., Gray, L., & Parkinson, L. (2018a). Telehealth interventions delivering home-based support group videoconferencing: Systematic review. *Journal of Medical Internet Research*, *20*(2), Article 2. psyh. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2018-29122-001&site=ehost-live

Banbury, A., Nancarrow, S., Dart, J., Gray, L., & Parkinson, L. (2018b). Telehealth interventions delivering home-based support group videoconferencing: Systematic review. *Journal of Medical Internet Research*, *20*(2), Article 2. psyh. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2018-29122-001&site=ehost-live

Barbosa Neves, B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019). Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study. *Journal of Applied Gerontology*, *38*(1), 49–72. cin20. https://doi.org/10.1177/0733464817741369

Barr, N. G., Randall, G. E., Archer, N. P., & Musson, D. M. (2019). Physician communication via Internet-enabled technology: A systematic review. *Health Informatics Journal*, *25*(3), 919–934. https://doi.org/10.1177/1460458217733122

Batinic, B., & Göritz, A. S. (2009). How Does Social Psychology Deal with New Media? *Social Psychology (18649335)*, *40*(1), 3–5. sih.

Bemelmans, R., Gelderblom, G. J., Jonker, P., & De Witte, L. (2012). Socially Assistive Robots in Elderly Care: A Systematic Review into Effects and Effectiveness. *Journal of the American Medical Directors Association*, *2*, 114.

Berg, T., Winterton, R., Petersen, M., & Warburton, J. (2017). “Although we’re isolated, we’re not really isolated”: The value of information and communication technology for older people in rural Australia. *Australasian Journal on Ageing*, *36*(4), 313–317. cin20. https://doi.org/10.1111/ajag.12449

Bessaha, M. L., Sabbath, E. L., Morris, Z., Malik, S., Scheinfeld, L., & Saragossi, J. (2020). A Systematic Review of Loneliness Interventions Among Non-elderly Adults. *Clinical Social Work Journal*, *48*(1), 110.

Besser, A., & Priel, B. (2005). The apple does not fall far from the tree: Attachment styles and personality vulnerabilities to depression in three generations of women. *Personality & Social Psychology Bulletin*, *31*(8), 1052–1073. https://doi.org/10.1177/0146167204274082

Best, P., Manktelow, R., & Taylor, B. (2014). Online communication, social media and adolescent wellbeing: A systematic narrative review. *Children & Youth Services Review*, *41*, 27–36. cin20. https://doi.org/10.1016/j.childyouth.2014.03.001

Bevilacqua, R., Cesta, A., Cortellessa, G., Macchione, A., Orlandini, A., & Tiberio, L. (2014). *Telepresence Robot at Home: A Long-Term Case Study* (pp. 73–85). https://doi.org/10.1007/978-3-319-01119-6_8

Boissy, P., Corriveau, H., Michaud, F., Labonté, D., & Royer, M.-P. (2007). A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects. *Journal Of Telemedicine And Telecare*, *13*(2), 79–84.

Boulianne, S. (2015). Social media use and participation: A meta-analysis of current research. *Information, Communication & Society*, *18*(5), 524–538. https://doi.org/10.1080/1369118X.2015.1008542

Campos Antunes, T. P., Bulle de Oliveira, A. S., Hudec, R., Crocetta, T. B., Ferreira de Lima Antão, J. Y., de Almeida Barbosa, R. T., Guarnieri, R., Massetti, T., Garner, D. M., & de Abreu, L. C. (2019). Assistive technology for communication of older adults: A systematic review. *Aging & Mental Health*, *23*(4), 417–427. psyh. https://doi.org/10.1080/13607863.2018.1426718

Casiddu, N., Cesta, A., Cortellessa, G., Orlandini, A., Porfirione, C., Divano, A., Micheli, E., & Zallio, M. (2015). Robot Interface Design: The Giraff Telepresence Robot for Social Interaction. In *Biosystems and Biorobotics* (Vol. 11, pp. 499–509). https://doi.org/10.1007/978-3-319-18374-9_46

Chen, Y.-R. R., & Schulz, P. J. (2016). The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review. *Journal of Medical Internet Research*, *18*(1), Article 1. psyh. https://doi.org/10.2196/jmir.4596

Chevalier, P., Martin, J.-C., Isableu, B., & Tapus, A. (2015, August 31). *Impact of Personality on the Recognition of Emotion Expressed via Human, Virtual, and Robotic Embodiments*. https://doi.org/10.1109/ROMAN.2015.7333686

*Cigna U.S. Loneliness Index*. (2018). [Index]. Cigna. https://www.multivu.com/players/English/8294451-cigna-us-loneliness-survey/docs/IndexReport_1524069371598-173525450.pdf

Ciocan, C. (2015). Heidegger's phenomenology of embodiment in the Zollikon Seminars. *Continental Philosophy Review*, *48*. https://doi.org/10.1007/s11007-015-9347-z

Czaja, S. J. (2016). Long-Term Care Services and Support Systems for Older Adults: The Role of Technology. *American Psychologist*, *71*(4), 294–301. https://doi.org/10.1037/a0040258

Czaja, S. J., Boot, W. R., Charness, N., Rogers, W. A., & Sharit, J. (2018). Improving Social Support for Older Adults Through Technology: Findings From the PRISM Randomized Controlled Trial. *Gerontologist*, *58*(3), 467–477. cin20. https://doi.org/10.1093/geront/gnw249

Das Neves Cavaco, A. M., Schaafsma, E., Bicer, B. K., Sahne, B. S., Volmer, D., Ozcelikay, G., Kurlovics, J., Krauja, N., Postma, M., & Yegenoglu, S. (2017). INTERNET AND COMPUTER USE AMONGST EUROPEAN PHARMACY UNDERGRADUATES: EXPLORING SIMILARITIES AND DIFFERENCES. *Farmacia*, *65*(3), 407–413.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. JSTOR. https://doi.org/10.2307/249008

De Jong Gierveld, J., & Van Tilburg, T. (1999). Living arrangements of older adults in the Netherlands and Italy: Coresidence values and behaviour and their consequences for loneliness. *JOURNAL OF CROSS CULTURAL GERONTOLOGY*, *1*, 1.

EPHPP. (2018, February 14). *McMaster Evidence Review & Synthesis Centre*. https://merst.ca/ephpp/

Fairchild, A. J., Heiney, S. P., Baruth, M., Tavakoli, A., Parker Hayne, P. D., & McDaniel, H. L. (2017). Mediators of social connection in a group teleconference intervention. *Research and Theory for Nursing Practice: An International Journal*, *31*(2), 121–136. psyh. https://doi.org/10.1891/1541-6577.31.2.121

Fang, Y., Chau, A. K. C., Fung, H. H., Woo, J., Chau, A. K. C., & Fung, H. H. (2019). Loneliness Shapes the Relationship between Information and Communications

Technology Use and Psychological Adjustment among Older Adults. *Gerontology*, *65*(2), 198–206. cin20. https://doi.org/10.1159/000495461

Freeman, S., Marston, H. R., Olynick, J., Musselwhite, C., Kulczycki, C., Genoe, R., & Xiong, B. (2020). Intergenerational Effects on the Impacts of Technology Use in Later Life: Insights from an International, Multi-Site Study. *International Journal of Environmental Research and Public Health*, *17*(16), 5711. https://doi.org/10.3390/ijerph17165711

Gierveld, J. de J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology*, *8*(1), 73–80. https://doi.org/10.1017/S0959259898008090

Hawkley, L. C., & Cacioppo, J. T. (2007). Aging and Loneliness: Downhill Quickly? *Current Directions in Psychological Science*, *16*(4), 187–191. https://doi.org/10.1111/j.1467-8721.2007.00501.x

Hojat, M., Borenstein, B. D., & Shapurian, R. (1990). Perception of childhood dissatisfaction with parents and selected personality traits in adulthood. *Journal of General Psychology*, *117*(3), 241–253.

Hu, M. (2009). Will online chat help alleviate mood loneliness? *Cyberpsychology & Behavior: The Impact Of The Internet, Multimedia And Virtual Reality On Behavior And Society*, *12*(2), 219–223.

Hu, S. S., Link, M. W., & Mokdad, A. H. (2010). Reaching linguistically isolated people: Findings from a telephone survey using real-time interpreters. *Field Methods*, *22*(1), 39–56. psyh. https://doi.org/10.1177/1525822X09349924

Hua Wang, & Wellman, B. (2010). Social Connectivity in America: Changes in Adult Friendship Network Size From 2002 to 2007. *American Behavioral Scientist*, *53*(8), 1148–1169. sih.

Husserl, E., & Schuhmann, K. (1977). *Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie: Erstes Buch: Allgemeine Einführung in die reine Phänomenologie* (1995 edition). Springer.

Ibarra, F., Baez, M., Cernuzzi, L., & Casati, F. (2020). A Systematic Review on Technology-Supported Interventions to Improve Old-Age Social Wellbeing: Loneliness, Social Isolation, and Connectedness. *Journal of Healthcare Engineering*, *2020*, e2036842. https://doi.org/10.1155/2020/2036842

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. *BMJ*, *339*. https://doi.org/10.1136/bmj.b2700

Lima, M. L., Marques, S., Muiños, G., & Camilo, C. (2017). All you need is Facebook friends? Associations between online and face-to-face friendships and health. *Frontiers in Psychology*, *8*. psyh. https://doi.org/10.3389/fpsyg.2017.00068

Lin, S., Liu, D., Niu, G., & Longobardi, C. (2020). Active social network sites use and loneliness: The mediating role of social support and self-esteem. *Current Psychology: A Journal for Diverse Perspectives on Diverse Psychological Issues*. psyh. https://doi.org/10.1007/s12144-020-00658-8

Luna Dolezal. (2009). The Remote Body: The Phenomenology of Telepresence and Re-Embodiment. *Human Technology: An Interdisciplinary Journal on Humans in ICT*

*Environments, Vol 5, Iss 2, Pp 208-226 (2009)*, *2*, 208. https://doi.org/10.17011/ht/urn.200911234471

Malone, J. C., Liu, S. R., Vaillant, G. E., Rentz, D. M., & Waldinger, R. J. (2016). Midlife Eriksonian Psychosocial Development: Setting the Stage for Cognitive and Emotional Health in Late Life. *Developmental Psychology*, *52*(3), 496–508. https://doi.org/10.1037/a0039875

Malpas, J. (2000). *Acting at a distance and knowing from afar: Agency and knowledge on the Internet*. https://doi.org/10.7551/mitpress/5980.003.0010

Mois, G., & Fortuna, K. (2020). Visioning the Future of Gerontological Digital Social Work. *Journal of Gerontological Social Work*, *63*, 1–16. https://doi.org/10.1080/01634372.2020.1772436

Neves, B. B., Dias de Carvalho, D., Serra, F., Torres, A., & Fraga, S. (2019). Social Capital in Transition(s) to Early Adulthood: A Longitudinal and Mixed-Methods Approach. *Journal of Adolescent Research*, *34*(1), 85–112. https://doi.org/10.1177/0743558418755685

Nicolaisen, M., & Thorsen, K. (2017). What Are Friends for? Friendships and Loneliness Over the Lifespan—From 18 to 79 Years. *International Journal of Aging & Human Development*, *84*(2), 126–158.

Nowland, R., Necka, E. A., & Cacioppo, J. T. (2018). Loneliness and Social Internet Use: Pathways to Reconnection in a Digital World? *Perspectives on Psychological Science*, *13*(1), 70–87. cin20. https://doi.org/10.1177/1745691617713052

Ortiz-Ospina, E., & Roser, M. (2020). Loneliness and Social Connections. *Our World in Data*. https://ourworldindata.org/social-connections-and-loneliness

Peplau, L. A., & Perlman, D. (1982). *Loneliness: A sourcebook of current theory, research, and therapy* (Main 6th floor BF575 .L7). New York : Wiley, ©1982.

Pew Research Center. (2018a). *Demographics of Mobile Device Ownership and Adoption in the United States*. Pew Research Center: Internet, Science & Tech. https://www.pewresearch.org/internet/fact-sheet/mobile/

Pew Research Center. (2018b, March 1). *Social Media Use 2018: Demographics and Statistics*. Pew Research Center: Internet, Science & Tech. https://www.pewresearch.org/internet/2018/03/01/social-media-use-in-2018/

Pittman, M., & Reich, B. (2016). Social media and loneliness: Why an Instagram picture may be worth more than a thousand Twitter words. *Computers in Human Behavior*, *62*, 155–167. cin20. https://doi.org/10.1016/j.chb.2016.03.084

Poscia, A., Stojanovic, J., La Milia, D. I., Duplaga, M., Grysztar, M., Moscato, U., Onder, G., Collamati, A., Ricciardi, W., & Magnavita, N. (2018). Interventions targeting loneliness and social isolation among the older people: An update systematic review. *Experimental Gerontology*, *102*, 133–144. https://doi.org/10.1016/j.exger.2017.11.017

Primack, B. A., Shensa, A., Sidani, J. E., Whaite, E. O., Lin, L. yi, Rosen, D., Colditz, J. B., Radovic, A., & Miller, E. (2017). Social Media Use and Perceived Social Isolation Among Young Adults in the U.S. *American Journal of Preventive Medicine*, *53*(1), 1–8. cin20. https://doi.org/10.1016/j.amepre.2017.01.010

Rama, M. D., de Ridder, H., & Bouma, H. (2001). Technology generation and Age in using layered user interfaces. *Gerontechnology*, *1*(1), 25–40. https://doi.org/10.4017/gt.2001.01.01.003.00

Ryff, C. D. (1982). Successful Aging: A Developmental Approach. *The Gerontologist*, *22*(2), 209–214. https://doi.org/10.1093/geront/22.2.209

Sebastian, J. G., Breslin, E. T., Trautman, D. E., Cary, A. H., Rosseter, R. J., & Vlahov, D. (2018). Leadership by collaboration: Nursing's bold new vision for academic-practice partnerships. *Journal of Professional Nursing*, *34*(2), 110–116. https://doi.org/10.1016/j.profnurs.2017.11.006

Shah, S. G. S., Nogueras, D., Woerden, H. van, & Kiparoglou, V. (2019). Effectiveness of digital technology interventions to reduce loneliness in adults: A protocol for a systematic review and meta-analysis. *BMJ Open*, *9*(9), e032455. https://doi.org/10.1136/bmjopen-2019-032455

Slater, C. L. (2003). Generativity Versus Stagnation: An Elaboration of Erikson's Adult Stage of Human Development. *Journal of Adult Development*, *10*(1), 53–65. https://doi.org/10.1023/A:1020790820868

Szabo, M., Botfalvai, G., Kocsis, L., Carnevale, G., Sztano, O., Evanics, Z., & Rabi, M. (2017). Upper Oligocene marine fishes from nearshore deposits of the Central Paratethys (Mariahalom, Hungary). *Palaeobiodiversity and Palaeoenvironments*, *97*(4), 747–771. https://doi.org/10.1007/s12549-017-0285-0

Taipale, J. (2014). *Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity*. Northwestern University Press.

Ten Bruggencate, T., Luijkx, K., & Sturm, J. (2018). When your world gets smaller: How older people try to meet their social needs, including the role of social technology. *Ageing and Society*, *39*, 1–27. https://doi.org/10.1017/S0144686X18000260

Thayer, C., & Anderson, G. O. (2018). *Loneliness and Social Connections: A National Survey of Adults 45 and Older*. AARP Research. https://doi.org/10.26419/res.00246.001

Thomas, L., Orme, E., & Kerrigan, F. (2020). Student Loneliness: The Role of Social Media Through Life Transitions. *Computers & Education*, *146*, 103754. https://doi.org/10.1016/j.compedu.2019.103754

Victor, C. R., & Yang, K. (2012). The prevalence of loneliness among adults: A case study of the United Kingdom. *The Journal of Psychology*, *146*(1–2), 85–104. https://doi.org/10.1080/00223980.2011.613875

Wiseman, H., Raz, A., & Sharabany, R. (2007). Depressive personality styles and interpersonal problems in young adults with difficulties in establishing long-term romantic relationships. *The Israel Journal of Psychiatry and Related Sciences*, *44*(4), 280–291.

Ye, Y., & Lin, L. (2015). Examining relations between Locus of control, loneliness, subjective well-being, and preference for online social interaction. *Psychological Reports*, *116*(1), 164–175. psyh. https://doi.org/10.2466/07.09.PR0.116k14w3

Yu, R. P., McCammon, R. J., Ellison, N. B., & Langa, K. M. (2016). The relationships that matter: Social network site use and social wellbeing among older adults in the United States of America. *Ageing & Society*, *36*(9), 1826–1852.

Zamir, S., Hennessy, C. H., Taylor, A. H., & Jones, R. B. (2018). Video-calls to reduce loneliness and social isolation within care environments for older people: An implementation study using collaborative action research. *BMC Geriatrics*, *18*(1), 62–62. https://doi.org/10.1186/s12877-018-0746-y

Zhou, J. (2018). Improving older people's life satisfaction via social networking site use: Evidence from China. *Australasian Journal on Ageing*, *37*(1), E23–E28. cin20. https://doi.org/10.1111/ajag.12499

*Zotero | Your personal research assistant*. (n.d.). Retrieved April 6, 2020, from https://www.zotero.org/

*Zotero | Your personal research assistant*. (2020, April 7). https://www.zotero.org/

# Appendix 1.1 Data Extraction Table

| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |
|---|---|---|---|
| (Lin et al., 2020) | ● Examine the relationship between social network sites use patterns and loneliness, as well as the mechanisms underlying the association by Investigating mediating roles of social support and self-esteem. | ● 390 Participants<br>● Aged 17-22 (M = 19.39)<br>● 138/390 male and all used SNS<br>● Undergraduate students from a university in Xi'an China | ● SNS use to loneliness was negatively significant (β = −0.26, p < 0.01)<br>● SNS use to social support and self-esteem was positively significant<br>● Social support to loneliness was negatively, indirectly significant (estimated indirect effect: –0.10, 95% CI: −0.18 ~ −0.05)<br>● Social support to self-esteem was positively significant. Indirect SNS use to self-esteem (Estimated indirect effect: 0.11, 95% CI: 0.06 ~ 0.18) |
| (Lima et al., 2017) Part 1 | ● Study 1- This study aimed to compare online and face-to-face friendship associations with health, and to test the mediating role of social capital variables. | ● 350 Participants<br>● 48.3% of the sample was under 46 years old (M= 46.4; SD= 17.1).<br>● 56% Male<br>● 21.2% had not completed any school education, 20.3% had completed primary school education, 23.1% had completed secondary education, and 35.4% had a university degree.<br>● More than half of the participants (50.6%) were married, 31.1% were single,12% were divorced, and 6.3%were widowed. Only 21% lived alone. | STUDY 1<br>● The introduction of Facebook and face-to-face friendship in the regression analyses significantly increased explained variance of health up to 32% (p < 0.01). However, this increase was only due to the contribution of traditional forms of friendship, b D 0.15, p < 0.01, as online friendship was not associated with health, b D 0.08, p D 0.242.<br>● The direct pathway between face-to-face friendship and health was totally mediated by bonding and bridging social capital. For the mediation of bonding, we found significant paths between friendship and bonding, b D 0.18, t D 5.59, p < 0.001, and between bonding and health, b D 0.39, t D 7.03, p < 0.001.<br>● No significant regression between Facebook friendship and bonding, b D 0.07, t D 1.62, p D 0.108, although bonding significantly predicted health, b D 0.35, t D 6.92, p < 0.001.<br>●The association between friendship and bridging, b D 0.10, t D 2.24, p D 0.026, and between bridging and health, b D 0.10, t D 2.13, p D 0.034, were both significant.<br>● The direct association between Facebook friends and health once the mediators were included wasn't significant, b D 0.03, t D 0.84, p D 0.399. |
| (Lima et al., 2017) Part 2 | ● Study 2- Replicate results of study 1 | ●803 Participants<br>● Age, 49.7% of the sample was under 46 years of age, (M= 44.1; SD=15.6).<br>● (50.2% male)<br>● Twelve-point eight percent hadn't completed any education level,<br>27% had completed primary education, 29% had completed<br>secondary education, and 31.1% had a university degree;<br>● 57.4% of the sample was married, 29.9% was single, 10.9%<br>was divorced, and 1.8% was widowed. Only 10% lived alone.<br>● A large majority of the participants (89.2%) had a Facebook account. | ● Almost all variables showed significant associations except Facebook friends<br>● Direct effect of face-to-face to bonding (B=0.7, p< 0.001)<br>● Bonding and bridging positively and significantly related to health (B=0.79, p< 0.001) and (B=0.17, p< 0.001)<br>● Facebook friends non-significant with bridging (B=-0.09) and negative significant with bonding (-0.34, p< 0.01) |
| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |

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|---|---|---|---|
| (Neves et al., 2017) | ● Feasibility of a novel communication technology to enhance social connectedness among older adults in residential care.<br>● Research suggests that technology can create opportunities for social connectedness, helping alleviate social isolation and loneliness. | ● 12 Participants<br>● Age range 74 to 95 years old, (M=82.5)<br>● 4 Male, 8 Female<br>● Residents of a Canadian retirement home<br>● Excluded those with dementia or other disorders that prevented them from consenting. | ● 11/12 adopted the app, 2 participants had increased use of app between mid to post deployment.<br>● Patterns of use were also reflected in study partners' opinions regarding the tool's offerings. Combining adoption and use, we derived four main stages of acceptability: introductory, associative, autonomous, and integrative.<br>● 4/12 report daily use, 5/12 reported weekly, 2/12 occasional use<br>● 4/12 report high social connectedness<br>● 6/12 increased perceived interactions but not more meaningful |
| (Banbury et al., 2016) | ● Examine relationship between changes in social support networks for older people living in a regional area following videoconference groups | ● 45 Participants<br>● Age (M=73; SD=7.2) (M=73; SD=6.0) Age range 58–90 and 61–84<br>● Mean no. of illnesses/medical conditions (SD)*<br>4 (1.5) 4 (1.3) More than 4, n (%) 31 (69) 17 (71)<br>Less than 4, n (%) 13 (29) 7 (29)<br>● Gender, n (%)Female 25 (56) 12 (50) Male 20 (44) 12 (50)<br>31.2% low income households.<br>● Study situated in regional town of Coffs Harbor in the new South Wales, Australia.<br>● Participants recruited via community events and health professional referrals. | ● Close family were important in helping participant manage their conditions.<br>● As gaining experience in using videoconferencing, three participants used videoconference with close family members, finding the experience more satisfying than a telephone call.<br>● Partners were ranked third in the most important domain, pre- and post-intervention; Changes were observed for wider family, with increases in domains both most important and less important by 12% and 13% respectively, and absent from the least important domain.<br>● Greater emotional support and connection between members<br>● Especially appreciated by housebound<br>● Mean number of network members increased from 5 to 7.1. |
| (Ye & Lin., 2015) | ● Examination of the effects of online communications on well-being, in particular: Locus of control, Loneliness, Subjective well-being, and Preference for online social interaction. | ● 260 Participants<br>● Age range: 18 to 24 years old (M= 20.1; SD= 1.2).<br>● 84 Male, 176 Female<br>● Undergraduate students from 4 different Chinese universities were recruited for the study.<br>● The majors represented were the arts (n = 195), sciences<br>(n = 40), and engineering (n = 25).<br>● Among the participants, there were 167 freshman, 74 sophomores, and 19 juniors;<br>● 142 lived in the countryside,<br>and 118 lived in the city. | ● Significant negative correlations between POSI and Subjective well-being scales, and significant positive correlations between loneliness, locus of control and POSI scales.<br>● Negative between loneliness, locus of control and subjective well-being scales, positive between loneliness and locus of control.<br>● Positive relations among low well-being, loneliness, external locus of control and POSI scale. |
| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |

| | | | |
|---|---|---|---|
| (Zhou, 2018) | ● Examine the pathways by which social networking sites can improve older people's life satisfaction | ● 596 Participants<br>● Male 48% (287), Female 52% (309)<br>● Age groups 55–64, 65–74 and older than 75, accounted for 49% (290), 37% (220) and 14% (86) respectively.<br>● Education levels middle school, high school, college, bachelor and postgraduate, accounted for 6% (34),29% (172), 37% (222), 26% (156) and 2% (12) respectively. | ● SNS use on loneliness (B- -0.32, T=-8.18), SNS use on self-efficacy (B=0.37, T= 9.72), loneliness on life satisfaction (B=-0.51, T=-15.59) and self-efficacy on life satisfaction (B=0.06, T=1.80) were significant<br>● SNS use can extend older people's social networks and reduce loneliness to improve life satisfaction<br>● The joint effects between social support and loneliness (b = 0.36, T value = 10.97) and self-efficacy (b = 0.11, T value = 3.40) were positive and significant.<br>● Social support is high, negative effect of loneliness is lower and positive effect of self-efficacy is higher.<br>● For older people, social support can alleviate the negative effect of loneliness, enhance the positive effect of self-efficacy and improve<br>their life satisfaction. |
| (Czaja et al., 2016) | ● Gather rigorous evidence about the value of a specially designed computer system for older adults, the Personal Reminder Information and Social Management (PRISM) system, which included a software application and a robust support system with training and instructional support. | ● 300 Participants<br>● Age M = 76.15, SD = 7.4, Range 65 to 98 years<br>● Male 22%, Female 78%<br>● 33% of the sample was 80 years and older and 15% was 85 and older.<br>● Participants were ethnically diverse (46% non-White)<br>● Participants were screened for living independently and at risk of social isolation<br>● Not employed<br>● Participants had minimal prior computer use | ● Across the study groups, at 6 months, there were decreases in perceived vulnerability (b = −0.48; p < .001; effect size = 0.45; 95% CI = −0.64 to −0.32); social isolation (b = 0.79; p < .01; effect size = 0.20; 95% CI = 0.24–1.35); loneliness (b = −1.68; p < .01; effect size = 0.17; 95% CI = −2.73 to −0.63); and quality of life (b = −1.08; p < .01; effect size = 0.19; 95% CI = −1.78 to −0.38).<br>● At 12 months, there were also decreases in perceived vulnerability (b = −0.41; p < .001; effect size = 0.38; 95% CI = −0.57 to −0.24); social isolation (b = 0.84; p < .01; effect size = 0.21; 95% CI = 0.27–1.41); and loneliness (b = −2.50; p < .001; effect size = 0.25; 95% CI = −3.59 to−1.41).<br>● Compared to binder group, PRISM has significantly greater decrease in loneliness ( b = 1.72, p < 0.04), and greater increase in perceived social support ( b = -1.96, p < 0.004). Trend showing greater decline in social isolation ( b = -0.66, p < 0.11)<br>● Compared to binder group, PRISM had greater increases in computer comfort at 6 months (b = -1.68, p < 0.001) and 12 months (b = -2.32, p< 0.001), greater increases in computer interest at 6 months ( b= -1.52, p < 0.001) and 12 months (b = -0.99, p < 0.01), and greater increase in computer efficacy at 6 months ( b= -1.29, p < 0.001) and 12 months (b = -0.94, p < 0.02)<br>● There were also decreases in the SF-36 ratings of physical functioning (b = −3.91; p < .05; effect size = 0.14; 95% CI = −6.99 to −0.83), and limitations in emotional functioning (b = −6.89; p < .05; effect size = 0.19; 95% CI = −13.68 to −0.11) and increases in social support (b = 1.33; p < .01; effect size = 0.19; 95% CI = 0.42–2.24) at 12 months but not 6 months.<br>● PRISM said useful in daily life (82%), made life easier (80%), improved daily life (84%), accomplish tasks quickly (73%), easy to use (88%), easy to become skilled (80%). Email (85%) and internet (82%) more valuable |
| (Szabo et al., 2018) | ● Test the direct impact of online engagement for social, informational, and instrumental purposes on older adults' well-being via reducing loneliness and supporting social engagement | ● 1,165 Participants<br>● 47.6% Male, 52.4% Female<br>● Ages 60–77 (M = 68.22, SD = 4.42) | ● Engagement across social media consistent of three driving forces: social, instrumental, and informational.<br>● Social use predicted a decrease in loneliness (β = −.073, p = .001) and an increase in the diversity of volunteering activities (β = .077, p = .001) but it was unrelated to the average time spent volunteering (β = −.010, not significant)<br>● Informational use was associated with greater diversity of volunteering activities over time (β = .062, p = .008) but was unrelated to loneliness (β = −.022 not significant.) and average time spent volunteering (β = −.044, not significant.).<br>● Instrumental use was not significantly associated with loneliness (β = −.009, not significant) or time spent volunteering (β = −.043, not significant).<br>● Diversity of volunteering associated with increments in well-being (B= 0.048, p= 0.032). loneliness predicted reduction in well-being (B=-0.004, not significant)<br>● Average time spent volunteering did not significantly predict well-being (β = −.004, not significant; |
| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |

| | | | |
|---|---|---|---|
| (Pittman & Reich, 2015) | ● Determine the relationship between use of popular social media platforms and feeling lonely. Specifically, we examine the relationships between loneliness (as well as two well-known correlates, happiness and SWL) and both text-based (Twitter and Yik Yak) and image-based (Instagram and Snapchat) social media platforms. | ● 153 Participants<br>● Age (M) 22.55 (SD)3.32<br>● 63.6% Male, 36.0% Female, 0.4% (preferred not to disclose) from a large university in the northwestern United States<br>● 163 Journalism majors and 90 business majors. | ● Loneliness highest among zero image-based platforms (M=3.47) followed by one image-based platform (M = 3.12), then two image-based (M=2.54)<br>● Happiness lowest among zero image-based platforms (M=4.82) followed by one image-based platform (M = 4.91), then two image-based (M=5.28)<br>● SWL increased as function of number of image-based platforms." |
| (Primack et al., 2017) | ● Assess associations between SMU and PSI in a nationally representative sample of U.S. young adults. The focus on young adults was appropriate because of the particular increase in SMU in this population. | ● 1,787 US adults<br>● Age range 19-32 years old, Age 19–23 (33.7% Participants), 24-36 (24.8% Participants, and 27-32 (41.6% Participants).<br>●49.7 Male, 50.3% Female<br>● 57.5% White,13.0% African American, 20.6% Hispanic, and 8.9% Biracial/Multiracial or other.<br>● Of these, slightly more than half (55.6%) were in a committed relationship and approximately a third (35.6%) reported living with a significant other.<br>● Nationally representative of US population | ● 42% low PSI, 31% medium PSI, 27% high PSI<br>● Median SMU was 61 mins per day. Median social media site visits per week was 30.<br>● Those who used SM > 121 mins/day had double the odds for increased PSI (OR=2.0).<br>● Those who visited >58 times/week had triple the odds of increased PSI<br>● Participants in highest quartile of time of SMU had significantly greater odds of increased PSI |
| (Thomas et al., 2019) | ● Predict loneliness in first year university students, assessing early university experiences, psychological, and behavioral constructs, and considering how these are manifested within a digital context for relationship building and maintenance.<br>● What factors predict loneliness in first year university students? | ● 510 Participants<br>● Age 18–24 (476 Participants), 25-34 (24 Participants, and 35 (10 Participants).<br>● 200 Male, 310 Female.<br>● The majority of our participants (402) were surveyed 6–7 months after they started university | ● Maintained Social Capital, Bridging Social Capital, Bonding Social Capital played a mediating role in Social information seeking and feeling of loneliness. |
| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |

| | | | |
|---|---|---|---|
| (Lin et al., 2020) | ● Examine the relationship between social network sites use patterns and loneliness, as well as the mechanisms underlying the association by Investigating mediating roles of social support and self-esteem. | ● 390 Participants<br>● Aged 17-22 (M = 19.39)<br>● 138 Male, 25 Female<br>● Undergraduate students from a university in Xi'an China | ● SNS use to loneliness was negatively significant (β = −0.26, p < 0.01)<br>● SNS use to social support and self-esteem was positively significant<br>● Social support to loneliness was negatively, indirectly significant (estimated indirect effect: –0.10, 95% CI: −0.18 ~ −0.05)<br>● Social support to self-esteem was positively significant. Indirect SNS use to self-esteem (Estimated indirect effect: 0.11, 95% CI: 0.06 ~ 0.18) |
| (Zamir et al., 2018) | ● Identify the barriers to and facilitators of implementing video-calls for older people in care environments. | ● 8 Participants<br>● Adult's age 60+<br>● Residents, patients and family members.<br>● 7 care homes and 1 hospital recruited- 4 care homes implemented intervention. | ● Positive reactions to the technology<br>● Appearance of device caused confusion and anxiety<br>● Various internet issues<br>● Lack of confidence in technology<br>● Issues on determining timing for families to call and residents to be up for conversation.<br>● Extremely beneficial for hearing impaired resident as she could see her family<br>● Participants saw SoW as an opportunity to connect with family members and more distance relatives<br>5 barriers found<br>● Staff turnover<br>● Risk averseness<br>● The SoW design<br>● Lack of family commitment<br>● Staff attitudes toward technology |
| Author | Aim/ Research Questions | Sample Demographics/Characteristics | Key Findings |
| (Bruggencate et al., 2018) | ● How do older adults at risk of being lonely or socially isolated meet their social needs?<br>● What are the social needs of older adults at risk of being lonely or socially isolated?<br>● What do older adults at risk of being lonely or socially isolated do in order to meet these needs?<br>● Which possibilities and barriers do they experience in meeting their | ● 19 Participants<br>● 75 to 94 years (M=82).<br>● 8 Male, 11 Female<br>● Fourteen of the participants lived alone; all of them were widowed. Five of the participants lived with a partner.<br>● Participants were at risk of social isolation and/or loneliness<br>● Medium-sized town in the south of the Netherlands | ● Most participants experienced moderate loneliness, Scores higher for emotional loneliness than social loneliness, social relationships play a important role in how participants experience loneliness.<br>● Relationships other than family are important. Human animal bond plays a important role in meeting need for affection and love. Participants noted importance of independence and autonomy.<br>● Connectedness is also related to relationships in the community. Life and personality traits impact one's sense of connectedness " individuals who report feeling positive" tend to report feeling independent and cheerful across various life experiences.<br>● BARIERS- inability to participate in voluntary activities, community activities, hobbies, share values and ideas, lack of physical resources, lack of public transportation, lack of family visits.<br>● TECHNOLOGY- all participants were familiar with tech; most participants use a phone. None of the participants own a smartphone. Tablet was used by 3 participants to read. six participants use email. Two participants use it to play bridge online. more than half do not use any form of social technology. Individuals who use social tech are enthusiastic. |

| | | | |
|---|---|---|---|
| | social needs?<br>● What is the role of social technology in meeting these needs? | | ● BARRIERS TO ADOPTION- Perceived usefulness, cost, concerned about overuse, privacy, misuse, |
| (Hu, 2009) | ● RQ1: Will social Internet use alleviate people's loneliness mood?<br>● RQ2: For individuals with high trait loneliness, will nonsocial activities more effectively reduce loneliness mood than will social activities?<br>● RQ3: For individuals with low trait loneliness, will social activities more effectively reduce loneliness mood than will nonsocial activities?<br>● RQ4: For individuals with high trait loneliness, will computer-mediated social interaction more effectively reduces loneliness mood than will face-to-face social interactions?<br>● RQ5: For individuals with low trait loneliness, will face-to face social interaction more effectively reduces loneliness mood than will computer-mediated interactions? | ● 234 Participants<br>● Age range 18-37 years old (M=21.5)<br>● 36% Male, 64%Female<br>● Recruited from a large midwestern university | ● Change in loneliness greater for computer-mediated communication for those with high trait loneliness<br>● No significant difference between mood loneliness change in computer mediated and control ($F(2,88)=2.32$, $p>0.05$)<br>● No significant difference in mood loneliness change between social and nonsocial activities. High trait ($F(1,57)=0.00$, $p>0.05$), low trait ($F(1,51)=0.33$, $p>0.05$)<br>● No significant difference of mood loneliness change between face-to-face and computer communication for low trait loneliness ($F(1,28) =0.02$, $p>0.05$) |

