

Alone with My Phone:
Exploring Links Between Solitude, Technology Use, and
Socio-Emotional Functioning in Adolescents

by

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Abstract

Technology use is ubiquitous in contemporary adolescent culture. Researchers studying *social interactive technologies* (e.g., smartphone) have begun to compare types of technology use (e.g., active versus passive). The increased access to technology is now changing how developmental contexts (e.g., solitude) are experienced. The aim of this study was to investigate how types of technology use while in solitude, might impact upon adolescents' perceptions of aloneness and feelings. Participants consisted of $N = 434$ grade 11 students from high schools in Ottawa. Based on self-report measures, results showed that within the context of solitude, adolescents believed they would feel more lonely, bored, and sad in the passive scenario compared to the active scenario. However, adolescents reported feeling the most content and socially connected in the audio-visual scenario. In addition, time spent alone was related to lower positive affect and greater loneliness, whereas active technology use was positively associated with negative affect.

Keywords: solitude, social interactive technologies, technology use, active technology use, passive technology use, social media applications, adolescent development, well-being

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Ironically, my thesis research somewhat mirrors the graduate school experience, in that I have spent countless hours using technology in many solitary spaces. However, this journey is far from a solo activity and it is imperative to recognize the people who have been along with me on this challenging, but rewarding ride.

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Alone with My Phone: Exploring Links Between Solitude, Technology Use, and Socio-Emotional Functioning in Adolescents

Social interactive technologies (SIT) have been embedded into the daily lives of youth. These platforms provide a convenient way to connect and communicate with others (e.g., phone, video chat, texting) and offer a space to create, post, share, comment, and consume information (e.g., social media applications) (see Ponti, 2019; Spies Shapiro & Margolin, 2014 for reviews). Online relationships are becoming central to adolescents' culture and social life (Helsper, 2008). Indeed, contemporary adolescents are the first to have grown up entirely surrounded by communication technologies (Ahn, 2011). According to a recent report by Anderson and Jiang (2018), 95% of teens report owning or having access to a smartphone, with 45% of teens stating they are "always online" (i.e., continuously checking their applications). These staggering reports provide evidence to suggest that SIT are clearly present in adolescents' lives, with this constant use likely influencing various developmental implications.

Previous research has underlined these social platforms as becoming important developmental contexts among adolescents (Lenhart, 2015; Michikyan & Subrahmanyam, 2012). These social mediums have the potential to significantly impact both social and psychological development for those who use them (Kross et al., 2013; Kuss & Griffiths, 2011; Liu & Yu, 2013; Reinecke & Trepte, 2014). For instance, studies about social media use have noted that youth are using these applications for self-presentation, self-disclosure, and to form social connections, with these online behaviours linked to identity development, intimacy, and well-being (Bartsch & Subrahmanyam, 2015). Indeed, Boyd (2014) suggests that normal adolescent conflicts of anxieties, distresses, and insecurities during this developmental period are also experienced and amplified through technological communications. Overall, social platforms provide a reciprocal process, where users not only create their profile, but they also receive

constant feedback from others on their developing identities (Underwood, Brown, & Ehrenreich, 2018).

Advancing technologies are providing opportunities for constant social “connection” (regardless of time and location), ultimately affecting social and spatial boundaries in time spent alone. Thus, raising questions about the meaning of solitude (Thulin & Vilhelmsen, 2019; Underwood et al., 2018). SIT are becoming increasingly integrated into society, influencing experiences, perceptions, and feelings of being truly alone. Today, individuals can simultaneously maintain physical solitude and virtual social interactions (Leung, 2015). A previous study with university students found that solitude increases social media use, where this use can impact certain socio-emotional outcomes while alone (Wang, Tchernev, & Solloway, 2012). However, little is known about the link between solitude and SIT use in adolescence. Accordingly, the purpose of the present study was to investigate the relations between adolescents’ solitude and technology use by exploring the effects of certain socio-emotional outcomes specifically, loneliness, social connectedness, positive affect, and negative affect.

SIT: Theoretical Perspectives

The increasing prevalence of SIT in today’s social world has been accompanied by an expanding number of theoretical perspectives related to online interactions. Many contemporary theories have been introduced to help explain and better understand how interactive mediums are influencing users’ peer interactions, emotions, social motivations, needs, and adjustment (Mesch & Talmud, 2010). In the following sections, a brief overview is provided of some prominent theoretical approaches to this research.

Media richness. *Media richness* is the idea that media varies in the degree of quality and transmission of cues, suggesting that mediums have the ability to relay a degree of different

communication capabilities (e.g., rich versus lean). The degree of richness is often based on factors such as: (1) immediacy of feedback (e.g., reciprocal, bi-directional process); (2) the ability to transfer nonverbal and verbal cues (e.g., ease of nonverbal messages, voice tone, face expressions, body gestures); (3) language variety, allowing for multiple meanings that can be conveyed (e.g., symbols, sending emojis, “liking” content, abbreviations); and (4) personalization (e.g., messages tailored to satisfy a receiver’s current needs) (Daft & Lengel, 1984). Face-to-face interactions are often considered the richest form of communication, with voice interactions providing a similar level of media richness (Daft & Lengel, 1986). In contrast, a text message is often regarded as a leaner medium due to less immediacy in feedback and reduced cues (Kwak, 2012). The choice of medium is related to how effective communication can be relayed and received (Rettie, 2003). Given that various mediums offer different levels of media richness, the type and choice of platform might influence the degree of positive socio-emotional outcomes experienced.

Social presence. *Social presence* also contributes to an important theoretical perspective within the SIT literature. Social presence refers to the extent a communication medium enables the perception of another person’s physical presence or closeness during an interaction (Short, Williams, & Christie, 1976). The degree of social presence is often perceived as the level of media richness and awareness of the receiver through a medium. Social presence is often conceptualized as how warm, sociable, and personable the medium is perceived to be (Han, Min, & Lee, 2015). Indeed, without clear cues, the feeling and perception of social presence is often diminished (Rovai, 2000).

Social presence is important when considering SIT as it implies a degree of direct or indirect human contact (Gefen & Straub, 2004). Social presence in *social networking sites* (SNS)

have been found to contribute to users' enjoyment (Choi, 2016) and social identity (Shen, Yu, & Khalifa, 2010). It has been noted that the degree of social presence can help explain individuals' behaviour and emotions online (Kim & Song, 2016), with this salience influencing emotional outcomes, such as feelings of connectedness (Short et al., 1976). When social presence is low in *computer-mediated communication* (CMC), social relationships are not as strong, which in turn reduces feelings of connectedness (Kreijns, Kirschner, & Jochems, 2003). For example, higher levels of social presence are likely experienced when one is using FaceTime with a friend compared to sending a text message. Indeed, Rettie (2003) found that perceived connectedness with another person was a function of media richness and social presence. Media richness helps to relay the quantity and quality of cues, whereas social presence enables an awareness of others.

The apparent awareness that others are also engaged with a selected medium can help to fulfill users' social needs. For example, in a study with university students, Hwang and Lombard (2006) found that the more a medium can elicit feelings of "being together" the more likely students reported that the medium helped them achieve and gratify their social needs. Although it has yet to be tested directly, it is plausible to suggest that the degree of social presence can impact feelings of loneliness and feelings of aloneness. For instance, a high degree of social presence in SIT may relay perceptions of intimacy and closeness during a conversation, in turn reducing feelings of loneliness. From a broader standpoint, the degree of social presence may even alter what it means to be alone with regards to how researchers define this context and it may influence how adolescents feel and perceive this solitary experience when using technology.

Social presence and media richness seem to be intimately related to how well a medium can convey interactive information and satisfaction with the selected medium. For example, Han et al. (2015) found that social presence through Twitter can help users achieve social

gratifications online. Researchers suggest that in addition to the physical presence of others, the psychological perceptions about the *virtual presence* of others can also be effective in fulfilling users' social needs. (Nass & Moon, 2000; Nass, Steuer, & Tauber, 1994). Indeed, high levels of social presence have been shown to increase gratifications of media use (Kreijns et al., 2003; Hwang & Lombard, 2006).

Uses and gratifications theory. Finally, the *uses and gratification* approach (U&G) aims to understand why and how people use media to fulfill various social and psychological needs while online (Katz, Blumler, & Gurevitch, 1973). Gratifications are the perceived fulfillment of these needs that are met through media use (Palmgreen, 1984). Historically, many studies have applied U&G theory to a wide range of media and SIT. For instance, this approach has been applied to technologies such as video cassette recorders (Cohen, Levy, & Golden, 1988), television (Bantz, 1982), the Internet (Flanagin & Metzger, 2001), mobile phones (Aoki & Downes, 2003), mobile Internet (Stafford & Gillenson, 2004), and computer-based audio calls (Park, 2010). Three central assumptions of this theory are that: (1) users behave actively online; (2) media is used in a goal-oriented way; and (3) users interpret messages and information that they receive (Abercrombie & Longhurst, 2007).

Motivations to use media are driven by individual needs and characteristics, which in turn may influence media use (Park, 2010). For example, if one feels isolated from their peers while at school and desires to maintain a form of social contact with others, they may be more inclined to use interactive media on a daily basis in order to fulfill their need to belong with others. Therefore, it is important to investigate ways in which SIT may be contributing and fulfilling social and emotional needs. Taken together, these three SIT perspectives will provide relevant theoretical underpinnings for the hypotheses for the present study.

Links Between SIT and Socio-Emotional Functioning

Extant studies on the effects of technology use on adolescents' socio-emotional development have provided considerable cause for continued debate. On one side, there is accumulating evidence suggesting that an over-reliance on technology is a risk factor for internalizing problems and social difficulties. For example, results from multiple studies have demonstrated that the excessive use of SNS is linked to depressive symptoms (Moreno et al., 2011), stress (Egan & Moreno, 2011), and social anxiety (Shaw, Timpano, Tran, & Joorman, 2015). Findings from other studies have suggested that increased frequency of Internet use is associated with depression, loneliness (Morahan-Martin & Schumacher, 2000), and reduced well-being (Wang, Jackson, Gaskin, & Wang, 2014).

Those who socialize exclusively through online mediums may also have a reduced quality of interactions, due to the lack of social cues online (Kiesler, Siegel, & McGuire, 1984). Furthermore, it has been suggested that spending excessive time on SIT may increase the risk for social isolation, reduced physical activity, and health problems (Thulin & Vilhelmsen, 2019). There is a general concern that increased dependency on interactive technologies may create the possibility of avoiding or replacing face-to-face interactions all together (Nie & Erbring, 2000). This view is consistent with the *displacement hypothesis*, which states that high intensity media use can sacrifice other valuable activities and emotionally gratifying relationships that face-to-face communication provides (Nie, 2001; Putnam, 1995). Kraut et al. (1998a) have argued that the Internet can replace meaningful relationships with family and friends, in turn posing negative effects on well-being.

Taken further, increased obsession and dependency on SNS has been defined as SNS addiction (Kuss & Griffiths, 2011). This addiction is characterized as spending too much time on

these social platforms (Can & Kaya, 2016) leading to major problematic outcomes (Turel & Serenko, 2012). For instance, many researchers have found that excessive use of SNS can lead to low tolerance when frustrated, decreased academic performance, irritability, depression, and low self-esteem (Cheung & Wong, 2011; Huang & Leung, 2009; Vilca & Vallejos, 2015). Indeed, Choi and Lim (2016) revealed that an overconsumption of social technology can significantly increase SNS addiction. Specifically, using social media applications, such as Facebook, to escape from real-life problems and stressors may explain a continued cycle of use (Masur, Reinecke, Ziegele, & Quiring, 2014). This view has also been supported by Davis and colleagues (2002) who found that using the Internet for distraction is positively associated with problematic Internet use. Collectively, there is ample evidence to suggest that SIT has the potential to lead to unhealthy online behaviours and negative implications.

Alternatively, there is a competing body of research that calls into question this notion of negative outcomes with technology use. For example, Wästlund and colleagues (2001) reported no significant associations between Internet use and poor psychological well-being. Similarly, the relation between negative outcomes (e.g., loneliness, depression, negative affect) and Internet use that was present in their initial study (Kraut et al., 1998a) was not apparent in their follow-up study (Kraut et al., 2002).

Turkle (2011) suggests that the online environment is quite appealing as it permits the control of physical appearance, becomes an additional medium to facilitate social interactions, and provides many opportunities to find others with similar interests. Indeed, social media platforms have helped users form connections and respond to activities of others (Boyd & Ellison, 2007). In accordance with the *stimulation hypothesis*, media use can aid in the development of positive social relationships and enhance well-being (Valkenburg & Peter,

2007). For example, SIT can help form and maintain online relationships and facilitate the quality of real-world friendships (Lenhart, Anderson, & Smith, 2015; Morgan & Cotton, 2003; Shaw & Gant, 2002). Previous studies have also argued that SIT may even encourage and increase face-to-face interactions (Kavanaugh, Carroll, Rosson, Zin, & Reese, 2005; McKenna & Bargh, 1999). Moreover, SNS has been shown to help enhance social capital (Ellison, Steinfield, & Lampe, 2007), provide social connectedness (Spies Shapiro & Margolin, 2014), increase social support from others (Kim, Sohn, & Choi, 2011), increase self-esteem (Gonzales & Hancock, 2011), and fulfill the need to belong (Nadkarni & Hofmann, 2012).

Another attractive aspect of SNS is that it can offer an alternative outlet for those who may find face-to-face interactions challenging and uncomfortable (Allen, Ryan, Gray, McInerney, & Waters, 2014). For example, SIT can provide opportunities for those with low social competence (e.g., socially anxious individuals). Those with social anxiety may be more engaged in social communications online, as this medium offers a safe space to relieve feelings of anxiety (Ledbetter et al., 2011). As a result, socially anxious individuals are able to cultivate strong social relationships with their peers (Birnie & Horvath, 2006) and experience social connectedness (Grieve, Indian, Witteveen, Tolan, & Marrington, 2013).

Notwithstanding the potential costs and benefits of SIT, there are many unique opportunities, important considerations, and methodological barriers for researchers who study technology use. First, it is important to emphasize that the direction of effect between technology use and socio-emotional outcomes remain unclear. For example, do feelings of loneliness encourage adolescents to use technology or does technology use lead to loneliness? These questions continue to be difficult for researchers to unpack and warrants future investigation.

(Stepanikova, Nie, & He, 2010). Indeed, many studies on technology use are cross-sectional in design rather than longitudinal, making it difficult to identify cause and effect relationships.

Another challenge with studying SIT is the ability to keep up with its ever-changing design and advancements. SNS are constantly changing as new platforms are introduced and existing ones continue to vary in popularity of use. For example, based on a recent study by Anderson and Jiang (2018), YouTube (85%), Instagram (72%), and Snapchat (69%) are now considered the most popular online platforms among teens. Interest in Facebook use has dropped (51%) compared to a survey by Lenhart (2015) who reported that Facebook use (71%) was the most popular platform among teens. Despite these limitations, research on technology use is needed due to their ubiquity in today's social world. One approach for tackling these challenges is to study technology use at a micro-level in terms of defining features and characteristics of applications and platforms.

As previously stated, spending increased amounts of time with technology can influence well-being in both positive and negative ways. However, current research on technology use has started to shift its focus to the *ways* in which technology is being used. Indeed, this distinction is needed as previous research has generally treated studies on social media as a relatively monolithic activity, therefore possibly ignoring important mechanisms and features of online behaviours. Relatedly, studies on SIT have also started to examine different *types* of technology use, which have been generally categorized into *active* and *passive* engagement (Burke, Kraut, & Marlow, 2011). Investigating whether users participate actively or passively online may shed a deeper light into explaining how technology use can impact and promote subjective well-being (Verduyn et al., 2015).