# CHAPTER 3

# UNDERSTANDING THE RELATIONSHIP BETWEEN COMMUNICATION TECHNOLOGIES AND PERCEIVED LONELINESS

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Abstract

***Background:*** The rapid growth in the experience of loneliness across the lifespan is raising many concerns surrounding the wellbeing of adults across all ages. Developing and leveraging existing tools and resources is crucial in combating this emerging health crisis. Over the past two decades the evolvement of communication technologies has presented a promising potential in helping social connectivity, especially when face-to-face communication is not possible. Understanding the role of communication technologies in facilitating meaningful social connections in helping address the experience of loneliness. ***Objective****:* The purpose of this research is to understand the factors contributing the experience of the multiple dimensions of loneliness, the use of communication technologies, and the characteristics associate with interest in the adoption of embodied telepresence technology. ***Method:*** The data for this study was collected using a Qualtrics survey which was distributed via Amazon Mechanical Turk (Amazon Mturk) Human Intelligence Tasks (HIT). The participants recruited for this study were adults across the lifespan constituting a total sample size of 384 participants. Multivariate regression and logistics regression analysis examined the experience of loneliness across the lifespan, use of communication technologies, and interest in adopting existing and emerging telepresence technologies ***Results:*** Communication technologies hold an important role in the addressing multiple dimensions of loneliness. Telepresence embodiment can be a meaningful component in the level of social connections achieved across technology mediated communication. ***Conclusion:*** Communication technologies is an important resources which should be carefully considered and leverage to facilitate and improve social connectivity across the lifespan.

INDEX WORDS: Gerontechnology, Telepresence, Embodiment, Loneliness, Social Connectivity, Lifespan, Older adults

## Introduction

In the United States two out of five adults report feelings of loneliness (*Cigna U.S. Loneliness Index*, 2018). Loneliness is most widely defined as the difference between actual social relationship and what one desires (Hawkley & Cacioppo, 2010; Marangoni & Ickes, 1989). Across the lifespan, the experience of loneliness has been attributed to a range of physiological, psychological, and social factors often linked to the developmental stages one experiences across various phases of adulthood (Qualter et al., 2015). The experience of loneliness can not necessarily be linked to a single factor or individual attributes and can vary in how individuals experience it during adulthood. Some of the common correlates include absence of meaningful social connections, social isolations, health (physiological, psychological, cognitive), personality characteristics, life events, and living circumstances (Adamczyk & Segrin, n.d.; Cacioppo et al., 2002, 2002; Child & Lawton, 2019; Gerst-Emerson & Jayawardhana, 2015; Gierveld, 1998; Hawkley & Cacioppo, 2010; Qualter et al., 2015; Weiss, 1973). However, loneliness is also a multidimensional phenomenon which has social and emotional dimensions (de Jong-Gierveld & Kamphuls, 1985; Gierveld, 1998; Weiss, 1973).

The experience of social loneliness has been connected to gaps in ones' social network, lack of meaningful connections, and feeling of not belonging(Dahlberg & McKee, 2014; Salimi, 2011; Weiss, 1973). Emotional loneliness has been attributed to the absence of attachment figures and an inability to develop a connection with someone whom can be trusted or be open with (Dykstra & Fokkema, 2007; Weiss, 1973). The factors which contribute to the experience across these dimensions have been scarcely studies with a wide range of factors attributed across the two dimensions (DiTommaso & Spinner, 1997; Dykstra & Fokkema, 2007; Holmén et al., 2000; Salimi, 2011; Weiss, 1973). The lack of research in this area presents challenges in being

able to understand how these two dimensions impact the experience of loneliness across the lifespan. However, across the current body of literature there seems to be a consensus concerning the important of meaningful social connectedness in addressing the two dimensions of loneliness (Ortiz-Ospina & Roser, 2020).

**Importance of Social Connectivity**

Social connectedness is defined as caring about others and feeling cared about by others and feeling of belonging to a group or community; in essence, it is a subjective evaluation of the extent to which one has meaningful, close, and constructive relationships with others (O'Rourke & Sidani, 2017a, 2017b). Identifying meaningful ways to support social connectivity can help alleviate the experience of loneliness. Individuals who report feeling socially connected across the lifespan are often more engaged with their community and report lower rates of loneliness (McLoughlin et al., 2018; Ortiz-Ospina & Roser, 2020). Facilitating social connectivity and the creation of resources and tools capable of supporting individuals needs and wants can help cater to the diverse set factors (e.g., personal health, living arrangement, location of household: urban vs rural, personal relationships) impacting the experience of loneliness(Ortiz-Ospina & Roser, 2020). More specifically, when thinking about the experience of loneliness across the lifespan, consideration of the diverse set of needs and preferences individuals have to communicate to maintain, facilitate, and create social connections.

**Technology-facilitated communication across embodiment**

Over the past two decades the evolvement of communication technologies has presented new opportunities in facilitating connection and enabled individuals to stay connected, especially when face-to-face communication is not possible. Communication mediated through technology allows individuals to remotely connect through text, voice, video, and even locomotion. Some

examples of communication technologies include Smartphones, tablets, social media (Facebook, twitter, LinkedIn, Pinterest, google+, Instagram, etc.), smart displays (Google Nest Hub, Amazon Echo Show), smart displays with limited locomotion (Kubi, Facebook Portal+), and telepresence robots (Toyota T-TR1, Ohmni Teleperesence Robot) to name a few.

The capabilities and functions of these technologies range in the ability to support social connection facilitate communication which mimics that which can be achieved face to face. The functions of technologies can range widely and provide the ability to connect people all over the world through both hardware and software. These functions contribute to the level of embodiment users can achieve through the technology mediated communication. For example, online social networks provide platforms for individuals to connect, share information, and communicate with individuals that share similar interest and hobbies (Heidemann et al., 2012). Individuals can chat, share images, videos, play videogames, and engage with friends, family, and individuals that share common interests (Antoci et al., 2012). More advanced communication applications and hardware such as video conferencing software, smart displays, telepresence technologies with limited mobility, and telepresence robots represent a range of higher-level technology embodiment. These technologies can provide users with the ability to engage in synchronous communication that allows the transfer for verbal, nonverbal, and paraverbal messages (Moyle et al., 2020; Zouinar & Velkovska, 2017).

The use of communication technologies to facilitate opportunities for meaningful social connections can help aid to address the resource gap needed to support meaningful social connections. More specifically, the emergence of technologies which give the user an ability to connect with others, replicating the experiences one may have in a face-to-face interaction presents a step towards creating, connecting, and supporting meaningful social connections. The

sense of connection which can be achieved though technology mediated communication is often described as embodiment (Casiddu et al., 2015; Choi & Kwak, 2016). Communication technologies can include features such as voice, video, and locomotion, impacting the sense of presence which can be achieved between the sender and receiver of messages. The sense of embodiment achieved through communication technologies can be thought about as a continuum, representing levels depending on the set of features provided by the technology being used (Haans & IJsselsteijn, 2012; Mois & Beer, 2020). Although

**Current Study**

The first aim of this study is to investigate the factors which contribute to the experience of loneliness across the lifespan. Prior research which investigated these factors have looked primarily at the experiences of older adults (Dahlberg & McKee, 2014; Dykstra & Fokkema, 2007; Holmén et al., 2000; Wolfers et al., 2021). The studies have linked social loneliness to factors such as low wellbeing, income, connectedness with family and friends, activity, social capital, and gender (Dahlberg & McKee, 2014; Wolfers et al., 2021). Emotional loneliness was correlated with relationship status (e.g. divorced, widowed), companionship, wellbeing, income, and emotional support (Dahlberg & McKee, 2014). Across these studies there seems to be little consensus across the two dimensions. Furthermore, although there has been prior studies which have looked at the experience of loneliness across the lifespan (Nicolaisen & Thorsen, 2017; Qualter et al., 2015), there are no studies which identified factors related to the multidimensionality of loneliness.

Communication technology has been identified across literature as potential tool in helping facilitate social connectivity and enhance the ability for be more connected when in person communication is not possible. Prior research has predominantly focus on the use of

communication technology by young (Aalbers et al., 2019; D. Ahn & Shin, 2013; J. Ahn, 2014; Antoci et al., 2012; Barry et al., 2017) and older adults (Aarts, 2018; Bevilacqua et al., 2014; Boissy et al., 2007; Casiddu et al., 2015; Yoshida & Tanaka, 2018; Zouinar & Velkovska, 2017) . However limited attention has been placed on the use behaviors of middle age adults to engage and facilitate meaningful relationships. Furthermore, the types of communication technologies previous work has predominantly focused on social media, video-conferencing, and telepresence. Current research provides a limited perspective on the types of technologies young adults, middle age adults, and older adults use to communicate with those with whom they have meaningful relationships. The second aim of this research is to investigate the relationship between use of communication technologies and the experience of overall loneliness, emotional loneliness, and quality of life.

The third aim of our research is to investigate the characteristics of adults across the lifespan interest to adopt telepresence technologies with various level of embodiment. Prior research has identified the potential benefits of embodiment of improved sense of presence achieved through technology mediated communication. However, the majority of research conducted in this area have been predominately focused on the use of these technologies by older adults (Boissy et al., 2007, 2007; Casiddu et al., 2015; Yoshida & Tanaka, 2018), office setting (Beno, 2018; Kuzuoka et al., 2018; Savela et al., 2018; Tsui et al., 2011), healthcare (Koceski & Koceska, 2016; Wang et al., 2021), and classroom (Cha et al., 2017; Newhart, 2014; Zhang et al., 2019). Findings across these studies have been promising, indicating high acceptance rates and users often reporting a stronger sense of connectedness when communicating across these platforms. However, across the current literature there is limited understanding surrounding how adults across the lifespan may be interested in adopting and individual characteristics which may

contribute to users' interest to adopt telepresence technologies across the continuum of telepresence embodiment. Through this research I aimed to answer the following research questions:

1. What are the individual and demographic characteristics contributing to the experience of loneliness across various phases of adulthood?
2. What are the types of technologies individuals adopt across the lifespan in helping engage in communication?
3. What are the types of technologies individuals across various phases of adulthood interested in adopting to help support maintenance of meaningful social connections?

## Methods

The aim of this exploratory study was twofold. First, to understand the experience of loneliness across the lifespan, particularly the technologies which adults leverage to communicate. Second, to gauge user interest in adopting existing and emerging telepresence technologies to engage in social connections.

### Participants

The data for this study was collected using a Qualtrics survey which was distributed via Amazon Mechanical Turk (Amazon Mturk) Human Intelligence Tasks (HIT). The participants recruited for this study included young adults (age 18-35) n=121, middle age adulthood (age 35-65) n=182, and older adults (age 65+) n=81, constituting a total sample size of 384 participants. I recruited 177 males, 200 females, 2 participant identified as non-binary/non-conforming, and 3participant identified as other. A full overview of the participant demographics is provided in table 3.1. All participants in this study lived in the United States and were registered as Amazon Mturk workers.

**Table 3.1** Participant Demographics

| Demographics Quant (N=384) | | |
|---|---|---|
| Gender | Freq | Percent |
| Male | 177 | 46.34 |
| Female | 200 | 52.36 |
| Gender Non-Conforming | 2 | .52 |
| Other | 3 | .79 |
| Age | | |
| 18-34 | 121 | 31.51 |
| 36-64 | 182 | 47.40 |
| 65+ | 81 | 21.09 |
| Race | | |
| White/Caucasian | 310 | 80.73 |
| Asian | 27 | 7.03 |
| Black/African American | 29 | 7.55 |
| Native America/Alaskan Native | 4 | 1.04 |
| More than one race/ethnicity | 7 | 1.82 |
| Other | 7 | 1.82 |
| Education | | |
| Less than high school graduate | 4 | 1.04 |
| High school graduate/GED | 48 | 12.50 |
| Vocational Training | 13 | 3.39 |
| Associate's degree | 41 | 10.68 |
| Some or in-progress college | 151 | 39.32 |
| Bachelor's degree (BA, BS) | 74 | 19.27 |
| Master's degree (or other post-graduate training) | 12 | 3.13 |
| Doctoral Degree (PhD, MD, EdD, DDS, JD, etc.) | 2 | .52 |
| Do not wish to answer | 39 | 10.16 |
| Marital Status | | |
| Single | 124 | 32.29 |
| Married/Co-habitation/Partnered | 188 | 48.96 |
| Divorced | 4 | 1.04 |
| Widowed | 53 | 13.80 |
| Other | 14 | 3.65 |
| Do not wish to answer | 1 | .26 |
| Housing Type | | |
| Single family home | 241 | 62.76 |
| Town home | 30 | 7.81 |
| Apartment or Condominium | 97 | 25.26 |
| Assisted Living residence | 2 | .52 |

| | | |
|---|---|---|
| Other | 12 | 3.13 |
| Do not wish to answer | 2 | .52 |
| County Type | | |
| Urban | 72 | 18.75 |
| Suburban | 196 | 51.04 |
| Rural | 110 | 29.65 |
| Other | 6 | 1.56 |

**Survey Design**

I facilitated a 71-item survey via a Qualtrics link which was embedded in the Mturk HIT. The information collected in this survey included demographics, health questions, technology use, overview of various telepresence technologies (e.g., video conferencing software, smart display, telepresence technologies with limited mobility, and telepresence technologies with full mobility), changes in technology use and relationships during COVID-19, and 3 previously published measures to asses participants personality type, social connectivity, and quality of life: Ten Item Personality Inventory (Nunes et al., 2018), deJong Loneliness Scale (de Jong-Gierveld, 1987), and The Quality of Life Scale (Burckhardt & Anderson, 2003). Scales items can be found in Appendix (3.1).

**Dependent Variables**

**Loneliness measure.** The de Jong loneliness scale was used to assess the participants sense of loneliness. This scale differs from other loneliness scales as it provides a measurement of the multidimensional nature of loneliness, including ones sense of social and emotional loneliness, along with a total score which provides a composite score resembling other loneliness scales, providing a overall loneliness score. The scale included items such as “There is always someone I can talk to about my day-to-day problems”. Participants were asked to report the frequency of the experiences. Cronchbach’s alpha for the scale is between ($\alpha = 0.70 - 0.76$).

**Quality of Life Measure.** The Quality-of-Life Scale was used to measure participants quality of life. The scale includes items such related to material and physical wellbeing, relationships with other people, social, community, and civic activities, personal development, and recreation (Burckhardt & Anderson, 2003). Participants were asked to report their satisfaction across the various items using a 7 item Likert like scale. Cronbach's alpha for the scale was between $\alpha = .82$ to .92.

**Telepresence technologies.** Participants were presented with a set of slides which presented them with four types of telepresence technologies. These technologies include video conferencing software, telepresence hardware (e.g., smart displays), telepresence hardware with limited mobility (e.g., smart displays with the ability to pan and tilt), and telepresence technologies with full mobility. To measure participants perception of these technologies I utilized items from the TAM-3 questionnaire (Lai, 2017; Venkatesh & Bala, 2008) which helped give insights pertaining to participants perceived ease of use, perceived usefulness, and intention to use. Items included in the instrument included the following "Using telepresence hardware with full mobility would improve my performance", "Learning to operate telepresence hardware with full mobility would be easy". Participants were asked to respond to these items by reporting their agreement to the statement, answer choice included the following "strongly agree", "agree", "somewhat agree", "neither agree nor disagree", "somewhat disagree", "disagree", and "strongly disagree". Cronbach's alpha for intention to adopt is $\alpha = .91$

**Independent Variables**

**Personality type measure.** To measure participants personality type I used the Ten-Item Personality Type Inventory which provides a brief assessment of the participants measure of extraversion, agreeableness, conscientiousness, and emotional stability. Items are rated on a scale

of one through 7 ranging from strongly disagree to strongly agree (Nunes et al., 2018). Example of items included in the scale include “I see myself as: extraverted, enthusiastic; critical“, Cronbach’s alpha for the scale was ($\alpha = 0.40–0.68$).

**Participant’s health.** To measure participants perceived personal health I asked four questions which were part of the HINTS5 questionnaire (*Survey Instruments | HINTS*, n.d.). These questions focused on general health, health satisfaction, and challenges pertaining to health. Some examples of the questions asked included: “In general, would you say your health is…”, “Compared to other people your own age, would you say your health is...”, “How satisfied are you with your present health?”, “How often do health problems stand in the way of your doing the things you want to do?”. Answer choices include poor, fair, good, very good, and excellent.

**Technology use.** Participant’s communication technology use was captured using a custom survey, organizing a series of questions listing various types of communication technologies. The technologies which participants were asked about included answering machine, fax, home phone, video call (e.g., Zoom, Skype, Google Hangout), social media (e.g., Instagram, Facebook), communication applications (e.g., GroupMe, Viber, WhatsAPP, WeChat), online bloggs/forums (e.g., reddit, personal blogg), tablet (e.g., IPad, Samsung Tab), computer (e.g., desktop, laptop), smart display (e.g., Amazon EchoShow, Google Nest Hub), pan and tilt smart displays (e.g., Facebook Portal+, Kubi), and telepresence robots (e.g., BeamPro Robot, Double 3 Robot). Participants were asked to report the frequency of use across these technologies, the answer choices included the following: “not sure what it is”, “not used”, “used once”, “used occasionally”, and “used frequently”.

**Analytic Strategy**

Data analysis was conducted using STATA, Version (*StataCorp*, 2021). The analysis began with a review of the data for missingness and variable distribution. The data was than analyzed at a bivariate level using crosstabulation. Following bivariate analysis, the data was analyzed using four multiple regression models, models examined relationships across total loneliness, social loneliness, emotional loneliness, and quality of life, including the types of technologies participants used to engage in communication. Five logistic regression models were run to overview the characteristic of participants interested in adopting telepresence technologies across various levels of embodiment and how the experience of loneliness impacted interest to adopt these technologies, when controlling for sociodemographic measure and various personality types.

## Results

The outcome of interest was to understand the experience of loneliness across various phases of adulthood. I was particularly interested in how individuals use technology, and how it's use may impact individuals' sense of social connectivity. Furthermore, we examined the characteristics of individuals who are interested in the adoption of telepresence technologies with the aim to facilitate social connectivity. The purpose of this analysis is to better understand the characteristics which may influence the experience of loneliness, and the overall impact on adult's quality of life.

This research implemented provides four multilinear regression model, that give an overview of the association between participants experience of social loneliness, emotional loneliness, total loneliness, and overall quality of life. To help us better understand the interest of the participants to adopt various types of telepresence technologies, across various levels of embodiment, four binomial logistic regression models are reported. These models provide odd

rations, pertaining to the relationship between the reported independent variables and participants interest in adopting telepresence, standalone telepresence technologies (e.g., smart displays), standalone telepresence technologies with limited mobility (e.g., pan and tilt smart displays), and telepresence technologies with full mobility (e.g., telepresence robot).

**Participant Characteristics and Bivariate Analysis**

Prior to running the full models, the data were tested for assumption at the univariate, bivariate, and multivariate levels. The data set was made up of 384 observations which meets the assumption for a large sample. Upon inspection across the included variables, the assumption for missingness was met, with total missingness well below the 10% threshold.

The primary stage of analysis was conducted using contingency table and Pearson's chi-square tests of independence were calculated across the independent variables included in the four multilinear regression models. Table 3.2 provides a complete overview of the distribution across age for the various independent variables included in the multilinear regression models. This table includes the distribution of lonely and not lonely participants. Bivariate results indicate participants who were young adults, divorced or widowed, and experienced poor health were more likely to report higher rates of overall loneliness.

**Table 3.2** Overview of study participants by age and experience of loneliness (N=384)

| | Young Adults | Middle Age Adults | Older Adults | Not Lonely | Lonely | Overall Loneliness Chi2 $\chi 2(df)$, p | |
|---|---|---|---|---|---|---|---|
| Gender | | | | | | 0.46 | 0.49 |
| Male | 70 | 74 | 33 | 57 | 117 | | |
| Female | 49 | 104 | 47 | 59 | 141 | | |
| Race | | | | | | 2.24 | 0.52 |
| White /Caucasian | 85 | 152 | 73 | 98 | 210 | | |
| Asian | 16 | 9 | 2 | 5 | 22 | | |
| Black /African American | 15 | 9 | 5 | 8 | 19 | | |
| Other | 5 | 12 | 1 | 6 | 11 | | |
| Age | | | | | | 19.06 | **0.01** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Young Adults | ** | ** | ** | 26 | 94 | | |
| Middle Age Adults | ** | ** | ** | 54 | 125 | | |
| Older Adults | ** | ** | ** | 37 | 43 | | |
| Income | | | | | | 1.16 | 0.76 |
| Less than $25,000 | 12 | 33 | 8 | 14 | 38 | | |
| $25,000 - $49,999 | 31 | 45 | 31 | 36 | 105 | | |
| $50,000 - $74,999 | 29 | 41 | 19 | 27 | 88 | | |
| $75,000 -$100,000+ | 44 | 57 | 21 | 35 | 121 | | |
| Marital Status | | | | | | 8.45 | **0.02** |
| Single | 65 | 46 | 13 | 26 | 97 | | |
| Married/Co-habitation/Partnered | 55 | 92 | 41 | 67 | 117 | | |
| Divorced/Widowed | 1 | 40 | 26 | 23 | 44 | | |
| Personal Health | | | | | | 8.07 | **0.02** |
| Poor-Fair | 18 | 44 | 12 | 15 | 57 | | |
| Good | 40 | 62 | 27 | 35 | 94 | | |
| Very Good- Excellent | 63 | 75 | 42 | 67 | 111 | | |
| County Type | | | | | | 0.38 | 0.83 |
| Urban | 21 | 40 | 11 | 23 | 48 | | |
| Suburban | 58 | 92 | 46 | 62 | 130 | | |
| Rural | 42 | 46 | 22 | 32 | 78 | | |
| Personality Type | | | | | | | |
| Extraversion | ** | ** | ** | ** | ** | 18.28 | 0.11 |
| Agreeableness | ** | ** | ** | ** | ** | 33.83 | **0.01** |
| Conscientiousness | ** | ** | ** | ** | ** | 25.53 | **0.01** |
| Emotional Stability | ** | ** | ** | ** | ** | 20.96 | **0.03** |
| Openness | ** | ** | ** | ** | ** | 20.36 | **0.04** |
| Quality of Life | ** | ** | ** | ** | ** | 125.34 | **0.01** |

Contingency tables and Pearson's chi-square tests of independence were calculated across the various independent variables included in the four bivariate linear regression models, please see Table 3.3. Bivariate results indicate those who were interested in adopting telepresence technologies were more likely than those who were not interested in adopting to have a higher level of education, a larger income, and less likely to be single. Participants who were interested in adopting telepresence hardware (e.g., smart displays) were less likely to be

single, and more likely to reside in a rural or suburban area. Those who were interested in adopting telepresence technologies with limited mobility (e.g., Facebook Portal+, Kubi) were more likely to have a higher level of education, less likely to be single, and more likely to reside in an area that was described as suburban or rural. Participants who were interested in adopting telepresence hardware with full mobility (e.g., Toyota T-TR1, Ohmni Telepresence Robot) were more likely to have a higher income and report higher rates of emotional loneliness.

**Table 3.3** Bivariate Analysis of Logistic Regression Independent Variables

| Variables | Telepresence | | Telepresence Hardware | | Telepresence Hardware with limited mobility | | Telepresence Hardware with full mobility | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$(df) | p | $\chi^2$(df) | p | $\chi^2$(df) | p | $\chi^2$(df) | p |
| Gender | 9.00 | 0.06 | 5.2 | 0.27 | 0.46 | 0.5 | 0.55 | 0.46 |
| Race | 3.53 | 0.32 | 5.53 | 0.14 | 0.89 | 0.83 | 2.16 | 0.54 |
| Age | 2.95 | 0.23 | 5.2 | 0.27 | 1.08 | 0.58 | 3.52 | 0.19 |
| Education | 7.56 | **0.05** | 1.73 | 0.19 | 8.71 | **0.03** | 7.53 | 0.11 |
| Income | 8.95 | **0.03** | 2.62 | 0.45 | 4.15 | 0.24 | 8.05 | **0.05** |
| Marital Status | 22.17 | **0.01** | 9.43 | 0.01 | 6.94 | **0.03** | 2.28 | 0.32 |
| Personal Health | 1.59 | 0.45 | 2.06 | 0.36 | 2.54 | 0.28 | 4.80 | 0.09 |
| County Type | 3.64 | 0.16 | 7.24 | **0.03** | 9.01 | **0.01** | 5.66 | 0.06 |
| Social Loneliness | 9.92 | 0.08 | 8.17 | 0.15 | 4.69 | 0.45 | 5.28 | 0.38 |
| Emotional Loneliness | 0.60 | 0.99 | 7.41 | 0.29 | 9.23 | 0.16 | 13.74 | **0.03** |
| Total Loneliness | 9.66 | 0.56 | 10.31 | 0.50 | 12.02 | 0.36 | 14.21 | 0.22 |
| Quality of Life | 65.57 | 0.42 | 77.93 | 0.10 | 59.26 | 0.61 | 64.11 | 0.44 |

**Multivariate Models – Relationship of Technology Use Across the Lifespan and Total Loneliness, Social Loneliness, Emotional Loneliness, and Quality of Life**

The experience of loneliness, social loneliness, and emotional loneliness was significantly correlated with participants age, marital status, health, household size, and communication technology use. Overall loneliness was significantly correlated with the use of social media (Coef. = -.14, SE=.06, $p<.05$) and personal computer (Coef. = -.22, SE=.08 $p<.05$), indicating that usurers of social media and personal computer were more likely to report lower rates of overall loneliness. The second model indicates that the experience of social loneliness is

correlated to the use of social media (Coef. = -.68, SE=.24 p<.05), indicating that social media users were more likely to report lower rates of social loneliness. The third model ran indicates that the experience of emotional loneliness was correlated to the use communication applications (Coef. = -.70, SE=.34 p<.05), online forum/blogs (Coef. = -.56, SE=.28 p<.05), and personal computer (Coef. = -1.20, SE=.37 p<.05), indicating that users of these technologies were more likely to report lower rates of emotional loneliness. The fourth multilinear regression model indicates that participants quality of life was significantly correlated with the use personal computers (Coef. = -4.46, SE=2.28 p<.05) and telepresence hardware (e.g., smart displays) (Coef. = -4.52, SE=2.19 p<.05), indicating that those who used these technologies were more likely to report lower rates of quality of life. Table 3.4 presents the four multilinear regression models.

**Logistic Regression Models Predict the Intent to Adopt Telepresence Technologies**

The intent to adopt telepresence technologies from low embodiment (Videoconferencing) to high embodiment (Telepresence Robot) are summarized in Table 3.5. Participants who divorced were divorced or widowed were 4 times more likely to have an intent to adopt telepresence software (OR=4.12, p<.05). Participants who earned between 50k -75k dollars (OR=3.19, p<.05) were 3 times more likely to adopt telepresence than those earning less than 25k; those who earned more than 75k dollars (OR=2.57, p<.05) were 2.5 times more likely to have the intent to adopt telepresence software. However, participants who earned between 25-49k dollars (OR= .34, p<.05) and 75k dollars (OR=.42, p<.05) had lower odds of having an intent to adopt telepresence technologies with limited mobility than those whom earned less than 25k dollars. Participants who reported residing in a rural area (OR=2.20, p<.05) were 2 times more likely to intend on adopting telepresence software to engage in meaningful relationships

than those who resided in an urban area. Participants' personality characteristics were correlated to their intention to adopt telepresence software. Participants who reported being more extraverted (OR=.87, p<.05) had lower odds of having an intent to adopt telepresence software. However, participants who score higher on agreeableness (OR=1.25, p<.05) were 1.2 times more likely of having an intent to adopt telepresence technologies. Interest to adopt standalone telepresence technologies such as smart displays was correlated with emotional loneliness and overall quality of life. Participants who were reported higher rates of emotional loneliness (OR=1.20, p<.05) were 1.2 times more likely of intending to adopt telepresence hardware. Participants who reported a reported lower quality of life (OR=.97, p<.05) had lower odds of being interested in adopting telepresence hardware.

**Table 3.4** Multilinear Regression Models

| | Total Loneliness | | | | | Social Loneliness | | | | | Emotional Loneliness | | | | | Quality of Life | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | SE | t | CI | | Coef. | SE | t | CI | | Coef. | SE | t | CI | | Coef. | SE | t | CI | |
| Age | | | | | | | | | | | | | | | | | | | | |
| Middle Age Adults | -0.06 | 0.06 | -0.87 | -0.18 | 0.07 | 0.30 | 0.27 | 1.11 | -0.23 | 0.82 | -0.88 | 0.31 | ***-2.87** | -1.48 | -0.28 | -2.12 | 1.86 | -1.14 | -5.78 | 1.54 |
| Older Adults | -0.19 | 0.08 | ***-2.4** | -0.35 | -0.03 | -0.60 | 0.33 | -1.81 | -1.25 | 0.05 | -1.19 | 0.38 | ***-3.13** | -1.94 | -0.44 | -8.86 | 2.32 | ***-3.82** | -13.42 | -4.29 |
| Young Adults | | | | | | | | | | | | | | | | | | | | |
| Gender | 0.04 | 0.05 | 0.69 | -0.06 | 0.14 | -0.10 | 0.21 | -0.48 | -0.52 | 0.31 | 0.27 | 0.24 | 1.12 | -0.21 | 0.75 | 1.11 | 1.47 | 0.75 | -1.79 | 4.00 |
| Race | | | | | | | | | | | | | | | | | | | | |
| Asian | -0.01 | 0.09 | -0.11 | -0.20 | 0.18 | -0.25 | 0.39 | -0.63 | -1.02 | 0.53 | 0.05 | 0.45 | 0.10 | -0.84 | 0.93 | 4.54 | 2.75 | 1.65 | -0.87 | 9.96 |
| Black /African American | -0.01 | 0.10 | -0.10 | -0.21 | 0.19 | 0.16 | 0.42 | 0.38 | -0.66 | 0.98 | -0.29 | 0.48 | -0.60 | -1.22 | 0.65 | -3.57 | 2.91 | -1.23 | -9.29 | 2.14 |
| Other | 0.05 | 0.12 | 0.39 | -0.20 | 0.29 | 0.57 | 0.52 | 1.10 | -0.45 | 1.59 | 0.53 | 0.59 | 0.89 | -0.64 | 1.70 | 7.00 | 3.62 | ***1.93** | -0.12 | 14.11 |
| White/Caucasian | | | | | | | | | | | | | | | | | | | | |
| Marital Status | | | | | | | | | | | | | | | | | | | | |
| Married/Co-habitation/Partnered | -0.19 | 0.07 | ***-2.74** | -0.32 | -0.05 | -1.02 | 0.29 | ***-3.58** | -1.58 | -0.46 | -0.37 | 0.33 | -1.12 | -1.01 | 0.28 | -2.96 | 2.00 | -1.48 | -6.89 | 0.97 |
| Divorced/Widowed | -0.02 | 0.08 | -0.25 | -0.18 | 0.14 | -0.31 | 0.33 | -0.92 | -0.96 | 0.35 | 0.78 | 0.38 | ***2.04** | 0.03 | 1.53 | 1.09 | 2.33 | 0.47 | -3.49 | 5.66 |
| Single | | | | | | | | | | | | | | | | | | | | |
| Income | | | | | | | | | | | | | | | | | | | | |
| $25,000 - $49,999 | -0.02 | 0.08 | -0.26 | -0.19 | 0.14 | -0.15 | 0.35 | -0.43 | -0.83 | 0.53 | 0.09 | 0.40 | 0.22 | -0.69 | 0.87 | 0.92 | 2.42 | 0.38 | -3.84 | 5.69 |
| $50,000 - $74,999 | 0.02 | 0.09 | 0.25 | -0.15 | 0.19 | -0.15 | 0.36 | -0.42 | -0.86 | 0.56 | -0.14 | 0.42 | -0.35 | -0.96 | 0.67 | 2.06 | 2.53 | 0.82 | -2.92 | 7.04 |
| $75,000 -$100,000+ | 0.07 | 0.09 | 0.78 | -0.10 | 0.24 | -0.30 | 0.37 | -0.82 | -1.02 | 0.42 | -0.20 | 0.42 | -0.48 | -1.03 | 0.62 | -0.46 | 2.55 | -0.18 | -5.49 | 4.57 |
| Less than $25,000 | | | | | | | | | | | | | | | | | | | | |
| Personal Health | | | | | | | | | | | | | | | | | | | | |
| Poor - Fair | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Good | -0.07 | 0.07 | -0.95 | -0.20 | 0.07 | -0.35 | 0.29 | -1.21 | -0.93 | 0.22 | -0.61 | 0.33 | -1.82 | -1.27 | 0.05 | -6.94 | 2.04 | ***-3.4** | -10.95 | -2.93 |
| Very Good - Excellent | -0.16 | 0.07 | ***-2.36** | -0.29 | -0.03 | -0.83 | 0.28 | ***-2.98** | -1.38 | -0.28 | -1.03 | 0.32 | ***-3.21** | -1.66 | -0.40 | -15.19 | 1.96 | *-7.77 | -19.04 | -11.34 |
| County Type | | | | | | | | | | | | | | | | | | | | |
| Suburban | -0.01 | 0.07 | -0.12 | -0.14 | 0.12 | 0.06 | 0.27 | 0.20 | -0.48 | 0.60 | -0.18 | 0.32 | -0.56 | -0.80 | 0.44 | 2.02 | 1.92 | 1.05 | -1.76 | 5.81 |
| Rural | 0.05 | 0.07 | 0.71 | -0.09 | 0.19 | 0.16 | 0.30 | 0.53 | -0.43 | 0.75 | 0.13 | 0.35 | 0.37 | -0.55 | 0.81 | 2.78 | 2.11 | 1.32 | -1.37 | 6.93 |
| Urban | | | | | | | | | | | | | | | | | | | | |
| Size of Household | | | | | | | | | | | | | | | | | | | | |
| 2 | 0.14 | 0.08 | 1.81 | -0.01 | 0.29 | 0.24 | 0.32 | 0.73 | -0.40 | 0.87 | 0.67 | 0.37 | 1.82 | -0.06 | 1.40 | 0.46 | 2.25 | 0.20 | -3.98 | 4.90 |
| 3 | 0.12 | 0.08 | 1.46 | -0.04 | 0.29 | -0.20 | 0.35 | -0.57 | -0.88 | 0.48 | 0.85 | 0.40 | ***2.12** | 0.06 | 1.63 | 3.20 | 2.43 | 1.31 | -1.59 | 7.98 |
| 4+ | 0.08 | 0.09 | 0.89 | -0.10 | 0.26 | 0.22 | 0.37 | 0.59 | -0.52 | 0.95 | 1.07 | 0.43 | ***2.51** | 0.23 | 1.92 | -0.20 | 2.61 | -0.08 | -5.34 | 4.93 |
| 1 | | | | | | | | | | | | | | | | | | | | |
| Communication Technologies | | | | | | | | | | | | | | | | | | | | |
| Phone | 0.03 | 0.06 | 0.44 | -0.09 | 0.14 | -0.04 | 0.25 | -0.16 | -0.53 | 0.44 | 0.30 | 0.28 | 1.05 | -0.26 | 0.85 | -0.28 | 1.72 | -0.16 | -3.67 | 3.11 |
| Telepresence | -0.05 | 0.05 | -0.99 | -0.16 | 0.05 | -0.06 | 0.22 | -0.29 | -0.51 | 0.38 | -0.11 | 0.26 | -0.44 | -0.62 | 0.39 | -2.17 | 1.57 | -1.38 | -5.26 | 0.92 |
| Social Media | -0.14 | 0.06 | ***-2.42** | -0.25 | -0.03 | -0.68 | 0.24 | ***-2.85** | -1.15 | -0.21 | -0.44 | 0.27 | -1.62 | -0.98 | 0.10 | -1.83 | 1.67 | -1.10 | -5.13 | 1.46 |
| Communication Applications | -0.06 | 0.07 | -0.86 | -0.20 | 0.08 | 0.03 | 0.29 | 0.12 | -0.54 | 0.61 | -0.70 | 0.34 | ***-2.06** | -1.36 | -0.03 | -3.38 | 2.06 | -1.64 | -7.43 | 0.67 |
| Online Forum/Blog | 0.09 | 0.06 | 1.62 | -0.02 | 0.21 | 0.27 | 0.24 | 1.14 | -0.20 | 0.75 | 0.56 | 0.28 | ***2.04** | 0.02 | 1.10 | 1.50 | 1.68 | 0.89 | -1.81 | 4.80 |
| Tablet | -0.01 | 0.05 | -0.22 | -0.12 | 0.09 | -0.35 | 0.22 | -1.56 | -0.79 | 0.09 | 0.02 | 0.26 | 0.09 | -0.48 | 0.53 | -1.16 | 1.56 | -0.75 | -4.23 | 1.90 |
| Computer | -0.22 | 0.08 | ***-2.79** | -0.37 | -0.06 | -0.55 | 0.33 | -1.70 | -1.19 | 0.09 | -1.20 | 0.37 | ***-3.22** | -1.94 | -0.47 | -4.46 | 2.28 | ***-1.96** | -8.94 | 0.01 |
| Smart display | -0.13 | 0.08 | -1.74 | -0.28 | 0.02 | -0.43 | 0.31 | -1.38 | -1.05 | 0.18 | -0.16 | 0.36 | -0.44 | -0.86 | 0.55 | -4.52 | 2.19 | ***-2.07** | -8.82 | -0.21 |
| Mobile Smart displays | 0.04 | 0.11 | 0.37 | -0.18 | 0.27 | -0.24 | 0.47 | -0.50 | -1.17 | 0.70 | 0.62 | 0.54 | 1.13 | -0.45 | 1.69 | 1.43 | 3.32 | 0.43 | -5.10 | 7.97 |
| Telepresence Robot | 0.29 | 0.16 | 1.84 | -0.02 | 0.60 | -0.09 | 0.65 | -0.13 | -1.37 | 1.20 | 1.22 | 0.75 | 1.62 | -0.26 | 2.70 | -0.39 | 4.58 | -0.08 | -9.40 | 8.62 |

**Table 3.5** Logistic Regression Models

| | Telepresence | | | | | Telepresence Hardware | | | | | Telepresence Hardware with Limited Mobility | | | | | Telepresence Hardware with Full Mobility | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Categories | | | | | | | | | | | | | | | | | | | | |
| | OR | SE | Z | CI | | OR | SE | Z | CI | | OR | SE | Z | CI | | OR | SE | Z | CI | |
| Age | | | | | | | | | | | | | | | | | | | | |
| 35-44 | 0.67 | 0.28 | -0.98 | 0.30 | 1.50 | 0.61 | 0.24 | -1.26 | 0.28 | 1.32 | 0.40 | 0.16 | *-**2.23** | 0.18 | 0.90 | 0.57 | 0.22 | -1.44 | 0.27 | 1.22 |
| 45-54 | 0.79 | 0.37 | -0.51 | 0.31 | 1.99 | 1.27 | 0.57 | 0.52 | 0.52 | 3.06 | 1.51 | 0.67 | 0.93 | 0.63 | 3.59 | 1.08 | 0.46 | 0.19 | 0.47 | 2.51 |
| 55-64 | 1.10 | 0.49 | 0.22 | 0.46 | 2.64 | 1.27 | 0.52 | 0.60 | 0.57 | 2.83 | 0.85 | 0.33 | -0.42 | 0.39 | 1.83 | 0.81 | 0.31 | -0.56 | 0.38 | 1.72 |
| 65+ | 0.99 | 0.44 | -0.02 | 0.41 | 2.38 | 1.16 | 0.47 | 0.36 | 0.52 | 2.56 | 1.01 | 0.39 | 0.03 | 0.47 | 2.18 | 0.84 | 0.32 | -0.46 | 0.39 | 1.78 |
| 18-34 | | | | | | | | | | | | | | | | | | | | |
| Race | | | | | | | | | | | | | | | | | | | | |
| Asian | 0.87 | 0.44 | -0.27 | 0.32 | 2.35 | 2.18 | 1.11 | 1.54 | 0.81 | 5.89 | 1.99 | 0.98 | 1.40 | 0.76 | 5.20 | 1.28 | 0.60 | 0.52 | 0.51 | 3.19 |
| Black /African American | 1.36 | 0.81 | 0.52 | 0.42 | 4.37 | 1.32 | 0.70 | 0.54 | 0.47 | 3.71 | 1.37 | 0.68 | 0.64 | 0.52 | 3.60 | 1.50 | 0.73 | 0.83 | 0.58 | 3.88 |
| Other | 1.02 | 0.65 | 0.02 | 0.29 | 3.56 | 0.45 | 0.29 | -1.25 | 0.13 | 1.57 | 1.65 | 1.04 | 0.80 | 0.48 | 5.69 | 1.07 | 0.64 | 0.12 | 0.34 | 3.44 |
| White/Caucasian | | | | | | | | | | | | | | | | | | | | |
| Gender | | | | | | | | | | | | | | | | | | | | |
| Female | 1.09 | 0.32 | 0.29 | 0.61 | 1.92 | 1.10 | 0.29 | 0.38 | 0.66 | 1.85 | 1.05 | 0.27 | 0.18 | 0.63 | 1.74 | 1.34 | 0.34 | 1.14 | 0.81 | 2.19 |
| Marital Status | | | | | | | | | | | | | | | | | | | | |
| Married/Co-habitation/Partnered | 1.45 | 0.48 | 1.13 | 0.76 | 2.78 | 1.29 | 0.40 | 0.83 | 0.70 | 2.38 | 1.65 | 0.51 | 1.60 | 0.89 | 3.04 | 1.20 | 0.36 | 0.61 | 0.66 | 2.17 |
| Divorced/Widowed | 4.12 | 2.02 | ***2.88** | 1.57 | 10.79 | 2.01 | 0.84 | 1.68 | 0.89 | 4.54 | 2.12 | 0.88 | 1.82 | 0.94 | 4.77 | 0.95 | 0.38 | -0.13 | 0.43 | 2.07 |
| Single | | | | | | | | | | | | | | | | | | | | |
| Income | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $25,000 - $49,999 | 1.95 | 0.88 | 1.48 | 0.80 | 4.73 | 0.63 | 0.27 | -1.07 | 0.27 | 1.48 | 0.34 | 0.15 | ***-2.50** | 0.14 | 0.79 | 0.66 | 0.27 | -1.02 | 0.30 | 1.47 |
| $50,000 - $74,999 | 3.19 | 1.52 | ***2.44** | 1.26 | 8.12 | 1.14 | 0.51 | 0.30 | 0.48 | 2.75 | 0.62 | 0.27 | -1.09 | 0.26 | 1.46 | 1.03 | 0.43 | 0.06 | 0.45 | 2.34 |
| $75,000 -$100,000+ | 2.57 | 1.20 | ***2.02** | 1.03 | 6.40 | 0.68 | 0.30 | -0.86 | 0.29 | 1.63 | 0.42 | 0.18 | ***-2.00** | 0.18 | 0.98 | 0.72 | 0.30 | -0.80 | 0.32 | 1.62 |
| Less than $25,000 | | | | | | | | | | | | | | | | | | | | |
| County Type | | | | | | | | | | | | | | | | | | | | |
| Suburban | 1.13 | 0.41 | 0.35 | 0.56 | 2.29 | 0.62 | 0.21 | -1.44 | 0.32 | 1.19 | 0.63 | 0.20 | -1.45 | 0.33 | 1.18 | 0.77 | 0.24 | -0.81 | 0.42 | 1.44 |
| Rural | 2.20 | 0.89 | *1.96 | 1.00 | 4.86 | 0.99 | 0.36 | -0.03 | 0.48 | 2.02 | 1.03 | 0.35 | 0.07 | 0.52 | 2.01 | 0.97 | 0.33 | -0.09 | 0.50 | 1.88 |
| Urban | | | | | | | | | | | | | | | | | | | | |
| Personal Health | | | | | | | | | | | | | | | | | | | | |
| Good | 0.96 | 0.37 | -0.10 | 0.45 | 2.04 | 1.34 | 0.48 | 0.81 | 0.66 | 2.69 | 1.38 | 0.50 | 0.89 | 0.68 | 2.79 | 1.05 | 0.37 | 0.15 | 0.53 | 2.10 |
| Very Good - Excellent | 0.80 | 0.32 | -0.56 | 0.36 | 1.76 | 1.03 | 0.39 | 0.08 | 0.49 | 2.15 | 1.38 | 0.52 | 0.86 | 0.66 | 2.91 | 1.42 | 0.52 | 0.96 | 0.69 | 2.91 |
| Poor - Fair | | | | | | | | | | | | | | | | | | | | |
| Personality Types | | | | | | | | | | | | | | | | | | | | |
| Extraversion | 0.87 | 0.06 | ***-2.05** | 0.76 | 0.99 | 0.98 | 0.06 | -0.27 | 0.87 | 1.11 | 0.96 | 0.06 | -0.69 | 0.85 | 1.08 | 0.96 | 0.06 | -0.60 | 0.86 | 1.08 |
| Agreeableness | 1.25 | 0.12 | ***2.21** | 1.03 | 1.52 | 1.20 | 0.11 | 1.90 | 0.99 | 1.44 | 1.12 | 0.10 | 1.24 | 0.94 | 1.34 | 1.15 | 0.10 | 1.56 | 0.97 | 1.37 |
| Conscientiousness | 1.00 | 0.09 | 0.01 | 0.83 | 1.20 | 0.90 | 0.08 | -1.11 | 0.76 | 1.08 | 1.04 | 0.09 | 0.47 | 0.88 | 1.23 | 0.98 | 0.08 | -0.23 | 0.83 | 1.16 |
| Emotional Stability | 0.97 | 0.11 | -0.29 | 0.78 | 1.20 | 0.99 | 0.10 | -0.08 | 0.82 | 1.21 | 0.89 | 0.09 | -1.22 | 0.73 | 1.08 | 1.01 | 0.10 | 0.13 | 0.84 | 1.22 |
| Openness to New Experiences | 1.09 | 0.08 | 1.13 | 0.94 | 1.27 | 0.98 | 0.07 | -0.23 | 0.86 | 1.13 | 0.98 | 0.07 | -0.23 | 0.86 | 1.13 | 0.92 | 0.06 | -1.18 | 0.81 | 1.05 |
| Loneliness | | | | | | | | | | | | | | | | | | | | |
| Emotional Loneliness | 1.11 | 0.09 | 1.31 | 0.95 | 1.29 | 1.20 | 0.09 | ***2.53** | 1.04 | 1.38 | 1.13 | 0.08 | 1.85 | 0.99 | 1.30 | 1.09 | 0.07 | 1.26 | 0.95 | 1.24 |
| Social Loneliness | 0.94 | 0.08 | -0.69 | 0.79 | 1.12 | 0.90 | 0.07 | -1.31 | 0.76 | 1.06 | 0.98 | 0.08 | -0.28 | 0.84 | 1.14 | 1.00 | 0.08 | 0.01 | 0.86 | 1.17 |
| Quality of Life | 0.98 | 0.01 | -1.58 | 0.96 | 1.00 | 0.97 | 0.01 | ***-2.27** | 0.95 | 1.00 | 0.98 | 0.01 | -1.64 | 0.96 | 1.00 | 0.99 | 0.01 | -0.98 | 0.97 | 1.01 |

Table 3.4 and Table 3.5 serve as the foundation for discussing the experience of loneliness across various phases of adulthood, the use of communication technologies, and the intent to adopt telepresence technologies across various level of embodiment.

## Discussion

The purpose of this study was threefold: (1) individual and demographic characteristics contributing the experience of loneliness, (2) explore the role of communication technology and its relationship with the experience of loneliness, (3) investigate the characteristics of adult's interest in the adoption of telepresence technologies across the various levels of embodiment. This research provides a unique insight into the experience of loneliness across the lifespan and clues in on the potential of technologies in serving as a tool to facilitate social connectivity.

### Individual and demographic characteristics contributing to the experience of loneliness across the lifespan.

The findings of this research indicate that the experience of loneliness was associated participants age, marital status, personal health, and personality types such as agreeableness, conscientiousness, emotional stability, and openness. Young adults were more likely to report feeling lonely than middle age and older adults. These findings align with recent research which has identified that young adults are more likely to report feeling lonely than older adults (Lee et al., 2020; Lisitsa et al., 2020). Although, this phenomenon has been more acutely observed during the outbreak of COVID-19, similar findings have been observed prior to the outbreak of the global pandemic(Odacı & Kalkan, 2010; Victor & Yang, 2012). However, implications of the pandemic cannot be underestimated as frequency of communication has been identified as a protective factor in the experience of loneliness among young adults (Qualter et al., 2015). It is

possible that the decrease in the frequency of social contact can have a greater impact on the experience of loneliness by young adults.

Findings indicate that individual who reported being divorced or widowed were more likely to experience feelings of loneliness than those who were single, married, cohabitating, or living with a partner. These differences across various relationship types may have a more severe impact among middle age and older adults. This supports findings from prior research which has indicated that relationships status can play a role in how individual report life satisfaction and through social and emotional loneliness (Adamczyk & Segrin, n.d.). Across the multivariate analysis I observed that adults who married, cohabitating, or living with a partner were significantly more likely to report lower rates of social loneliness than single individuals. Participants who were divorced or widowed were significantly more likely to report emotional loneliness than individuals who were single. This data suggests that relationship types can have a contributing effect on the experiences of both social and emotional loneliness.

Health was identified as contributing factor to the experience of loneliness at both the bivariate and multivariate level. Individuals who reported very good or excellent health were significantly more likely to report lower rates of both social and emotional loneliness than those who reported poor and good health. These findings align with previous finding which have indicated that health and chronic health conditions can have severe implications in in the experience of loneliness (Cacioppo et al., 2002; Lee et al., 2020; Luanaigh & Lawlor, 2008). The experience of loneliness is often connected to chronic health conditions such as cardiovascular disease, high blood pressure, mental health challenges such as depression, anxiety, and declines in cognitive health (Gerst-Emerson & Jayawardhana, 2015; Kristensen et al., 2019). This data suggests that the impact of health may have implications not only on the opportunity to engage in

social connections but also on the quality of connections individuals are able to achieve due to poor health. This indicates that the experience poor health can impact individual's ability to form, support, maintain meaningful relationships increasing the likelihood of loneliness.

Participants who scored higher across agreeableness, conscientiousness, emotional stability, and openness have been identified as contributing factors to the experience of loneliness. However, these effects were not observed when included in a multivariate model which may indicate that personality types may not be a determinant of loneliness. However, the effect of personality on the experience of loneliness may indirect, as variations and combinations of personality traits can influence the ways in which individuals are able to form and maintain meaningful relationships. Prior research has indicated that the personality types are stable though the aging process (Dahlberg & McKee, 2014; Ormstad et al., 2020), therefore awareness of personality types may help aid in developing strategies to help raise awareness and create strategies to support meaningful relationships.

**Quality of life across the lifespan**

Supporting the quality of life of adults is particularly important in helping support healthy aging and promote wellbeing across adulthood. This study indicates that there was significant difference in the quality of score reported by older adults when compared to young adults. Older adults were more likely to report a lower quality of life. Although age alone is not necessarily a predictor of an overall quality of life, challenges which are often associated with aging can present challenges in supporting a maintaining a high quality of life (Carr et al., 2001; Netuveli & Blane, 2008; van Leeuwen et al., 2019). For example, changing social support, loss of a friends or partner, and development of strategies to changing social roles can have strong implications individual's quality of life. Interestingly, this research indicated that higher

perceived health had a negative relationship with that of participants quality-of-life scores. However, this may be due to quality of life being a multidimensional construct that includes internal (physical health, mental health, social wellbeing) and external features (resources, community membership, economics) (Estebsari et al., 2013). Prior research indicates that social support, individual coping strategies, social interactions, and living conditions are important factor in the experience of a higher quality of life(Abbasi et al., 2018; Carr et al., 2001; Schrag et al., 2000).

**Communication technologies and the experience of loneliness**

Communication technologies have become a key component in the day-to-day interactions and enable us to connect with the world around and have been increasingly utilized in interventions. Understanding how technology may be able to allow us to formulate and maintain meaningful social connections is an important step toward leveraging them as tools to help address various needs of their users across phases of adulthood. Findings indicates that participants who used social media and a personal computer were more likely to report a lower level of overall loneliness than those that were not using these technologies. Individuals who use social media were also more likely to have a reduced level of social loneliness than those who did not use it. One explanation for social media's role in reducing the experience of overall and social loneliness could be that it provides opportunities for improved social network, wider range of access to close relationships such as friends and family members. Other researchers have found similar results which indicate that the use of social media may be beneficial in supporting relationships, creating a wider range social connections and opportunities for new relationships (Aarts, 2018; Appel et al., 2020; Barry et al., 2017).

Participants who used communication applications and a personal computer were less likely to report emotional loneliness than those who did not use it. However, individuals who engaged via blogs or online forums were more likely to experience a higher level of emotional loneliness. Findings indicate that the use of technology platforms which enable communication with individuals who one knows or has meaningful relationships with may be more beneficial in helping address feelings of emotional loneliness which is the result of a gap in feelings of attachment and having someone to rely on. Using communication apps (e.g., GroupMe, What's App) may provide users a stronger sense of connection with those with whom they have developed meaningful relationships with. Online blogs, forum style sites, and forum style application (e.g., reddit) tend to be geared toward maintaining the user's anonymity(Clark et al., 2018). Findings indicate that the types of connections formed across the communication technology may have an impact on the feelings of attachment and ability to have someone to rely on.

Participants who were users of a computer or a smart display were more likely to report a lower quality of life. This is particularly interesting as computer users were more likely to report lower rates of loneliness. An explanation for this observation may be related to how individuals use their computer and smart display. Another explanation could be related to the expectation individuals may have in relation to the technology. Previous research has indicated that the application for which the technology is being used can play a role in the users perception and potentially have an impact on the perceived quality of life (Hacker, 2010; McPheat, 1996; Wac et al., 2017). For example, the use of personal technologies such as personal computers to facilitate remote social integrations may result in the replacement of face-to-face interactions which have a negative effect on individuals' sense of connectivity and overall quality of life

(Chan et al., 2014; Fortunati et al., 2013; Muñoz Sáez et al., 2013). Therefore, a deeper understanding of how each technology is being used and implemented in the day-to-day life can help give insights in how it may serve a role a tool to facilitate access or if usability challenges create barriers for users in being able to attain a higher quality of life. This research has not focused on understanding each individual technology and its overall integration. For example, an individual may have access and use a personal computer, however, this does not mean that the user is utilizing the technology to engage in meaningful social connection and access resources.

**Intent to Adopt Technology across Embodiment Levels**

The intent to adopt telepresence technologies across various level of embodiment varied across marital status, age, income, type of county participants lived in, experience of emotional loneliness, and overall quality of life. Participants who earned a higher income had higher odds of adopting technologies with a lower level of embodiment. A potential explanation for this is that those who have a higher income may already be users and have access to video conferencing and smart displays. Those who earned more had lower odds of adopting telepresence technologies with a higher level of embodiment such telepresence technologies with limited mobility, when compared to individuals who earned $25,000 or less. However, access and use of these technologies may reduce the need to adopt and use higher embodied technologies. This is particularly concerning because as the embodiment levels of telepresence technologies increase, the cost to attain and maintain them also increases, posing particular challenge for those with lower incomes. This presents a social justice issue as those with lower income may perceive higher embodied technologies more beneficial in bridging the resource gap hindering them from being able to engage in meaningful social connections. The location of participants residence also had implications for their intent to adopt technologies. Individuals who resided in a rural

community were 2.2 times more likely to have an intent to adopt telepresence technologies than those residing in urban areas. Previous research has provided insights pertaining to the challenges faced by rural dwelling adults, as greater distances between family member, acquittances, and community resources can create challenges in access to resources (Berg et al., 2017; Burholt & Scharf, 2014). Based on our findings, telepresence technologies may present opportunities to help adults who reside in more rural areas to have improved access to engage in meaningful social connections.

Telepresence technology may present an opportunity in creating not only connections but also access to social resources, health services, and contact with local and distant communities. A key challenge often faced by individuals living in rural communities is access to the requirements in being able to access telepresence technologies and running them effectively (Chhachhar et al., 2013). This research supports the need to expand telepresence resources and improve accessibility to help facilitate social connectivity and address the experience of loneliness of those living in rural communities (Cotten et al., 2013; Kelly et al., 2019; Savikko et al., 2005). Participant's personality types were also associated with their intent to adopt these technologies. Those who reported being more agreeable had higher odds of being interested in adopting telepresence, however, those who reported higher levels of extraversion were less likely to intend on adopting telepresence technology. Previous research has indicated that individuals who reported higher level of agreeableness and extraversion tend to be less lonely (Buecker et al., 2020; Hensley et al., 2012; Teppers et al., 2013). Agreeableness is characterize with positive interpersonal outcomes and limited social conflict while extraversion is associated with high levels of engagement in social interactions and activities (Kamath & Kanekar, 1993; Selfhout et al., 2010; Zalk et al., 2010; Ziegler et al., 2019). A possible explanation for the findings in this

study may be individuals who report being more agreeable may be more inclined to leverage telepresence to maintain social connection and meet the needs of their family or friends. Individuals who report higher rates of extraversion may be less likely to adopt technologies because they tend to be more outgoing and more likely to reach out to individuals in their social network (Breil et al., 2019; Sherman et al., 2015). Comprehending the role of personality types is particularly important in the development of strategies which aim to understand individual needs and preferences and creating services and programs which meet the individuals where they are at.

Those who were emotionally lonely had higher odds of having the intent to adopt standalone telepresence hardware, such as smart displays. Emotional loneliness is tied to feelings of anxiety and a lack of intimate attachment. Study findings indicate that an increase in the level of presence achieved through a technology medium may present an opportunity to enhance feeling attachment. Although there is no significant difference amongst other forms of higher levels of embodiment, across all technologies, there seems to be a linear relationship between those who report higher levels of emotional loneliness and intent adopt telepresence technologies. These findings indicate that the sense of presence which can be achieved through higher level embodied telepresence technologies may provide a stronger sense of attachment between the senders and receivers of messages (Moyle et al., 2017, 2020; Yoshida & Tanaka, 2018). Telepresence technologies, including but not limited to personal devices such as smartphones can offer the ability to access engagement and connections on the go, and through a medium which individuals may already be familiar with. Adoption of more advanced technologies such as smart displays or telepresence robots require their use in specific spaces (e.g., home, apartment, community center). However, the role of these technologies may serve

certain roles in allowing individual to engage with remote spaces which could otherwise not be attained. For example, an individual may use a telepresence software through their personal device (e.g., smartphone) to control a telepresence robot located in the home of a friend, or in a museum which they would like to visit.