Passive Versus Active Technology Use

Historically, technology use was almost always passive in nature. For example, Rubin (1984) identified both ritualized and instrumental behaviours as two types of passive use in television viewing. Of note, this distinction has also been carried over to the context of SIT (Joo & Sang, 2013). Ritualized activities were characterized as less cognitively involved and more habitual in nature (e.g., watching television, videos, playing games, listening to music), whereas instrumental activities were described as more-goal oriented, in hopes of gratifying a need for information (e.g., surfing the web/media applications to gain news and information). During this early technological period, both television and the Internet were primarily used for entertainment or information purposes (Kraut, Mukhopadhyay, Szczypula, Kiesler, & Scherlis, 1998b). At this time, it had been emphasised that watching television reduced social involvement and communication with others (Brody, 1990; Jackson-Beeck & Robinson, 1981), which was linked to reduced physical health, mental health, and negative mood (Anderson, Crespo, Bartlett, Cheskin, & Pratt, 1998). Using a home computer and the Internet generally implied limited face-to-face interactions. Indeed, it had been suggested that when people use technologies in a passive manner (e.g., learning new software, playing computer games, retrieving information) they would likely spend more time alone (Vitalari, Venkatesh, & Gronhaug, 1985). However, subsequent technological advancements led to the Internet as being increasingly acknowledged for its interpersonal communication (Kraut et al., 1998b). This technological progression has led to increased opportunities for both active and passive engagement while online.

Researchers in this field now recognize that despite the nature of social platforms, these technologies are not always inherently intended for social purposes, and some users may be more or less inclined to use technology in a passive way for different reasons. For example, passive

use within a social media context refers to monitoring or consuming peoples' lives or updates by viewing their profiles without direct exchanges (e.g., scrolling through newsfeeds, reading information on the Internet, viewing content) (Burke et al., 2011; Verduyn et al., 2015). Research on passive social media use appears to be less straightforward with regards to the experience of positive or negative socio-emotional outcomes. For example, reading stories or posts online of friends' activities could allow users to feel embedded in a social environment. Additionally, consuming undirected messages may offer a chance to keep in touch or be "up to date" with social networks and may allow users to feel connected (Burke et al., 2011). However, passive social media/online use has generally been associated with more negative outcomes compared to active technology use (Burke, Marlow, & Lento, 2010; Frison & Eggermont, 2016; Qiu, Lin, Leung, & Tov, 2012; Verduyn et al., 2015).

Passive technology use has been linked to reduced levels of subjective well-being (Krasnova, Wenninger, Widjaja, & Buxmann, 2013), feelings of disconnection, and loneliness (Amichai-Hamburger & Ben-Artzi, 2003). A study with undergraduate students reported a negative relation between passive SNS and well-being (Wang, Jackson, Gaskin, & Wang, 2014). Previous studies have found that passive Facebook use has been positively related to feelings of loneliness (Burke et al., 2010; Frison & Eggermont, 2015). Notably, Kraut et al. (1998a) reported that users experience increased social isolation when they passively consume online content, due to the lack of interactions with others. Indeed, Matook, Cummings, and Bala (2015) found that passive consumption of social media creates perceptions of social loneliness, suggesting that less interactive engagement online could eliminate a sense of belonging.

In addition, it has also been noted that adolescents who engage in passive technology use are at risk of viewing information about their friends' social activities, such as through posts or

photos. Youth tend to report that viewing these updates are among their most painful online experiences (Lenhart, 2015; Underwood & Faris, 2015). Passive technology use may be particularly harmful for youth who are already vulnerable, such as those who feel disconnected from their peers or are depressed (Underwood et al., 2018). One explanation for this link between passive social media use and the experience of negative socio-emotional outcomes may be due to *social comparison theory* (Festinger, 1954). This theory refers to the idea that individuals often compare their own accomplishments and experiences to others (Buunk & Gibbons, 2006). As adolescents scroll on their social media feeds, they are constantly exposed to a range of filtered images and social behaviours by peers (Underwood et al., 2018). Within the online environment, platforms easily enable a place for social comparisons, which can influence one's psychological well-being (Yang, 2016), by altering feelings such as low self-esteem (Vogel, Rose, Okdie, Eckles, & Franz, 2015). Indeed, researchers have found that passive social media use with undergraduate students reduced well-being by eliciting feelings of envy (Lim & Yang, 2015; Verduyn et al., 2015). In the context of Facebook, users often portray themselves more favourably (Barash, Ducheneaut, Isaacs, & Bellotti, 2010; Yang & Brown, 2016) and post about more positive events compared to negative ones (Kross et al., 2013). Given the previous research on passive social media use and its potentially damaging effects on socio-emotional outcomes, it is imperative to not simply dismiss this type of use, as youth spend a significant amount of time reading their social media feeds without posting (Lenhart, 2015).

In contrast, active technology use refers to activities that facilitate direct communication and exchanges with others (e.g., texting/instant messaging with a friend, commenting, sharing, “liking” online content). Similarly, active engagement also encompasses non-targeted activities known as *broadcasting*, which involves sharing content to a wide audience that is not targeted at

a specific individual (Burke et al., 2011). Since broadcasting online can facilitate information with an entire social network, this may in turn attract reciprocity from others (Matook et al., 2015). Reciprocity from both direct and indirect interactions (e.g., receiving a “like” on a photo) may help encourage feelings of connection and social integration within the online social environment.

Generally, SIT features related to active technology use online have been identified as positive predictors for well-being with most of this research examined in the context of Facebook. For instance, Burke and colleagues (2010) found that directed communications and broadcasting reduced feelings of loneliness with adults. Indeed, one-on-one messaging has been associated with reduced loneliness and depression (Shaw & Gant, 2002). In an experimental study, Facebook users who were instructed to post more frequent status updates during a one week period, experienced increased feelings of belonging and reduced feelings of social loneliness compared to the control group (Deters & Mehl, 2013). Relatedly, it has been suggested that active technology use can reinforce existing relationships, which can offer feelings and perceptions of social support (Frison & Eggermont, 2016). For instance, wall posts and messages are considered strong predictors of relationship strength (Gilbert & Karahalios, 2009). This suggests that behaving actively online may help to foster a sense of friendship.

Several studies have also concluded that online communication can positively impact community interactions, social involvement, and social capital (Hampton & Wellman, 2003; Kavanaugh et al., 2005). Social capital often refers to resources that are obtained through relationships found on networks (Coleman, 1988). This may suggest that social capital is intimately related to aspects of social connectedness, in turn influencing well-being. Indeed, researchers have found that forms of social capital, such as ties with friends and neighbours, are

related to positive aspects of self-esteem and overall satisfaction with life (Bargh & McKenna, 2004; Helliwell & Putnam, 2004).

Social capital is typically characterized as being comprised of two constructs. First, *bridging* social capital involves access to new information through acquaintances, whereas *bonding* involves emotional support from close others, such as family and friends (Burke et al., 2011). Social capital online enables reciprocal processes, emotional support, and companionship (Wellman & Wortley, 1990). For example, previous studies have found that students who engage actively on Facebook experience both forms of social capital with these benefits greater for those with low self-esteem (Ellison et al., 2007; Steinfield, Ellison, & Lampe, 2008). This finding suggests that active technology use can promote social capital and this may improve certain psychological indices of well-being. However, researchers have yet to explore if active technology use in other technological forms, such as texting and video chatting, are also related to positive social experiences. Despite the mention of the above studies, research on active and passive technology use is still in its infancy and remains to be an imperative consideration for future research in this field. Therefore, one of the goals of the present study was examine if active versus passive technology use would emerge as distinct constructs in order to investigate the relation between types of technology use and each socio-emotional outcome of interest (i.e., loneliness, social connectedness, positive affect, negative affect).

Technology Use and Solitude

A possible explanation for the inconsistent findings about the experience of socio-emotional functioning and technology use (known as the *Internet paradox* by Kraut et al., 1998a), is that researchers are just starting to explore the innerworkings of *how* and *ways* people are using it. Expanding on this notion, it can be further postulated that technology use should

also be examined more explicitly within different social contexts. For example, particularly among adolescents, it may be important to consider specific types of technology use in the context of solitude.

The concept of solitude as a physical separation (i.e., objective state away from others) is not explicitly apparent with the increasing introductions of contemporary technologies. For instance, it is now plausible to be physically separated from others, but still in the *virtual presence* of others (Coplan, Zelenski, & Bowker, 2018a). This consideration is now changing and challenging not only the physical definition of solitude, but also the experience of solitude. Indeed, a constant social demand to respond instantaneously in real-time to electronic communications can quickly disrupt solitary activities (Kushlev, Proulx, & Dunn, 2016). However, the issue of how technology use might impact upon solitude is not a completely new phenomenon. Larson (1990) previously alluded to this idea noting that in the context of watching television or listening to music, one would be considered physically alone, as these technologies do not directly command reciprocal interactions or require feedback.

It has been argued that media use in adolescence becomes more solitary in nature. (Larson, 1995). For example, watching television alone becomes more common as adolescents begin to have their own television in their bedroom or become less inclined to watch with family members (Kubey & Larson, 1990). This solitary activity elicits more opportunities for personal choice when viewing programs. Similarly, listening to music is often experienced in a solitary context, becoming an important feature of music listening. Indeed, time spent listening to music increases during adolescence as it speaks to personal issues, facilitates a separate domain at home, and helps to define one's self outside the family, which are all critical aspects to adolescent development (Larson, 1995). Taken together, the combination of both technology use

and solitude during adolescence can help to encourage positive development. Today more than ever, youth have the freedom to choose *how* and *where* they want to spend their spare time, with more options to engage with SIT in solitary environments if they desire (Thulin & Vilhelmsen, 2019).

Along this idea, Wang et al. (2012) sought to examine the role of media and gratifications of needs with college students while considering social environments, such as solitude. Media was categorized into social media (SM) and other media (OM) use. SM was defined as tools used for communicating (e.g., blogs, email, messaging, Facebook, Skype, Twitter), whereas OM was defined as media not involving communication or interactions (e.g., television, listening to music, magazines, newspapers, computer use not related to social communications). The researchers were specifically interested in four types of needs: (1) emotional (e.g., fun, entertainment, relaxing); (2) cognitive (e.g., information, studying, working); (3) social (e.g., personal, professional); and (4) habitual (e.g., habits, background noise).

Participants ($N = 28$) consisted of undergraduate students, around an average age of 21 years old. The procedure used an experience sampling design, where participants were instructed to provide daily reports using a cell phone device throughout the day at regular time intervals (e.g., lunchtime, early evening, right before bed) for approximately one month. In these reports, participants recorded detailed activities of their SM and OM use, along with non-mediated activities. They also reported whether they were alone during these activities and their socio-emotional gratifications of these needs. Wang et al. (2012) hypothesized that solitude would influence SM and OM use and moderate the effects of the selected needs on media use.

Results indicated that solitude increased mediated activities in both SM applications and in OM use. This finding has been generally found with other studies (e.g., Larson &

Csikszentmihalyi, 1978; Morahan-Martin & Schumacher, 2003). In particular, Wang et al. (2012) found that solitude moderated different processes for SM and OM use. More specifically, time alone led to increased gratifications of emotional and habitual needs while using SM, whereas time alone lead to increased gratifications of cognitive and social needs while using OM. Interestingly, the effects of solitude were larger on OM use, meaning that during solitude, OM use occurred more often compared to SM use among participants. The researchers argue that individuals may be more likely to select OM activities when alone to fulfill relaxation needs (e.g., reading, listening to music) rather than SM online, which may require participation or reciprocal interaction. This study provides two important avenues for future research. First, solitude can provide an environment that may facilitate increased media use, in terms of both social interactive applications and ritualized/leisure media. Second, the context of solitude can help to fulfill different gratification needs while using different types of media. Overall, these findings suggest a relation between time alone and technology use and underline the importance of investigating media use in various environments, such as solitude. Therefore, it was of interest to investigate the moderating role of active technology use between time spent alone and socio-emotional functioning.

Conceptualizing solitude. Solitude is often conceptualized and distinguished as a *physical* or *perceived* aloneness (Coplan et al., 2018a). Physical solitude (as mentioned above) is the objective state of aloneness, or being in the absence of others (Larson, 1990). Importantly, a physical separation from others may be experienced positively or negatively. In this regard, when time alone is experienced negatively, it can be equated with loneliness, but when time alone is experienced positively, it may be constructive and provide beneficial outcomes

(Galanaki, 2013). Of note, it is important to not confuse solitude with loneliness, often defined as a discrepancy between one's desired and perceived belonging (Peplau & Perlman, 1982).

Solitude can also be further defined as a perceived aloneness, which is considered a subjective state or frame of mind of being alone (Galanaki, 2004). In fact, a person may feel alone despite being in the presence of family or other peers (van Roekel, Scholte, Engels, Goossens, & Verhagen, 2015). Solitude has also been noted as a vital social phenomenon, in that it can influence the experience and attitudes about the social life of individuals and societies (Long & Averill, 2003). Furthermore, Winnicott (1958) has even argued that the capacity for solitude is a fundamental developmental achievement that can be valued as early as childhood. One must learn to be alone in the presence of a caregiver in order to successfully be alone during both adolescence and adulthood. Taken together, these aspects of solitude suggest that time alone does offer adaptive functions that may be important for development.

Along with the conceptualization of solitude, researchers have also studied how frequencies of solitude vary across the lifespan. Previous studies have provided different insights on how this time alone influences developmental and subjective well-being (Coplan, Ooi, & Baldwin, 2018b). Broadly speaking, the amount of time spent alone tends to increase from birth through old age. Individual differences (e.g., personality) often influence perceptions, motivations, and attitudes about time alone (Larson, 1990). For example, solitude in childhood and middle childhood has been reported to not provide any specific psychological benefits and is typically seen as deviant by peers (Rubin & Mills, 1988). During later adolescence, solitude is often characterized with more positive experiences and more acceptance, with older adolescents expressing a desire for more time alone (Coplan & Weeks, 2010). However, this positive experience of solitude is not always pertinent for all adolescents. Indeed, adolescents often report

that time alone is associated with feelings of loneliness (Larson, 1990; Marcoen, & Goossens, 1993). This feeling of loneliness may be due to increased social pressures from their peers during this period (Harris, 1998). Finally, from adulthood through old age, solitude generally tends to be perceived and experienced more positively compared to all other age groups (Larson, 1990; Larson, Zuzanek, & Mannell, 1985; Long & Averill, 2003). Based on these developmental effects of solitude, adolescence is a particularly interesting and crucial period to investigate. Continued research is needed in order to better understand factors and conditions that influence positive and negative experiences of solitude.

Role of solitude in adolescence. Adolescence is a developmental period that presents new opportunities for personal independence, yet comes with increased expectations about both social interactions and time spent alone (Larson, 1990; 1999; Long & Averill, 2003). It has been argued that solitude becomes more meaningful for adolescents, but also lonelier (Larson, 1990). Many researchers have acknowledged this *paradox of solitude* (Coplan et al., 2018a; Galanaki, 2013; Larson, 1999). Adolescents may seek out solitude due to its positive effects and self-enhancing functions, but it can also be experienced as an undesirable and even painful state.