## Implications

Communication technologies presents much potential in helping bridge the resource gap needed to help address the loneliness epidemic. Leveraging communication can be an effective way of providing adults with a tool which can be used to help facilitate meaningful relationships. However current literature is limited in explain how young and middle age adults are using and implementing communication technologies. Research is needed to expand the understanding on communication technologies with technology embodiment features could be used and implement in the lives of all adults. The current literature has found promising findings surrounding the application of telepresence robots (Boissy et al., 2007; Cesta et al., 2012; Moyle et al., 2017) however its application with young and middle age adults has only been studied in settings outside the home (Cha et al., 2017; Keller et al., 2021; Newhart, 2014). Future research should aim in understanding how individuals across lifespan perceive and intend to use these technologies.

Findings indicate that the use and application of communication technology types had varied positive and negative impacts on the emotional and social dimensions of loneliness. Prior research has indicated that the experience of emotional and social loneliness is distinct and the factors contributing to the experience of loneliness across these dimensions can often be attributed to distinct factors associate with personality types and demographic data (Dahlberg & McKee, 2014; Holmén et al., 2000; Wolfers et al., 2021). However, this area of research is

limited and has been predominantly focused on the experience of loneliness of older adults. Future research should aim to better understand the factors contributing to the multidimensional experience of loneliness by adults across the lifespan. Furthermore, the translational of existing surrounding the application of communication technologies can be an important step towards the development of real world intervention and applications (Mois & Fortuna, 2020; Sixsmith et al., 2017).

## Strengths and Limitations

There are many strengths in the current study. The study provides a large sample, a overview of technology use and implementation across the lifespan, and an overview of the experience of loneliness across various phases of adulthood. However, there are some limitations which should be addressed. The predictive qualities of a cross-sectional design study are limited as they only provide a point in time understanding of the phenomenon being study. Future research should aim to develop a longitudinal approach to understanding loneliness along with the technology adoption process. A longitudinal approach could also help address and enhance the understanding if adoption and implementation of communication technologies to engage in meaningful communication is related to specific phases of adulthood or is the result of a cohort effect, meaning that the technologies which individuals adopt currently will impact the adoption of technologies in the future. For example, early adaptors across the lifespan may not only be inclined to adopt the latest technology during early adulthood, but also as they transition across various phases of adulthood.

This research accounted for technologies which included prevalent modes of communication such, including alternative modes of communication such as video games, virtual reality, and platforms which support online communities may provide a deeper

understanding of how individual may use and apply a more diverse set of technologies. I presented participants with a set of four different types of telepresence technologies across various levels of embodiment using a series of slides which identified the qualities of potential uses. It may be useful in future research that elaborate videos be utilized to ensure that participants interpretation of the technology is more controlled. Furthermore, the current sample implemented Amazon Mturk as a database for recruitment limiting the diversity of the sample. Future research should aim to make an extensive recruitment effort diversifying sampling. However, this limitation also presents a need in expanding the understanding of the online workforce and their overall experience of loneliness and quality of life.

## Conclusion

This research provides an in-depth overview of the experience of loneliness and contributes to the existing knowledge base. This investigation of communication technologies indicates that it holds an important role in the addressing multiple dimensions of loneliness and may aid in facilitating social connectivity. Furthermore, findings indicate that telepresence embodiment can be a meaningful component in the level of social connections achieved across technology mediated communication. Research is needed to further explore how extended use of communication technologies across various levels of embodiment may impact the user's sense of connection.

## References

Aalbers, G., McNally, R. J., Heeren, A., de Wit, S., & Fried, E. I. (2019). Social media and depression symptoms: A network perspective. *Journal of Experimental Psychology: General*, *148*(8), 1454–1462. psyh. https://doi.org/10.1037/xge0000528

Aarts, S. (2018). Social media and loneliness among community-dwelling older adults. *International Journal of Geriatric Psychiatry*, *33*(3), 554–555.

Abbasi, A., Ghezeljeh, T. N., & Farahani, M. A. (2018). Effect of the self-management education program on the quality of life in people with chronic heart failure: A randomized controlled trial. *Electronic Physician*, *10*(7), 7028–7037. https://doi.org/10.19082/7028

Adamczyk, K., & Segrin, C. (n.d.). Direct and Indirect Effects of Young Adults' Relationship Status on Life Satisfaction through Loneliness and Perceived Social Support. *Psychologica Belgica*, *55*(4), 196–211. https://doi.org/10.5334/pb.bn

Ahn, D., & Shin, D.-H. (2013). Is the social use of media for seeking connectedness or for avoiding social isolation? Mechanisms underlying media use and subjective well-being. *Computers in Human Behavior*, *29*(6), 2453–2462. psyh. https://doi.org/10.1016/j.chb.2012.12.022

Ahn, J. (2014). Review of It's complicated: The social lives of networked teens and The app generation: How today's youth navigate identity, intimacy, and imagination in a digital world. *Journal of Children and Media*, *8*(3), 313–316. psyh. https://doi.org/10.1080/17482798.2014.923607

Antoci, A., Sabatini, F., & Sodini, M. (2012). See you on Facebook! A framework for analyzing the role of computer-mediated interaction in the evolution of social capital. *Journal of Socio-Economics*, *41*(5), 541–547. sih.

Appel, M., Marker, C., & Gnambs, T. (2020). Are Social Media Ruining Our Lives? A Review of Meta-Analytic Evidence. *Review of General Psychology*, *24*(1), 60–74. cin20. https://doi.org/10.1177/1089268019880891

Barry, C. T., Sidoti, C. L., Briggs, S. M., Reiter, S. R., & Lindsey, R. A. (2017). Adolescent social media use and mental health from adolescent and parent perspectives. *Journal of Adolescence*, *61*, 1–11. psyh. https://doi.org/10.1016/j.adolescence.2017.08.005

Beno, M. (2018). Work Flexibility, Telepresence in the Office for Remote Workers: A Case Study from Austria. In M. Kaenampornpan, R. Malaka, D. D. Nguyen, & N. Schwind (Eds.), *Multi-disciplinary Trends in Artificial Intelligence* (pp. 19–31). Springer International Publishing. https://doi.org/10.1007/978-3-030-03014-8_2

Berg, T., Winterton, R., Petersen, M., & Warburton, J. (2017). "Although we're isolated, we're not really isolated": The value of information and communication technology for older people in rural Australia. *Australasian Journal on Ageing*, *36*(4), 313–317. cin20. https://doi.org/10.1111/ajag.12449

Bevilacqua, R., Cesta, A., Cortellessa, G., Macchione, A., Orlandini, A., & Tiberio, L. (2014). *Telepresence Robot at Home: A Long-Term Case Study* (pp. 73–85). https://doi.org/10.1007/978-3-319-01119-6_8

Boissy, P., Corriveau, H., Michaud, F., Labonté, D., & Royer, M.-P. (2007). A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects. *Journal Of Telemedicine And Telecare*, *13*(2), 79–84.

Breil, S. M., Geukes, K., Wilson, R. E., Nestler, S., Vazire, S., & Back, M. D. (2019). Zooming into Real-Life Extraversion – how Personality and Situation Shape Sociability in Social Interactions. *Collabra: Psychology*, *5*(1). https://doi.org/10.1525/collabra.170

Buecker, S., Maes, M., Denissen, J. J. A., & Luhmann, M. (2020). Loneliness and the Big Five Personality Traits: A Meta–Analysis. *European Journal of Personality*, *34*(1), 8–28. https://doi.org/10.1002/per.2229

Burckhardt, C. S., & Anderson, K. L. (2003). The Quality of Life Scale (QOLS): Reliability, Validity, and Utilization. *Health and Quality of Life Outcomes*, *1*(1), 60. https://doi.org/10.1186/1477-7525-1-60

Burholt, V., & Scharf, T. (2014). Poor Health and Loneliness in Later Life: The Role of Depressive Symptoms, Social Resources, and Rural Environments. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *69*(2), 311–324. https://doi.org/10.1093/geronb/gbt121

Cacioppo, J. T., Hawkley, L. C., Crawford, L. E., Ernst, J. M., Burleson, M. H., Kowalewski, R. B., Malarkey, W. B., Van Cauter, E., & Berntson, G. G. (2002). Loneliness and Health: Potential Mechanisms: *Psychosomatic Medicine*, *64*(3), 407–417. https://doi.org/10.1097/00006842-200205000-00005

Carr, A. J., Gibson, B., & Robinson, P. G. (2001). Is quality of life determined by expectations or experience? *BMJ : British Medical Journal*, *322*(7296), 1240–1243.

Casiddu, N., Cesta, A., Cortellessa, G., Orlandini, A., Porfirione, C., Divano, A., Micheli, E., & Zallio, M. (2015). Robot Interface Design: The Giraff Telepresence Robot for Social Interaction. In *Biosystems and Biorobotics* (Vol. 11, pp. 499–509). https://doi.org/10.1007/978-3-319-18374-9_46

Cesta, A., Cortellessa, G., Orlandini, A., & Tiberio, L. (2012). Addressing the long-term evaluation of a telepresence robot for the elderly. *ICAART 2012 - Proceedings of the 4th International Conference on Agents and Artificial Intelligence*, *1*, 652–663.

Cha, E., Chen, S., & Mataric, M. J. (2017). Designing telepresence robots for K-12 education. *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 683–688. https://doi.org/10.1109/ROMAN.2017.8172377

Chan, W. C. H., Kwan, C. W., Chi, I., & Chong, A. M. L. (2014). The impact of loneliness on the relationship between depression and pain of Hong Kong Chinese terminally ill patients. *Journal Of Palliative Medicine*, *17*(5), 527–532.

Chhachhar, A. R., Makhijani, H., Khushk, G., & Maher, Z. (2013). Information and Communication Technologies for Rural Development in Developing Countries. *Journal of American Science*, *9*, 83–88.

Child, S. T., & Lawton, L. (2019). Loneliness and social isolation among young and late middle-age adults: Associations with personal networks and social participation. *Aging & Mental Health*, *23*(2), 196–204.

Choi, J.-J., & Kwak, S. S. (2016). Can you feel me?: How embodiment levels of telepresence systems affect presence. *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 606–611. https://doi.org/10.1109/ROMAN.2016.7745180

*Cigna U.S. Loneliness Index*. (2018). [Index]. Cigna. https://www.multivu.com/players/English/8294451-cigna-us-loneliness-survey/docs/IndexReport_1524069371598-173525450.pdf

Clark, J. L., Algoe, S. B., & Green, M. C. (2018). Social network sites and well-being: The role of social connection. *Current Directions in Psychological Science*, *27*(1), 32–37. psyh. https://doi.org/10.1177/0963721417730833

Cotten, S. R., Anderson, W. A., & McCullough, B. M. (2013). Impact of internet use on loneliness and contact with others among older adults: Cross-sectional analysis. *Journal of Medical Internet Research*, *15*(2), e39–e39. cin20. https://doi.org/10.2196/jmir.2306

Dahlberg, L., & McKee, K. J. (2014). Correlates of social and emotional loneliness in older people: Evidence from an English community study. *Aging & Mental Health*, *18*(4), 504–514. https://doi.org/10.1080/13607863.2013.856863

de Jong-Gierveld, J. (1987). Developing and testing a model of loneliness. *Journal of Personality and Social Psychology*, *53*(1), 119–128. https://doi.org/10.1037/0022-3514.53.1.119

de Jong-Gierveld, J., & Kamphuls, F. (1985). The Development of a Rasch-Type Loneliness Scale. *Applied Psychological Measurement*, *9*(3), 289–299. https://doi.org/10.1177/014662168500900307

DiTommaso, E., & Spinner, B. (1997). Social and emotional loneliness: A re-examination of weiss' typology of loneliness. *Personality and Individual Differences*, *22*(3), 417–427. https://doi.org/10.1016/S0191-8869(96)00204-8

Dykstra, P. A., & Fokkema, T. (2007). Social and Emotional Loneliness Among Divorced and Married Men and Women: Comparing the Deficit and Cognitive Perspectives. *Basic and Applied Social Psychology*, *29*(1), 1–12. https://doi.org/10.1080/01973530701330843

Estebsari, F., Taghdisi, M. H., Mostafaei, D., Jamshidi, E., & Latifi, M. (2013). Determining the Factors Contributing to Quality of Life of Patients at the Last Stage of Life: A Qualitative

Study. *Iranian Red Crescent Medical Journal*, *15*(12), e13594. https://doi.org/10.5812/ircmj.13594

Fortunati, L., Taipale, S., & de Luca, F. (2013). What happened to body-to-body sociability? *Social Science Research*, *42*, 893–905. https://doi.org/10.1016/j.ssresearch.2012.12.006

Gerst-Emerson, K., & Jayawardhana, J. (2015). Loneliness as a Public Health Issue: The Impact of Loneliness on Health Care Utilization Among Older Adults. *American Journal of Public Health*, *105*(5), 1013–1019. https://doi.org/10.2105/AJPH.2014.302427

Gierveld, J. de J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology*, *8*(1), 73–80. https://doi.org/10.1017/S0959259898008090

Haans, A., & IJsselsteijn, W. A. (2012). Embodiment and telepresence: Toward a comprehensive theoretical framework. *Interacting with Computers*, *24*(4), 211–218. https://doi.org/10.1016/j.intcom.2012.04.010

Hacker, E. D. (2010). Technology and Quality of Life Outcomes. *Seminars in Oncology Nursing*, *26*(1), 47–58. https://doi.org/10.1016/j.soncn.2009.11.007

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *40*(2), 218–227. https://doi.org/10.1007/s12160-010-9210-8

Heidemann, J., Klier, M., & Probst, F. (2012). Online social networks: A survey of a global phenomenon. *Computer Networks*, *56*(18), 3866–3878. https://doi.org/10.1016/j.comnet.2012.08.009

Hensley, B., Martin, P., Margrett, J. A., MacDonald, M., Siegler, I. C., Poon, L. W., Jazwinski, S. M., Green, R. C., Gearing, M., Woodard, J. L., Johnson, M. A., Tenover, J. S., Rodgers, W. L., Hausman, D. B., Rott, C., Davey, A., & Arnold, J. (2012). Life events and personality predicting loneliness among centenarians: Findings from the Georgia Centenarian Study. *The Journal of Psychology*, *146*(1–2), 173–188. https://doi.org/10.1080/00223980.2011.613874

Holmén, K., Ericsson, K., & Winblad, B. (2000). Social and emotional loneliness among non-demented and demented elderly people. *Archives of Gerontology and Geriatrics*, *31*(3), 177–192. https://doi.org/10.1016/S0167-4943(00)00070-4

Kamath, M., & Kanekar, S. (1993). Loneliness, Shyness, Self-Esteem, and Extraversion. *The Journal of Social Psychology*, *133*(6), 855–857. https://doi.org/10.1080/00224545.1993.9713949

Keller, L., Gawron, O., Rahi, T., Ulsamer, P., & Müller, N. H. (2021). Driving Success: Virtual Team Building Through Telepresence Robots. In P. Zaphiris & A. Ioannou (Eds.), *Learning and Collaboration Technologies: Games and Virtual Environments for Learning* (pp. 278–291). Springer International Publishing. https://doi.org/10.1007/978-3-030-77943-6_18

Kelly, E. P., Payne, N., & Pawlik, T. M. (2019). Understanding patient expectations around therapeutic benefits, risks, and the chance of cure. *American Journal Of Surgery*, *217*(3), 410–412.

Koceski, S., & Koceska, N. (2016). Evaluation of an Assistive Telepresence Robot for Elderly Healthcare. *Journal of Medical Systems*, *40*(5), 121. https://doi.org/10.1007/s10916-016-0481-x

Kristensen, K., König, H.-H., & Hajek, A. (2019). The association of multimorbidity, loneliness, social exclusion and network size: Findings from the population-based German Ageing Survey. *BMC Public Health*, *19*(1), 1–10. cin20. https://doi.org/10.1186/s12889-019-7741-x

Kuzuoka, H., Kodama, Y., Harada, E., Osawa, H., Xu, J., & Myodo, E. (2018). Telepresence Robot's Salutations to Trigger Informal Conversation with Teleworkers. In *Companion of the 2018 Acm Conference on Computer Supported Cooperative Work and Social Computing (cscw'18)* (pp. 233–236). https://doi.org/10.1145/3272973.3274063

Lai, P. C. (2017). THE LITERATURE REVIEW OF TECHNOLOGY ADOPTION MODELS AND THEORIES FOR THE NOVELTY TECHNOLOGY. *Journal of Information Systems and Technology Management*, *14*, 21–38. https://doi.org/10.4301/s1807-17752017000100002

Lee, C. M., Cadigan, J. M., & Rhew, I. C. (2020). Increases in Loneliness Among Young Adults During the COVID-19 Pandemic and Association With Increases in Mental Health Problems. *Journal of Adolescent Health*, *67*(5), 714–717. https://doi.org/10.1016/j.jadohealth.2020.08.009

Lisitsa, E., Benjamin, K. S., Chun, S. K., Skalisky, J., Hammond, L. E., & Mezulis, A. H. (2020). Loneliness among young adults during covid-19 pandemic: The mediational roles of social media use and social support seeking. *Journal of Social and Clinical Psychology*, *39*(8), 708–726. https://doi.org/10.1521/jscp.2020.39.8.708

Luanaigh, C. O., & Lawlor, B. A. (2008). Loneliness and the health of older people. *INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY*, *12*, 1213.

Marangoni, C., & Ickes, W. (1989). Loneliness: A Theoretical Review with Implications for Measurement. *Journal of Social and Personal Relationships*, *6*(1), 93–128. https://doi.org/10.1177/026540758900600107

McLoughlin, L., Spears, B., & Taddeo, C. (2018). The Importance of Social Connection for Cybervictims: How Connectedness and Technology Could Promote Mental Health and Wellbeing in Young People. *International Journal of Emotional Education*, *10*(1), 5–24.

McPheat, D. (1996). Technology and Life-Quality. *Social Indicators Research*, *37*(3), 281–301.

Mois, G., & Beer, J. M. (2020). The Role of Healthcare Robotics in Providing Support to Older Adults: A Socio-ecological Perspective. *Current Geriatrics Reports*, *9*(2), 82–89. https://doi.org/10.1007/s13670-020-00314-w

Mois, G., & Fortuna, K. (2020). Visioning the Future of Gerontological Digital Social Work. *Journal of Gerontological Social Work*, *63*, 1–16. https://doi.org/10.1080/01634372.2020.1772436

Moyle, W., Arnautovska, U., Ownsworth, T., & Jones, C. (2017). Potential of telepresence robots to enhance social connectedness in older adults with dementia: An integrative review of feasibility. *International Psychogeriatrics*, *29*(12), 1951–1964. https://doi.org/10.1017/S1041610217001776

Moyle, W., Jones, C., & Sung, B. (2020). Telepresence robots: Encouraging interactive communication between family carers and people with dementia. *Australasian Journal on Ageing*, *39*(1), e127–e133. https://doi.org/10.1111/ajag.12713

Muñoz Sáez, D., Cornejo, R., Ochoa, S., Favela, J., Gutierrez, F., & Tentori, M. (2013). Aligning Intergenerational Communication Patterns and Rhythms in the Age of Social Media. In

*ACM International Conference Proceeding Series*. https://doi.org/10.1145/2535597.2535607

Netuveli, G., & Blane, D. (2008). Quality of life in older ages. *British Medical Bulletin*, *85*(1), 113–126. https://doi.org/10.1093/bmb/ldn003

Newhart, V. A. (2014). Virtual inclusion via telepresence robots in the classroom. *CHI '14 Extended Abstracts on Human Factors in Computing Systems*, 951–956. https://doi.org/10.1145/2559206.2579417

Nicolaisen, M., & Thorsen, K. (2017). What Are Friends for? Friendships and Loneliness Over the Lifespan—From 18 to 79 Years. *International Journal of Aging & Human Development*, *84*(2), 126–158.

Nunes, A., Limpo, T., Lima, C. F., & Castro, S. L. (2018). Short Scales for the Assessment of Personality Traits: Development and Validation of the Portuguese Ten-Item Personality Inventory (TIPI). *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00461

Odacı, H., & Kalkan, M. (2010). Problematic Internet use, loneliness and dating anxiety among young adult university students. *Computers & Education*, *55*(3), 1091–1097. https://doi.org/10.1016/j.compedu.2010.05.006

Ormstad, H., Eilertsen, G., Heir, T., & Sandvik, L. (2020). Personality traits and the risk of becoming lonely in old age: A 5-year follow-up study. *Health and Quality of Life Outcomes*, *18*(1), 47. https://doi.org/10.1186/s12955-020-01303-5

O'Rourke, H. M., & Sidani, S. (2017a). Definition, Determinants, and Outcomes of Social Connectedness for Older Adults: A Scoping Review. *Journal of Gerontological Nursing; Thorofare*, *43*(07), 43–52. http://dx.doi.org.proxy-remote.galib.uga.edu/10.3928/00989134-20170223-03

O'Rourke, H. M., & Sidani, S. (2017b). Definition, Determinants, and Outcomes of Social Connectedness for Older Adults: A Scoping Review. *Journal of Gerontological Nursing; Thorofare*, *43*(07), 43–52. http://dx.doi.org.proxy-remote.galib.uga.edu/10.3928/00989134-20170223-03

Ortiz-Ospina, E., & Roser, M. (2020). Loneliness and Social Connections. *Our World in Data*. https://ourworldindata.org/social-connections-and-loneliness

Qualter, P., Vanhalst, J., Harris, R., Roekel, E. van, Lodder, G. M. A., Bangee, M., Maes, M., & Verhagen, M. (2015). Loneliness across the life span. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science*, *10*(2), 250–264. https://doi.org/10.1177/1745691615568999

Salimi, A. (2011). Social-Emotional Loneliness and Life Satisfaction. *Procedia - Social and Behavioral Sciences*, *29*, 292–295. https://doi.org/10.1016/j.sbspro.2011.11.241

Savela, N., Turja, T., & Oksanen, A. (2018). Social Acceptance of Robots in Different Occupational Fields: A Systematic Literature Review. *International Journal of Social Robotics*, *10*(4), 493–502. https://doi.org/10.1007/s12369-017-0452-5

Savikko, N., Routasalo, P., Tilvis, R. S., Strandberg, T. E., & Pitkälä, K. H. (2005). Predictors and subjective causes of loneliness in an aged population. *Archives of Gerontology and Geriatrics*, *41*(3), 223–233. https://doi.org/10.1016/j.archger.2005.03.002

Schrag, A., Jahanshahi, M., & Quinn, N. (2000). What contributes to quality of life in patients with Parkinson's disease? *Journal of Neurology, Neurosurgery & Psychiatry*, *69*(3), 308–312. https://doi.org/10.1136/jnnp.69.3.308

Selfhout, M., Burk, W., Branje, S., Denissen, J., van Aken, M., & Meeus, W. (2010). Emerging late adolescent friendship networks and Big Five personality traits: A social network

approach. *Journal of Personality*, *78*(2), 509–538. https://doi.org/10.1111/j.1467-6494.2010.00625.x

Sherman, R. A., Rauthmann, J. F., Brown, N. A., Serfass, D. G., & Jones, A. B. (2015). The independent effects of personality and situations on real-time expressions of behavior and emotion. *Journal of Personality and Social Psychology*, *109*(5), 872–888. https://doi.org/10.1037/pspp0000036

Sixsmith, A., Mihailidis, A., & Simeonov, D. (2017). Aging and Technology: Taking the Research into the Real World. *Public Policy & Aging Report*, *27*(2), 74.

*StataCorp* (Version 17). (2021). [Computer software]. TX: StataCorp LLC.

*Survey Instruments | HINTS*. (n.d.). Retrieved June 16, 2021, from https://hints.cancer.gov/data/survey-instruments.aspx

Teppers, E., Klimstra, T. A., Damme, C. V., Luyckx, K., Vanhalst, J., & Goossens, L. (2013). Personality traits, loneliness, and attitudes toward aloneness in adolescence. *Journal of Social and Personal Relationships*, *30*(8), 1045–1063. https://doi.org/10.1177/0265407513481445

Tsui, K. M., Desai, M., Yanco, H. A., & Uhlik, C. (2011). Exploring use cases for telepresence robots. *2011 6th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 11–18. https://doi.org/10.1145/1957656.1957664

van Leeuwen, K. M., van Loon, M. S., van Nes, F. A., Bosmans, J. E., de Vet, H. C. W., Ket, J. C. F., Widdershoven, G. A. M., & Ostelo, R. W. J. G. (2019). What does quality of life mean to older adults? A thematic synthesis. *PLoS ONE*, *14*(3), e0213263. https://doi.org/10.1371/journal.pone.0213263

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Victor, C. R., & Yang, K. (2012). The prevalence of loneliness among adults: A case study of the United Kingdom. *The Journal of Psychology*, *146*(1–2), 85–104. https://doi.org/10.1080/00223980.2011.613875

Wac, K., Rivas, H., & Fiordelli, M. (2017). Quality-of-Life Technologies. *Computer*, *50*(03), 14–19. https://doi.org/10.1109/MC.2017.89

Wang, M., Pan, C., & Ray, P. K. (2021). Technology Entrepreneurship in Developing Countries: Role of Telepresence Robots in Healthcare. *IEEE Engineering Management Review*, *49*(1), 20–26. https://doi.org/10.1109/EMR.2021.3053258

Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation* (pp. xxii, 236). The MIT Press.

Wolfers, M. E. G., Stam, B. E., & Machielse, A. (2021). Correlates of emotional and social loneliness among community dwelling older adults in Rotterdam, the Netherlands. *Aging & Mental Health*, *0*(0), 1–13. https://doi.org/10.1080/13607863.2021.1875191

Yoshida, H., & Tanaka, F. (2018). Maintaining the Presence of Remote Speakers on Telepresence Robots by Visual Morphing to Reduce Loneliness. In J. J. Cabibihan, F. Mastrogiovanni, A. K. Pandey, S. Rossi, & M. Staffa (Eds.), *2018 27th Ieee International Symposium on Robot and Human Interactive Communication (ieee Ro-Man 2018)* (pp. 404–409).

Zalk, M., Burk, W., Branje, S., Denissen, J., Aken, M., & Meeus, W. (2010). Emerging Late Adolescent Friendship Networks and Big Five Personality Traits: A Social Network

Approach. *Journal of Personality*, *78*, 509–538. https://doi.org/10.1111/j.1467-6494.2010.00625.x

Zhang, M., Duan, P., Zhang, Z., & Esche, S. (2019, January 15). *Development of Telepresence Teaching Robots With Social Capabilities*. ASME 2018 International Mechanical Engineering Congress and Exposition. https://doi.org/10.1115/IMECE2018-86686

Ziegler, M., Horstmann, K., & Ziegler, J. (2019). Personality in Situations: Going Beyond the OCEAN and Introducing the Situation Five. *Psychological Assessment*, *31*. https://doi.org/10.1037/pas0000654

Zouinar, M., & Velkovska, J. (2017). Talking about things: Image-based topical talk and intimacy in video-mediated family communication. *Pragmatics*, *27*(3), 387–418.

Appendix 3.1 Survey Instrument (Available per request)

Appendix 3.2 Consent Form (Available per request)

# CHAPTER 4

# UNDERSTANDING THE ROLE OF EMBODIMENT IN SUPPORTING QUALITY SOCIAL CONNECTIONS

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Abstract

***Background:*** The experience of loneliness across the lifespan is one most pressing and significant health challenges in the United States and across the globe. (Bruce et al., 2019; *Cigna U.S. Loneliness Index*, 2018). Identifying and leveraging resources to help facilitate social connectivity is essential in helping address the experience of loneliness. Communication technologies like video conferencing and telepresence robots are creating opportunities for social connections which can help enhance the receiver' and sender' sense of presence. ***Purpose:*** The purpose of this research was to understand the characteristics of meaningful relationships and role of telepresence embodiment in facilitating meaningful social relationships ***Method:*** This research implemented a qualitative design with a sample of 30 adults (10 young adults, 10 middle age adults, and 10 older adults). Participants completed a short questionnaire and participated in a semi-structured interview. embodiment in facilitating meaningful social connections. ***Results:*** Results indicate that across adulthood there are differences and similarities in how individuals develop and maintain meaningful relationships, use of communication technologies, and report interest to adopt telepresence across embodiment levels. ***Conclusion:*** Leveraging communication telepresence technologies across various levels of embodiment presents an opportunity to help promote social connectivity.

INDEX WORDS: Gerontechnology, Telepresence, Embodiment, Loneliness, Social Connectivity, Lifespan, Older adults

## Introduction

The experience of loneliness across the lifespan is one of the greatest health dilemmas of current times, with two in five adults reporting feeling lonely in the United States (Bruce et al., 2019; *Cigna U.S. Loneliness Index*, 2018). Loneliness is defined as the difference in one's desired and actual quality and number of social relationships (De Jong Gierveld & Van Tilburg, 1999; Hawkley & Cacioppo, 2007). The experience of loneliness is multidimensional, encompassing social (e.g., absence of acceptance in a social network, feelings of estrangement, lack of companionship) and emotional characteristics (e.g., lack of attachment and individuals to rely on(Dahlberg & McKee, 2014; de Jong-Gierveld, 1987; Yanguas et al., 2018). These two dimensions provide a structured approach to how individuals experience loneliness across lifespan. Lifespan refers to the three phases of adulthood highlight by Erikson, which includes young adults, middle age adults, and older adults. Across each phase the experience of loneliness has been linked to diverse set of factors which influence and impact the experience of loneliness.

The experience of loneliness is complex and challenging to research as there is little agreement surrounding the factors which contribute to the phenomena. Contributing to the complex nature of loneliness is the stigma which is often associated with it, making it a difficult and sensitive topic for study participants to discus and express how they feel (Griffin, 2010). Measuring loneliness is difficult as surveys and questionnaires cannot always capture the diverse set of experiences which contribute to each persons' subjective experiences. For example, although the experience of loneliness is often associated with the number of relationships and social isolation, individual can have be surrounded by a large number of people and still report feeling lonely (Ortiz-Ospina & Roser, 2020). Individuals can also have a hard time discussing and explain how they feel, even though they may want to provide truthful responses.

Considering the wide range of implication loneliness can have on one's wellbeing and quality of life across the lifespan, developing interventions which are sensitive and attentive to the diversity of individuals experiences (Child & Lawton, 2019a; Golden et al., 2009). Breakthroughs in the development of embodied communication technologies such as video conferencing and telepresence robots present an opportunity in expanding the ability to provide individuals with customizable resources capable to help create, support, and maintain opportunities for meaningful social connects.

**Role of Embodiment Communication Technologies**

Communication technologies are tools which can help adults remain socially connected and engaged. These technologies include a host of communication platforms, including both software (i.e., social media, video conferencing) and hardware (i.e., smart displays, virtual and augmented reality hardware, telepresence robots) which aim to support and encourage social connectedness (McLoughlin et al., 2018; Moyle et al., 2019). These technologies help address some of the challenges that individuals may experience across phases of adulthood, and hinder ones' ability to be socially connected with family, friends, and their community (Fausset et al., 2011; Wang et al., 2014). However, not all communication technologies share the same features and capabilities. Through these platforms social contact can be achieved through text, voice, video, virtual spaces, and locomotion in physical environments. An important consideration when discussing communication technologies is how they can facilitate communicate and the level of presence, the receiver and sender of messages are able to achieve (Haans & IJsselsteijn, 2012). The sense of presence across the literature is often referred to as technology embodiment. For example, two individuals using video conferencing can communicate synchronously, hear,

and see each other, resembling more closely in person communication than what may be achieved through a text messages or social media posts.