As previously mentioned, adolescents become increasingly accustomed to spending more time alone (Marcoen & Goossens, 1993) and start to value their private lives (Parke & Sawin, 1979). The emergence of this private self becomes more salient during adolescence (Larson, 1997). For instance, time alone may help cultivate self-exploration (Greenwood & Long, 2009), creativity, increase productivity, and provide relief from social pressures from both family and peers (Goossens, 2006). In particular, closing the bathroom and bedroom door offer an intimate space, promoting this private self (Larson, 1995). Indeed, solitary time is thought to occur most often in one's own bedroom (Larson, 1979). These private settings become personal

environments to possibly endure different experiences of solitude, which could potentially contribute to positive well-being. Related to this concept, it has also been highlighted that when solitude is intrinsically motivated, it affords more desired affective states and beneficial outcomes (Nguyen, Ryan, & Deci, 2018a). For example, previous studies with undergraduate students have revealed that those who experienced solitude in positive ways had higher self-esteem (Long, Seburn, Averill, & More, 2003). In addition, those in grades seven through nine who spent an intermediate time alone displayed better adjustment outcomes than those who spent too little or too much time alone (Larson, 1997). Intermediate time alone in adolescence has been found to be related to less alienation (Larson & Csikszentmihalyi, 1978), better school grades, better teacher-parent rated adjustment, and lower self-reported depression, even after controlling for the effects of loneliness when alone (Larson, 1997; 1999). High school students have been reported to use solitude as a time for self-reflection, emotional discharge, and personal renewal (Freeman, Csikszentmihalyi, & Larson, 1986). Collectively, solitude is often noted as emerging as a unique and necessary domain for positive adolescent development (see Galanaki, 2013; Goossens, 2014 for reviews).

On the other hand, according to the *belongingness hypothesis*, individuals have a fundamental need to form and maintain positive interpersonal relationships and connections (Baumeister & Leary, 1995). This need becomes particularly prominent in adolescence, as experiences with peers are related to feelings of support, acceptance, and approval from others (Berndt & Keefe, 1995). Therefore, adolescents who spend too much time alone may be at risk for experiencing internalizing difficulties, such as loneliness (Larson, 1990) and become socially isolated from others (Larson & Csikszentmihalyi, 1978). Indeed, Hansell, Mechanic, and Brondolo (1986) found that solitary adolescents are more depressed and anxious than their more

sociable peers. In addition, there is some evidence to suggest that even those who prefer solitude may be more likely to experience social anxiety and depression (Goossens & Marcoen, 1999). For instance, one study found that regardless of age, students who had positive dispositions for solitude in eighth and twelfth grade, felt negatively about their social abilities. Based on the belongingness hypothesis, a possible explanation for this finding may be that those who prefer solitude, likely engage in fewer social experiences and events, and therefore miss out on opportunities to strengthen their social skills (Wang, Rubin, Laursen, Booth-LaForce, & Rose-Krasnor, 2013).

Even voluntary time alone has been found to have an impact on youth's affective states (Larson, 1990). When comparing samples between adolescents, adults, and retired adults, it was found that adolescents reported time alone to be the loneliest when engaged in productive and leisure activities (Larson, 1979). This finding implies that despite the beneficial aspects of solitude, time alone is not always pleasantly experienced during adolescence. For some adolescents, time alone is related to frequent feelings of loneliness and negative mood. Indeed, Larson and Richards (1991) suggest that part of these negative emotions occur during adolescents' private time.

To summarize these previous sections, technologies are becoming even more advanced and complex as application features continually change. As such, so do the ways in which technology is used by youth (Michikyan & Suárez-Orozco, 2016). Indeed, smartphone ownership is steadily increasing among adolescents (Anderson & Jiang, 2018), offering both costs and benefits in terms of developmental contexts and implications for socio-emotional functioning. A majority of studies on technology use have focused within an undergraduate or adult sample, with little attention on adolescents' use, specifically when considering types of

technology use. Researchers have underlined the conflicting experiences and outcomes of time spent alone in adolescence (Galanaki, 2004; 2013; Long & Averill, 2003). Too much solitude may be problematic (Larson, 1990) however, it is not well known if using SIT in this context may be beneficial or detrimental in terms of overall well-being. Continued research on the relation between solitude and the effects of technology use on well-being is needed and promises to be a topical area of research. Indeed, Turkle (2011) highlights that today, individuals continue to be increasingly connected and tied to their digital lives, resulting in fewer places to feel and be truly alone, perhaps inferring a combined *paradox* about the relationship between technology use and solitude all together. As these two aspects begin to overlap, there are limited opportunities to be fully alone (Smith, 2017). Thus, it is imperative to not only assess overall frequencies of technology use, but to specifically examine online features, spatial contexts, and ways of use, in order to gain a better understanding of SIT behaviours in adolescence.

The Present Study

The overarching aim of the present research was to explore the relations between technology use, solitude, and well-being among adolescents. The first goal of this study was to investigate adolescents' attitudes, beliefs, and experiences with solitude under different "technological circumstances." Secondly, the particular implications of active versus passive technology use on well-being was examined. Finally, the potential moderating effects of active technology use between time spent alone and well-being was explored.

To elaborate, the first objective of the current study was to investigate how the differential use of technology impacts upon adolescents' perceptions and emotional responses while in solitude. To accomplish this goal, adolescents were presented with four different scenarios: (1) physically alone; (2) physically alone using technology passively; (3) physically

alone using technology actively; (4) physically alone using technology audio-visually.

Participants were asked to imagine themselves alone in their room (with the door closed) and to indicate how they felt regarding their self-reported loneliness, social connectedness, boredom, contentment, and sadness within each scenario. Although reports of perceived aloneness while using technology have yet to be explored, based on the three theoretical perspectives of SIT, it was hypothesized that the audio-visual context (e.g., FaceTime, Skype) would elicit the most positive solitude experience in terms of socio-emotional functioning, followed by using SIT actively, then using SIT passively.

Similarly, it was expected that the audio-visual context would be perceived as the least “being alone.” As formerly mentioned, researchers are starting to acknowledge the idea of a *virtual presence* of others through SIT (Coplan et al., 2018a). Research on media richness and social presence suggest that the use of certain characteristics of a medium may influence how effectively communication is relayed, interpreted, and experienced (Rettie, 2003). For example, audio-visual interactions may be found to provide a similar level of media richness as face-to-face communications, which are considered the richest form of communication (Daft & Lengel, 1986). When cues are ambiguous or not directly transferred from one person to another, the feeling and perception of social presence is often diminished (Rovai, 2000). Taken together, feelings of social presence are likely to be more apparent in audio-visual mediums since they allow for a more fluid transmission of personal cues, providing immediate feedback. Following a similar notion, active technology use may be more successful in relaying direct cues compared to passive technology use, which involves reading or viewing content where personal cues are not always clearly apparent (Kwak, 2012).

Studies on technology use are increasingly starting to consider active versus passive engagement in SIT, as these features are producing distinct implications to one's well-being (Alloway & Alloway, 2012; Burke et al., 2011; Ellison et al., 2007; Verduyn et al., 2015). Therefore, an additional goal of the present study was to examine general technology use in how these types influence the experience of socio-emotional functioning. According to previous research, active technology use is likely to have higher media richness and social presence, leading to positive gratifications with SIT, compared to passive technology use (Kreijns et al., 2003; Rovai, 2000; Verduyn et al., 2015). Active technology use has been correlated with increased belonging, less loneliness (Deters & Mehl, 2013), and has contributed to more positive than negative indices of well-being (Ellison et al., 2007; Shaw & Gant, 2002; Steinfield et al., 2008). Therefore, it was hypothesized that active technology use would be negatively associated with loneliness and negative affect, but positively associated with social connectedness and positive affect.

In contrast, passive technology use has reduced media richness and social presence, likely leading to decreased social gratification. Passive engagement has been related to increased loneliness and disconnection (Amichai-Hamburger & Ben-Artzi, 2003), and has been associated with lower subjective well-being (Krasnova et al., 2013; Wang et al., 2014). Therefore, it was hypothesized that passive use would be positively associated with loneliness and negative affect, but negatively associated with social connectedness and positive affect.

The final goal of the present research was to investigate the moderating role of active technology use at a general level (not considering context) between the amount of time spent alone and indices of well-being. Youth who spend moderate amounts of time alone are found to experience the best adjustment outcomes (Larson, 1990; Larson & Csikzentmihalyi, 1978).

Based on limited studies, researchers have identified a link between solitude and technology use. In particular, solitude can facilitate increased mediated activities (Larson & Csikszentmihalyi, 1978; Morahan-Martin & Schumacher, 2003), influencing the experience of certain socio-emotional experiences. It has been found that those who use technology for social purposes have reported this use can help to reduce stress (Leung, 2015), suggesting that SIT use may influence both emotional needs (Wang et al., 2012) and social experiences. Therefore, based on the existing literature and overall benefits of the “social components” of active technology use, it was hypothesized that adolescents who spend too much or too little time alone and use technology actively would serve as a protective role towards each socio-emotional outcome of interest (i.e., loneliness, social connectedness, positive affect, negative affect).

Method

Participants

Participants were $N = 434$ adolescents from 15 to 18 years old (292 females; $M = 16.15$, $SD = .49$). Adolescents were predominantly in grade 11, recruited from high schools in the Ottawa Catholic School Board (OCSB) and the Ottawa-Carleton District School Board (OCDSB). The overall consent rate was approximately 70%. The data collection was part of a larger ongoing research project investigating adolescents' attitudes, beliefs, and individual preferences about spending time alone. Students from this sample were enrolled in an introductory Psychology/Sociology/Anthropology class (referred to as *HSP3U* or *HSP3C*). Data collection took place over two semesters, in the Fall of 2018 (from late October to December), and then continued in the Winter-Spring of 2019 (from February to May). The same teachers typically taught the course in both terms with new students in the second semester.

Measures

Technology use. In order to gauge types of technology use, participants were asked to indicate on average, how much time per day they spent using different forms of technology (see Appendix F). This measure was adapted from a previous technology use scale (Perkins, 2014). Drawing upon previous characterizations of active versus passive technology use (Burke et al., 2011; Burke et al., 2010; Verduyn et al., 2015), several specific types of use were assessed. Active technology use included email, texting, talking (e.g., phone calls), and video chatting (e.g., FaceTime, Skype), whereas passive use included browsing the Internet for news and information. A few items also assessed social media use (e.g., Facebook, Instagram, Snapchat, Twitter, YouTube), both actively (e.g., posting, sharing, “liking” content) and passively (e.g., scrolling on newsfeed, looking at photos, posts, watching videos). Technology use was rated on a

6-point scale, (1 = “Less than 15 minutes” to 6 = “8 hours and up”). Psychometric properties and factor structure of this measure are described in the results section.

Beliefs about solitude and technology. Hypothetical vignettes were created to assess the impact of technology use on attitudes and responses to solitude (see Appendix G). The vignette protocol was adapted from previous research assessing attitudes and beliefs about various social behaviors in different social contexts (e.g., Coplan, Girardi, Findlay, & Frohlick, 2007; Ding et al., 2015). For comparison purposes, participants were first presented with a scenario where they were asked to imagine themselves alone in their room (with the door closed). The following scenarios were then presented in three different circumstances of technology use. Participants were asked to imagine themselves physically alone in their room (with the door closed), but while using social media and SIT (e.g., passively, actively, audio-visually). Characterization of these forms described in the vignettes were drawn from previous studies on active and passive technology use (Burke et al., 2011; Frison & Eggermont, 2016; Verduyn et al., 2015).

Following each vignette, participants were asked to rate their feelings of loneliness, social connectedness, boredom, contentment, and sadness in each of the vignettes using a 5-point scale (1 = “Not at all” to 5 = “Extremely”). These selected responses were drawn from previous research on emotional responses to solitude (Larson & Csikszentmihalyi, 1978; Wilson et al., 2014). Finally, to address perceived aloneness, participants were asked to indicate if they considered themselves to be “alone” in the technology vignettes using a 5-point scale (1 = “Strongly disagree” to 5 = “Strongly agree”).

Solitude. Participants were also asked to complete the *Time Spent Alone and Solitary Activities* measure (Coplan et al., 2019a – see Appendix E). This measure assessed the frequency (1 = “Not at all during the last week” to 6 = “More than three times a day”) and amount of time

(1 = “Less than one hour” to 6 = “More than 15 hours”) participants spent physically alone (i.e., “doing something by themselves, not including sleeping”) within the last week.

Indices of socio-emotional functioning. To assess loneliness, participants were asked to complete the *Loneliness and Aloneness Scale for Children and Adolescents (LACA)* (Marcoen Goossens, & Caes, 1987 – see Appendix H). This scale is a 36-item multidimensional measure of loneliness that has been used in multiple studies with adolescents (Danneel, Maes, Vanhalst, Bijttebier, & Goossens, 2018; Majorano, Musetti, Brondino, & Corsano, 2015) and has displayed evidence of reliability and validity (Goossens et al., 2009). This scale assesses loneliness in relationships with parents and peers and negative and positive evaluations towards being alone. Although the parent and peer-related loneliness subscales are significantly intercorrelated, Marcoen et al. (1987) note that they address different aspects of one’s experience of loneliness. Therefore, for the purpose of the study, only the scale assessing loneliness in relationships with peers was utilized as a measure of loneliness. This subscale includes 12 items (e.g., “I feel excluded by my classmates”) rated on a 4-point scale from (1 = “Never” to 4 = “Often”). This scale has met high internal consistency ($\alpha = .87$) (Marcoen et al., 1987), with similar results of this subscale from the present study also demonstrating excellent reliability ($\alpha = .91$).

Participants were also asked to complete the *Social Connectedness Scale-Revised (SCS-R)* (Lee & Robbins, 1995 – see Appendix I). The SCS-R is an 8-item measure rated on a 5-point scale from (1 = “Strongly disagree” to 5 = “Strongly agree”) with statements where lower scores indicated feeling more socially connected (e.g., “I feel so distant from people”). This scale has shown good psychometric properties demonstrating strong content validity and good structural validity (Cordier et al., 2017). High internal consistency has also been met ($\alpha = .91$) (Lee &

Robbins, 1995), which is similar to that found by Kleynshteyn (2013) with a clinical sample. Reliability analysis from the present study was also sufficient ($\alpha = .78$).

Finally, as an assessment of well-being, participants completed the *Positive and Negative Affect Schedule (PANAS)* (Watson, Clark, & Tellegen, 1988 – see Appendix J). This is a 20-item measure rated on a 5-point scale from (1 = “Very slightly or not at all” to 5 = “Extremely”) that has been shown to represent independent constructs of low to high levels of emotional experiences (Watson et al., 1998). Items consist of words describing different positive (e.g., enthusiastic, inspired, excited) and negative (e.g., afraid, irritable, upset) emotions. This measure has been widely used in community (Merz et al., 2014) and clinical contexts (Dyck, Jolly, & Kramer, 1994), and has been effectively translated and administered internationally to assess positive and negative affect (Balatsky & Diener, 1993; Gaudreau, Sanchez, & Blondin, 2006). The PANAS has demonstrated adequate reliability, test-retest reliability, convergent, and discriminant validity (Watson & Clark, 1994) showing both strong internal consistency for dimensions of positive ($\alpha = .89$) and negative affect ($\alpha = .85$) (Crawford & Henry, 2004), with similar findings from the present study of positive ($\alpha = .82$) and negative affect ($\alpha = .87$).

Procedure

Before proceeding with the study, research ethics forms were completed and approved from the Carleton University Research Ethics Board (CUREB) and the Ottawa-Carleton Research and Evaluation Advisory Committee (OCREAC). Approval from principals and teachers of the participating high schools were also obtained.