Philosophers such as Heidegger (Ciocan, 2015) and Husserl (Husserl & Schuhmann, 1977) have described embodiment as being an active agent in the physical world, pointing to the lived body as the lived center of experience (Taipale, 2014). Embodiment, is broadly understood as the way in which an individual establishes contact while being in control of one's body (Ciocan, 2015; Haans & IJsselsteijn, 2012; Keshmiri et al., 2019; Luft, 2015; Streeck, 2015; Titchkosky, 2007) . When embodiment is facilitated through telepresence technology, the actions of the body become technologically/virtually embodied (Meloncon, 2013). For example, an individual visiting a friend or family member using a telepresence robot is embodied through the robot enabling them to speak, visualize, and virtually interact with the remote physical space. Increased levels of embodiment present opportunities for greater immersive experiences for both sender and receiver of communication. Increasing access and promoting the development of communication technologies can have implications to support healthy aging, wellbeing, promote social connectivity and help address the experience of loneliness (Burmeister & Marks, 2016; Chopik, 2016; McLoughlin et al., 2018, 2018; Yayan et al., 2019). For example, telepresence technologies and telepresence robots, present opportunities for increasing the frequency social encounters, but also creating meaningful social connections which allow individuals to engage through a diverse set of functions that more closely resemble communication which may occur face to face (Chen et al., 2013; Haans & IJsselsteijn, 2012; Mollahosseini et al., 2018; Richardson & Swan, 2019; Streeck, 2015).

**Telepresence across Embodiment**

Telepresence-technology offers the sense of being present in a remote location, without physically being there, by simultaneously transferring audio and video in two or more locations. Unlike traditional communication technologies and other video conferencing telepresence technologies, telepresence *robots* also offer mobility through teleoperation control. Telepresence technologies vary in the level of embodiment one can achieve depending on a various functionalities and capabilities of the technologies in allowing the individual in developing a sense of presence in a remote environment. Telepresence technology across embodiment can be thought of as a technological representation of the user – in other words, the technology serves as a medium to represent, or embody, the user in a remote location. A key interest of this study is how the level of embodiment affects the perception of social connection and how it may impact the perceived quality of relationships one is able to achieve using various forms of telepresence technology. Prior research has indicated that an increase in the level of embodiment creates a stronger sense of social connectedness (Beer & Takayama, 2011; Choi & Kwak, 2016; Fischer et al., 2012; Takayama, 2015). Lack of meaningful social connectedness is an indicator of both social isolation and loneliness (Achilleos et al., 2013; Barbosa Neves et al., 2019a; Gierveld, 1998; Jong Gierveld et al., 2015; Perlman, 1988). Therefore, utilizing a technology platform which can increase one's sense of social connectedness may result in a decrease in both loneliness and social isolation as well as an overall improvement in wellbeing.

Across the literature the majority of studies have investigated the use of telepresence in office settings, for which the systems were originally intended (Beno, 2018; Edwards, 2011; Keller et al., 2021; Kristoffersson et al., 2011). However, over the past decade the application of robots for assisting older adults has become a primary goal of the assistive robotics research community (Broadbent et al., 2011; Bugmann & Copleston, 2011; Robinson et al., 2014; Smarr

et al., 2014). Findings support the potential of telepresence robots in keeping older adults socially engaged with family, friends, and health care providers (Beer & Takayama, 2011; Bevilacqua et al., 2014a; Cesta et al., 2016; Tsui et al., 2014), with the potential for providing telehealth, monitoring, and social supports (Liles et al., 2015a, 2015b). They could also offer the opportunity for individuals with mobility impairment to communicate face to face with doctors without having to leave their homes, as well as offer peace of mind to caregivers who live remotely. However, most of the research focused on the application of higher embodied technologies such as telepresence robots have not been studied across  phases of adulthood (young adulthood, middle age  (Cesta et al., 2016; Takayama, 2015; Tsui et al., 2014). There is limited understanding regarding the perception and attitudes towards higher embodiment technologies from the perspective of young adults and middle age adults (Mois & Beer, 2020).

In today's world telepresence has become an extension of how humans communicate daily, access healthcare and services, chat with our friends and family, and attend community events. Understanding telepresence technology and the impact of its use serves a important role in expanding the understanding of how a emerging technological tool may be leverage to potentially help serve as a tool and aid in addressing the loneliness epidemic. In the current literature, much of the focus has been aimed at understanding how telepresence, across various levels of embodiment, has been geared primarily towards the older adult population. Little focus has been placed on understanding how young adults and middle age adults are using or could be using these technologies for maintain, support, and facilitate opportunities for social connectivity. Considering the emerging transitions across phases of adulthood and shift in population demographics, understanding the use of communication technologies, particularly those which present opportunities to address the experience of loneliness is imperative.

### Goal and Purpose

The goal of this exploratory qualitative research was to explore and answer the following research questions: “What are the key features of a meaningful relationships across phases of adulthood?”, “How does the level of telepresence embodiment impact social connectedness across the lifespan?” and “What are the key distinctions between different levels of embodiment?” The purpose of the current research is to expand the understanding of factors contributing to the development meaningful relationships across the phases of adulthood. Furthermore, this study aims to understand the role telepresence technologies across levels of embodiment in supporting and maintaining meaningful social connections. Understanding meaningful social connections is particularly important as it serves as the core of facilitating potential opportunities in developing interventions and programs which can help address the social injustices experienced by individuals due to a lack of resources to help address the loneliness epidemic.

## Qualitative Methodology

### Sampling and Recruitment

This study employed a purposeful random sampling strategy. Purposeful sampling is defined as information rich cases from which one can learn about the issues central to the study (Palinkas et al., 2015, Meriam & Tisdell, 2016). The goal of purposeful sampling is to represent a typical sample that reflects the average person, situation, or instance of the phenomenon of interest (Meriam and Tisdell, 2016). In order to ensure sample representativeness of the adult lifespan, sample recruitment was subdivided into three general age groups based on Erikson developmental stages: early adulthood (18-35), middle adulthood (35-65), and late adulthood (65+) (Brown & Lowis, 2003; Hoare, 2002; Rosenthal et al., 1981; Slater, 2003). All participants

lived in their own home or considered themselves as aging in place, were available for 1.5 hours to participate in the study, and reported access to telepresence technology (e.g., smartphone, tablet, computer). The full participant inclusion criteria are summarized in Table 4. 1.

Recruitment for this study was twofold: Amazon Mechanical Turk (Mturk) and university listservs. The Mturk user demographics indicate that the user base closely resembles the demographics of the United States population. Participants were recruited using Human Intelligence Task (HIT) which were posted on Amazon Mechanical Turk specifying the inclusion criteria and requirements for completing the interview and survey. The HIT specified the number of people that can complete the survey and interview and allows workers to accept assignments. Additional recruitment efforts were made through university listserv to help supplement participant recruitment for the young adult category. Although Mturk does not publish worker demographic information, previous research with larger a larger Mturk sample ( *N*=1707) found that the mean age of Mturk workers is 36 , SD=12.03, explaining the difficulty in recruitment of younger participants (Burnham et al., 2018). Recruitment emails delivered through the listservs provided the same information as that included in the HIT posting along with identical incentives.

Table 4.1 Participant Inclusion Criteria

1. Early adulthood (18-35) n=10, middle adulthood (35-65) n=10, and late adulthood (65+) n=10 (total N=30)
2. Fluent English Speakers
3. Access to a quiet/private room
4. Access to computer, tablet, or cellphone, access to home-based internet 1-4Mbps (Download/Upload Speed)
5. Ability to hear and see video during conference call
6. Community Dwelling

**Survey Design**

I compiled a 33-item survey in Qualtrics. The information collected in this survey included demographics, health status, technology use and changes in use during COVID-19, and 3 previously published measures to asses participants personality type, social connectivity, and quality of life: Ten Item Personality Inventory (Nunes et al., 2018), deJong Loneliness Scale (de Jong-Gierveld, 1987), and The Quality of Life Scale (Burckhardt & Anderson, 2003). Scales items can be found in Appendix (4.1). Measures are summarized in table 4.2.

Table 4.2 Summary of survey measures

| Construct | Measure | Summary of Scale |
|---|---|---|
| Demographic Information | Gender, Age, Race, Education, Marital status, Housing type, County type | I collected this data using questions addressing each item. Table 4.4 provides a summary of these results. Cronchbach's alpha for the scale is between (α = 0.70 - 0.76) |
| Loneliness Measure | De Jong Loneliness Scale | The de Jong scale provides a measure which enables the measure of overall loneliness, emotional loneliness, and social loneliness. Cronchbach's alpha for the scale is between (α = 0.70 - 0.76) |
| Quality of Life | The Quality of Life Scale | The Quality of Life Scale was used to measure participants quality of life. The scale includes items such related to material and physical wellbeing, relationships with other people, social, community, and civic activities, personal development, and recreation (Burckhardt & Anderson, 2003). Cronbach's alpha for the scale was between α = .82 to .92. |
| Personal Health | HINTS5 questionnaire | These questions focused on general health, health satisfaction, and challenges pertaining to health. (*Survey Instruments | HINTS*, n.d.) |
| Personality Type | Ten-Item Personality Type Inventory | provides a brief assessment of the participants measure of extraversion, agreeableness, conscientiousness, and emotional stability. Items are rated on a scale of one through 7 ranging from strongly disagree to strongly agree (Nunes et al., 2018). Cronbach's alpha for the scale was (α = 0.40–0.68). |
| Technology Use | | Participant's communication technology use was captured using a series of questions listing various types of communication technologies. |

**Interview Design**

The interview design was informed by previous works in the area of loneliness (Bruce et al., 2019; Fang et al., 2019; Ortiz-Ospina & Roser, 2020), social connectedness (Barbosa Neves et al., 2019b; Findlay & Nies, 2017), communication technology (Arthanat et al., 2016; Berg et al., 2017), telepresence (Takayama, 2015; Tsui et al., 2014), and embodiment(Haans & IJsselsteijn, 2012; Meloncon, 2013; Taipale, 2014). The interview questions discussing meaningful relationships, participant's descriptions of meaningful relationships, communication, communication technology use, and changes in communication over the past year, and thoughts about various types of telepresence technologies across different levels of embodiment after watching four different short videos which demonstrated types of communication technologies across different levels of embodiment. Some of the questions included in the semi structured interview were "How would you describe a meaningful relationship?"," How often do you use technology to communicate with those you described as having a meaningful relationship with?"," You watched four videos describing four different types of communication technologies with different capabilities and ways of connecting individuals together. Now imagine you had these technologies in your home, and you would get to use it regularly with friends and family, do you think it would affect the amount of contact you would have with friends and family?". A full overview of the interview script is provided in Appendix 4.3. A total of 30 interviews were conducted April 7 through May 3rd, 2021. Interview's lengths ranged between 29 minutes and 85 minutes, with a mean length of 48 minutes.

**Procedures**

Interviews were conducted remotely through a video conferencing software between April 7 through May 3rd, 2021. All participants were asked to select a preferred time to participate in the

interview and were provided with a link to participate in the video-conferencing call. Upon entering the video-conferencing call participants were provided with an overview of the study and then presented with a link to the informed consent form and survey distributed via Qualtrics. Once the participants reviewed the informed consent they were asked if they would like to participate in the survey and interview. If participants chose to participate in the study they proceeded to complete the Qualtrics survey. While the participants completed the survey, the researcher was available on the call to help with any technical difficulties or clarifying questions. Once the questionnaire was completed, the researcher proceeded with the interview. Prior to beginning all interview, participants were asked to confirm if they consent for the interview to be audio recorded. Interviews lasted on average 48 minutes. The lead author carried out all the interviews after receiving informed consent electronically from all the participants. An interview protocol was developed to provide guidance to the conversation carried out during the interview.

The interview was divided into two core parts. The interview began with an icebreaker question which focused on the briefly discussing meaningful relationships. The first part of the interview focused on participant's descriptions of meaningful relationships, communication, communication technology use, and changes in communication over the past year. The goal of the second part of the interview was get their opinions and thoughts about various types of communication technologies and how they might be used to communicate with those with whom you have meaningful relationships with. Participants were presented with four videos that demonstrate the capabilities of four various types of communications technologies (videoconferencing, telepresence hardware, telepresence technology with limited mobility, and telepresence robots). After each video participants were asked about their perception and thoughts about each of these technologies. A full overview of the interview questions is included

in (Appendix 4.3). On completion of the interview participants were provided with a $15 voucher/payment as a thank you for participating in the interview.

**Qualitative Data Analysis**

All audio recordings were transcribed and segmented into meaning full data units. Two researchers read and reviewed the transcribed transcripts. The segmentation strategy was developed by the two-researcher using thematic analysis and iterative content analysis project was used. Existing theoretical frameworks and research were used by the two researchers to identify key concepts and categories and develop the full coding scheme. The coding scheme was structured and organized using a qualitative data analysis software, MAXQDA (Verbi Software, 2010). A total of three transcripts were coded by each researcher, the three transcripts were representative of the three age groups which were included in this study The three groups included young adults, middle age adults, and older adults. Each of the researchers utilized the developed coding scheme to code each of the transcripts. Following each coding attempt, the two researchers discussed and reviewed all discrepancies and uncertainties. The two researchers made adjustments to the coding scheme and provided clarified definitions for each code to ensure coding was conducted accurately. Following two rounds of revision, the researchers achieved an intercoder agreement of 89%, all remaining inconsistencies and discrepancies were discussed amongst the researchers and revised until consensus was achieved. This final coding scheme was implemented to analyze the remaining transcript by the researchers. A full overview of the coding scheme is provided in the (Appendix 4.2) The themes identified across the interviews along with a summary of key findings are summarized in Table 4.3

Table 4.3 Overview of qualitative themes

| Key Qualitative Themes | Area | Components |
|---|---|---|
| Meaningful Social Connections | Communication | Openness<br>Frequency |

| | | |
|---|---|---|
| | Relationships | Trust<br>Caring<br>Understanding |
| | Types of Relationships | Friends<br>Child<br>Spouse/Partner |
| | Changes in Facilitating Relationship | Format |
| | Frequency of communication | |
| Technology Use | Facilitate Meaningful Communication | Video Conferencing<br>Text<br>Calls<br>social media |
| | Sense of Connection | Every day (7 times a week/ multiple times a day<br>2-3 Times (weekly) |
| | Distinctions (When compared to in-person communication) | Non-verbal communication<br>Touch/Physical contact<br>Physical presence<br>Body language |
| Telepresence Embodiment | Affect | Telepresence software<br>Telepresence hardware with limited mobility<br>Telepresence hardware<br>Telepresence hardware with full Mobility |
| | Adoption/Interests | Video Conferencing<br>Telepresence hardware<br>Telepresence hardware with limited mobility<br>Telepresence hardware with full mobility |

## Results

### Participants

The data for this study was conducted remotely via videoconferencing software. The participants recruited for this study included young adults (age 18-35) n=10, middle age adulthood (age 35-65) n=10, and older adults (age 65+) n=10, with a total sample of 30 participants. I recruited 11 males, 17 females, 1 participant identified as non-binary/non-conforming, and 1 participant identified as transgender female. A full overview of the participant

demographics is provided in table 4.4. All participants in this study lived in the United States, had access to video conferencing, and had a reliable internet connection.

Table 4.4 Demographic information by age group

| Demographic Information | Young Adults | Middle Age Adults | Older Adults | Total | |
|---|---|---|---|---|---|
| Gender | Freq | Freq | Freq | Freq | Percent |
| Male | 4 | 3 | 4 | 11 | 36.67 |
| Female | 3 | 7 | 6 | 17 | 56.67 |
| Non-Conforming | 1 | | | 1 | 3.33 |
| Transgender Female | 1 | | | 1 | 3.33 |
| Age | | | | | |
| 18-34 | 10 | | | 10 | 33.33 |
| 36-64 | | 10 | | 10 | 33.33 |
| 65+ | | | 10 | 10 | 33.33 |
| Race | | | | | |
| White | 6 | 10 | 10 | 25 | 83.33 |
| Asian | 3 | | | 3 | 10 |
| More than 1 race | 1 | | | 1 | 3.33 |
| Other | 1 | | | 1 | 3.33 |
| Education | | | | | |
| High School/GED Graduate | | 1 | | 1 | 3.33 |
| Associate degree | | 2 | | 2 | 13.33 |
| Some or in-progress college | 2 | 2 | 5 | 9 | 30.00 |
| Bachelor’s degree | 3 | 3 | 2 | 8 | 26.67 |
| Master's degree (or other post-graduate training) | 1 | | 2 | 3 | 10.00 |
| Do not wish to answer | 4 | 2 | 1 | 7 | 23.33 |
| Marital Status | | | | | |
| Single | 8 | 3 | 2 | 13 | 43.33 |
| Married/Co-habitation/Partnered | 2 | 2 | 6 | 10 | 33.33 |
| Divorced | | 3 | | 3 | 10 |
| Widowed | | 2 | 1 | 3 | 10 |
| Other | | | 1 | 1 | 3.33 |
| Housing Type | | | | | |
| Single family home | 3 | 10 | 7 | 20 | 66.67 |
| Town home | 2 | | | 2 | 6.67 |
| Apartment or Condominium | 4 | | 3 | 7 | 23.33 |
| Other (please specify) | 1 | | | 1 | 3.33 |

| | | | | | | |
|---|---|---|---|---|---|---|
| County Type | | | | | | |
| | Rural | 1 | 3 | 1 | 5 | 16.67 |
| | Suburban | 5 | 5 | 4 | 14 | 46.67 |
| | Urban | 4 | 2 | 5 | 11 | 36.67 |

**Components of Meaningful Relationships**

This study aimed to investigate the components of meaningful communication and qualities which contribute to the facilitation of meaningful communication amongst young adults, middle age adults, and older adults. Across phases of adulthood openness and frequency of were described as the key contributors to the engagement of meaningful communication (please see figure 4.1). When asked about how they would describe a meaningful relationship, participants noted the following regarding openness (8) and frequency (6) of communication:

***Openness***

"Be open to feedback."

"Something where there's a sharing between two people, trust and respect between each other."

"Openness, communication, having things in common, enjoying each other's company, ability to talk about stuff, good listening on both sides."

***Frequency***

"Someone that you can call and talk to, at any time, if you need help, or just need somebody to speak with about anything during the day, somebody that's going to respond in a meaningful time period"

"Stay in touch frequently. Because with friendships, you know, they can go stale if you if you like don't contact them for a long time. People move on in their lives."

"The frequency that you see the person, how well you're able to communicate with the person, if the person wants to communicate with you, as well, you're not just talking at them, they're actually talking with you and listening."

Throughout adulthood, middle age adults reported higher rates of focus on the quality of interactions (3). Quality referred to the ability to engage in communication is beyond small talk, and engagement in more meaningful topics. When asked about how they would characterize a meaningful relationship, one participant noted the following "I guess when you feel connected to someone and communicate with them regularly feel comfortable talking about like, I don't know, like deep stuff and vulnerable stuff." Across the phases of adulthood here was no significant difference across the groups. A full overview of the qualities mentioned by the study participants are summarized in Figure 4.1.

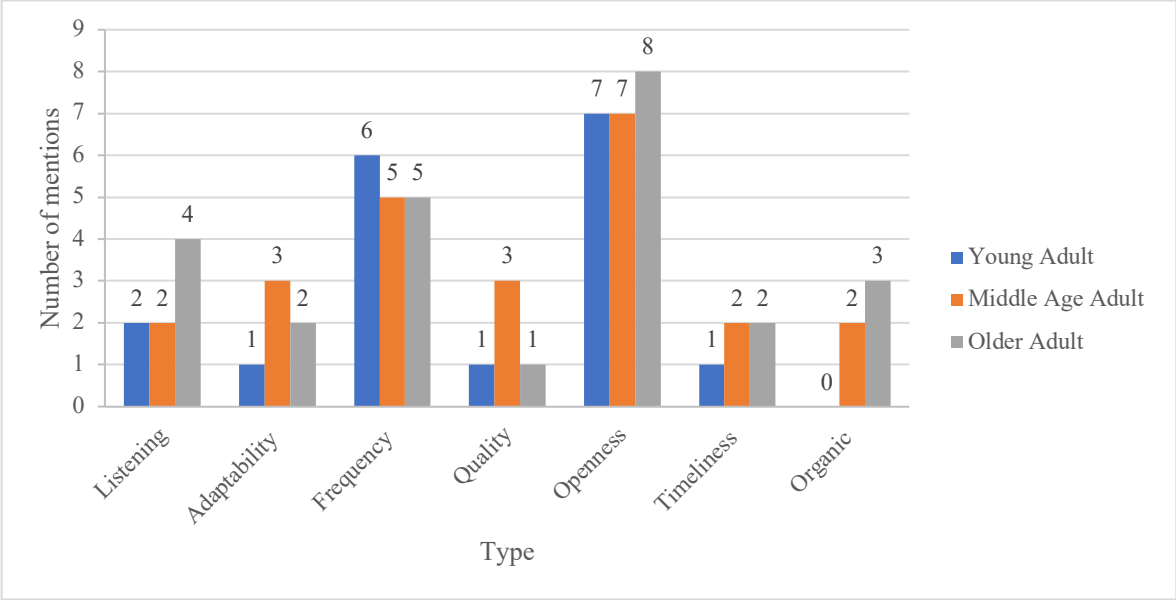



**Figure 4.1** Components of meaningful communication

When asked about the qualities of meaningful relationships, across phases of adulthood, the three core qualities included trust (22), caring (16), understanding (15), and shared interests (13). A full overview of the qualities mentioned by the study participants are summarized in Table 4.5. Young adults noted higher importance on availability (4) and important dates (4). Middle age adults placed an emphasis on shared experiences (4), while older adults noted that working together (5) are important qualities in maintaining and supporting meaningful relationships.

Below I provide an overview of the key quotes related to these themes. Across the phases of adulthood there was no significant difference across the qualities mentioned.

***Trust***

"Being able to trust the person that if you tell them something that they would understand and not criticize you or make fun of you"

"Where you can trust other people and confide in things with them that you wouldn't normally with others."

"I believe it's one that's based on trust and commitment."

***Caring***

"Taking the time going out of your way to reach out to that person. emails, texts, phone call, Facebook, but just really making an effort."

"Showing that you care, even if it's a text or a phone call, and like an important day, or if it's been a long time, so you've been able to catch up to, like, still try to reinforce that you care about that person."

" Just being able to be there for someone or they'd be there for you just whenever needed, you know, just someone that you can count on, in pretty much any situation, you know, say need to be help, you need help for something, and it's just, you know, I think a lot of it's just like that. Reliability, familiarity, and just, and, you know, just knowing that the person's there for you."

***Understanding***

"I think the ability to communicate, to understand shared experiences"

"I can be transparent and open and honest, without feeling like I'll be put down or punished or dismissed or ignored."

"If you tell them something that they would understand and not criticize you or make fun of you"

**Table 4.5** Qualities of a meaningful relationships

| Personal Qualities | Young Adult | Middle Age Adult | Older Adult | Overall |
|---|---|---|---|---|
| Closeness | 1 | 1 | 1 | 3 |

| | | | | |
|---|---|---|---|---|
| Understanding | 5 | 5 | 5 | 15 |
| Caring | 7 | 4 | 5 | 16 |
| Respect | 2 | 3 | 4 | 9 |
| Trust | 9 | 5 | 8 | 22 |
| Availability | 4 | 3 | 4 | 11 |
| Shared interests | 3 | 4 | 6 | 13 |
| Shared Values | 1 | 3 | 3 | 7 |
| Shared Experiences | 3 | 4 | 1 | 8 |
| Work together | 1 | 3 | 5 | 9 |
| Important Dates | 3 | 1 | 1 | 5 |
| Compatibility | 0 | 1 | 1 | 2 |
| Comfort | 2 | 2 | 2 | 6 |
| Commitments | 2 | 2 | 1 | 5 |

**Relationship Types**

Across adulthood the participants reported that the individuals whom they have developed most meaningful relationships with were individuals who identified as friends (13). Among middle age and older adults' individuals reported that their most meaningful relationships were formed with their children (8) and spouse (7). There was a significance in the across middle and older adulthood when comparing meaningful relationships with a spouse ($F(2,27)=4.12$, $p=.03$). For a detailed overview of the relationship types across which meaningful relationships were formed across the lifespan please see Table 4.6.

**Table 4.6** Meaningful Relationships (Connection Types)

| Relationship type | Young Adults | Middle Age Adults | Older Adults | Total |
|---|---|---|---|---|
| Mother | 1 | 2 | 0 | 3 |
| Father | 2 | 0 | 0 | 2 |
| Child | 0 | 4 | 4 | 8 |
| Brother | 1 | 1 | 1 | 3 |
| Sister | 1 | 1 | 1 | 3 |
| Spouse | 0 | 2 | 5 | 7 |
| Partner | 1 | 1 | 0 | 2 |
| Friend | 6 | 4 | 3 | 13 |
| Boyfriend/Girlfriend | 0 | 0 | 1 | 1 |

| | | | | |
|---|---|---|---|---|
| House Mate | 0 | 0 | 1 | 1 |

**Frequency of Communication Across Meaningful Relationships**

Frequency of communication was identified as major contributing factor to the formation and maintenance of meaningful relationships. Among all participants, the most common frequency of meaningful communication between participants and individuals with whom they reported as having a meaningful relationship with was "Everyday and/or multiple times a day". Across each segment of adulthood, the frequency of communication varied. Older adults reported that they often engaged in meaningful communication 2-3 times per week. Middle age adult's frequency of communication with those with whom they had meaningful relationships were often 2-3 times a week and also on weekly basis. Middle age adults were the most likely to report more infrequent communication such as monthly (every few months) or yearly (once or twice a year). T here was no significant difference across the age groups. For a full overview of the frequency of communication with those with whom the participants had meaningful relationships please see Table 4.7.

**Table 4.7** Frequency of Engagement in Meaningful Communication

| Frequency | Young Adults | Middle Age Adults | Older Adults | Overall Total |
|---|---|---|---|---|
| Every day (7 times a week/ multiple times a day | 9 | 7 | 11 | 27 |
| 4-5 Weekly (4-5 times a (1) | 0 | 2 | 1 | 3 |
| 2-3 Weekly (2-3 times a week) | 1 | 3 | 6 | 10 |
| Weekly (Once a week) | 3 | 2 | 1 | 6 |
| Monthly + (Every Month/ Few Times a (1) | 0 | 0 | 1 | 1 |
| Monthly - (Every Month) | 0 | 1 | 0 | 1 |
| Monthly - (Every Few Months | 0 | 0 | 0 | 0 |
| Yearly (Once or twice a year) | 0 | 1 | 0 | 1 |

**Changes in Communication Across Meaningful Relationships**

Participants were asked “Are there are any changes you would like to make as to how you are currently able to communicate with those whom you describe you have a meaningful relationship with?”. The most common change across phases of adulthood was the format (10) in which individuals were able to communicate. For example, participants noted that they wanted to be able to communicate and engage in communication face to face and through platforms which allow them to feel more connected. When comparing their experience of texting with individuals with whom they had a meaningful relationship on weekly basis, ten of the participants (N=30) noted that they would make no changes to how they are currently able to be communicated with those with whom they had a meaningful relationship with. Below we provide quotes related to the key themes which emerged regarding the changes participants would like to make as to how they are currently able to communicate. Across the phases of adulthood here was no significant difference across the groups related to changes that they would like to make. For a full overview of the change participants wanted to make as to how they are currently able to communicate please see Figure 4.2.

**Format**

“Yeah, I would prefer to actually talk to them on the phone once or twice a month. And I wouldn't mind if you always feel a little awkward doing Skype or zoom for some reason. I don't know why it just doesn't feel natural, sitting in front of the camera. That was puzzling because I got to see my daughter and granddaughter and then my son we all got it was a zoom that we did over Christmas. I got to see them all. So it was nice seeing them all. So just because it was holidays, I was nice. But on an ongoing basis. I would much rather do a once or twice a month phone call then four texts a week type thing.”

“More in person communication.”

“I wish I could see them in person more.”

“We both live in Michigan, and I wish I could like see them in real life. Sometimes.”

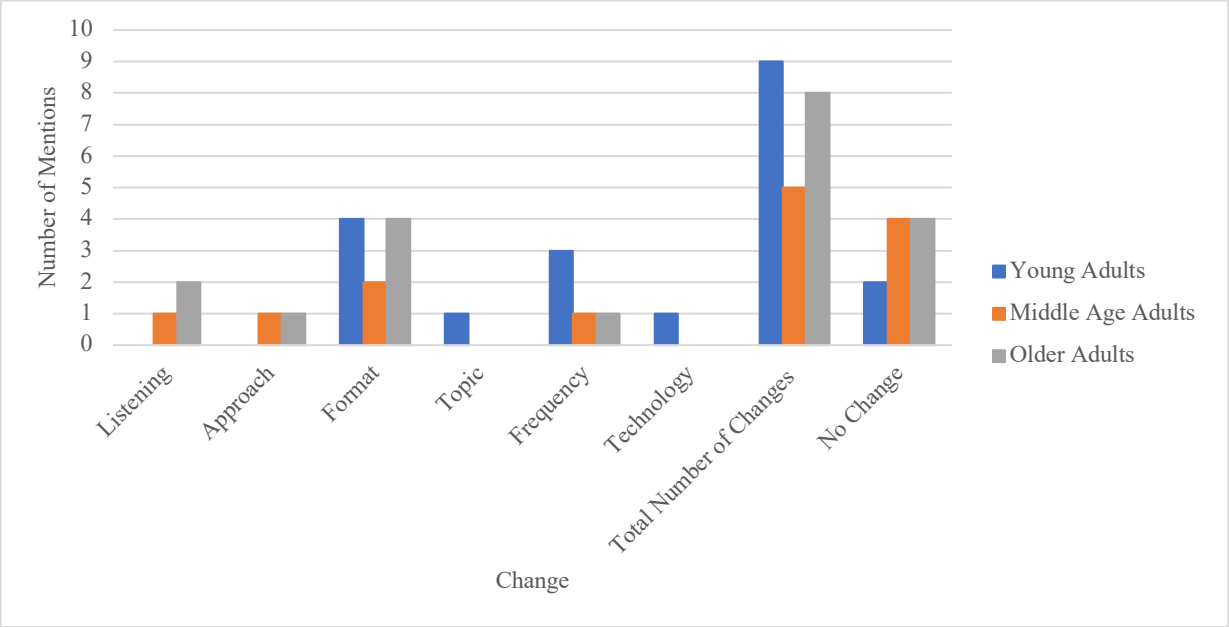



**Figure 4.2** Changes in Communication to support Meaningful Social Connections

**Technology Used to Facilitate Meaningful Communication**

Across  phases of adulthood, the three most commonly used communication technologies to engage in meaningful communication included video conferencing (25), text messaging (24), and voice calls (19). Older adults (11) were more likely to report having used social media to engage in meaningful connections than middle age (2) and young adults(3).  Middle age adults (3) were more likely to report using email to engage in meaningful communication than older (2) and young adults (1). Across the  phases of adulthood there was a significant difference in the use of video conferencing software to form meaningful connections ($F(2,27)=3.55$, $p=.04$). For a full overview of the technologies used by the participants please see Figure 4.3.