An initial visit to each participating class was made to describe the purpose of the study. Consent packages (see Appendix A, B, and C) were then distributed to students to bring home to their parents/guardians. Parental/guardian and student consent was obtained on the second visit

before continuing with the study. During the second visit, data was collected from the students who completed online self-report questionnaires through Qualtrics on their smartphone or provided laptop computers in their classroom. Non-participating students were instructed to stay in their classroom and sit quietly or complete class work. Participation in the study remained anonymous and confidential with students only providing demographic information (e.g., gender and age – see Appendix D). Participants had the option to withdraw from the study at any time. Following data collection, selected pedagogical interactive workshop modules about research on solitude and information about studying psychology in university were presented to all students in the class.

Results

Preliminary Analyses

An overview about decisions made about data cleaning, missing data, outliers, normality, and testing assumptions are first presented. This is followed by an examination of the factor structure and psychometric properties of the technology use scale, and then descriptive statistics and inter-associations among study variables.

Missing data. Missing data was addressed following procedures from Tabachnik and Fidell (2007). First, data that was completely missing or cases with only demographic information (e.g., age, gender) were removed. A missing data variable was created to assess how many *total* items were missing from each case indicating that 35 (8.1%) participants had a total of one missing item, which was the highest percentage of missing data when each case was considered. Next, a dummy variable was created for each variable of interest (1 = response, 0 = no response). Frequencies revealed that the highest percentage of missing data when considering each variable was 6.9%, specifically the item on *perceived aloneness in the audio-visual context*.

A series of independent samples *t*-tests were performed for each missing dummy variable with all other dependent variables. Overall, *t*-tests suggested that most values were missing completely at random (MCAR), $p > .05$ (Tabachnik & Fidell, 2007). However, one item from the technology use scale (*video chatting*) and one item from the hypothetical vignettes (*perceived aloneness in the audio-video context*) suggested that they were not MCAR, $p < .05$. To investigate this further, an independent samples *t*-test was performed on each selected missing data variable with the respective series mean substitution variable (e.g., video chatting missing data variable with video chatting series mean variable), which revealed no significant difference, therefore these variables were not considered to be problematic. Since there was a low

percentage of missing data for all variables in relation to the sample size, imputation was not used. Indeed, Bennett (2001) notes that analyses may be influenced by bias when at least 10% of data is missing. Therefore, cases with missing values remained in the analyses.

Outliers. Visual inspection of histograms and boxplots were created to examine outliers. For a further investigation, standardized z -scores were computed for all variables of interest. A score that exceeded $z = 3.29$ was considered a potential outlier (Tabachnik & Fidell, 2007). An examination of these univariate outliers revealed that the majority were within items on the technology use scale, specifically *email* (13 outliers), *talking on the phone* (6 outliers), *video chatting* (4 outliers), *surfing the Internet* (10 outliers), and *social media: posting, sharing, “liking” content* (8 outliers). Univariate outliers were also present within the hypothetical vignettes, specifically, *feeling lonely* (5 outliers), *bored* (5 outliers), and *sad* (10 outliers) in the active context and *feeling lonely* (6 outliers), *bored* (2 outliers), and *sad* (10 outliers) in the audio-visual context. Mahalanobis distance values were calculated and compared against the criterion $\chi^2(38) = 70.7$. Moreover, 14 multivariate outliers exceeded this value (11 cases within the 70s value, 1 case in the 80s, 1 case in 90s and 1 unique case in the 100s). One case (ID #20) had both univariate and multivariate outliers. Each univariate and multivariate case was visually inspected, but did not reveal problematic responses (e.g., responding with the same number on all items, empty cases) therefore, no alterations or transformations of data were conducted.

Normality. Data was checked for normality, testing for skewness and kurtosis using the following procedures from Field (2013). First, histograms were visually examined. In particular, the technology use scale and items from the hypothetical vignettes were positively skewed. However, all other variables of interest were normally distributed using a criterion to indicate departure from normality with skewness (> 2) and kurtosis (> 7) (West, Finch, & Curran,

1995). With the technology use scale, there were two items that exceeded this criteria. *Email* (skewness = 4.33, kurtosis = 20.53) and *talking on the phone* (skewness = 2.42, kurtosis = 7.53). Similarly, two items from the hypothetical vignettes also exceeded this criteria, specifically, *feeling lonely* (skewness = 2.91, kurtosis = 8.40) and *feeling sad* (skewness = 2.17) in the audio-visual context. However, when considered as a whole, these values did not extremely deviate from the threshold and since the main analyses for this study (ANOVA, MANOVA, regression) are often robust to moderate departure from normality (Kim, 2013), this data was not omitted or transformed. Second, normal probability plots (P-P plots) for variables of interest showed that points fell along the line with no extreme departure, therefore the normality assumption was met (Raykov & Marcoulides, 2008). Assumptions of linearity, homoscedasticity, and independence were examined by graphing standardized *z*-score residuals (Y) with *z*-score predicted values (X), residuals points were randomly plotted (e.g., no specific shape or curve) revealing that all variables appropriately meet these assumptions (Field, 2013).

Technology use scale. As previously mentioned, the technology use scale was created based on content from several assessments of technology use and SIT platforms. For these previous measures, protocols for composing subscales have been inconsistent with most researchers aggregating items solely on a conceptual basis (e.g., Burke et al., 2010), tailored around an SIT application (e.g., Frison & Eggemont, 2016), or from focus groups discussing common technology behaviours and activities (e.g., Leung, 2015). Only a few studies have relied upon the results of factor analysis (e.g., Matook et al., 2015). It was expected that the technology measure created for the current study would be comprised of subscales to appropriately reflect active and passive technology use. However, one of the goals of this study was to explore the factor structure of this technology use scale by conducting an exploratory factor analysis (EFA).

A principle axis factor analysis using an oblique rotation (i.e., direct oblimin) was conducted on the original 8-items that comprised the technology use scale. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis at KMO = .84, which is above the suitable value of .5 (Hair, Anderson, Tatham, & Black, 1995) and deemed as an excellent value to proceed with EFA (Hutcheson & Sofroniou, 1999). The Bartlett's test of sphericity was met at $\chi^2(10) = 660.19, p < .001$. Two factors had eigenvalues over the Kaiser criterion of 1 (Kaiser, 1960). The first factor had an eigenvalue = 3.46, explaining 37.53% of the variance with the second factor just making the cut-off at an eigenvalue = 1.09, explaining 7.77% of the variance. Visual examination of the scree plot could be justified in terms of retaining 1 or 2 factors. The pattern matrix revealed a few findings of note. First, *email* did not load onto any factors ($< .3$). Second, all of the items including passive technology use (*surfing the Internet, social media: scrolling on newsfeed, looking at photos, watching videos*) loaded onto one factor except for *talking on the phone* and *video chatting*, which emerged as the second factor. These results suggest that the first factor could be represented as *general technology use*, whereas the second factor could be represented as *real-time communication*. This means that the technology use scale was not representative of active and passive technology use from the EFA.

Therefore, a few decisions were made regarding the next steps with the use of this measure. First, the *email* item was removed because of its low frequency of occurrence and because it did not reach a substantial factor loading. Active technology use then remained the specific interest in the present study (e.g., moderation analyses). It was not feasible to create separate subscales of active and passive items (i.e., since the two remaining theoretically identified passive items loaded with the active items). Therefore, these two passive items were dropped from the scale and a second EFA was computed.

Based on the second factor analysis, the Kaiser-Meyer-Olkin measure was still acceptable at KMO = .76 with the Bartlett's test of sphericity significant at $\chi^2(10) = 660.19, p < .001$.

Findings revealed that all items loaded onto one factor (see Table 1) with an eigenvalue = 2.75, explaining 55.04% of the variance, with the scree plot clearly indicating a one factor structure. Therefore, this measure of active technology use was represented by 5-items: *texting, talking on the phone, video chatting, social media: posting, sharing, “liking” content, and social media: messaging/interacting directly*. Reliability analysis of these items revealed a Cronbach's $\alpha = .79$, which was deemed as acceptable ($> .70$, see Fabrigar, Wegener, MacCallum, & Strahan, 1999). Therefore, a variable based on these 5-items was created to reflect a measure of active technology use, which was used in the proceeding analyses.

Descriptive statistics and correlations. Frequency distributions for the types of technology are presented in Table 2. Over half of the sample reported spending less than 2 hours a day using all types of technology (except for passive social media use, which was less than 4 hours a day). However, the majority of adolescents reported using types of technology for less than 15 minutes a day, including *email* (89%), *talking on the phone* (69%), *video chatting* (57%), and using active *social media: posting, sharing, “liking” content* (40%). Adolescents most often reported using other types of technology for 1-2 hours a day, including *surfing the Internet* (43%), *texting* (42%), and *messaging people directly on social media applications* (38%). Of note, adolescents reported engaging in passive social media use between 1-2 hours (36%) and for 3-4 hours a day (33%).

Table 1

Final Factor Loadings for Items on the Technology Use Scale

Items	Factor 1 (Active Technology Use)
Texting	.74
Talking (phone calls)	.54
Video Chatting	.52
Social Media: liking/commenting/sharing statuses/photos/posts	.70
Social Media: messaging/interacting directly	.80

Table 2

Frequencies of Average Time Spent per Day on Each Type of Technology Use

Items		Frequency	%
Email	< 15 minutes	374	88.8
	1-2 hours	25	5.9
	3-4 hours	9	2.1
	5-6 hours	7	1.7
	6-7 hours	3	.7
	8 hours +	3	.7
Texting	< 15 minutes	121	28.5
	1-2 hours	178	42
	3-4 hours	73	17.2
	5-6 hours	24	5.7
	6-7 hours	12	2.8
	8 hours +	16	3.8
Talking (Phone calls)	< 15 minutes	292	69.4
	1-2 hours	96	22.8
	3-4 hours	21	5
	5-6 hours	6	1.4
	6-7 hours	5	1.2
	8 hours +	1	.2
Video Chatting	< 15 minutes	237	56.7
	1-2 hours	107	25.6
	3-4 hours	50	12
	5-6 hours	14	3.3
	6-7 hours	6	1.4
	8 hours +	4	1
Surfing the Internet	< 15 minutes	116	27.4
	1-2 hours	180	42.6
	3-4 hours	75	17.7
	5-6 hours	31	7.3
	6-7 hours	11	2.6
	8 hours +	10	2.4
Social Media Passive	< 15 minutes	21	5
	1-2 hours	152	35.8
	3-4 hours	138	32.5
	5-6 hours	62	14.6
	6-7 hours	29	6.8

	8 hours +	22	5.2
Social Media Active 1	< 15 minutes	170	40.3
	1-2 hours	150	35.5
	3-4 hours	62	14.7
	5-6 hours	20	4.7
	6-7 hours	12	2.8
	8 hours +	8	1.9
Social Media Active 2	< 15 minutes	93	22
	1-2 hours	161	38.2
	3-4 hours	93	22
	5-6 hours	41	9.7
	6-7 hours	17	4
	8 hours +	17	4

Descriptive statistics (e.g., means, standard deviations) and inter-correlations for all study variables are presented in Table 3. There was a significant negative association between age and negative affect (age and gender were controlled for in further analyses).

Independent samples *t*-tests were used to examine gender differences with variables of interest. Results revealed that females ($M = 2.54$, $SD = .84$) reported higher levels of negative affect compared to males ($M = 2.35$, $SD = .81$), $t(414) = -2.23$, $p < .05$. Similarly, females ($M = 2.23$, $SD = .68$) reported higher levels of loneliness compared to males ($M = 2.08$, $SD = .69$), $t(408) = -2.11$, $p < .05$. With regards to active technology use, females ($M = 2.03$, $SD = .79$) reported using this type more often than males ($M = 1.82$, $SD = .81$), $t(419) = -2.57$, $p < .05$. However, males ($M = 4.12$, $SD = 1.43$) reported spending more time alone compared to females ($M = 3.73$, $SD = 1.34$), $t(416) = 2.68$, $p < .05$.

Of note, active technology use was significantly and positively associated with negative affect. As well, time alone was significantly and positively associated with loneliness, and negatively associated with positive affect.

Finally, there were significant inter-correlations among the outcomes variables. For example, loneliness was negatively associated with positive affect and social connection, and positively associated with negative affect. Social connectedness was positively associated with positive affect, and negatively associated with negative affect.

Table 3

Correlations, Means, Standard Deviations for Study Variables

	1	2	3	4	5	6	7
1. Age							
2. Active Use		-.066					
3. Time Alone	.011		-.095				
4. Loneliness	-.075	.048		.147**			
5. Social Connection	-.077	.085	.063		-.191**		
6. Positive Affect	-.032	.032	-.125*	-.374**		.189**	
7. Negative Affect	-.176**	.224**	.091	.498**	-.100*		-.186**
M	16.15	1.97	3.86	2.18	2.90	3.23	2.49
(SD)	(.49)	(.81)	(1.38)	(.69)	(1.04)	(.68)	(.84)

Note. ** $p < .01$, * $p < .05$

Solitude and Technology Vignettes

To test differences in adolescents' beliefs about solitude and technology use, a series of ANOVAs and MANOVAs were computed.

Perceptions of being alone. The first ANOVA examined vignette differences in adolescents' perceptions of being "alone" across the various technological circumstances. A 3 X 2 mixed-repeated measures ANOVA was conducted, with technology Vignette (passive, active, audio-visual) serving as the within-participant variable and participant Gender as the between-participant variable. Results revealed a significant main effect of Vignette, $F(2, 397) = 290.089$, $p < .001$, partial $\eta^2 = .594$. However, there was no significant main effect of Gender, $F(1, 398) = 2.56$, $p = .110$, partial $\eta^2 = .006$, and no significant Vignette X Gender interaction, $F(2, 397) = .763$, $p = .467$, partial $\eta^2 = .004$.

Results from follow-up post hoc comparisons (i.e., paired samples t -tests with a Bonferroni correction of critical alpha value / number of groups to compare; $\alpha / 3 = .0167$) indicated significant differences between all three vignettes. Adolescents perceived themselves to be the least alone in the audio-visual context ($M = 1.74$, $SD = .99$), followed by the active context ($M = 2.43$, $SD = 1.15$), and then the passive context ($M = 3.46$, $SD = 1.20$) (see Figure 1).

Contentment. For the remaining variables, the Vignette measure was expanded to include an additional context that represented being alone, but with no technology (i.e., physical solitude). Thus, to assess differences in feelings of contentment across the different vignettes, a 4 x 2 mixed-repeated measures ANOVA was conducted, with Vignette (just alone, passive, active, audio-visual) serving as the within-participant variable and participant Gender as the between-participant variable. Results indicated a significant main effect of Vignette, $F(3, 403) = 57.846$, $p < .001$, partial $\eta^2 = .301$, but no significant main effect of Gender, $F(1, 405) = .238$, $p = .626$,

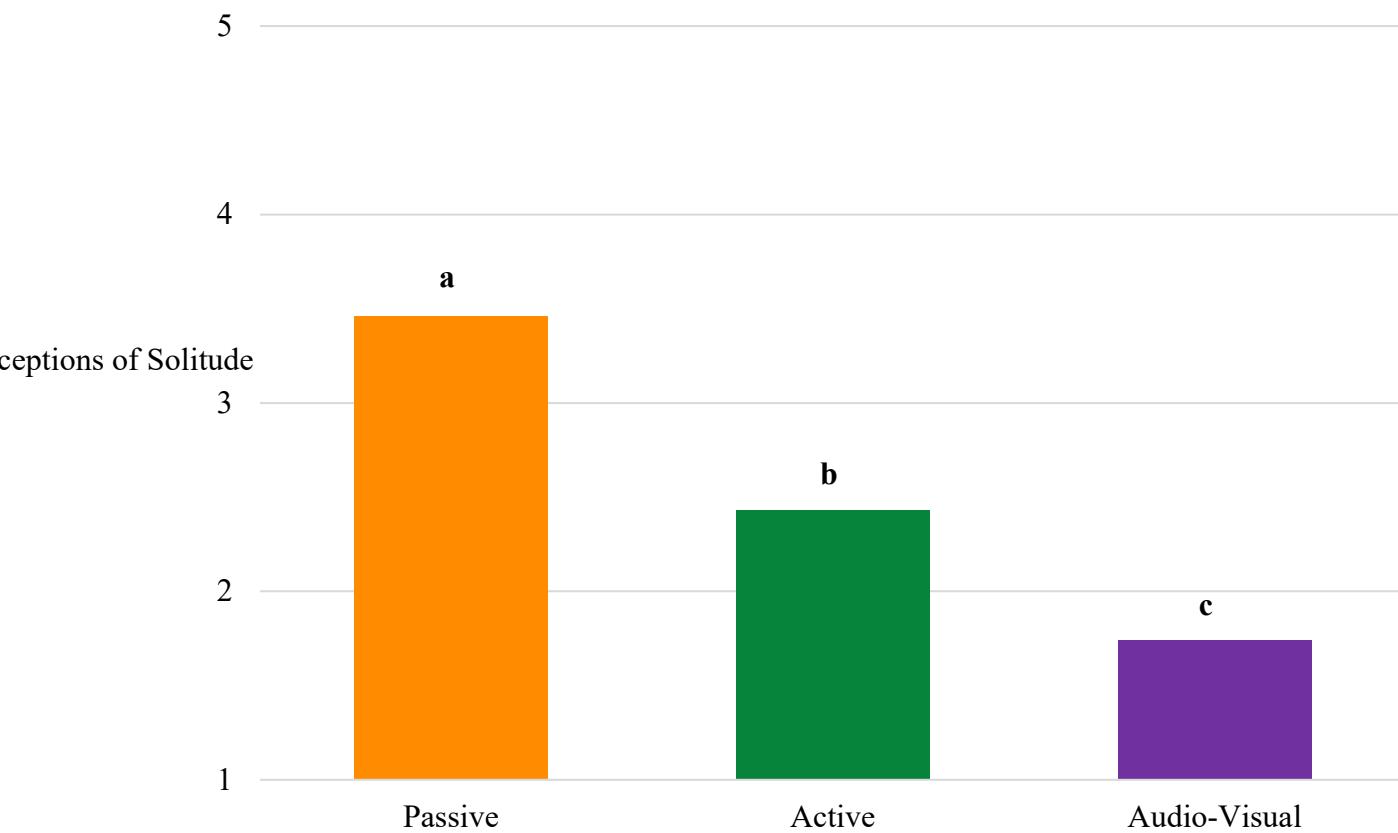


Figure 1. Post-hoc mean comparisons between contexts for perceived aloneness.

Notes. Higher score = perceive self to be alone; Means with different subscript differ at $p < .0167$.

partial $\eta^2 = .001$. However, there was a significant Vignette X Gender interaction, $F(3, 403) = 3.221, p = .023$, partial $\eta^2 = .023$.

Results from follow-up post hoc comparisons (i.e., paired samples t -tests with Bonferroni correction $\alpha / 6 = .0083$) indicated that adolescents reported feeling the most content in the audio-visual context ($M = 3.77, SD = .94$), followed by the active context ($M = 3.36, SD = .88$), the just alone ($M = 3.06, SD = 1.06$) and passive contexts ($M = 2.95, SD = .96$), which did not differ significantly from each other (see Figure 2).

For the Vignette X Gender interaction, a follow-up independent samples t -test was conducted within each Vignette. Females reported feeling significantly more content in the audio-visual context ($M = 3.84, SD = .92$) compared to males ($M = 3.60, SD = .96$). There were no significant differences between gender for the other three vignettes (see Figure 3).

Social connectedness. For feelings of social connectedness, there was a significant main effect of Vignette, $F(3, 399) = 233.655, p < .001$, partial $\eta^2 = .637$, but no significant main effect of Gender, $F(1, 401) = 1.641, p = .201$, partial $\eta^2 = .004$, nor a significant Vignette X Gender interaction, $F(3, 399) = .365, p = .779$, partial $\eta^2 = .003$. Results from post-hoc comparisons (i.e., paired samples t -tests with Bonferroni correction $\alpha / 6 = .0083$) indicated significant differences in feelings of social connectedness for all four vignettes. Adolescents reported feeling more socially connected in the audio-visual context ($M = 3.94, SD = .98$), followed by the active context ($M = 3.61, SD = .95$), the passive context ($M = 3.03, SD = 1.10$), and then the just alone context ($M = 1.97, SD = 1.05$) (see Figure 4).

Negative feelings. The examination of negative feelings was also of interest to compare relative scores of different negative emotions (e.g., boredom versus sadness versus loneliness) across each of the four vignettes. Accordingly, a 4 X 2 X 3 mixed-repeated measures MANOVA

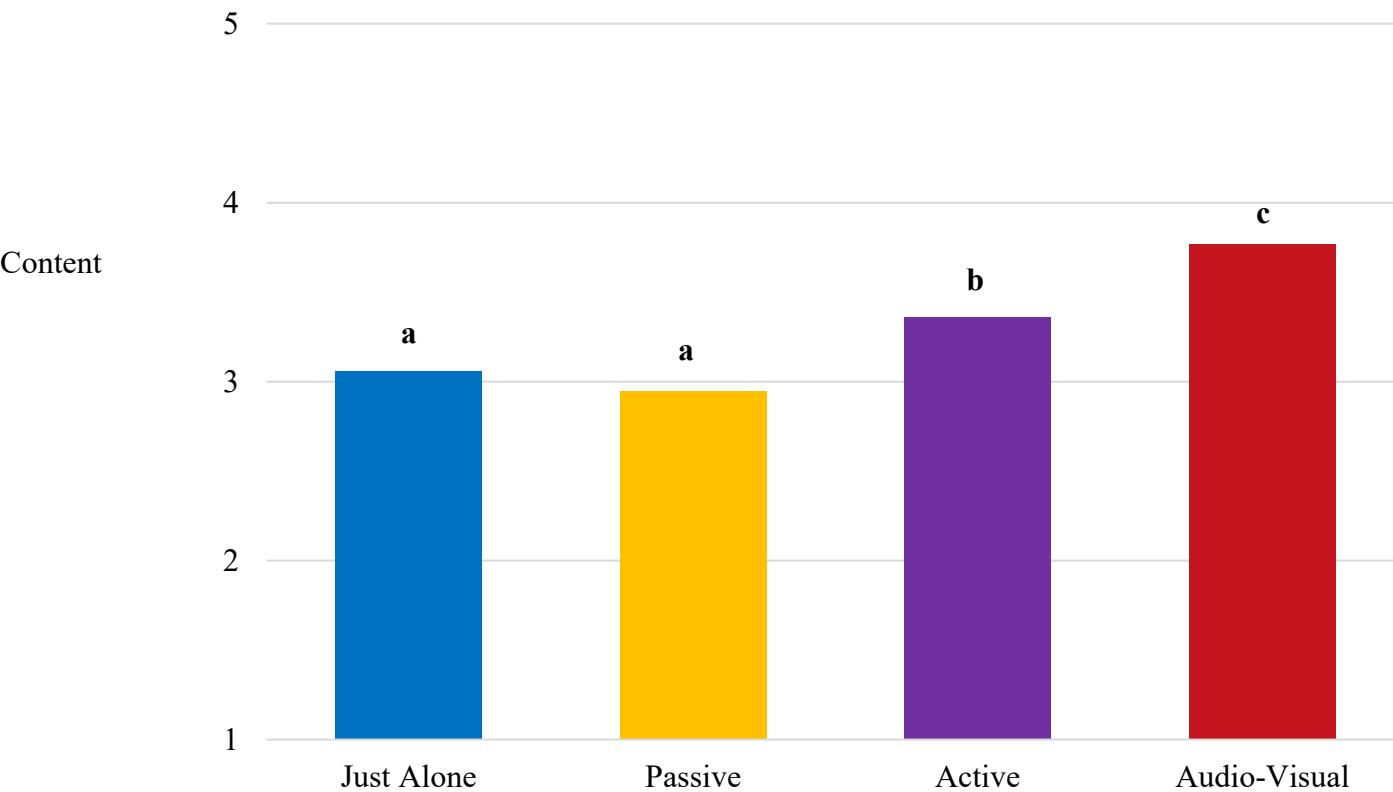


Figure 2. Post-hoc mean comparisons between contexts for contentment.

Note. Means with different subscript differ at $p < .0083$.

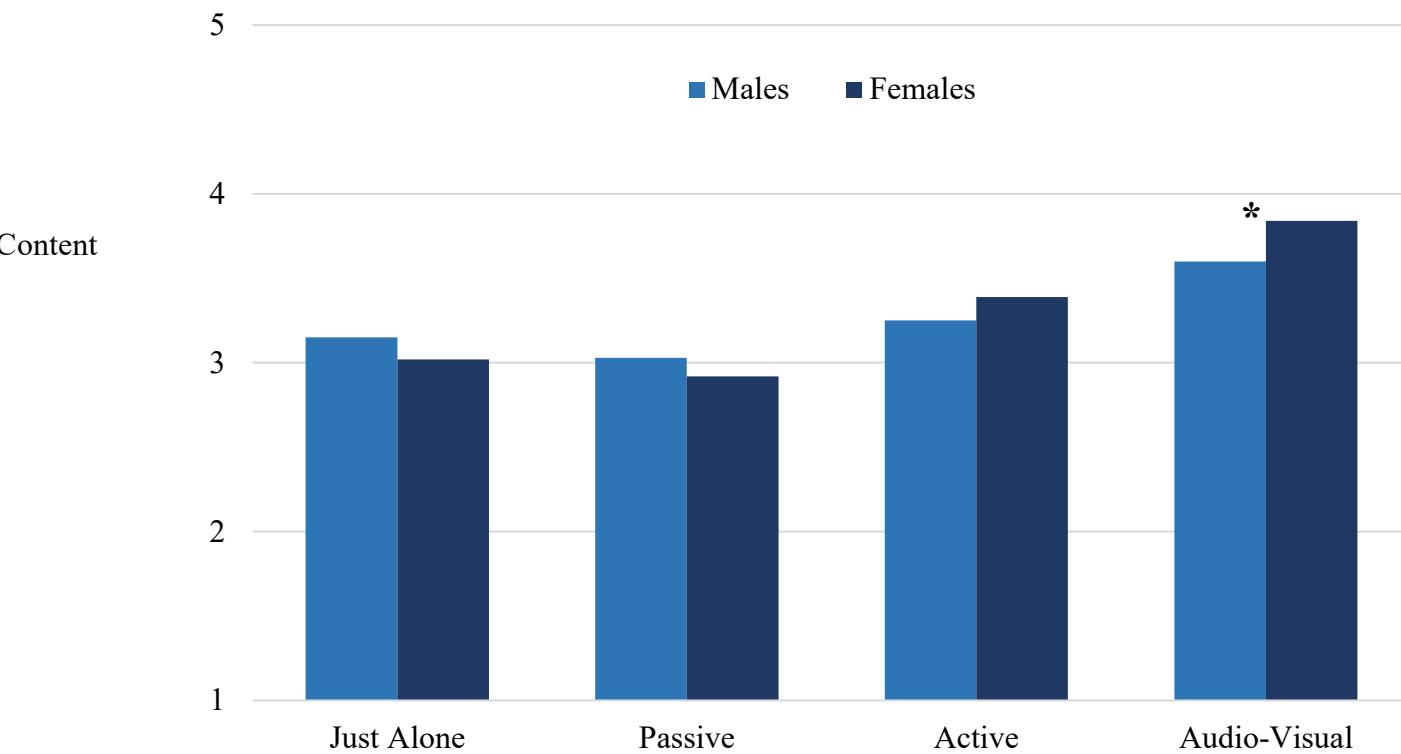


Figure 3. Post-hoc mean comparisons for Vignette X Gender for contentment.

Note. * differ at $p < .05$.

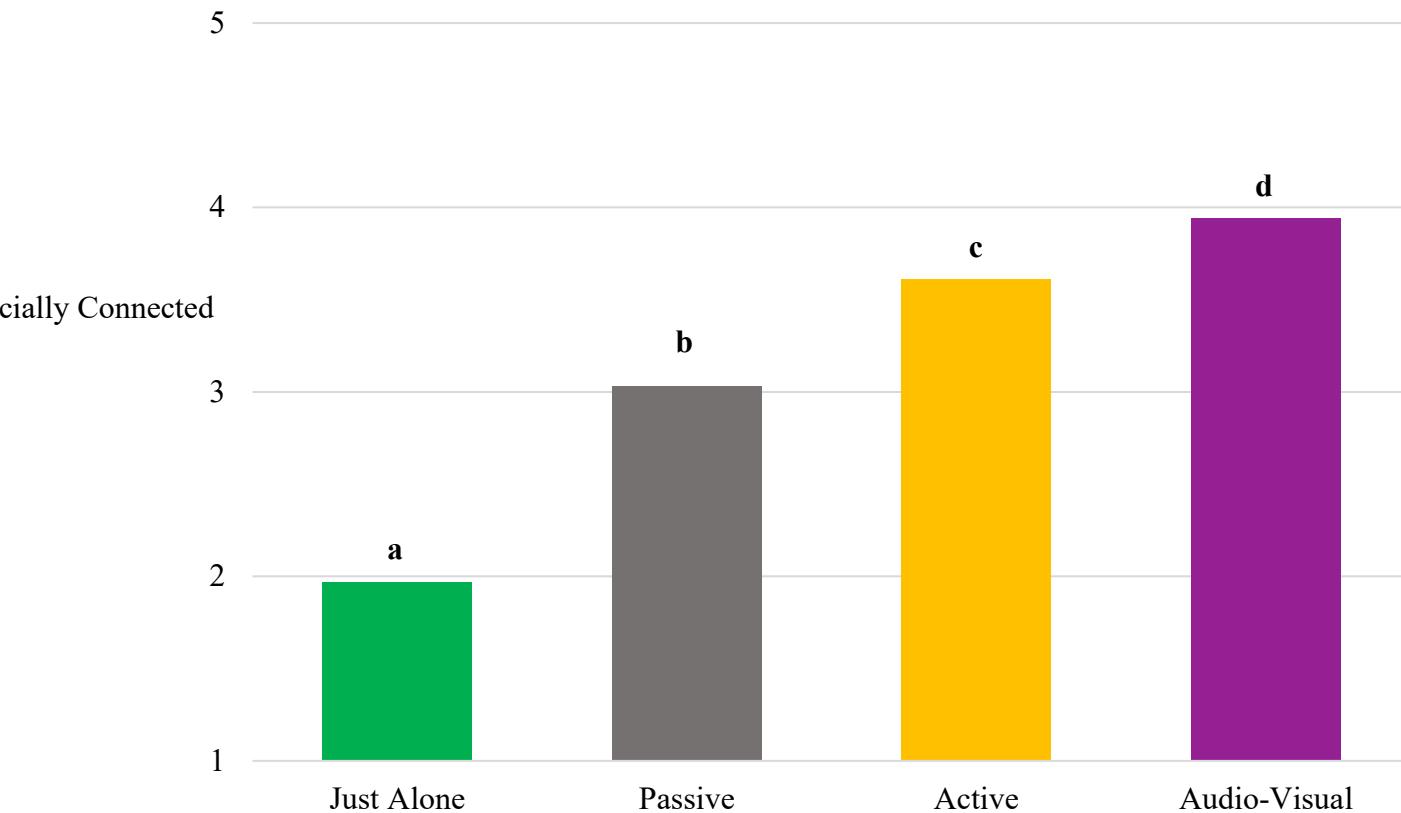


Figure 4. Post-hoc mean comparisons between contexts for social connectedness.