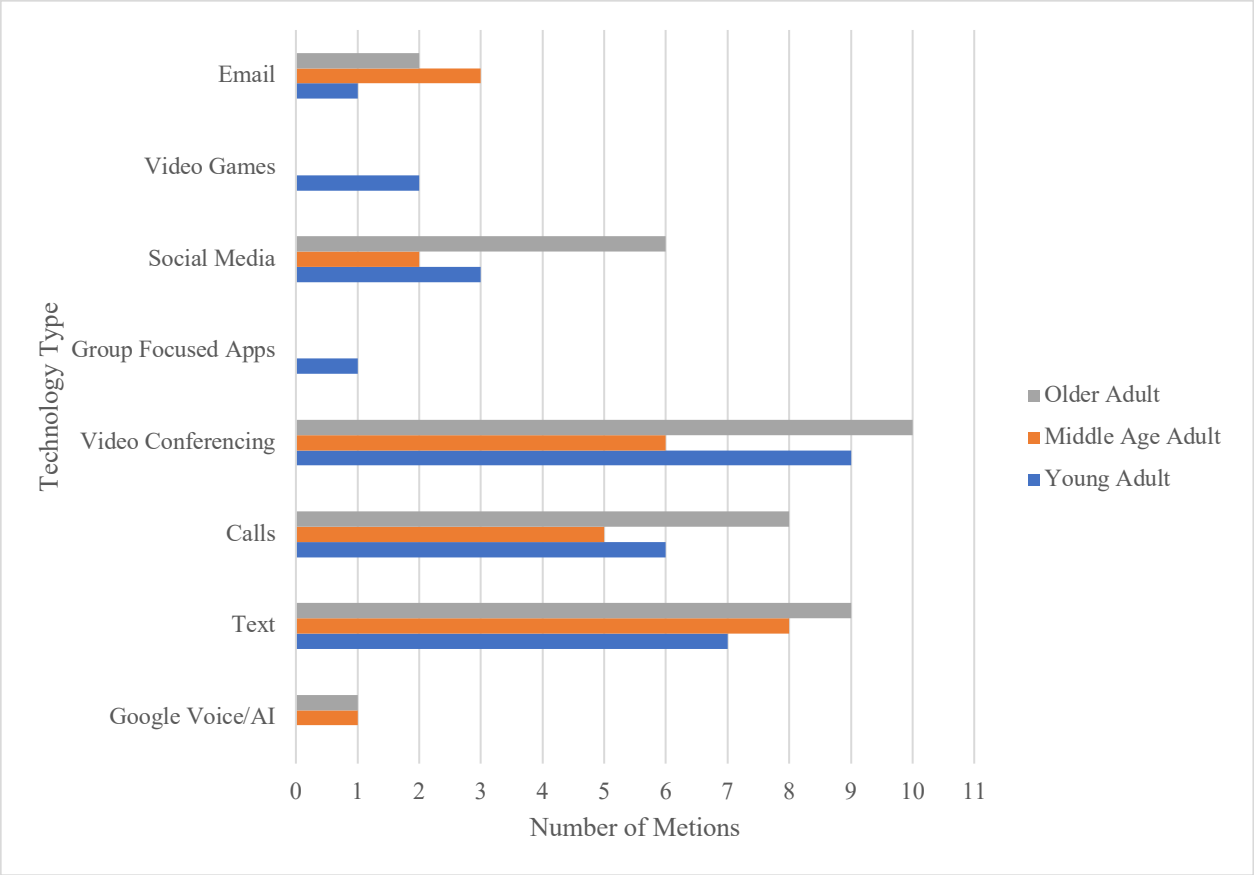
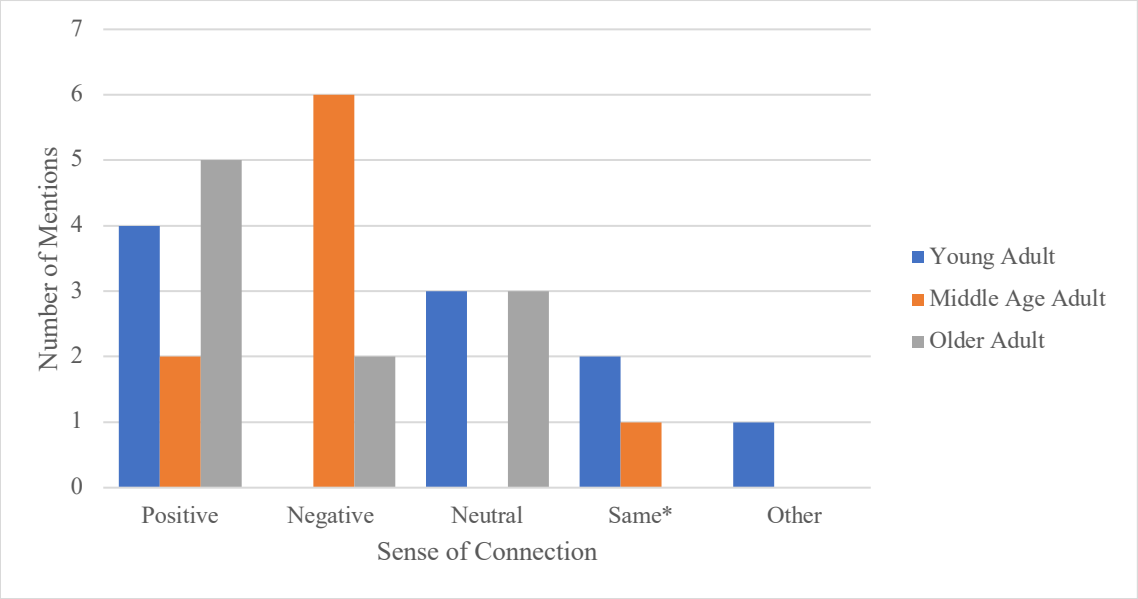



**Figure 4.3** Technologies Used to Engage in Meaningful Social Connections

**Sense of Connection Achieved through Communication Technologies**

When asked about the sense of connection participants experienced through technology mediated communication most young and older adults reported a positive (4,5) and neutral (3,3) experience respectively. One participant stated the following "It's a lot. It's a lot better to be in person, of course, I think there's more. It's more the kind of reality to be to be with somebody in person then over the phone or even looking through the screen. So at times, it does feel like it's less real sometimes. But I think when we are able to laugh together and kind of make fun of funny situations together, I think that kind of brings some energy and liveliness into our system." Middle aged adults reported that when engaging in meaningful communication their sense of connection has been negative (6), reporting a decline in the sense of connection with whom they were communicating. Middle age adults were significantly more likely to report a negative attitude

towards engaging in communication through technology mediated communication ($F(2,27)= 6.30$, $p=.01$). However, there was no significant difference across attitude towards sense of connection and participants experience of loneliness. For a full overview of the sense of connection achieved through technology mediated communication please see Figure 4.4




*Same – Refers to a similar sense of connection as if the person was communicating face to face

**Figure 4.4** Sense of Connection through Technology Mediated Communication

**Distinctions of Technology Mediated Communication and In-person Communication**

Participants often reported key distinctions which occurred in meaningful communication that happened in face-to-face interaction that was often omitted in technology mediated communication. Throughout adulthood there were differences across what stood out the most for participants; the most prevalent themes included the lack of non-verbal communication (11), touch and physical contact (9), sense of physical presence (9), and inability to recognize body language (7). Across the phases of adulthood here was no significant difference among groups. For a full overview of the differences experienced when engaging in meaningful relationship through technology mediated communication, please see Table 4.6.

**Table 4.6** Key differences when engaging in meaningful relationships through technology mediated communication when compared to face-to-face communication

| Key Difference | Number of Mentions | | | |
|---|---|---|---|---|
| | Young Adults | Middle Age Adult | Older Adult | Overall |
| Touch physical contact | 2 | 2 | 5 | 9 |
| Body language | 2 | 4 | 1 | 7 |
| Non-verbal communication | 2 | 6 | 3 | 11 |
| Technology limitations | 0 | 2 | 2 | 4 |
| User related challenges | 0 | 1 | 0 | 1 |
| Personable | 2 | 1 | 1 | 4 |
| Physical presence | 4 | 1 | 4 | 9 |
| Focus and formality | 0 | 0 | 2 | 2 |
| none | 1 | 0 | 1 | 2 |
| Overall (Total Mentions) | 15 | 17 | 19 | 49 |

**Affect Towards Telepresence Across Embodiment**

Participants often noted that video conferencing was one of the core technologies which they leveraged to engage in communication with those with whom they described as having a meaningful relationship. A key portion of the interview aimed to understand the participants attitudes and thoughts about various types of telepresence technologies representing a range of embodiment. These technologies include video conferencing software, telepresence hardware such smart displays, telepresence hardware with the ability to pan and tilt, and telepresence robotic hardware which have a full range of mobility in a remote space. Across the phases of adulthood, the technologies towards which participants had the most positive affect towards included telepresence software and telepresence technologies with limited mobility. Across the phases of adulthood, middle age adults were most likely to have a positive affect towards the

various types of technologies, include telepresence technologies with full mobility (8). For a full overview of the participants affect towards the types of communication technologies please see table 4.8.

**Table 4.8** Affect towards telepresence technology across various level of embodiment

| | Technology Type | Young Adults | Middle Age Adults | Older Adults | Overall Affect |
|---|---|---|---|---|---|
| Telepresence Software | Positive | 9 | 10 | 10 | 29 |
| | Negative | 1 | 0 | 0 | 1 |
| | Neutral | 0 | 0 | 0 | 0 |
| | Mixed | 0 | 0 | 0 | 0 |
| | Other | 0 | 0 | 0 | 0 |
| Telepresence Hardware | Positive | 7 | 8 | 8 | 23 |
| | Negative | 2 | 0 | 2 | 4 |
| | Neutral | 0 | 2 | 0 | 2 |
| | Mixed | 0 | 0 | 0 | 0 |
| | Other | 0 | 0 | 0 | 0 |
| Telepresence Hardware (Limited Mobility) | Positive | 9 | 10 | 10 | 29 |
| | Negative | 0 | 0 | 0 | 0 |
| | Neutral | 1 | 0 | 0 | 1 |
| | Mixed | 0 | 0 | 0 | 0 |
| | Other | 0 | 0 | 0 | 0 |
| Telepresence Hardware (Full Mobility) | Positive | 2 | 8 | 5 | 15 |
| | Negative | 6 | 1 | 4 | 11 |
| | Neutral | 0 | 0 | 0 | 0 |
| | Mixed | 1 | 1 | 1 | 3 |
| | Other | 0 | 0 | 0 | 0 |

A key factor mentioned phases of adulthood was the importance of communication frequency to both maintain and support meaningful relationships. When asked if access to the various types of telepresence technologies, participants noted that their frequency of communication with those with whom they had meaningful relationships would improve. Across the phases of adulthood here was no significant difference across the groups. For a full overview

of participants response to how access to telepresence technologies across the spectrum of embodiment would impact the frequency of communication, please see table 4.9.

**Table 4.9** Frequency of Communication if Access to Telepresence Technologies

| Frequency | Young Adults | Middle Age Adults | Older Adults | Overall Total |
|---|---|---|---|---|
| Every day (7 times a week/ multiple times a day | 9 | 7 | 11 | 27 |
| 4-5 Weekly (4-5 times a (1) | 0 | 2 | 1 | 3 |
| 2-3 Weekly (2-3 times a week) | 1 | 3 | 6 | 10 |
| Weekly (Once a week) | 3 | 2 | 1 | 6 |
| Monthly + (Every Month/ Few Times a (1) | 0 | 0 | 1 | 1 |
| Monthly - (Every Month) | 0 | 1 | 0 | 1 |
| Monthly - (Every Few Months | 0 | 0 | 0 | 0 |
| Yearly (Once or twice a year) | 0 | 1 | 0 | 1 |

**Interest to Adopt Telepresence Technologies Across Various Level of Embodiment**

Participants were asked to list the telepresence technologies across the spectrum of embodiment from most to least useful and easy to use. The technologies which were perceived as most useful across the phases of adulthood include telepresence software, telepresence with limited mobility, and telepresence technologies with full mobility, please see Table 4.10. Participants reported that the technology which was the easiest to use was video conferencing software, some reporting that prior experience and comfort with the technology. Following telepresence software, some participants noted that using a telepresence technology such as smart displays would be easier to use as all the functionalities and requirements to participate in video conferencing are streamlined. Some participants noted the following regarding each of the four technologies across various levels of embodiment:

***Video conferencing***

"I think it'd be most useful because from what I understand, it's something you could take with you on the go."

“ I think the zoom would be your ideal, okay. And I would want to get better at it.”

“Video conference, the first one is the most useful because I can do it on my computer while doing other things.”

***Telepresence hardware***

“The standalone unit, I don't have any use for that. I've got the computer and I use that, you know, computers versatile enough for me.”

“I don't really envision buying a unit specifically for that unless like it was the more advanced one that has all the extra bits in it can follow you around”

“There was not much difference between this FaceTime one and the second one (telepresence hardware.”

***Telepresence hardware with limited mobility***

“The one that has what they call limited mobility works on expanding the room, and you can swivel it around and visit second.”

“The third one where you can move things around, you feel like you would have more control over your conversation and meeting relationship.”

***Telepresence hardware with full mobility***

“Well, I think the, I think the robot would be the most useful. Because it can follow you around in your normal, you know, home environment when you're discussing or, you know, talking with people”

“The fourth one (telepresence robot), the fourth one, okay. Yeah, because you're, you feel like you're more there and can do more.

**Table 4.10** Perceived ease and usefulness of telepresence systems across embodiment levels

| Technology Type | Ranking | Young Adults | | Middle Age Adults | | Older Adults | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| | | Ease | Useful | Ease | Useful | Ease | Useful | Ease | Useful |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Video Conferencing | 1 | 5 | 5 | 6 | 2 | 5 | 4 | 16 | 11 |
| | 2 | 2 | 2 | 3 | 1 | 1 | 3 | 6 | 6 |
| | 3 | 1 | 3 | 2 | 2 | 0 | 2 | 3 | 7 |
| | 4 | 2 | 0 | 0 | 3 | 1 | 1 | 3 | 4 |
| Telepresence technology | 1 | 5 | 2 | 4 | 0 | 2 | 0 | 11 | 2 |
| | 2 | 4 | 4 | 5 | 4 | 3 | 3 | 12 | 11 |
| | 3 | 0 | 1 | 1 | 5 | 2 | 5 | 3 | 11 |
| | 4 | 1 | 3 | 0 | 1 | 0 | 2 | 1 | 6 |
| Telepresence technology with limited mobility | 1 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 8 |
| | 2 | 4 | 3 | 2 | 2 | 3 | 4 | 9 | 9 |
| | 3 | 6 | 5 | 7 | 2 | 4 | 3 | 17 | 10 |
| | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Telepresence technology with full mobility | 1 | 0 | 1 | 0 | 4 | 0 | 3 | 0 | 8 |
| | 2 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 3 |
| | 3 | 3 | 1 | 0 | 0 | 1 | 0 | 4 | 1 |
| | 4 | 7 | 7 | 10 | 4 | 6 | 7 | 23 | 18 |
| Same | 1-4 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 |

*Ranking-Participants ranked perceived ease of use and usefulness across the four different types of communication technologies- 1=most useful/easy to use and 4=least useful/most difficult to use

Participants were asked to report which of telepresence technologies across the spectrum of embodiment would be most helpful to maintain their meaningful relationships. Most participants reported these technologies in the following order, video conferencing software, telepresence technologies with full mobility, telepresence technologies with limited mobility, and telepresence hardware such as smart displays. Across the phases of adulthood here was no significant difference among groups. For a full overview of the participants thoughts please see figure 4.5.

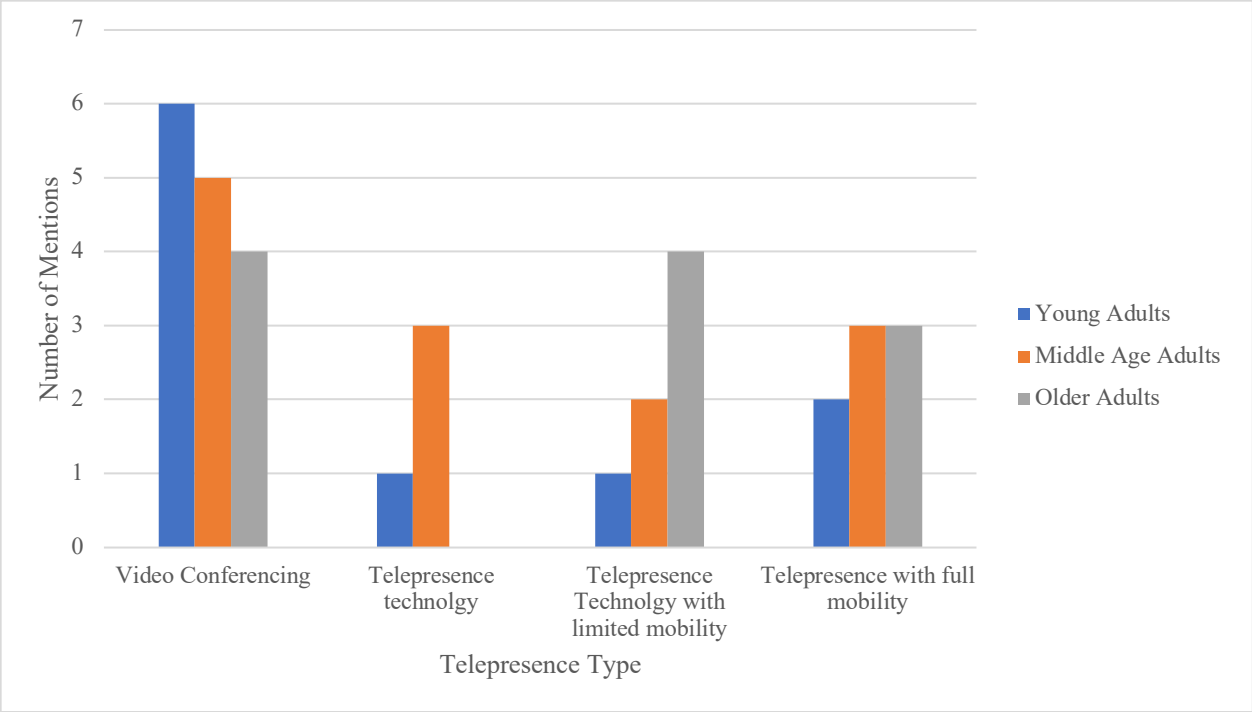



**Figure 4.5** Perceived interest in technology across telepresence embodiment to facilitate meaningful social connections

Participants were asked if they would use the technology if it was offer to them for free "If the technologies and demonstration you watch were offered to you for free today, would you use them?" The technologies which most participants noted that they would use included video conferencing software and telepresence technology with limited mobility. Across the phases of adulthood, middle age adults were most likely to use each of the technologies highlighted in the interview. Some participants noted the following regarding interest to adopt the different types if technologies. For a full overview of the participants interest in using the types of telepresence technologies please see table 4.11.

***Video conferencing***

"Being able to do it from anywhere, anytime. It doesn't have to be scheduled."

"That's always useful. Because it's you can take it with you, wherever you need to go. You don't have to necessarily rely upon your eye connection. My if you have the connection through your

phone, if it's loaded on your phone, then most service plans have their data so you can chat through video if you need to."

***Telepresence hardware***

"No, probably not. But I would probably give it to my partner's elderly father, as I think maybe he could"

"Depending on what I wanted to do with it at home, I might think about trying it out. I don't know that I would fall over myself wanting to get it, but I might be willing to try it out."

***Telepresence hardware with limited mobility***

"I think I would use it if it does a good enough job of tracking me around the room and in No, not like glitching around for as long as it works as it's supposed to work."

"Yeah, well, that was my favorite. I don't know if you will compute any other tool, but yeah, I would. Yeah, I would definitely use that."

***Telepresence hardware with full mobility***

"I would use the robot without any hesitation."

"I really would like to have that. But there again, I'm seeing dollar signs, something like it's really going to be expensive. And it would depend on how expensive it was."

**Table 4.11** Willingness to adopt telepresence technology

| | | Participant Group | | | |
|---|---|---|---|---|---|
| Technology Type | Answer Choice | Young Adults | Middle Age Adults | Older Adults | Overall |
| Video Conferencing | Yes | 10 | 10 | 10 | 30 |
| | No | 0 | 0 | 0 | 0 |
| | Maybe | 0 | 0 | 0 | 0 |
| Telepresence hardware | Yes | 5 | 8 | 7 | 20 |
| | No | 4 | 2 | 3 | 9 |
| | Maybe | 1 | 1 | 0 | 2 |
| | Yes | 9 | 8 | 8 | 25 |

| | | | | | |
|---|---|---|---|---|---|
| Telepresence hardware with limited mobility | No | 1 | 1 | 1 | 3 |
| | Maybe | 0 | 2 | 1 | 3 |
| Telepresence hardware with full mobility | Yes | 7 | 7 | 7 | 21 |
| | No | 3 | 3 | 2 | 8 |
| | Maybe | 0 | 0 | 0 | 0 |

## Discussion

The findings of this research indicate that the implementations and application of communication technologies can serve as tools which can enable individuals to become more social connected and have the potential in helping address the experience of loneliness. The implementation and application of communication technologies needs to be considered when trying to identify its role and meeting the needs of adults across phases of adulthood. The goal of this research was to answer the following three research questions:

1. What are the characteristics which exemplify meaningful social connection?
2. How does the level of telepresence embodiment impact social connectedness across the lifespan?
3. What are the key distinctions between different levels of embodiment?

### Characteristics of Meaningful Social Connections

The research findings suggest that the characteristics which contribute the experience of social connectivity can be connected to components of meaningful communication and characteristics of meaningful relationships. Findings indicate that across adulthood, openness and frequency of communication were the most important components which support engagement in meaningful communication. These findings indicate that meaningful relationships require the ability to feel vulnerable about sharing ones' thoughts and opinions. Moreover, in a meaningful

relationship individual can feel like they are understood and accepted. Previous research has indicated that feelings of acceptance are closely tied to participants report of rewarding relationships across life (Twenge et al., 2003). Meaningful relationships were often described by participants dynamic and accommodating to shifting life experiences. These findings indicate that meaningful relationships may be based on the formation of a set of interdependence accommodations. Prior research has found that interdependence across meaningful relationships was associated with shared socio-emotional goals, intimacy, and mutual assistance (Amati et al., 2018).

Findings indicate that a lack in frequency and adaptation to the preference of individuals needs can result in impacting the perceived quality of relationships. For example, participants often noted that individual whom they were in less contact often reflected on the perceived quality of their relationships. These finding fall in line with previous research which has indicated that openness, particularly self-disclosure is an essential component in the maintenance of close relationships (Bochner, 1981). Furthermore, the inability to engage in openness, is also a key predictor and closely tied to the experience of loneliness. Across the literature, findings often indicate that individuals often report that their experience of loneliness is tied to a inability to talk with someone about the things that they are experiencing and have the confidence to trust the individuals who they are sharing the information with (Bartels et al., 2008; Shankar et al., 2011; Stokes, 1985).

The need to experience meaningful relationships was tied to participants experience of trust, caring, understanding, shared interests, and availability with the individuals whom they engaged in relationships with. Like the characteristics of meaningful communication, the qualities mentioned by participants that pertained to meaningful relationships are closely tied to

the characteristic which have been attributed to social connectivity, and often noted as contributing factors in helping address feelings of loneliness across the literature (Child & Lawton, 2019b; Franzoi & Davis, 1985). Across the lifespan there was similar trends amongst the qualities of meaningful relationships mentioned by young and older adults. For example, older adults and young adults were more likely to mention trust, caring and availability as important characteristics in meaningful relationships along with a higher frequency of engaging in communication daily than middle age adults. Similar to previous research, across the lifespan middle age adults and older adults were more likely to report meaningful relationships with family members which included children, spouse's, partner's and siblings (Child & Lawton, 2019b; Fowler et al., 2015; Kobayashi et al., 2009). When asked about changes regarding as to how they can engage in communication with those with whom they have meaningful relationships, young adults and older adults were more likely to mention changes. The most notable changes noted by the participants included format (e.g in-person communication, phone calls), frequency of contact, and want to be better listeners. Findings indicate that challenges related to meaningful communication were often related to limitations of the medium of communication (e.g., texting, social media) used by the participants.

**Telepresence Embodiment and Social Connectivity**

Across the lifespan the technology adopted and implemented to support meaningful social connection included telepresence, texting, phone calls, social media, and email. Older adults and young adults were more likely to utilized telepresence, phone calls, and social media. Young and middle age adults were more likely to utilized text-based communication to engage in communication with those with whom they reported having meaningful relationships with. Furthermore, young, and older adults were more likely to report positive social interactions

through technology mediated communication and use it on a more frequent basis than middle age adults. The current body of literature provides little insight pertaining to the technology use behaviors of middle age adults. The predominant focus of existing work has been on the experiences of young adult (Chopik, 2016; Shah et al., 2019; Thomee et al., 2010; Yayan et al., 2019) and older adults (Chopik, 2016; Fang et al., 2019; Pauly et al., 2019). Findings indicate that middle age adults may be less likely to engage in communication with those with whom they have meaningful relationships than young and middle age adults.

Some of the key factors contributing to the experience of loneliness across middle adulthood included living alone, frequency of contact with neighbors, social exclusion, psychological distress, emotional wellbeing, employment status and perceived health (Franssen et al., 2020). Understanding these contributing factors can help provide insight into the adoption, implementation, and attitudes towards the use of communication technologies. For example, the adoption and use of communication technologies may not always mean that they are being used to engage in meaningful communication. Across the interviews carried out, middle age adults were more likely to report being busy working, limiting the time they had to engage in meaningful social connections, often deferring to mediums which involved text-based communication such as texting and email. Further, exploration of the interaction of middle age adult's interaction with technology and their experience of loneliness. As the transition from middle age adulthood into older adulthood is one of the fastest growing shifts in population demographics, it may give insights into the development of resources and services need to support a rapidly growing older adults population. Further longitudinal research is needed to help identify if the trends observed in This study are representation of age demographics or depictions of age cohorts transitioning across the phases of adulthood.

The data indicates that across the three phases of adulthood, the use of telepresence was the most frequently mentioned technology utilized by study participants in maintaining and supporting meaningful social connections. Through this research I investigated the affect and interest to adopt telepresence technologies across various levels of embodiment. Embodiment refers to sense of presence which can be achieved through technology mediated communication. Participants were presented with four various types of telepresence technologies ranging from low embodiment (e.g telepresence software) to high embodiment (e.g., telepresence robot). Across low to middle embodiment technologies participant affects was identical. However, when presented with telepresence robots, middle age participants were more inclined in having a positive affect towards the technology than young adults and older adults. Participants were asked about their thoughts on how easy and useful the four different types of technologies would be, indicating potential interest to adopt. Across adulthood, young adults were more interest in the adoption of low embodied technologies (e.g., telepresence software, telepresence hardware).

Across technologies with a higher level of embodiment, middle age adults and older adults' interest to adopt often surpassed that of young adults. Understanding the preferences of participants regarding the embodiment level which they perceive as most beneficial in helpful in supporting meaningful connection have help give insights to the features which technologies need to include to help users engage in the meaningful social connections. For example, across study participants, young adults often noted that they valued the portability and accessibility of lower embodiment technologies as it could always be present with them. Middle age adults and older adults often noted that a higher embodiment technology would enable them to connect with family members and help them feel like they were present. These findings are particularly interesting as middle age adults were generally more likely to report use of lower embodiment

technologies (e.g., email, texting) as their primary modes of communication. It is important to note that the current research did not provide the participants with the ability to engage in a full demo, allowing the participants to engage directly with the technology and grasp the full range of its capabilities. However, study findings support previous findings related to work conducted in understand the role of higher embodiment technologies (Bevilacqua et al., 2014b; Moyle et al., 2020). I also provide insights pertaining to the application of a range of telepresence technologies across phases of adulthood which has not yet been explore. Future research should aim in conducting a full demonstration allowing the users to engage with individual with whom they have meaningful relationships.

**Considerations across technology embodiment**

When thinking about communication technologies, the role of embodiment is an important consideration when trying to understand how the sense of presence achieved by the user is attained by both the sender and receiver of messages. In-person communication is multidimensional involving the transmission of verbal, non-verbal, and paraverbal messages which are decoded by the receiver of messages (Allwood, 2008; Fowler et al., 2015). Findings indicate that the application of communication technologies with the aim of replicating in-person communication may help lead to a stronger sense of presence for both the senders and receivers of message. It is important to note, the goal of communication technologies, regardless of embodiment, should never be to replace in-person communication. Its role should merely be a resource to help address the needs of individuals to maintain and support meaningful social connections, and in turn serve as an avenue which leads to more in-person communication. Future research should aim to provide an organizational structure for existing communication technologies along with a measurement tool which could provide researchers and developers

with a systematic approach of quantifying the implication of embodiment in achieving meaningful interactions.

## Implications

This research provides unique implications for research, practice, education, and policy development. The qualities of meaningful communication and connections is an essential component in the development of tools, resources, and interventions aimed to enhance social connectivity and address the experience of loneliness across the lifespan. Providing a lifespan approach to the understanding of loneliness is essential in strengthening the understanding of the diverse set of experiences and the requirements needed to meet individual needs (Campbell et al., 2015). Although the primary focus of research focused on understanding the uptake and implementation of technology resources has been focused on the experience of young adults and older adults, adopting a lifespan approach can help provide additional insights pertaining to the diverse set of experiences across middle adulthood. This research indicates that there is a particular interest in the adoption of higher embodied technologies by middle and older adults. Future research should aim to elaborate the adoption behaviors of adults across technologies with different levels of embodiment. However, this may be challenging as many of the technologies which present a higher level of embodiment can be more costly and dependent on a wider assortment of requirement (e.g., broadband internet, open home design) in order to function properly.

The adoption and implementation of technologies also has implications for practitioners. Study participants often noted that being able to engage in communication technologies may be beneficial in helping support and strengthening the relationships that they perceived as meaningful. This in turn may present opportunities for the creation and implementation of

resources and services which can help reduce the experience of loneliness across adulthood. Distributing this knowledge through social work curriculum and continued education credits can help equip future and existing practitioners with the knowledge needed to apply existing communication technologies to facilitate social connectivity along with the critical thinking ability to implement new and emerging technologies.

Practitioners' awareness and understanding of the communication technologies can play an important role in providing the community members they serve with the tools they need to facilitate social connectivity not only on an individual level but also from a communal perspective. For example, technologies are not limited to connecting individual with family and friends but also enable them to be present in environments such as senior center, libraries, recreational centers, gyms, school, museums, and other communal places, enabling interactions which could potentially resemble what may be achieved in a in person circumstance (Bevilacqua et al., 2014b; Edwards, 2011; Moyle et al., 2020; Tsui et al., 2014). Furthermore, social work practitioners can help serve as advocates for the communities which they serve to raise awareness about the barriers which may exist pertaining to the adoption and implementation of resources. Researchers and practitioners should work together to facilitate discussions surrounding the social injustice related to access and address the concerns raised by the community they serve. Furthermore, the collaboration of researchers and practitioners can serve as a platform which can inform and advocate policy makers and work together to develop policies with the intention of meeting the needs of the community and those experiencing loneliness and social disconnect. It is important to note that although attractive, the application of technology tools should never be aimed at removing or replacing in person interaction, but rather serve as aid and enable individuals who would otherwise not be able to be socially connected.