Note. Means with different subscript differ at $p < .0083$.

was conducted, with Vignette (just alone, passive, active, audio-visual) and Negative Emotions (loneliness, boredom, sadness) both serving as within-participant variables, and participant Gender as a between-participant variable.

Results indicated significant main effects of Vignette, $F(3, 398) = 135.980, p < .001$, partial $\eta^2 = .506$, and Negative Emotions, $F(2, 399) = 51.439, p < .001$, partial $\eta^2 = .205$. However, these main effects were superseded by significant interaction effects of Vignette X Negative Emotions, $F(6, 395) = 7.722, p < .001$, partial $\eta^2 = .105$, as well as Negative Emotions X Gender, $F(2, 399) = 3.295, p = .038$, partial $\eta^2 = .016$. There was no significant Vignette X Gender interaction, $F(3, 398) = 1.12, p = .342$, partial $\eta^2 = .008$.

For the main effect of Vignette, results from post-hoc comparisons (i.e., paired-samples t -tests with Bonferroni correction $\alpha / 6 = .0083$) revealed significant differences between all four contexts. Adolescents reported feeling more negative emotions *overall* in the just alone context ($M = 2.29, SD = .95$), followed by the passive context ($M = 2.08, SD = .88$), the active context ($M = 1.68, SD = .72$), and then the audio-visual context ($M = 1.35, SD = .60$) (see Figure 5).

For the main effect of Negative Emotions, results from post-hoc comparisons (i.e., paired-samples t -tests with Bonferroni correction $\alpha / 3 = .0167$) indicated that *across contexts*, adolescents reported feeling the most bored ($M = 2.06, SD = .71$), followed by sad ($M = 1.75, SD = .80$) and lonely ($M = 1.73, SD = .69$), which did not differ significantly from one another (see Figure 6).

To decode the Vignette X Negative Emotions interaction, post-hoc comparisons (i.e., paired-samples t -tests with Bonferroni correction $\alpha / 6 = .0083$) were used to test differences between vignettes for each negative emotion. For loneliness, adolescents reported feeling the

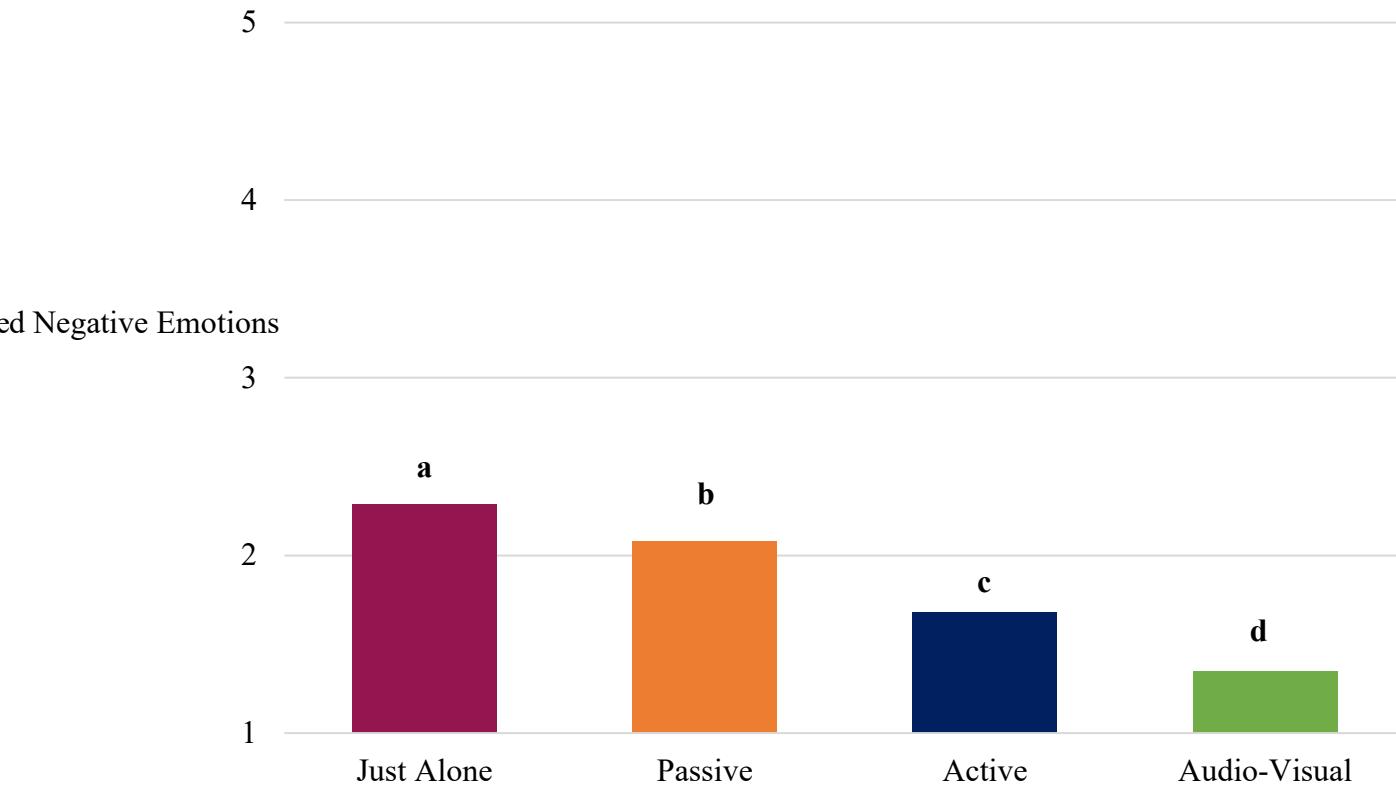


Figure 5. Post-hoc mean comparisons between contexts for combined negative emotions.

Note. Means with different subscript differ at $p < .0083$.

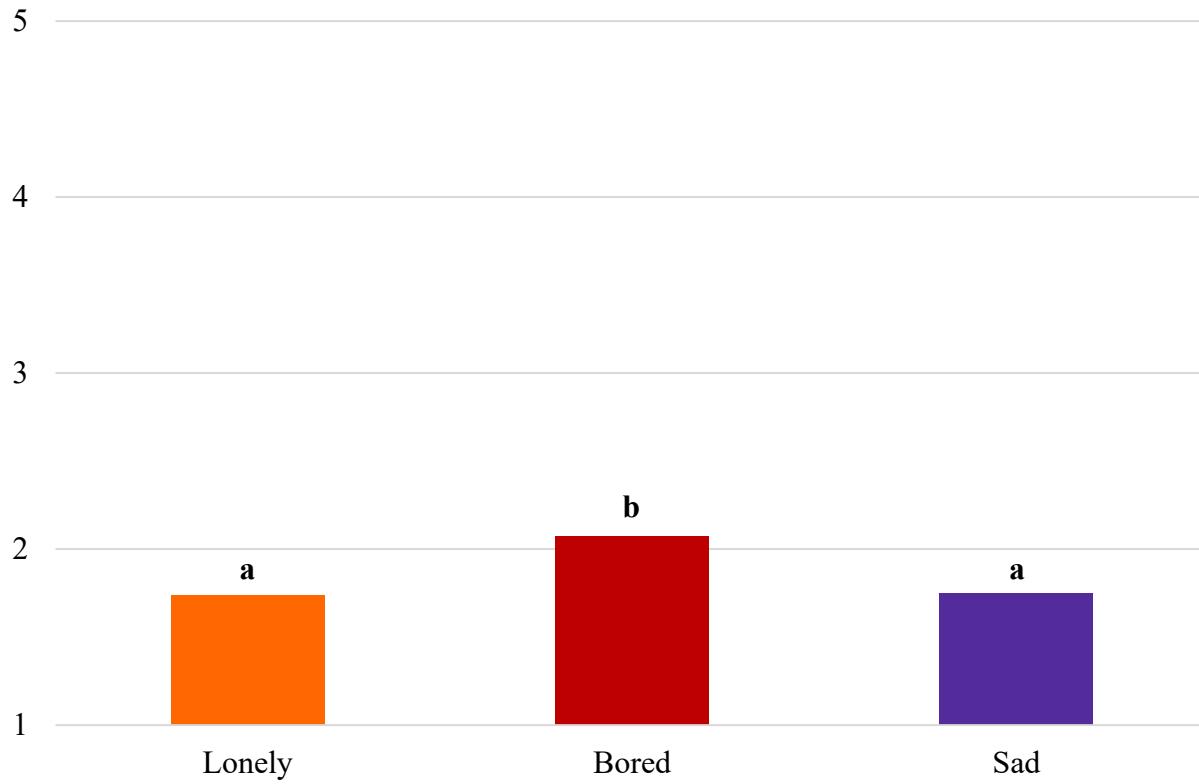


Figure 6. Post-hoc mean comparisons between each negative emotion.

Note. Means with different subscript differ at $p < .0167$.

most lonely in both the just alone ($M = 2.11, SD = 1.13$) and passive contexts ($M = 2.01, SD = 1.07$) (which did not differ significantly from each other), followed by the active context ($M = 1.57, SD = .84$), and then the audio-visual context ($M = 1.23, SD = .61$) (see Figure 7). For boredom, adolescents reported feeling the most bored in the just alone context ($M = 2.64, SD = 1.27$), followed by the passive context ($M = 2.29, SD = 1.16$), the active context ($M = 1.85, SD = .92$), and then the audio-visual context ($M = 1.46, SD = .78$), which all differed significantly from one another (see Figure 8). This pattern was identical for sadness, where adolescents reported feeling the most sad in the just alone context ($M = 2.11, SD = 1.20$), followed by the passive context ($M = 1.92, SD = 1.09$), the active context ($M = 1.60, SD = .89$), and then the audio-visual context ($M = 1.35, SD = .72$), which all differed significantly from one another (see Figure 9).

Finally, despite a significant Negative Emotions X Gender interaction, results from follow-up post-hoc analysis did not indicate any significant differences between genders. For instance, there were no significant differences between males ($M = 1.69, SD = .76$) and females ($M = 1.75, SD = .67$) for reported feelings of loneliness, $t(410) = -.829, p = .41$. Similarly, there were no significant differences between males ($M = 2.13, SD = .83$) and females ($M = 2.05, SD = .65$) for reported feelings of boredom, $t(205) = .891, p = .37$. This pattern followed with no significant differences between males ($M = 1.64, SD = .85$) and females ($M = 1.80, SD = .78$) for reported feelings of sadness, $t(410) = -1.834, p = .07$.

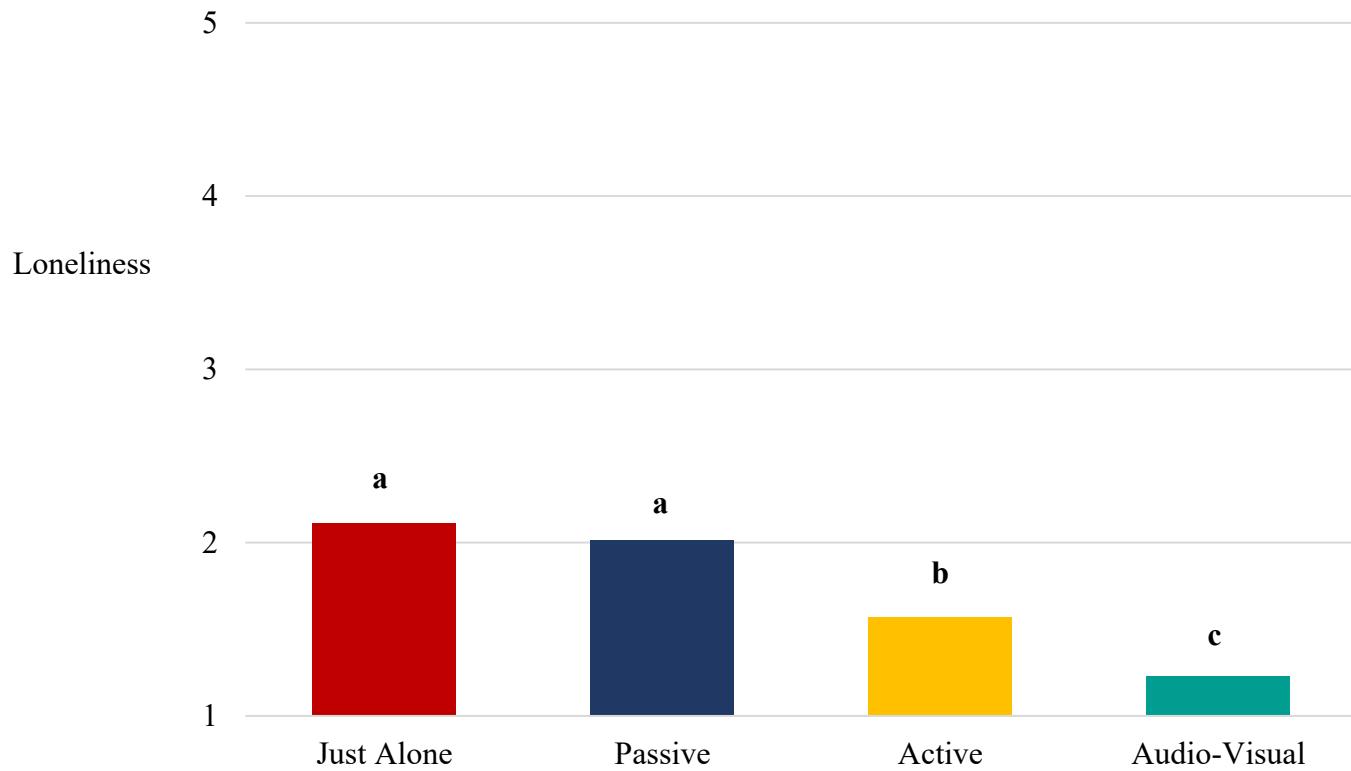


Figure 7. Post-hoc mean comparisons between contexts for loneliness.

Note. Means with different subscript differ at $p < .0083$.