## Limitations

In the current study there are some limitations which should be discussed as they may present opportunities in future research. This is a small sample qualitative study implementing purposeful sampling, representative of phases of adulthood with limited diversity across the sample, therefore findings lack generalizability to the entire United States population. Quantitative research with a large representative sample would be needed to further explore the insights identified in the present research related to the formation and maintenance of meaningful relationships and adoption of telepresence technologies across various levels of embodiment. Furthermore, do the nature of research focused on understanding the subjective experience of loneliness, participants were asked about their sense of social connection and meaningful connection, and no direct questions were geared towards feelings of loneliness. This research was conducted during the COVID-19 pandemic which may have impacted participants the relationships participants had and the quality of these relationships.

This study utilized video demonstrations of the technologies across various level of embodiment, highlighting various capabilities, features, and provided examples of actual human interactions. Although video demonstrations can be an effective way of demonstrating technologies due to an inability to demonstrate the technologies in-person, enabling participants to experience embodiment through the technology mediated communication may help enhance their understanding of the construct. Future research should aim to provide participants with the ability to interact with the technology proving the participant with a better baseline as to how sense of presence is and feels like across these various types of technologies. Furthermore, longitudinal research is needed to better understand the use behaviors and implementation of telepresence technologies across phases of adulthood.

## Conclusion

This research presents unique insights pertaining to the facilitation and engagement in meaningful relationships, implementation and utilization of communication technologies, and interests to adopt telepresence technologies across various level of embodiment by individuals across phases of adulthood. Results indicate that across adulthood there are some variations pertaining to the development of meaningful relationships and how individuals utilize and leverage communication technologies to connect with others. Understanding the application and role of communication technologies, specifically technologies which can enable individuals to have a strong sense of presence with others, may present an opportunity towards enhancing social connectivity and addressing the loneliness epidemic. Future research should aim to understand the role of technology and how across adulthood it may be leveraged as tool. However, careful attention is needed to help ensure that the needs of the users are met and concerns pertaining to its implementation are further explored, in both short- and long-term implementation.

## References

Achilleos, A. P., Mettouris, C., Papadopoulos, G. A., Neureiter, K., Rappold, C., Moser, C., Tscheligi, M., Vajda, L., Toth, A., Hanak, P., Jimenez, O., & Smit, R. (2013). The Connected Vitality System: Enhancing Social Presence for Older Adults. In K. Pripuzic & M. Banek (Eds.), *Proceedings of the 12th International Conference on Telecommunications (contel 2013)* (pp. 199–206).

Allwood, J. (2008). Dimensions of Embodied Communication—Towards a typology of embodied communication. *Embodied Communication in Humans and Machines*. https://doi.org/10.1093/acprof:oso/9780199231751.003.0012

Amati, V., Meggiolaro, S., Rivellini, G., & Zaccarin, S. (2018). Social relations and life satisfaction: The role of friends. *Genus*, *74*(1), 7. https://doi.org/10.1186/s41118-018-0032-z

Arthanat, S., Vroman, K. G., & Lysack, C. (2016). A home-based individualized information communication technology training program for older adults: A demonstration of effectiveness and value. *Disability and Rehabilitation-Assistive Technology*, *11*(4), 316–324. https://doi.org/10.3109/17483107.2014.974219

Barbosa Neves, B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019a). Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study. *Journal of Applied Gerontology*, *38*(1), 49–72. cin20. https://doi.org/10.1177/0733464817741369

Barbosa Neves, B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019b). Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study.

*Journal of Applied Gerontology*, *38*(1), 49–72. cin20. https://doi.org/10.1177/0733464817741369

Bartels, M., Cacioppo, J. T., Hudziak, J. J., & Boomsma, D. I. (2008). Genetic and environmental contributions to stability in loneliness throughout childhood. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *147B*(3), 385–391. https://doi.org/10.1002/ajmg.b.30608

Beer, J. M., & Takayama, L. (2011a). Mobile remote presence systems for older adults: Acceptance, benefits, and concerns. *Proceedings of the 6th International Conference on Human-Robot Interaction - HRI '11*, 19. https://doi.org/10.1145/1957656.1957665

Beer, J. M., & Takayama, L. (2011b). Mobile remote presence systems for older adults: Acceptance, benefits, and concerns. *Proceedings of the 6th International Conference on Human-Robot Interaction - HRI '11*, 19. https://doi.org/10.1145/1957656.1957665

Beno, M. (2018). Work Flexibility, Telepresence in the Office for Remote Workers: A Case Study from Austria. In M. Kaenampornpan, R. Malaka, D. D. Nguyen, & N. Schwind (Eds.), *Multi-disciplinary Trends in Artificial Intelligence* (pp. 19–31). Springer International Publishing. https://doi.org/10.1007/978-3-030-03014-8_2

Berg, T., Winterton, R., Petersen, M., & Warburton, J. (2017). "Although we're isolated, we're not really isolated": The value of information and communication technology for older people in rural Australia. *Australasian Journal on Ageing*, *36*(4), 313–317. cin20. https://doi.org/10.1111/ajag.12449

Bevilacqua, R., Cesta, A., Cortellessa, G., Macchione, A., Orlandini, A., & Tiberio, L. (2014a). *Telepresence Robot at Home: A Long-Term Case Study* (pp. 73–85). https://doi.org/10.1007/978-3-319-01119-6_8

Bevilacqua, R., Cesta, A., Cortellessa, G., Macchione, A., Orlandini, A., & Tiberio, L. (2014b). *Telepresence Robot at Home: A Long-Term Case Study* (pp. 73–85). https://doi.org/10.1007/978-3-319-01119-6_8

Bochner, A. P. (1981). On the Efficacy of Openness in Close Relationships. *Annals of the International Communication Association*, *5*(1), 109–124. https://doi.org/10.1080/23808985.1981.11923841

Broadbent, E., Jayawardena, C., Kerse, N., Stafford, R., & Macdonald, B. (2011, January 1). *Human-Robot Interaction Research to Improve Quality of Life in Elder Care—An Approach and Issues.* AAAI Workshop - Technical Report.

Brown, C., & Lowis, M. J. (2003). Psychosocial development in the elderly: An investigation into Erikson's ninth stage. *Journal of Aging Studies*, *17*(4), 415–426. https://doi.org/10.1016/S0890-4065(03)00061-6

Bruce, L. D., Wu, J. S., Lustig, S. L., Russell, D. W., & Nemecek, D. A. (2019). Loneliness in the United States: A 2018 National Panel Survey of Demographic, Structural, Cognitive, and Behavioral Characteristics. *American Journal of Health Promotion*, *33*(8), 1123–1133. cin20. https://doi.org/10.1177/0890117119856551

Bugmann, G., & Copleston, S. (2011). *What Can a Personal Robot Do for You? 6856*, 360–371. https://doi.org/10.1007/978-3-642-23232-9_32

Burckhardt, C. S., & Anderson, K. L. (2003). The Quality of Life Scale (QOLS): Reliability, Validity, and Utilization. *Health and Quality of Life Outcomes*, *1*(1), 60. https://doi.org/10.1186/1477-7525-1-60

Burmeister, O. K., & Marks, E. (2016). Rural and remote communities, technology and mental health recovery. *Journal of Information Communication & Ethics in Society*, *14*(2), 170–181. https://doi.org/10.1108/JICES-10-2015-0033

Burnham, M. J., Le, Y. K., & Piedmont, R. L. (2018). Who is Mturk? Personal characteristics and sample consistency of these online workers. *Mental Health, Religion & Culture*, *21*(9–10), 934–944. https://doi.org/10.1080/13674676.2018.1486394

Campbell, W. K., Campbell, S. M., Siedor, L. E., & Twenge, J. M. (2015). Generational Differences Are Real and Useful. *Industrial and Organizational Psychology*, *8*(3), 324–331. https://doi.org/10.1017/iop.2015.43

Cesta, A., Cortellessa, G., Orlandini, A., & Tiberio, L. (2016). Long-Term Evaluation of a Telepresence Robot for the Elderly: Methodology and Ecological Case Study. *International Journal of Social Robotics*, *8*(3), 421–441. https://doi.org/10.1007/s12369-016-0337-z

Chen, Y.-S., Hsu, Y.-L., & Lu, J.-M. (2013). TRiC(mini)(+)—A Telepresence Robot for Interpersonal Communication for Older Adults. *JOURNAL OF THE CHINESE SOCIETY OF MECHANICAL ENGINEERS*, *34*(2), 121–127.

Child, S. T., & Lawton, L. (2019a). Loneliness and social isolation among young and late middle-age adults: Associations with personal networks and social participation. *Aging & Mental Health*, *23*(2), 196–204.

Child, S. T., & Lawton, L. (2019b). Loneliness and social isolation among young and late middle-age adults: Associations with personal networks and social participation. *Aging & Mental Health*, *23*(2), 196–204.

Choi, J.-J., & Kwak, S. S. (2016). Can you feel me?: How embodiment levels of telepresence systems affect presence. *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 606–611. https://doi.org/10.1109/ROMAN.2016.7745180

Chopik, W. J. (2016). The Benefits of Social Technology Use Among Older Adults Are Mediated by Reduced Loneliness. *Cyberpsychology, Behavior, and Social Networking*, *19*(9), 551–556. https://doi.org/10.1089/cyber.2016.0151

*Cigna U.S. Loneliness Index*. (2018). [Index]. Cigna. https://www.multivu.com/players/English/8294451-cigna-us-loneliness-survey/docs/IndexReport_1524069371598-173525450.pdf

Ciocan, C. (2015). Heidegger's phenomenology of embodiment in the Zollikon Seminars. *Continental Philosophy Review*, *48*. https://doi.org/10.1007/s11007-015-9347-z

Dahlberg, L., & McKee, K. J. (2014). Correlates of social and emotional loneliness in older people: Evidence from an English community study. *Aging & Mental Health*, *18*(4), 504–514. https://doi.org/10.1080/13607863.2013.856863

De Jong Gierveld, J., & Van Tilburg, T. (1999). Living arrangements of older adults in the Netherlands and Italy: Coresidence values and behaviour and their consequences for loneliness. *JOURNAL OF CROSS CULTURAL GERONTOLOGY*, *1*, 1.

de Jong-Gierveld, J. (1987). Developing and testing a model of loneliness. *Journal of Personality and Social Psychology*, *53*(1), 119–128. https://doi.org/10.1037/0022-3514.53.1.119

Edwards, J. (2011). Telepresence: Virtual Reality in the Real World [Special Reports]. *IEEE Signal Processing Magazine*, *28*(6), 9–142. https://doi.org/10.1109/MSP.2011.941853

Fang, Y., Chau, A. K. C., Fung, H. H., Woo, J., Chau, A. K. C., & Fung, H. H. (2019). Loneliness Shapes the Relationship between Information and Communications Technology Use and Psychological Adjustment among Older Adults. *Gerontology*, *65*(2), 198–206. cin20. https://doi.org/10.1159/000495461

Fausset, C. B., Kelly, A. J., Rogers, W. A., & Fisk, A. D. (2011). Challenges to Aging in Place: Understanding Home Maintenance Difficulties. *Journal of Housing for the Elderly*, *25*(2), 125–141. https://doi.org/10.1080/02763893.2011.571105

Findlay, A. H., & Nies, M. A. (2017). Understanding social networking use for social connectedness among rural older adults. *Healthy Aging Research*, *6*, e12. https://doi.org/10.1097/HXR.0000000000000012

Fischer, K., Lohan, K. S., & Foth, K. (2012). Levels of Embodiment: Linguistic Analyses of Factors Influencing Hri. *Proceedings of the Seventh Annual ACM/IEEE International Conference on Human-Robot Interaction*, 463–470. https://doi.org/10.1145/2157689.2157839

Fowler, C., Gasiorek, J., & Giles, H. (2015). The role of communication in aging well: Introducing the communicative ecology model of successful aging. *Communication Monographs*, *82*(4), 431–457. https://doi.org/10.1080/03637751.2015.1024701

Franssen, T., Stijnen, M., Hamers, F., & Schneider, F. (2020). Age differences in demographic, social and health-related factors associated with loneliness across the adult life span (19–65 years): A cross-sectional study in the Netherlands. *BMC Public Health*, *20*(1), 1118. https://doi.org/10.1186/s12889-020-09208-0

Franzoi, S. L., & Davis, M. H. (1985). Adolescent self-disclosure and loneliness: Private self-consciousness and parental influences. *Journal of Personality and Social Psychology*, *48*(3), 768–780. https://doi.org/10.1037//0022-3514.48.3.768

Gierveld, J. de J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology*, *8*(1), 73–80. https://doi.org/10.1017/S0959259898008090

Golden, J., Conroy, R. M., Bruce, I., Denihan, A., Greene, E., Kirby, M., & Lawlor, B. A. (2009). Loneliness, social support networks, mood and wellbeing in community-dwelling elderly. *International Journal of Geriatric Psychiatry*, *24*(7), 694–700.

Haans, A., & IJsselsteijn, W. A. (2012). Embodiment and telepresence: Toward a comprehensive theoretical framework. *Interacting with Computers*, *24*(4), 211–218. https://doi.org/10.1016/j.intcom.2012.04.010

Hawkley, L. C., & Cacioppo, J. T. (2007). Aging and Loneliness: Downhill Quickly? *Current Directions in Psychological Science*, *16*(4), 187–191. https://doi.org/10.1111/j.1467-8721.2007.00501.x

Hoare, C. H. (2002). *Erikson on Development in Adulthood: New Insights From the Unpublished Papers*. Oxford University Press. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=129711&site=eds-live

Husserl, E., & Schuhmann, K. (1977). *Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie: Erstes Buch: Allgemeine Einführung in die reine Phänomenologie* (1995 edition). Springer.

Jong Gierveld, J., Pas, S., & Keating, N. (2015). Loneliness of Older Immigrant Groups in Canada: Effects of Ethnic-Cultural Background. *Journal of Cross-Cultural Gerontology*, *30*(3), 251–268.

Keller, L., Gawron, O., Rahi, T., Ulsamer, P., & Müller, N. H. (2021). Driving Success: Virtual Team Building Through Telepresence Robots. In P. Zaphiris & A. Ioannou (Eds.), *Learning and Collaboration Technologies: Games and Virtual Environments for Learning* (pp. 278–291). Springer International Publishing. https://doi.org/10.1007/978-3-030-77943-6_18

Keshmiri, S., Sumioka, H., Yamazaki, R., & Ishiguro, H. (2019). Differential Effect of the Physical Embodiment on the Prefrontal Cortex Activity as Quantified by Its Entropy. *Entropy*, *21*(9), 875.

Kobayashi, K. M., Cloutier-Fisher, D., & Roth, M. (2009). Making meaningful connections: A profile of social isolation and health among older adults in small town and small city, British Columbia. *Journal of Aging and Health*, *21*(2), 374–397. psyh. https://doi.org/10.1177/0898264308329022

Kristoffersson, A., Coradeschi, S., Loutfi, A., & Severinson-Eklundh, K. (2011). An Exploratory Study of Health Professionals' Attitudes about Robotic Telepresence Technology. *Journal of Technology in Human Services*, *29*(4), 263–283. https://doi.org/10.1080/15228835.2011.639509

Liles, K. R., Stuck, R. E., Kacmar, A. A., & Beer, J. M. (2015a). Understanding Retirement Community Employees' Perceived Benefits and Concerns of Smart Presence Technology. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *59*(1), 75–79. https://doi.org/10.1177/1541931215591016

Liles, K. R., Stuck, R. E., Kacmar, A. A., & Beer, J. M. (2015b). Exploring Use Cases of Smart Presence for Retirement Communities. In J. Zhou & G. Salvendy (Eds.), *Human Aspects of IT for the Aged Population. Design for Everyday Life* (pp. 446–455). Springer International Publishing. https://doi.org/10.1007/978-3-319-20913-5_41

Luft, S. (2015). Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity. *Review of Metaphysics*, *69*(2), 415–418.

McLoughlin, L., Spears, B., & Taddeo, C. (2018). The Importance of Social Connection for Cybervictims: How Connectedness and Technology Could Promote Mental Health and Wellbeing in Young People. *International Journal of Emotional Education*, *10*(1), 5–24.

Meloncon, L. (2013). Toward a Theory of Technological Embodiment. In L. Meloncon (Ed.), *Rhetorical Accessability: At the Intersection of Technical Communication and Disability Studies*. Baywood Publishing Company, Inc. https://doi.org/10.2190/RAAC3

Mois, G., & Beer, J. M. (2020). The Role of Healthcare Robotics in Providing Support to Older Adults: A Socio-ecological Perspective. *Current Geriatrics Reports*, *9*(2), 82–89. https://doi.org/10.1007/s13670-020-00314-w

Mollahosseini, A., Abdollahi, H., Sweeny, T. D., Cole, R., & Mahoor, M. H. (2018). Role of embodiment and presence in human perception of robots' facial cues. *International Journal of Human-Computer Studies*, *116*, 25–39. https://doi.org/10.1016/j.ijhcs.2018.04.005

Moyle, W., Jones, C., Dwan, T., Ownsworth, T., & Sung, B. (2019). Using telepresence for social connection: Views of older people with dementia, families, and health professionals from a mixed methods pilot study. *Aging & Mental Health*, *23*(12), 1643–1650. https://doi.org/10.1080/13607863.2018.1509297

Moyle, W., Jones, C., & Sung, B. (2020). Telepresence robots: Encouraging interactive communication between family carers and people with dementia. *Australasian Journal on Ageing*, *39*(1), e127–e133. https://doi.org/10.1111/ajag.12713

Nunes, A., Limpo, T., Lima, C. F., & Castro, S. L. (2018). Short Scales for the Assessment of Personality Traits: Development and Validation of the Portuguese Ten-Item Personality Inventory (TIPI). *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00461

Ortiz-Ospina, E., & Roser, M. (2020). Loneliness and Social Connections. *Our World in Data*. https://ourworldindata.org/social-connections-and-loneliness

Pauly, T., Lay, J. C., Kozik, P., Graf, P., Mahmood, A., & Hoppmann, C. A. (2019). Technology, physical activity, loneliness, and cognitive functioning in old age. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, *32*(3), 111–123. psyh. https://doi.org/10.1024/1662-9647/a000208

Perlman, D. (1988). Loneliness: A life-span, family perspective. In *Families and social networks* (pp. 190–220). Sage Publications, Inc.

Richardson, J. C., & Swan, K. (2019). EXAMINING SOCIAL PRESENCE IN ONLINE COURSES IN RELATION TO STUDENTS' PERCEIVED LEARNING AND SATISFACTION. *Online Learning*, *7*(1). https://doi.org/10.24059/olj.v7i1.1864

Robinson, H., Macdonald, B., & Broadbent, E. (2014). The Role of Healthcare Robots for Older People at Home: A Review. *International Journal of Social Robotics*, *6*, 575–591. https://doi.org/10.1007/s12369-014-0242-2

Rosenthal, D. A., Gurney, R. M., & Moore, S. M. (1981). From trust on intimacy: A new inventory for examining erikson's stages of psychosocial development. *Journal of Youth and Adolescence*, *10*(6), 525–537. https://doi.org/10.1007/BF02087944

Shah, S. G. S., Nogueras, D., Woerden, H. van, & Kiparoglou, V. (2019). Effectiveness of digital technology interventions to reduce loneliness in adults: A protocol for a systematic review and meta-analysis. *BMJ Open*, *9*(9), e032455. https://doi.org/10.1136/bmjopen-2019-032455

Shankar, A., McMunn, A., Banks, J., & Steptoe, A. (2011). Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychology*, *30*(4), 377–385. https://doi.org/10.1037/a0022826

Slater, C. L. (2003). Generativity Versus Stagnation: An Elaboration of Erikson's Adult Stage of Human Development. *Journal of Adult Development*, *10*(1), 53–65. https://doi.org/10.1023/A:1020790820868

Smarr, C.-A., Mitzner, T. L., Beer, J. M., Prakash, A., Chen, T. L., Kemp, C. C., & Rogers, W. A. (2014). Domestic Robots for Older Adults: Attitudes, Preferences, and Potential. *International Journal of Social Robotics*, *6*(2), 229–247. https://doi.org/10.1007/s12369-013-0220-0

Stokes, J. P. (1985). The relation of social network and individual difference variables to loneliness. *Journal of Personality and Social Psychology*, *48*(4), 981–990. https://doi.org/10.1037/0022-3514.48.4.981

Streeck, J. (2015). Embodiment in Human Communication. *Annual Review of Anthropology*, *44*(1), 419–438. https://doi.org/10.1146/annurev-anthro-102214-014045

Taipale, J. (2014). *Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity*. Northwestern University Press.

Takayama, L. (2015). Telepresence and Apparent Agency in Human–Robot Interaction. In *The Handbook of the Psychology of Communication Technology* (pp. 160–175). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118426456.ch7

Thomee, S., Dellve, L., Harenstam, A., & Hagberg, M. (2010). Perceived connections between information and communication technology use and mental symptoms among young adults—A qualitative study. *Bmc Public Health*, *10*, 66. https://doi.org/10.1186/1471-2458-10-66

Titchkosky, T. (2007). *Reading and writing disability differently: The textured life of embodiment*. University of Toronto Press.

Tsui, K., McCann, E., McHugh, A., Medvedev, M., Yanco, H., Kontak, D., & Drury, J. (2014). Towards designing telepresence robot navigation for people with disabilities. *International Journal of Intelligent Computing and Cybernetics*, *7*, 307–344. https://doi.org/10.1108/IJICC-10-2013-0044

Twenge, J., Catanese, K., & Baumeister, R. (2003). Social Exclusion and the Deconstructed State: Time Perception, Meaninglessness, Lethargy, Lack of Emotion, and Self-Awareness. *Journal of Personality and Social Psychology*, *85*, 409–423. https://doi.org/10.1037/0022-3514.85.3.409

Wang, D., Subagdja, B., Kang, Y., Tan, A.-H., & Zhang, D. (2014). Towards intelligent caring agents for Aging-In-Place: Issues and challenges. *2014 IEEE Symposium on Computational Intelligence for Human-like Intelligence (CIHLI)*, 1–8. https://doi.org/10.1109/CIHLI.2014.7013393

Yanguas, J., Pinazo-Henandis, S., & Tarazona-Santabalbina, F. J. (2018). The complexity of loneliness. *Acta Bio Medica : Atenei Parmensis*, *89*(2), 302–314. https://doi.org/10.23750/abm.v89i2.7404

Yayan, E. H., Dağ, Y. S., & Düken, M. E. (2019). The effects of technology use on working young loneliness and social relationships. *Perspectives in Psychiatric Care*, *55*(2), 194–200. https://doi.org/10.1111/ppc.12318

Appendix 4.1 Survey Instrument (Available per request)

Appendix 4.2 Coding Scheme

| High Level Codes | Medium Level Codes | Low Level Codes |
|---|---|---|
| Communication in Relationships (How would you describe a meaningful relationship) | | Communication |
| | Listening | Listening |
| | Adaptability | Adaptability – communication adapts to what each party may be interested in discussing |
| | Frequency | Frequency – Communication happens on a regular basis with no major gaps |
| | Quality | Quality – The communication is beyond small talk |
| | Openness | Openness – Can be open about topics that may be difficult to discuss with others |
| | Timeliness | Timeliness – person is responsive to communication |
| | Organic | Organic – Communication flows easily without have to think about it |
| | Other | Other |
| Qualities in Relationship | | Relationship qualities |
| | closeness | |
| | Understanding | Understanding – person understand the things the person is going through |
| | Caring | Caring AND/OR Reliant. Sincerely cares about one another's wellbeing |

| | | |
|---|---|---|
| | Respect | Respect – They are respectful of one another's needs |
| | Trust | Trust – Ability to trust someone with important matters, secrets, |
| | Availability | Availability -Able to talk to them at anytime |
| | Shared interests | Shared interests – Interested in similar things |
| | Shared Values | Shared Values – Share values or mutual respect for each others values |
| | Shared Experiences | |
| | Work together | Ability to work together through various circumstances |
| | Important Dates | Remember birthdays, meaningful dates, important aspect shared within the relationship |
| | Compatibility | |
| | Comfort | |
| | Commitments | a shared sense of commitment to the relationship, bring a similar contribution |
| | Other | |
| Who are two people in your life that you would describe your re | | Who are two people in your life that you would describe your relationship with them as meaningful? |
| | Mother | Mother |
| | Father | Father |
| | Child | (the child of a parent) |
| | Brother | Brother |
| | Sister | Sister |
| | Step Siblings | |
| | Half-Siblings | |
| | Spouse | Spouse |
| | Partner | Partner |
| | Friend | Friend |

| | | |
|---|---|---|
| | boyfriend/girlfriend | |
| | House Mate | |
| | Other | |
| | Quote | |
| Age | | Age(s) of the people with whom you have a meaningful relationship with |
| | 15-20 | 15-20 |
| | 21-25 | 21-25 |
| | 26-30 | 26-30 |
| | 31-35 | 30-35 |
| | 36-40 | 36-40 |
| | 41-45 | 41-45 |
| | 46-50 | 46-50 |
| | 51-55 | 51-55 |
| | 56-60 | 56-60 |
| | 61-65 | 61-65 |
| | 66-70 | 66-70 |
| | 71-75 | 71-75 |
| | 76-80 | 76-80 |
| | 81-85 | 81-85 |
| | 86-90 | 86-90 |
| | 91-95 | 91-95 |
| | 30-35 | 30-35 |
| Frequency of Communication | | Frequency of Communication |
| | Every day (7 times a week/ multiple times a day | Every day (7 times a week/ multiple times a day |
| | 4-5 Weekly (4-5 times a (1) | 4-5 Weekly (4-5 times a week) |
| | 2-3 Weekly (2-3 times a week) | 2-3 Weekly (2-3 times a week) |
| | Weekly (Once a week) | Weekly (Once a week) |
| | Monthly + (Every Month/ Few Times a (1) | Monthly + (Every Month/ Few Times a month) |
| | Monthly - (Every Few Month) | Monthly - (Every Few Month) |

| | | | |
|---|---|---|---|
| | Monthly - (Every Few (2) | | Monthly - (Every Few Month) |
| | Yearly (Once or twice a year) | | Yearly (Once or twice a year) |
| Communication Improvements with meaningfull relationships | | | |
| | Yes | | |
| | | Listening | |
| | | Approach | Changes in how one communicated and approaches communication - Try to be more patient and understanding. |
| | | Format | Access to a favored format weather it be being able to talk in person, have a call, video chat etc |
| | | Topic | |
| | | Frequency | |
| | | Technolog y | change technology to meet friends preferences |
| | | Other | |
| | No change | | |
| | Quote | | |
| How often do you use technology to communicate with those you d | | | How often do you use technology to communicate with those you described as having a meaningful relationship with? |
| | Every day (7 times a week/ multiple times a day (1) | | Every day (7 times a week/ multiple times a day |
| | 4-5 Weekly (4-5 times a week) | | 4-5 Weekly (4-5 times a week) |
| | 2-3 Weekly (2-3 times a (1) | | 2-3 Weekly (2-3 times a week) |
| | Weekly (Once a (1) | | Weekly (Once a week) |
| | Monthly + (Every Month/ Few Times a month) | | Monthly + (Every Month/ Few Times a month) |
| | Monthly - (Every Few (1) | | Monthly - (Every Few Month) |

| | | |
|---|---|---|
| | Yearly (Once or twice a (1) | Yearly (Once or twice a year) |
| | Other | |
| Ways of communicating | | Ways of communicating |
| | Face to face | Face to face |
| | Google Voice/AI | |
| | Text | Text |
| | Calls | Calls |
| | Video Conferencing | Video Conferencing |
| | Group Connections | Discord, Group me, etc. other apps/platform that allow individuals that connect with each other |
| | Video Conferencing Dedicated tech | Video Conferencing Dedicated tech |
| | Social Media | Social Media |
| | Video Games | |
| | Email | |
| | Other | Technology Use |
| | Quote | |
| Sense of Connection Through Technolgy | | |
| | Increased | |
| | Decreases | |
| | Same | Neither better or worst |
| | Mixed | |
| | Other | connection is different than what may be experienced in person. |
| | Quote | |
| | Improved | |
| Differences Tech/Face to face | | |
| | Touch Physical contact | ability to hug |
| | Body language | |
| | Non-verbal communication | |
| | Technology Limitations | Poor internet connection, technology failure (drop calls), etc |

| | | |
|---|---|---|
| | User related challenges | User does not know how the technology functions. There may be some challenges in understanding the functionalities of the technology. |
| | Personable | Feeling of connecting with a individual(s). Person is not focused on other things (Multitasking) |
| | physical presence | |
| | Technology novelty | With time use of technology is no longer exciting |
| | Focus and Formality | Focus of the conversation and The connection is less spontaneous |
| | Other | |
| | none | |
| | Quote | |
| | Touch | E.g., ability to hug |
| | | Impact of COVID 19 |
| Use of Technology to engage in communication | | Use of Technology to engage in communication |
| | Opportunities | Opportunities |
| | Challenges | Challenges |
| | Both | Both |
| | Other | |
| | Quote | |
| How has the use of these technologies changed in the past year? | | How has the use of these technologies changed in the past year? |
| | Increased | Increased |
| | Same | Same |
| | Decreased | Decreased |
| | Mixed | |
| | Quote | |
| Impact of technology on relationships | | |
| | Positive | |
| | Negative | |
| | No impact | |
| | Other | |
| | Quote | |
| | | Technology Embodiment |
| Sense of Connection Affect | | Sense of Connection Affect |

| | | | |
|---|---|---|---|
| | Quote | | |
| | Telepresence Software | | Telepresence Software |
| | | Positive | Positive |
| | | Negative | Negative |
| | | Neutral | Neutral |
| | | Mixed | |
| | | Other | |
| | Telepresence Hardware | | Telepresence Hardware |
| | | Positive | |
| | | Negative | |
| | | Neutral | |
| | | Mixed | |
| | | Other | |
| | Telepresence Hardware with limited mobility | | Telepresence Hardware with limited mobility |
| | | Positive | |
| | | Negative | |
| | | Neutral | |
| | | Mixed | |
| | | Other | |
| | Telepresence Hardware with full mobility | | Telepresence Hardware with full mobility |
| | | Positive | |
| | | Negative | |
| | | Neutral | |
| | | Mixed | |
| | | Other | |
| Tech Access and frequency of contact | | | If you had access to all the technologies how do you think it would impact the frequency of contact with friends and family? |
| | Improve | | Improve |
| | Decline | | Decline |
| | Same | | Stay the same |
| | Mixed | | |
| | Other | | |
| | | | Adoption |

| Perceived usefulness | | Perceived usefulness<br><br>Pick the number that corresponds with the order in which participants place the technologies<br><br>1-signifies most useful<br>2<br>3<br>4- signifies least useful |
|---|---|---|
| | Quote | |
| | Video -conferencing | Video Conferencing through a personal device (smartphone, tablet, computer) |
| | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | Other | |
| | Telepresence technologies | Telepresence technologies |
| | 1 | 1 |
| | 2 | 2 |
| | 3 | 3 |
| | 4 | 4 |
| | Other | |
| | Telepresence technologies with limited mobility | Telepresence technologies with limited mobility |
| | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | Other | |
| | Telepresence technology with full mobility | Telepresence technology with full mobility |
| | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | Other | |
| | Same | All technologies are perceived to have the |

| | | |
|---|---|---|
| | | same level of perceived usefulness |
| | All | |
| | | Are there any other uses any of these technologies outside of what we have discussed thus far? |
| Business | | Business |
| Education | | Education |
| Medicine | | Medicine |
| Institutionalized Care | | Institutionalized Care |
| Public Spaces | | Visit public spaces like Museums/Public Spaces/vacation destinations'/stores |
| Surveillance | | Check in on home, persons, pets |
| Attend events | | |
| Direct Assistance | | Help or directions on how to do something, direct, enabling ability to support with various things. |
| Other | | e.g., Be able to control a remote environment |
| none | | |
| Quote | | |
| | | Perceived Ease of Use |
| Perceived ease of use | | Can you list these technologies from easiest to use to what you think would be most difficult to use?<br><br>Pick the number that corresponds with the order in which participants place the technologies<br><br>1-signifies easiest to use<br>2<br>3<br>4- Most difficult to use |
| | Video Conferencing | 1-Most easy<br>2<br>3<br>4-Least Easy to use |
| | 1 | |
| | 2 | |

| | | | |
|---|---|---|---|
| | | 3 | |
| | | 4 | |
| | | Other | |
| | Telepresence technology | | 1-Most easy<br>2<br>3<br>4-Least Easy to use |
| | | 1 | |
| | | 2 | |
| | | 3 | |
| | | 4 | |
| | | Other | |
| | Telepresence technology with limited mobility | | 1-Most easy<br>2<br>3<br>4-Least Easy to use |
| | | 1 | |
| | | 2 | |
| | | 3 | |
| | | 4 | |
| | | Other | |
| | Telepresence technology with full mobility | | 1-Most easy<br>2<br>3<br>4-Least Easy to use |
| | | 1 | |
| | | 2 | |
| | | 3 | |
| | | 4 | |
| | | Other | |
| | Same | | |
| | | All | All technologies are perceived to have the same level of ease of use |
| Quote | | | |
| | | | Most useful in supporting meaningful relationships |
| Video Conferencing | | | |
| Telepresence technolgy | | | |
| Telepresence Technolgy with limited mobility | | | |
| Telepresence with full mobility | | | |

| | | |
|---|---|---|
| Same | | All of the technologies were perceived equally useful |
| Quote | | |
| Video Conferencing | | If the technologies in the demonstration you watched were offered to you for free today, would you use them?<br><br>All technologies should be described below<br><br>Yes- would use<br>no- not willing to use<br>Maybe- if participant wasn't sure if they would want to use the technology<br>other -Any other type of thoughts |
| | Yes | |
| | No | |
| | Maybe | |
| | Other | |
| Telepresence technolgy | | |
| | Yes | |
| | No | |
| | Maybe | |
| | Other | |
| Telepresence technology with limited mobility | | |
| | Yes | |
| | No | |
| | Maybe | |
| | Other | |
| Telepresence technology with full mobility | | |
| | Yes | |
| | No | |
| | Maybe | |
| | Other | |

Appendix 4.3 Interview Script and Questions

**Interview/Survey Script and Questions**

**Introduction:**

Thank you for taking the time to participate in the interview today. My name is _____, and I work at the University of Georgia. Before we get started do you mind silencing your phone, so we do not have any interruptions? Thank you!