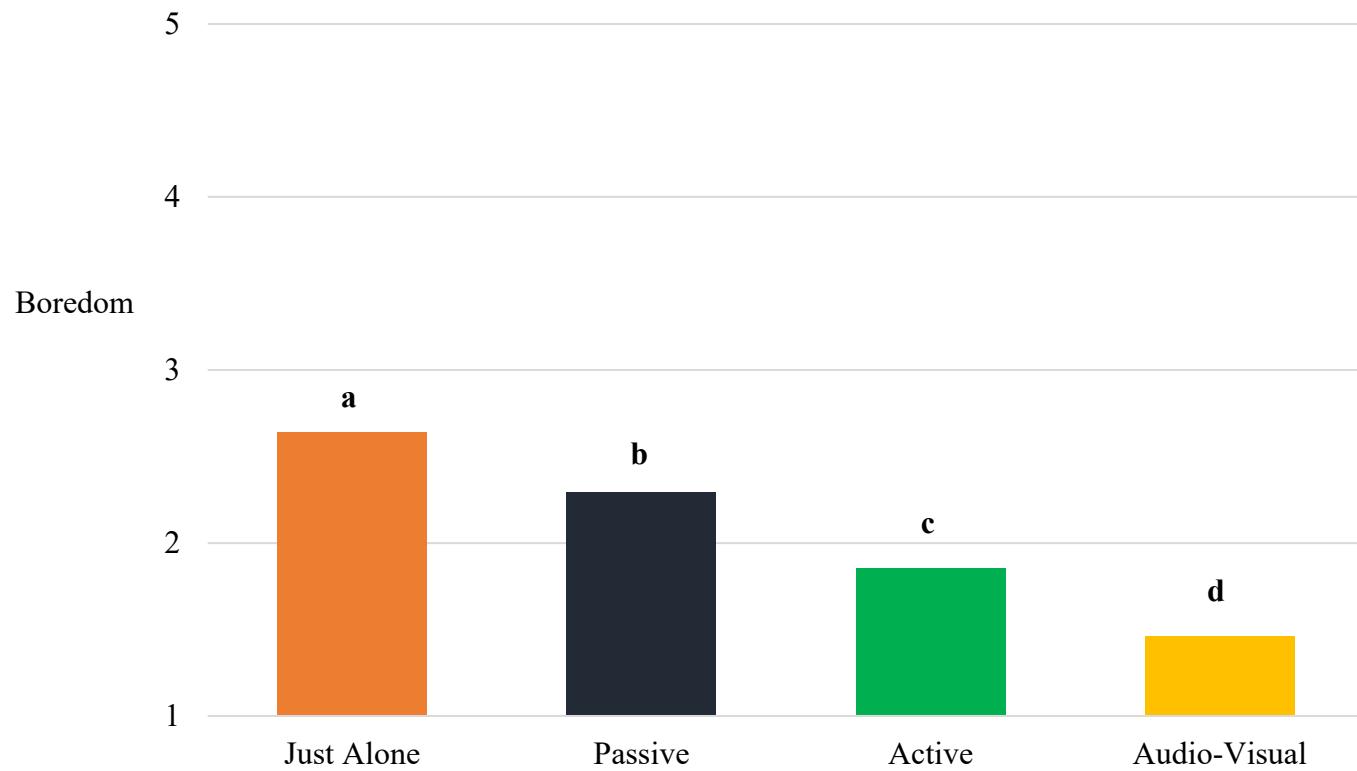


Figure 8. Post-hoc mean comparisons between contexts for boredom.

Note. Means with different subscript differ at $p < .0083$.

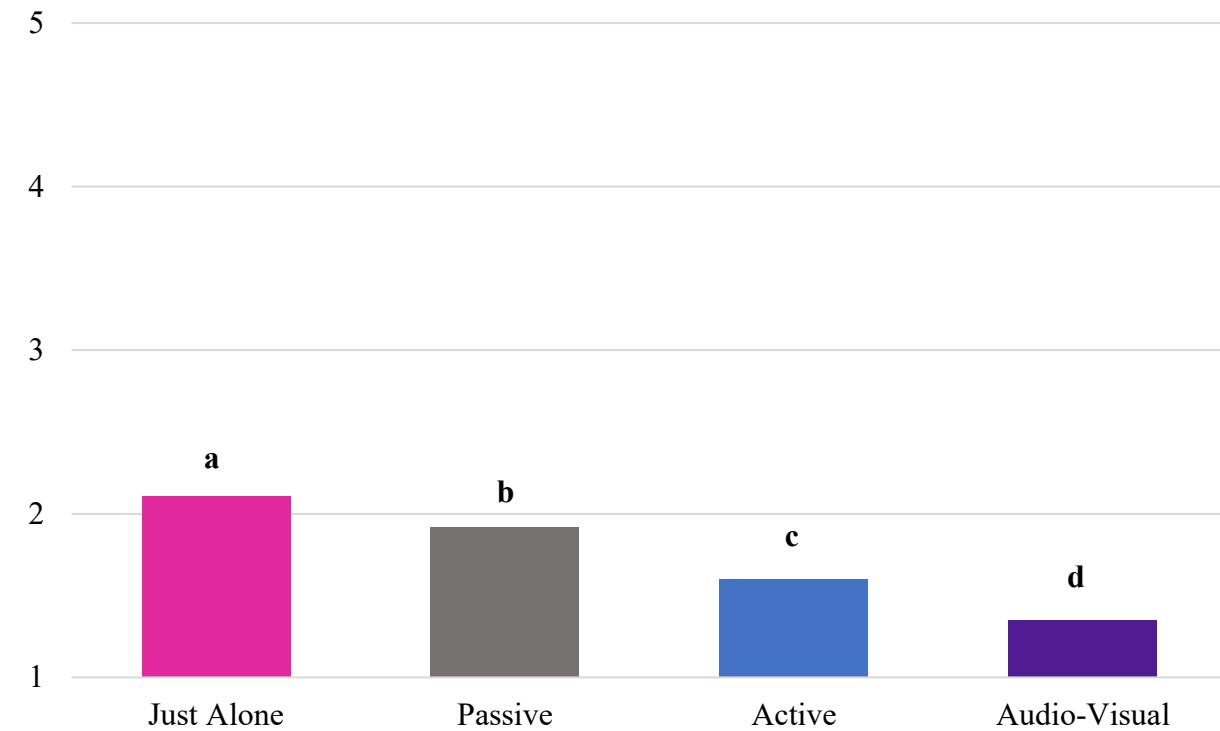


Figure 9. Post-hoc mean comparisons between contexts for sadness.

Note. Means with different subscript differ at $p < .0083$.

Links Between Technology Use, Solitude, and Indices of Well-being

The final goal of the present study was to address the link between technology use, time spent alone, and indices of well-being. Of particular interest, the moderating role of active technology use in the link between time spent alone and indices of each socio-emotional were examined. A series of hierarchical regression analyses were conducted. Given the relatively modest inter-associations among indices of well-being, separate equations were computed to predict each variable. For each equation, control variables (demographics, gender) were entered at Step 1, main effects (time alone, active technology use) at Step 2, and the interaction term (time alone X active technology use) at Step 3 with each socio-emotional outcome assessed as the dependent variable (loneliness, social connectedness, positive affect, negative affect). Results are presented in Table 4. Overall, active technology use only significantly predicted negative affect and no moderation effects were found.

For loneliness, time alone and active technology use contributed significantly to the regression model, $R^2 = .045$, $F(2, 384) = 6.632$, $p < .05$. When age and gender were controlled, 3.3% of the variance was explained by time alone and active technology use in loneliness. However, the time alone X active technology use interaction was not significant, $R^2 = .045$, $F(1, 383) = .519$, $p = .47$. In terms of the individual predictors, it was found that time alone significantly predicted loneliness ($\beta = .183$, $p < .001$), but active technology use ($\beta = .024$, $p = .64$) and the interaction term did not ($\beta = .037$, $p = .472$).

For social connectedness, time alone and active technology use did not significantly contribute to the model, $R^2 = .018$, $F(2, 386) = 2.418$, $p = .090$ this pattern was also true for the time alone X active technology use interaction, $R^2 = .018$, $F(1, 385) = .003$, $p = .957$. Similarly,

Table 4

Hierarchical Multiple Regression Analyses Predicting Socio-Emotional Functioning from Time Alone and Active Technology Use

Loneliness			Social Connectedness			Positive Affect			Negative Affect					
	Variable	β	$SE B$	ΔR^2	β	$SE B$	ΔR^2	β	$SE B$	ΔR^2	β	$SE B$	ΔR^2	
Step 1	Age	-.063	.071	.012	-.072	.109	.006	-.062	.069	.008	-.166	.084	.047*	
	Gender	.080	.073		.012	.111		-.072	.071		.115	.086		
Step 2	Time Alone	.183*	.025	.033*	.080	.038	.012	-.150*	.024	.024*	.138*	.029	.046*	
	Active Technology Use													
Step 3	Time Alone X Active Technology Use	.037	.031	.001	.003	.048	.000	.067	.031	.004	.035	.037	.001	
	Total R^2													
	n		389			391			392			392		

Note. Age, Time Alone, and Active Technology Use were centered at their means

* $p < .05$

the individual predictors, time alone ($\beta = .080, p = .12$), active technology use ($\beta = .087, p = .09$), and the interaction term ($\beta = .003, p = .96$) did not uniquely contribute to social connectedness.

For positive affect, time alone and active technology use contributed significantly to the regression model, $R^2 = .032, F(2, 387) = 4.777, p < .05$. When age and gender were controlled, 2.4% of the variance was explained by time alone and active technology use in positive affect. However, the time alone X active technology use interaction was not significant, $R^2 = .036, F(1, 386) = 1.692, p = .19$. In terms of the individual predictors, it was found that time alone significantly predicted positive affect ($\beta = -.150, p = .003$), but active technology use ($\beta = .028, p = .58$), and the interaction term did not ($\beta = .067, p = .19$).

Finally, for negative affect, time alone and active technology use contributed significantly to the regression model, $R^2 = .093, F(2, 387) = 9.754, p < .05$. When age and gender were controlled, 4.6% of the variance was explained by time alone and active technology use in negative affect. However, the time alone X active technology use interaction was not significant, $R^2 = .094, F(1, 386) = .503, p = .48$. In terms of the individual predictors, it was found that time alone significantly predicted negative affect ($\beta = .138, p = .005$). Active technology use also significantly predicted negative affect ($\beta = .179, p = .001$), while the interaction term did not ($\beta = .035, p = .48$).

Discussion

Technology use has become a central companion in adolescent contemporary culture (Anderson & Jiang, 2018; Ponti, 2019). With this continual use, researchers (e.g., Coplan et al., 2018a; Turkle, 2011; Underwood et al., 2018) are beginning to examine the potential implications of this constant *virtual presence* in the definition and understanding of the construct of solitude. Ongoing research with SIT and digital media use underscores the importance of investigating features of online technology behaviours (e.g., active versus passive use) in relation to various social contexts (e.g., solitude), since these factors may have implications for adolescent development. Thus, the primary aim of this thesis research was to explore the relations between adolescents' solitude, technology use, and indices of socio-emotional functioning (e.g., loneliness, social connectedness, positive affect, negative affect).

The results from this study have extended the limited previous empirical research (e.g., Leung, 2015; Wang et al., 2012) directly exploring links between solitude and technology use. First, findings suggest that considering the *ways* in which technology is used in solitude, are indeed important when examining socio-emotional functioning. Second, findings suggest that perceptions of solitude vary as a function of *how* one uses their phone (e.g., passively, actively, audio-visually) and with these types of use, adolescents report differences in positive and negative feelings when thinking about their time alone. These specific findings provide support for the current theoretical perspectives on SIT (e.g., media richness, social presence, U&G). In addition, individual associations with active technology use and solitude in relation to the selected socio-emotional outcomes will also be discussed. Overall, these findings help to enhance knowledge about the ever-changing digital world by investigating specific types of technology use under contexts, such as solitude.

The Intersection Between Solitude and Technology Use

As previously emphasized, researchers have recently started speculating about the possible role of technology in our experiences of solitude. As society continues to become more technologically advanced, it is now crucial to investigate this emerging dynamic as it may pose various implications and consequences for development (Coplan et al., 2018b). Contextual factors (e.g., being alone versus with others) have shown to influence individuals' frequency of technology use (Wang et al., 2012) and how one may choose to interact with SIT (Boal-Palheiros & Hargreaves, 2001; Leung. 2015). However, other aspects, such as perceptions and feelings of solitude while using different types of technology use have been mainly overlooked.

Perceptions of solitude. One novel contribution of the present study was to examine adolescents' perceived aloneness while considering different engagements of technology use within the context of solitude. Results revealed that adolescents clearly distinguished between each technological circumstance in their perceived aloneness. More specifically, they perceived themselves to be the least alone in the audio-visual context, followed by the active context, and then the passive context, providing support for one of the hypotheses. Extending upon previous studies (Leung, 2015; Wang et al., 2012), these results provide evidence to support the idea that people can maintain physical solitude, but be presented with a *virtual presence*. Moreover, this presence does impact the perception of solitude when engaged with an interactive device. Taken together, the findings offer two notable conclusions about research on solitude and technology use. First, they suggest that adolescents do not classify themselves as alone the richer the technological medium, which is in line with the theoretical perspectives on SIT (Kwak, 2012). Second, they suggest that researchers studying and investigating solitude need to be more

explicit in their operational definition of this construct as the use of technology appears to influence the self-perceived definition of being alone.

Understanding how adolescents psychologically perceive this experience with different forms of technology use is important because it may influence how one chooses to use SIT and interact with others. For example, if one is feeling alone in moments of solitude, they may use their phone in an audio-visual manner with a friend in order to eliminate a sense of perceived aloneness. Depending on how technology is used can then in turn impact the experience of different feelings while in solitude. Therefore, another aim of the present study was to also explore reported socio-emotional feelings with regards to the vignettes.

Positive and Negative Feelings of Solitude with Technology

Having established that adolescents clearly distinguished between each technology context in their perceptions of solitude, the next goal was to investigate the same vignettes (also considering a just alone context), in terms of adolescents' report of positive (e.g., contentment, social connectedness) and negative (e.g., loneliness, boredom, sadness) feelings. Overall, each vignette revealed unique characteristics in terms of adolescents' emotional responses.

Alone, but engaged passively. When comparing the just alone context versus the passive context, these two solitary vignettes did not differ significantly in adolescents' reported feelings of contentment or loneliness. In other words, adolescents did not believe that simply passively engaging with technology would improve their mood or lessen their loneliness. However, adolescents did believe that compared to the just alone context, passive technology use would help to reduce their boredom and sadness, and increase their social connectedness. These findings are consistent with previous research suggesting that doing *anything* (even a negative

task) while alone is viewed as more favorable than simply being alone and doing nothing at all (Leung, 2015; Wilson et al., 2014).

Although passive technology use has been generally associated with negative outcomes, there is some evidence to suggest that this use can perhaps offer benefits depending on an individual's personal motives to use technology (Lometti, Reeves, & Bybee, 1977). Indeed, Shao (2009) notes that using media for informational purposes can increase awareness and knowledge about one's self, others, and the world. For example, a study on YouTube engagement found that users seek information and entertainment gratifications through viewing videos and reading comments, which are features of passive engagement (Khan, 2017). Some researchers have also suggested that motives to "escape" from reality may be a particular driver of passive technology use (Young, Kuss, Griffiths, & Howard, 2017). This escapism can help to provide a sense of entertainment, enjoyment, relief from anxiety, and relaxation (Leung, 2015; McQuail, 2005). These aspects of escapism can also be similarly experienced in physical solitude (Galanaki, 2004). Adolescents may reap benefits, such as feeling content while in private spaces, such as in their bedroom (Larson, 1995). Indeed, solitude can provide an emotionally valuable escape from social pressures and freedom from social judgements (Larson, 1990).

On the other hand, passive consumption could also provide similar levels of loneliness that may be felt in solitude. As previously stated, adolescents typically report this time alone to be a lonely experience (Larson, 1990; Marcoen & Goossens, 1993). Some researchers argue that users may experience social isolation during passive engagement due to the lack of social interaction, reducing opportunities for creating and managing relationships (Kraut et al., 1998; Peplau & Perlman, 1982). Similarly, findings from Matook et al. (2015) revealed that passive consumption creates perceptions of social loneliness due to reduced social engagement in users'

online network. As the definition of physical solitude suggests, this objective separation from others denotes a lack of social interaction.

With regards to social connection, adolescents reported feeling significantly more socially connected in the passive context compared to the just alone context. This finding provides evidence to suggest that feelings of social connection can be achieved through passive technology use while online. Indeed, a few studies have found that belonging to online forums or consuming news from friends can increase feelings of social connection with others (Burke et al., 2011). Indeed, continuous checking on Facebook has been found to be associated with feelings of connectedness and fitting in with the peer group (Bourgeois, Bower, & Carroll, 2014). The awareness that others are also online can help to convey a sense of connectedness without the exchange of direct messaging (Rettie, 2003).