Great! First as we begin the interview, I'm going to ask you a few questions to make sure everything is set-up correctly. This is to make sure that everything related to technology will run smoothly on both of our ends.

- Are you able to hear me clearly?
- Are you able to see the video on your screen clearly?

**Reminders and Overview**

Wonderful, it looks like we are ready!

- First, in order to be consistent between participants, I am required to read directly from this script. I apologize if questions sound formal or repetitive. It's okay if your answers seem repetitive.
- If the connection is interrupted and you are unable to see or hear what is being displayed on the screen, please let know.
- Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. No aspect of your educational record or trajectory will be impacted by the decision to participate or choose not to participate.
- As a reminder, all your answers are confidential.
- There are no right or wrong answers
- I am really interested in capturing your personal experiences and ideas. However, some of these questions might be personal. If there is anything you do not wish to discuss, we can always skip that topic. Please just let me know.
- If at any time you no longer wish to be in this study, just let us know.

To kicks things off, I would like to go over some of the things that we will be discussing today:
The main topics of today's interview will include the relationships, particularly those with family and friends or any other relationship you would consider as most meaningful to you, communication which happens remotely with those with whom you have these relationships with, and your use of technology to communicate. I will also be presenting you with a set of various communication technologies and I will ask your opinions and thought about them. Please keep in mind that there are no right or wrong answers.

Before we get started, I want to check in to make sure you are able to hear me and see the screen?

(Participant signal that technology is working properly)

Great lets get started!

**Brief Survey**

In the chat bar located to the right of your screen I have shared with you a link to a quick online survey. As a reminder, all your answers are confidential. The first page of the survey is the consent form which will inform you about the various component of today's survey and interview. Please read it carefully and let me know if you have any questions. If you decide to participate in today's study please click **continue** This survey will ask demographic information, questions pertaining to you use of technology, communication, and changes in how you communicated over the past year. Once you complete the survey, we will proceed with today interview. I will be on the zoom call as you complete the survey, and you can ask me any question you might have.

Qualtrics Link:

(Participant signal that survey is complete)

**Interview**

Great, it looks like we are ready to begin todays interview.

---

- **How would you describe a meaningful relationship?**
  - What are some of the things that make the relationship meaningful?
  - What are some the things that you do to maintain a meaningful relationship?
    - Communicate
    - Activities

- **Who are two people in your life that you would describe your relationship with them as meaningful?**
  - What is the age of the individuals you described?
  - Can you describe your relationship with them?
  - What are some of the things that make these relationships different than other relationships?

- **What aspect of your communication with them works well for you?**

    - How often do you communicate with them?
    - Are there are any changes you would like to make as to how you are currently able to communicate with those whom you describe you have a meaningful relationship with?
- **How often do you use technology to communicate with those you described as having a meaningful relationship with?**
    - How would you describe the use of communication technologies by two persons you mentioned earlier?
    - What technologies have you used to connect with those with whom you have meaningful relationships with?
        - How would you describe the sense of connection with these individuals when you communicate with them through technology?
        - What are the difference when communicating with these individual through technology when comparing your experience of talking to them face to face?
            - Does your sense of presence or feeling of connection change when communicating through technology?
                - How do these changes affect your ability to communicate?
    - What are the similarities when communicating with these individual through technology when comparing your experience of talking to them face to face?

- **How has the use of these technologies changed in the past year?**
    - Has technology created opportunities or challenges in communicating with those with whom you have meaningful relationships?
    - How would you describe the frequency of communication?
        - Has it decreased, stayed the same, or increased when compared to prior the spread of COVID-19?
        - Has the use of technology affected the relationships you have with these individuals?
- Thus far we have discussed about the components of a meaningful relationships, the ways in which you communicate with those with whom you have meaningful relationships with, how you might use technology to communicate, and the changes which have occurred in how you communicate with those with whom you have meaningful relationships.

- **The goal of this next section is to get your opinion and thoughts about various types of communication technologies and how they might be used to communicate with those with whom you have meaningful relationships with.**

- We are going to begin by watching four short videos which will help demonstrate four different types of communication technologies. These technologies vary in their capabilities and how two or more connect with each

other. Some of the technologies can be used through a smart phone and devices someone owns, while others are standalone devices and systems which can be used to communicate with others. These videos will explain how the technologies function, what they are capable of doing, and how they differ from one another.

- **Now that you have watched the 1st video**
  - How would you describe the sense of connection you feel you could achieve across the types of technologies demonstrated?
- **Now that you have watched the 2nd video**
  - How would you describe the sense of connection you feel you could achieve across the types of technologies demonstrated?
- **Now that you have watched the 3rd video**
  - How would you describe the sense of connection you feel you could achieve across the types of technologies demonstrated?
- **Now that you have watched the 4th video**
  - How would you describe the sense of connection you feel you could achieve across the types of technologies demonstrated?

- **You watched four videos describing four different types of communication technologies with different capabilities and ways of connecting individuals together.** Now imagine you had these technologies in your home, and you would get to use it regularly with friends and family, do you think it would affect the amount of contact you would have with friends and family?

  - Can you list these technologies from most useful to least useful? Why did you choose that order?
    - Telepresence software
    - Telepresence technologies
    - Telepresence technologies with limited mobility
    - Telepresence technology with full mobility
    - Are there any other uses any of these technologies outside of what we have discussed thus far?
    - Can you tell me a bit about why you chose that order?

  - Can you list these technologies from easiest to use to what you think would be most difficult to use?
    - Telepresence software
    - Telepresence technologies
    - Telepresence technologies with limited mobility
    - Telepresence technology with full mobility
  - Can you tell me a bit about why you chose that order?

- **Based on the descriptions of the technologies which of these technologies do you think would be most useful in keeping you connected with the individuals that you described as having meaningful relationships?**

    - Can you describe what functions of that technology stood out to you the most?

- **If the technologies in the demonstration you watched were offered to you for free today, would you use them?**
    - Telepresence software
    - Telepresence technologies
    - Telepresence technologies with limited mobility
    - Telepresence technology with full mobility

- **Before we close,** I would like to ask you if you wanted to say anything else about anything we have discussed thus far or if you had any other questions for me regarding the study?

- Great! Thank you so much for your time and for participating in this interview.

# CHAPTER 5

# SUMMARY, IMPLICATIONS, AND CONCLUSION

## Overview

The goal of this dissertation is to understand the potential application of communication technologies as tools aimed to help address the social injustices related to the experience of loneliness across various phases of adulthood. Furthermore, this research provides an enhanced understanding of how the sense of embodiment achieved through a communication technology may impact the user's sense of being present while communicating.

The basis of this research was informed by the Cognitive Theoretical Approach to understanding loneliness as a phenomenon which highlights the multidimensionality of the phenomenon, integrating many of the strengths highlighted by both the Social Needs Approach along with the Behavioral Theoretical Approach. A key feature of this approach is the close relationships between the experience of loneliness and the insufficiencies experienced by individuals pertaining to the quality and absence of social relationships which make up one's sense of social connectedness (Wong & Waite, 2016). Therefore, developing strategies which aim to support and advance an individual's ability to maintain and create opportunities for social connectedness present an important strategy to help address the experience of loneliness across various phases of adulthood. In recent history, advancements in communication technology and internet-based communication platforms have presented opportunities towards advancing humans' ability to engage and facilitate communication. Leveraging communication

technologies as tools presents an opportunity to promote social connectivity (Barbosa Neves et al., 2019; Pensas et al., 2014)

Technology platforms have various ways of facilitating and enabling individuals to engage in communication. For example, communication technology platforms can facilitate social contact through text, voice, images, video, locomotion in remote environments, or a combination of these various media. An important aspect of understanding the communication, which is facilitated through a technology medium, is the sense of embodiment or sense of presence that can be achieved by the sender and receiver of messages through technology mediated communication (Ciocan, 2015; Keshmiri et al., 2019; Luft, 2015). Understanding the role of embodiment that is achieved through various technologies can inform how an individual's perceived sense of social connectedness is impacted when they can feel more present with the individuals with whom they are communicating. Social presence theory notes that the level of perceived presence achieved through technology mediated communication directly impacts the interpersonal emotional reaction which occurs between the sender and receiver of messages (Heerink et al., 2010; Lee et al., 2006).

Previous research has investigated the role of individual communication technologies and how their use and application in day-to-day life impacts social connectedness and the experience of loneliness. However, there is limited research exploring the use of communication technologies across the lifespan, the types of technologies being utilized, and the interest to adopt technologies which can facilitate various levels of embodiment. Considering the rapid shift in population demographic across young adulthood, middle adulthood, and late adulthood, understanding how technologies are adopted and used can inform the development and implementation of strategies and programs with the aim of promoting social connectedness and

addressing the experience of loneliness. This dissertation aims to address and answer the following set of objectives and research questions, through a set of three studies.

**Table 5.1** Objectives and Research Questions

| | |
|---|---|
| Study 1 | • Understand the experience of loneliness across various phases of adulthood.<br>• Identify the various forms of communication technologies used across interventions to help address loneliness across the lifespan<br>• Understand how one's sense of social connectedness is impacted by the level of technology embodiment used. |
| Study 2 | • What are the characteristics contributing to the experience of loneliness across various phases of adulthood?<br>• What are the types of technologies individuals adopt across the lifespan in helping engage in communication?<br>• What are the types of technologies individuals across various phases of adulthood interested in adopting to help support maintenance of meaningful social connections? |
| Study 3 | • What are the characteristics of social connections which exemplify meaningful social connection?<br>• How does the level of telepresence embodiment impact the sense of social connectedness across the lifespan?<br>• What are the key distinctions of social connection across different levels of embodiment? |

## Summary of Findings

### Chapter 2: Understanding the role of Embodiment in facilitating Social Connectivity to Address Loneliness Across the Lifespan: A Systematic Review

Chapter 2 presented *Understanding the role of Embodiment in facilitating Social Connectivity to Address Loneliness Across the Lifespan: A systematic review.* This systematic review helps address a gap in the current research, as I aimed to identify the various technologies used across the lifespan and the role of embodiment in facilitating opportunities for social connectivity. Unlike previous work, this study aims to understand the role of communication technologies in facilitating social connectivity across the lifespan (Bessaha et al., 2020; Poscia et

al., 2018). The purpose of this systematic review is to further the understanding of communication technology's role in facilitating social connectivity across the lifespan and its role in helping address the current loneliness epidemic. The aim of this research was to carry out a systematic review of the various communication technologies utilized to facilitate social connectivity across various levels of embodiment and address loneliness across the lifespan. The objectives of this systematic review were as follows:

1. Understand the experience of loneliness across various phases of adulthood
2. Understand the types of communication technologies adopted and implemented through interventions to assist adults to formulate social connectedness and address loneliness.
3. Understand how one's sense of social connectedness may be impacted by the level of technology embodiment used.

The studies included in this review had to meet the initial set of predefined criteria for inclusion, described in Table 2.1. The studies that were included span across a period of ten years: between January 1, 2009, and February 2019. This time frame denotes a crucial shift in accessibility to networks capable of supporting synchronous video communication across mobile devices. The total number of articles reviewed was 3654. Following multiple stages of screening, 15 articles were included in the qualitative synthesis.

Communication technologies present opportunities to enable social connectivity and addressing the experience of loneliness. Technologies often range in capabilities and functions, representing diverse set of embodiment functions. Findings indicate that the existing literature provides limited insight pertaining to communication via technologies with a diverse set of functions, such as videoconferencing (Bamoallem, 2017; Banbury et al., 2018), telepresence hardware, and telepresence robots (Bevilacqua et al., 2014; Boissy et al., 2007; Casiddu et al.,

2015). The implementation and use of higher embodied telepresence technologies may be connected to the users' sense of social connectivity and experience of loneliness. However, current literature provides few insights pertaining to the practical behaviors related to higher embodied technologies among adults across phases of adulthood. Future research should consider the application of communication technology and its functions to maintain, support, and create opportunities for social connections across the lifespan.

**Chapter 3: Understanding the Relationship Between Communication Technologies and Perceived Loneliness.**

Chapter 3 presented *Understanding the Relationship Between Communication Technologies and Perceived Loneliness.* Loneliness has implications on the well-being and lives of individuals across all ages. In the United States three out of five adults report feelings of loneliness (*Cigna U.S. Loneliness Index*, 2018). The formation, maintenance, and support of social relationships is an integral component in the maintenance of a healthy lifestyle, promoting well-being, and reducing the experience of loneliness. The lack of opportunities for social contact, or the experience of social isolation, can have severe implications to an individual's health and well-being (Aarts, 2018; Franssen et al., 2020). In recent history, the evolution of communication technologies has presented new opportunities in facilitating connection and enabled individuals to stay connected, especially when face to face communication is not possible. However, the way individuals can connect with one another varies by how two or more people are able to communicate with each other through technology. Communication technologies have the potential to serve as tools to facilitate opportunities for social connection and bridge the resource gap experienced by individuals who are unable to be social connected with family, friends, and their community. The goal of this study is to understand the experience

of loneliness across adulthood and understand the contributing factors to the experience of overall loneliness, social loneliness, and emotional loneliness. Furthermore, this study provides insights pertaining to the attributes of individuals interested in adopting telepresence technologies with a range of levels of embodiment. The purpose of this study was to expand the current understanding of loneliness as a multidimensional phenomenon across various phases of adulthood. Moreover, I aimed to investigate the characteristics of adults' interest in the adoption of telepresence technologies across the various levels of embodiment. Through this study, I aimed to answer the following research questions:

1. What are the characteristics of individuals experiencing loneliness across various phases of adulthood?
2. What are the types of technologies individuals adopt to help them engage in communication?
3. What are the types of technologies individuals across various phases of adulthood are interested in adopting to help support maintenance of meaningful social connections?

The data for this study was collected using a Qualtrics survey which was distributed via Amazon Mechanical Turk (Amazon Mturk) Human Intelligence Tasks (HIT). The sample recruited for this study constituted 384 participants, representing the three phases of adulthood: young adults, middle age adults, and older adults. Findings indicate that the application and implementation of communication technology presents an opportunity to increase access to resources needed to remain and support social connectivity. Furthermore, telepresence embodiment is an important feature which should be considered when studying how people engage in and formulate meaningful social connections across technology mediated communication. Research is needed to further explore the interest of adults across various phases

of adulthood to understand how extended use of technologies across various levels of embodiment may impact the user's sense of connection.

**Chapter 4: Understanding the Role of Embodiment in Supporting Quality Social Connections**

Chapter 4 presented *Understanding the Role of Embodiment in Supporting Quality Social Connections.* The experience of loneliness is detrimental to the well-being of adults across the lifespan, having impacts on an individuals' physical, psychological, and cognitive health (Child & Lawton, 2019; Franssen et al., 2020). Technology presents an opportunity to enhance well-being and improve access to resources which enable individuals to remain socially connected across the lifespan. However, the emergence of new technologies with various abilities in enabling the users to achieve various levels of feeling present while communicating presents an exciting area of interest which expands on the embodiment which can be achieved through text or voice only communication. This research aimed to answer the following research questions:

1. What are the characteristics which exemplify meaningful social connection?
2. How does the level of telepresence embodiment impact social connectedness across the lifespan?
3. What are the key distinctions between different levels of embodiment?

The data for this study was collected remotely via videoconferencing software. The participants recruited for this study included young adults (age 18-35) n=10, middle age adulthood (age 35-65) n=10, and older adults (age 65+) n=10, with a total sample of 30 participants. Findings indicate that characteristics which contribute to the experience of social connectivity can be connected to components of meaningful communication and characteristics of meaningful relationships. Across adulthood, there are some variations pertaining to the

development of meaningful relationships and also how communication technologies are leveraged to connect with others. The technologies adopted and implemented to support meaningful social connection included telepresence, texting, phone calls, social media, and email. Older adults and young adults were more likely to utilize telepresence, phone calls, and social media. Young and middle age adults were more likely to utilized text-based communication to engage in communication with those whom they reported having meaningful relationships. Young adults and older adults were more likely to report positive social interactions through technology mediated communication and use it on a more frequent basis than middle age adults.

In-person communication is multidimensional involving the transmission of verbal, non-verbal, and paraverbal messages which are decoded by the receiver of messages (Allwood, 2008; Fowler et al., 2015). Findings indicate that the application of communication technologies with the aim of replicating in-person communication is important as it could potentially lead to a stronger sense of presence with the receivers of messages and in turn serve as a tool which can enable individuals to have stronger social connections. Participants' interest to adopt technologies across various levels of embodiment varied. I found that young adults valued the ability to access communication platforms which could be more mobile while middle age adults and older adults were being more interested in technologies which presented opportunities for higher levels of embodiment. The findings of this research provide important implication for future research, social work education, practitioners, and policy development. The qualities of meaningful communication and connections is an essential component in the development of tools, resources, and interventions aimed to enhance social connectivity and address the experience of loneliness across the lifespan.

# Implications

## Social Work Research

The current literature focuses on the understanding and application of communication technologies to facilitate social connectivity and address the experience of loneliness across the lifespan. This research has identified multiple areas that need further expansion and exploration pertaining to the implications of leveraging communication technologies as tools to facilitate social connectivity. For example, future research may be designed to dissect the various attributes and functionalities of technologies and provide a structured and systematic approach to conceptualizing the sense of presence across levels of embodiment. This research aimed to understand embodiment and implementation of market ready technologies used primarily in the context of communication. However, it may be important for future research to explore how technologies such as virtual reality, videogames, and virtual worlds can enable individuals to be present and engage in meaningful social connections (Antunes et al., 2017; Barnett et al., 2014; Lankoski, 2016). Researchers should aim to engage social work practitioners and community members in discussions surrounding the challenges centered around the experience of loneliness and social disconnect. Furthermore, these discussions should be implemented in the development of strategies and interventions geared toward addressing the experience of loneliness. Discussions surround the social injustices related to access to technological tools should be accentuated through the research in order to push the field toward the development of resources which can be accessed by all members of society. Furthermore, the application of implementation science within the research approach can help expand the facilitation and distribution of research (Mois & Fortuna, 2020).

## Social Work Education

Social work education focuses on addressing social injustices and aims to advocate for equity which holds an important role in addressing the challenges faced by lonely adults across various phases of adulthood (NASW *Code of Ethics: English*, 2019). Educating students and enhancing their understanding pertaining to the diverse set of experiences related to loneliness can help facilitate a heighten sense of understanding pertaining to the wide range of implications it has on the individual, community, and the society in which we live. Equipping students with an understanding of the tools and resources needed to facilitate social connections can help bridge the resource gap experienced by the individuals they serve. Educating students on the possibilities and concerns related to the application of communication technologies can help ensure that they are ready and capable of applying and implementing strategies which are able to leverage existing and emerging technological resources. In recent years, social work education has made significant progress in acknowledging the emergence of technology innovations, but continued advancement is necessary.

**Social Work Practice**

Practitioners' awareness and understanding of communication technologies can play an important role in providing the community members they serve with the tools they need to facilitate social connectivity not only on an individual level but also from a communal perspective (Antonio & Marcuello, 2018; Mois & Fortuna, 2020). For example, technologies are not limited to connecting individuals with family and friends but also enable them to be present in environments such as senior centers, libraries, recreational centers, gyms, schools, museums, and other communal places, enabling interactions which could potentially resemble what may be achieved in an in-person circumstance. Furthermore, social work practitioners can help serve as

advocates for the communities which they serve to raise awareness about the barriers which may exist pertaining to the adoption and implementation of resources (Mois & Fortuna, 2020).

### Social Work Policy

Social work engaged in the development and implementation of policies can serve an important role in expanding awareness surrounding the experience of loneliness. Policies should be aimed at improving access to resources which can help facilitate social connectivity, increase access to mental and cognitive health services, and target funding local programs aimed to address the experience of loneliness across each phase of adulthood. Furthermore, development of policies can stimulate the advancement of health services, loneliness screening, and improve access to social services which can connect and provide individuals with the tools they need. Furthermore, the collaboration of researchers and practitioners can serve as a platform which can inform and advocate policy makers to work together to develop policies with the intention of meeting the needs of the community and those experiencing loneliness and social disconnect.

## Limitations

Mixed methods integrate qualitative and quantitative research methodology to help understand the research problem (Creswell, 2015). Although this approach provides advantages such as increased validity due to the triangulation of methods, there are some concerns pertaining to the detail this approach can provide (Menon & Cowger, 2010). Due to the complex nature of the phenomenon of interest, applying a mixed methods approach has helped provide a more holistic framework to understanding the experience of loneliness and the role of embodiment in facilitating social connectedness.

The second limitation of this research is the generalizability of the findings. This research provides insights pertaining to the experience of loneliness across the various phases of

adulthood and modes of application, as well as the interest to adopt technologies across various phases of adulthood. However, these findings present a snapshot of a point in time. Sampling for this research involved the use of Amazon Mturk, which is a representative sample of the online user population. However, there was limited diversity across sample demographics. Future research should make significant efforts in expanding the sampling strategy to ensure that the sample is diverse and representative of the United States population. Future research should aim to provide participants with the ability to interact with the technology, providing the participant with a better baseline of the sense of presence that can be achieved across the levels of embodiment. Furthermore, longitudinal research is needed to better understand the practical behaviors and implementation of telepresence technologies across various phases of adulthood.

## Conclusion

The goal of this dissertation was to provide the reader with an understanding regarding the implications of loneliness across the various phases of adulthood and its implication for the use and adoption of communication technologies. Leveraging communication technology presents a range of opportunities in facilitating social connectivity and combating the loneliness epidemic. However, additional investigations surrounding technological capabilities to enable social connectivity requires longitudinal exploration to better understand the adoption and use across transitionary periods of adulthood. Social workers' involvement in the development and implementation of technologically focused strategies plays an integral role in advocating on behalf of the individuals they serve. Social injustices related to accessibility and usability of technology resources by marginalized and lonely individuals should be considered in the development and application of communication technology resources. Working toward the

expansion and access to resources capable of supporting social connectivity presents an important step towards addressing the loneliness epidemic.

## References

Aarts, S. (2018). Social media and loneliness among community-dwelling older adults. *International Journal of Geriatric Psychiatry*, *33*(3), 554–555.

Allwood, J. (2008). Dimensions of Embodied Communication—Towards a typology of embodied communication. *Embodied Communication in Humans and Machines*. https://doi.org/10.1093/acprof:oso/9780199231751.003.0012

Antonio, L., & Marcuello, C. (2018). e-Social work and digital society: Re-conceptualizing approaches, practices, and technologies. *European Journal of Social Work*, *21*, 801–803. https://doi.org/10.1080/13691457.2018.1520475

Antunes, T. P. C., Oliveira, A. S. B. de, Crocetta, T. B., Antão, J. Y. F. de L., Barbosa, R. T. de A., Guarnieri, R., Massetti, T., Monteiro, C. B. de M., & Abreu, L. C. de. (2017). Computer classes and games in virtual reality environment to reduce loneliness among students of an elderly reference center: Study protocol for a randomised cross-over design. *Medicine*, *96*(10), e5954–e5954. https://doi.org/10.1097/MD.0000000000005954

Bamoallem, B. S. (2017). *MobiBot: Personifying telepresence communication*.

Banbury, A., Nancarrow, S., Dart, J., Gray, L., & Parkinson, L. (2018). Telehealth interventions delivering home-based support group videoconferencing: Systematic review. *Journal of Medical Internet Research*, *20*(2), Article 2. psyh. http://proxy-remote.galib.uga.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2018-29122-001&site=ehost-live

Barbosa Neves, B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019). Can Digital Technology Enhance Social Connectedness Among Older Adults? A Feasibility Study.

*Journal of Applied Gerontology*, *38*(1), 49–72. cin20. https://doi.org/10.1177/0733464817741369

Barnett, S., Jones, S. C., Caton, T., Iverson, D., Bennett, S., & Robinson, L. (2014). Implementing a virtual community of practice for family physician training: A mixed-methods case study. *Journal of Medical Internet Research*, *16*(3), 235–250. psyh. https://doi.org/10.2196/jmir.3083

Bessaha, M. L., Sabbath, E. L., Morris, Z., Malik, S., Scheinfeld, L., & Saragossi, J. (2020). A Systematic Review of Loneliness Interventions Among Non-elderly Adults. *Clinical Social Work Journal*, *48*(1), 110.

Bevilacqua, R., Cesta, A., Cortellessa, G., Macchione, A., Orlandini, A., & Tiberio, L. (2014). *Telepresence Robot at Home: A Long-Term Case Study* (pp. 73–85). https://doi.org/10.1007/978-3-319-01119-6_8

Boissy, P., Corriveau, H., Michaud, F., Labonté, D., & Royer, M.-P. (2007). A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects. *Journal Of Telemedicine And Telecare*, *13*(2), 79–84.

Casiddu, N., Cesta, A., Cortellessa, G., Orlandini, A., Porfirione, C., Divano, A., Micheli, E., & Zallio, M. (2015). Robot Interface Design: The Giraff Telepresence Robot for Social Interaction. In *Biosystems and Biorobotics* (Vol. 11, pp. 499–509). https://doi.org/10.1007/978-3-319-18374-9_46

Child, S. T., & Lawton, L. (2019). Loneliness and social isolation among young and late middle-age adults: Associations with personal networks and social participation. *Aging & Mental Health*, *23*(2), 196–204.

*Cigna U.S. Loneliness Index*. (2018). [Index]. Cigna. https://www.multivu.com/players/English/8294451-cigna-us-loneliness-survey/docs/IndexReport_1524069371598-173525450.pdf

Ciocan, C. (2015). Heidegger's phenomenology of embodiment in the Zollikon Seminars. *Continental Philosophy Review*, *48*. https://doi.org/10.1007/s11007-015-9347-z

*Code of Ethics: English*. (2019, November 14). https://www.socialworkers.org/About/Ethics/Code-of-Ethics/Code-of-Ethics-English

Fowler, C., Gasiorek, J., & Giles, H. (2015). The role of communication in aging well: Introducing the communicative ecology model of successful aging. *Communication Monographs*, *82*(4), 431–457. https://doi.org/10.1080/03637751.2015.1024701

Franssen, T., Stijnen, M., Hamers, F., & Schneider, F. (2020). Age differences in demographic, social and health-related factors associated with loneliness across the adult life span (19–65 years): A cross-sectional study in the Netherlands. *BMC Public Health*, *20*(1), 1118. https://doi.org/10.1186/s12889-020-09208-0

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2010). Assessing Acceptance of Assistive Social Agent Technology by Older Adults: The Almere Model. *International Journal of Social Robotics*, *2*(4), 361–375. https://doi.org/10.1007/s12369-010-0068-5

Keshmiri, S., Sumioka, H., Yamazaki, R., & Ishiguro, H. (2019). Differential Effect of the Physical Embodiment on the Prefrontal Cortex Activity as Quantified by Its Entropy. *Entropy*, *21*(9), 875.

Lankoski, P. (2016). Embodiment in Character-based Videogames. *Proceedings of the 20th International Academic Mindtrek Conference*, 358–365. https://doi.org/10.1145/2994310.2994320

Lee, K. M., Jung, Y., Kim, J., & Kim, S. R. (2006). Are physically embodied social agents better than disembodied social agents?: The effects of physical embodiment, tactile interaction, and people's loneliness in human–robot interaction. *International Journal of Human-Computer Studies*, *64*(10), 962–973. https://doi.org/10.1016/j.ijhcs.2006.05.002

Luft, S. (2015). Phenomenology and Embodiment: Husserl and the Constitution of Subjectivity. *Review of Metaphysics*, *69*(2), 415–418.

Mois, G., & Fortuna, K. L. (2020). Visioning the Future of Gerontological Digital Social Work. *Journal of Gerontological Social Work*, *0*(0), 1–16. https://doi.org/10.1080/01634372.2020.1772436

Pensas, H., Vainio, A.-M., Garschall, M., Kivimäki, T., Konakas, S., Costicoglou, S., & Vanhala, J. (2014). Using Ambient Communication and Social Networking Technologies to Reduce Loneliness of Elders. In G. Meiselwitz (Ed.), *Social Computing and Social Media* (pp. 91–102). Springer International Publishing. https://doi.org/10.1007/978-3-319-07632-4_9

Poscia, A., Stojanovic, J., La Milia, D. I., Duplaga, M., Grysztar, M., Moscato, U., Onder, G., Collamati, A., Ricciardi, W., & Magnavita, N. (2018). Interventions targeting loneliness and social isolation among the older people: An update systematic review. *Experimental Gerontology*, *102*, 133–144. https://doi.org/10.1016/j.exger.2017.11.017

Wong, J. S., & Waite, L. J. (2016). Theories of social connectedness and aging. *Handbook of Theories of Aging*, 349–363.