Overall, these results may offer interesting considerations and implications about the features of passive behaviours online. Passive technology use has often been criticized as providing negative socio-emotional functioning, indeed some of our findings suggest evidence for this notion. However, passive technology use also seems to have some positive functions in terms of alleviating negative emotions when considering the context of solitude. Thus, findings seem to support the noted complex relation with passive technology use and socio-emotional functioning (Burke et al., 2011; 2010), highlighting the importance of investigating experiences of social contexts, such as solitude (van Roekel et al., 2015).

Alone, but engaged audio-visually. Results were generally consistent with our hypothesis in that the audio-visual context did elicit the most positive solitude experience with regards to positive emotional responses, followed by the active context, and then the passive

context. In particular, adolescents reported feeling the most content and socially connected in the audio-visual context when compared with the other technological vignettes.

In relation to the negative emotions, adolescents reported feeling the least lonely, bored, and sad in the audio-visual context compared to all other technological vignettes. This may be in line with one of the findings from Wilson et al. (2014), in that engagement with an external activity (e.g., using a smartphone) is more tolerable compared to being alone with one's thoughts. Generally, the pattern of results revealed that when considering each negative emotion within each vignette, adolescents' report of each negative emotion declined the richer the medium. This suggests that negative feelings while in solitude are not intensely considered when thinking about technological mediums that encourage rich interaction capabilities, which is in accordance with previous theoretical perspectives on SIT mediums (Kwak, 2012).

In terms of media richness, mediums have communication capabilities, which vary in the strength, quality, and transmission of nonverbal and verbal cues. As such, it is easy to imagine that a medium with audio-visual capabilities promote these aspects. Indeed, Daft and Lengel (1986) have noted that audio and visual technologies offer an environment that elicits rich communication and the transmission of nonverbal and verbal cues to a similar degree as face-to-face interactions. Relatedly, high levels of social presence are often felt in mediums with high levels of media richness. This degree of social presence allows the medium to feel less mediated and increase the awareness or feelings of another person's closeness during social interactions (Lombard & Ditton, 1997; Short et al., 1976). Therefore, communicating by FaceTime allows for this perception of another to be easily met, which may positively encourage and influence users' perception that they are actively involved in a reciprocal interaction (Rice, 1993; Qiu & Benbasat, 2005). This active component in turn helps to fulfill users social needs and emotions in

positive ways (Han et al., 2015; Hwang & Longbard, 2006; Kreijns et al., 2003), which is also in line with the U&G theory.

As a whole, findings from the present study helped to inform and support these theoretical SIT perspectives in a solitary context. Active technology use was generally believed to provide more positive outcomes than passive technology use. Furthermore, the audio-visual context continually provided the report of positive feelings (above and beyond all other technological vignettes), due to increasing levels of media richness, which is consistent with previous research (Rettie, 2003; Rovai, 2000; Verduyn et al., 2015).

Gender effects. With regards to the solitude and technology vignettes, females reported feeling significantly more content in the audio-visual context compared to males. Although this finding was somewhat unexpected (i.e., no specific hypotheses regarding gender differences were forwarded), some explanations are plausible. For example, a collection of research has found gender differences regarding the report of emotional feedback and responses from social interactions (Garside & Klimes-Dougan, 2002). This difference may be due to features that each gender typically values in communication. For instance, women are often more emotionally expressive than men (Kring & Gordon, 1988), with happiness typically more characteristic and conveyed in interactions compared to men (Kelly & Hutson-Comeaux, 1999). Weiser (2000) found that women typically use the Internet for interpersonal communication. Therefore, females might use forms of technology that favour interactive components to relay expressive dialogue, as these emotional expressions represent core foundations of female friendships (Caldwell & Peplau, 1982). Indeed, Parkins (2012) found that women were more emotionally expressive online compared to males by using emotional markers (e.g., exclamation points, emojis) to display this expressiveness, particularly in terms of positive emotions. Taken together, it is

reasonable to expect that an audio-visual medium fosters the perfect environment to seamlessly receive and transmit these verbal and emotional contextual cues (e.g., pitch, gestures, facial expressions) that are so characteristic to female communication. Thus, leading females to rate the audio-visual context as a more positive experience compared to males in their overall satisfaction with this form of interaction.

Implications of Solitude for Adolescents' Well-being

Historically, solitude has been considered a necessary phenomenon (Winnicott, 1958), but this experience can also be felt with ambivalence, particularly in adolescence (i.e., *solitude paradox*) (Coplan et al., 2018a; Galanaki, 2013; Larson, 1999). The findings from the present study provide support towards the adverse effects of solitude in adolescence.

Overall, self-reported time spent alone was positively related to loneliness and negatively related to positive affect. These associations held even after controlling for age and gender, where a negative association with positive affect was also found. These findings are supported by previous research in that individuals generally report feeling less positive affect and more negative affect when alone than in time with others (Coplan et al., 2019; Matias, Nicolson, & Freire, 2011). More specifically, adolescents often report feeling less alert, weaker, more passive (Larson & Csikszentmihalyi, 1978), and the most lonely (Larson, 1990; Marcoen & Goossens, 1993) when spending time alone. Indeed, some adolescents describe solitude as being a painful or undesirable state (Galanaki, 2013; Long & Averill, 2003).

Given the significance of peer relationships and interactions during this developmental period (Gray, Romanuk, & Daraganova, 2018), it is not surprising that the experience of solitude would be paired with negative feelings in adolescence. It is well established that peer relationships play a formative role for emotional support and in building social skills in order to

bolster healthy psychosocial development and psychological well-being (Bowker, Nelson, Markovic, & Luster, 2014; Hartup & Laursen, 1999; Rubin, Bowker, & Gazelle, 2010). As such, adolescents who socially withdraw from the peer group and choose to spend time alone likely miss out on these important opportunities for peer interactions and experiences (Rubin, Coplan, & Bowker, 2009), therefore enduring feelings such as anxiety, loneliness, and depressive symptoms (Woodhouse, Dykas, & Cassidy, 2012).

Notwithstanding the above explanation, it is also imperative to acknowledge key factors that may influence adolescents' positive and negative experiences of solitude. Nguyen, Weinstein, and Ryan (2018) note that the detrimental consequences of solitude are thought to vary as a function of individual characteristics. Moreover, it may be worthwhile to assess various motivational underpinnings as to *why* one may choose to spend more time alone, which could influence how they subjectively respond to this experience. For example, an individual who is depressed or highly anxious may be motivated to seek time alone, therefore possibly exacerbating these negative feelings. Under these circumstances, solitude serves as a continued maladaptive context (Long & Averill, 2003).

Considering whether one voluntarily chooses to spend time alone is also emphasized as a critical factor in distinguishing between positive and negative experiences of solitude (Galanaki, 2013; Larson, 1979). For instance, external circumstances (e.g., ostracism) could automatically permit individuals to spend more time alone, likely leading to negative adjustment outcomes (Ren, Wesselmann, & Williams, 2016). Yet those who actively seek solitude and recognize its beneficial and productive functions are more likely to be rewarded by this time alone (Nguyen et al., 2018a).

Given that time alone becomes more normative in adolescence, attitudes towards aloneness (e.g., aversion versus affinity) might also influence adjustment (Goossens & Beyers, 2002). Aversion to aloneness refers to unwanted isolation, often felt with unease, whereas affinity to aloneness refers to a preference and constructive use of solitude (Marcoen et al., 1987). Attitudes towards solitude may be predicted by different personality traits (Teppers, Luyckx, Klimstra, & Goossens, 2013). For example, sociable or extraverted people are reported to characterize solitude as a less enjoyable experience (Zelenski, Sobocko, & Whelan, 2014). Those who have a negative attitude toward solitude and spend more time alone likely experience negative outcomes, such as loneliness (Marcoen & Goossens, 1993), with this being particularly true in middle adolescence (Teppers et al., 2013). However, those who are shy or introverted, typically appreciate solitude as this environment provides an opportunity to re-energize and self-reflect (Zelenski et al., 2014). In the present research, only a general measure of solitude was used (e.g., frequency of time spent alone), leaving out these aspects, which are potentially important considerations in the report of positive or negative experiences of solitude in adolescence. As such, future studies must continue to recognize these factors in order to help untangle and inform this paradoxical nature of solitude.

Implications of Technology Use for Adolescents' Well-being

A large body of research has tended to measure screen time and technology use within a very broad context (e.g., measuring total time spent on phone) (Kraut et al., 1998; Pierce, 2009; Primack et al., 2017). Not surprisingly, results have been inconclusive regarding implications for well-being (Egan & Moreno, 2011; Michikyan & Suárez-Orozco, 2016; Valkenburg & Peter, 2007). However, in recent years, researchers have attempted to reconcile this controversy by stressing the importance of examining the different *ways* in which people are using technology

(Escobar-Viera et al., 2018). One way this has been investigated is by distinguishing between active versus passive behaviours online (Burke et al., 2011; Verduyn et al., 2015). Accordingly, another aim of the present study was to distinguish between active versus passive technology use. It was hypothesized that active and passive use would be differentially associated with selected socio-emotional outcomes. In particular, it was expected that active technology use would be positively linked with social connectedness and positive affect, but negatively linked with loneliness and negative affect. In addition, passive technology use was speculated to be positively linked with loneliness and negative affect, but negatively linked with social connectedness and positive affect.

Results provided inconsistent findings and conclusions regarding adolescents' technology use. First, types of technology use (i.e., active versus passive) was not able to be assessed as independent subscales. Thus, correlations with passive technology use was not explored (i.e., unable to test the passive hypothesis). Results from the original EFA suggest that adolescents seem to be engaging more or less in both active and passive behaviours (perhaps simultaneously). Although not directly examining active versus passive technology use, Moreno et al. (2012) found that about 57% of undergraduate students reported engaging in multiple activities online simultaneously (e.g., academic work, using SNS, email, browsing), suggesting the use of both active and passive online behaviours. Indeed, media multitasking (i.e., using multiple media simultaneously) has been noted to be the most prevalent among adolescents and emerging adults (see van der Schuur, Baumgartner, Sumter, & Valkenburg, 2015 for a review).

Although we were unable to examine associations between passive technology use and socio-emotional outcomes, it is important to not to minimize the importance of this use. Indeed, when investigating different aspects of technology use from the present research, adolescents

reported spending the most time engaged in passive social media use (e.g., scrolling on newsfeeds) compared to other technological behaviours. Also to reiterate, findings from the vignettes, perhaps provide some indirect support towards the expected hypothesis for passive technology use. Continuing to investigate and acknowledge these distinct forms of technology use will likely be worthwhile for future research as technology continues to develop in features.

A measure representing active technology use was created. However, it is important to note that this final measure of active technology use was formed after omitting items that were thought to represent passive technology use. Accordingly, participants who scored high on the active items likely also reported high levels of passive technology use as well. Therefore, future research should continue to investigate both active and passive technology use by continuing to use factor analysis procedures.

Contrary to the expected hypothesis, active technology use was positively associated with negative affect. In addition, there were no significant relations between active technology use and the other indices of socio-emotional functioning (i.e., loneliness, social connectedness, positive affect). These findings also held after controlling for age and gender. Although active technology use has been generally related to positive outcomes in the literature (Burke et al., 2010; Deters & Mehl, 2013), there are a few possible explanations for this finding. For example, Wang et al. (2012) found that social media use (e.g., communicating with others online, posting content) was not socially gratifying with a sample of undergraduate students. This conflicting finding with active technology use could be due to how social gratifications, such as connectedness and joy are measured across studies. For example, it may be important to discern between immediate and long-term feelings of connectedness. Indeed, Wang et al. (2012) note that social benefits are not always recognized from short-term or quick responses. In fact, one

study found that even short-term SNS experiences may be socially adverse and taxing due to peer pressures to socially present one's identity and communicate in a certain way (Dunne, Lawlor, & Rowley, 2010). It is possible that the accumulation of interactions with others over a period of time could help to explain the positive benefits found from active technology use, therefore further investigation is needed.

It is also important to recognize other variables that may be contributing factors in the relation between types of technology use on the impact of healthy socio-emotional functioning. As mentioned in the previous section, considering individual motivations towards active versus passive technology use could help to inform about adolescents' online behaviours. Since many (if not all) SIT platforms provide the opportunity to engage in both active and passive behaviours (Tosun, 2012), perhaps the next important question is to understand reasons *why* users are motivated or gravitate towards each type of use (Nadkarni & Hofmann, 2012).

Importantly, the direction of effect between technology use and well-being remain to be a continuous challenge, but deserve more exploration (Stepanikova et al., 2010). For instance, in a longitudinal study, Teppers and colleagues (2013) found that motives towards Facebook use can predict the degree of peer-related loneliness. For instance, adolescents who used Facebook to compensate for social skills had increased feelings of loneliness over time. This finding suggests two important considerations. First, it highlights the importance of implementing longitudinal designs and considering motivational factors, as these perspectives may be the distinguishing factor in understanding indices of well-being with technology use. Second, this finding supports the *social displacement hypothesis*, in that media can be used to sacrifice other valuable activities, such as face-to-face interactions. Although those who may be socially vulnerable (e.g., socially anxious, withdrawn) are often motivated to connect with others online, this

overcompensation can be used to substitute real life (Gosling, Augustine, Vazire, Holtzman, & Gaddis, 2011), posing more risks towards negative outcomes (e.g., depression, lower academic performance) (Yang & Tung, 2007; Huang & Leung, 2009).

Although SIT can be used in active ways, the benefits of this use are not always experienced (e.g., could be used as a means for a coping strategy). Individual motivations and preferences toward each type of technology use, along with personality characteristics, and levels of social competence should be brought to attention. Associations between these features and adjustment outcomes may serve different, yet important implications in the impact of positive or negative socio-emotional development in adolescence.

Solitude, Technology Use, and Well-being

On a more exploratory basis, we aimed to address the moderating role of active technology use between time spent alone and indices of well-being. We postulated that the link between solitude and each socio-emotional outcome would be attenuated with active technology use. However, no evidence was found to support this notion. There could be various reasons from both a methodological and conceptual standpoint as to why this was the case. For instance, in our study, selected measures for each socio-emotional outcome were relatively within a broad context, while active technology use was also comprised of general components (e.g., texting, FaceTime, sharing content). It is possible (and may be necessary) to discriminate between active technology use beyond the general definition that has been provided. For instance, Frison & Eggermont (2015) examined components of active behaviours by distinguishing between *active public* Facebook use (e.g., interactions with friends in a public setting online, status updating, sharing, commenting on photos) versus *active private* Facebook use (e.g., interactions with friends in a private setting, direct messaging online), with results revealing distinct findings in

terms of perceptions of support from friends. In line with this idea, true benefits of active technology use may stem from real-time communication, such as through audio-visual mediums. Different forms of active engagement, such as FaceTime or phone calls may be more likely to offer increased feelings of social connectedness and positive emotions while reducing loneliness. Text messaging and commenting on a SNS platform does not always promise or initiate real-time interactions and responses, therefore benefits of online social interaction could be delayed or diminished as a whole (Frison & Eggermont, 2016). Therefore, other facets of active technology use could be tested separately in future moderation analyses.

Other aspects that might be important to consider in relation to active technology use and solitude are perhaps specific spaces of solitude (e.g. alone in a bedroom versus alone at school). Indeed, Leung (2015) focused on tablet use in different contexts of solitude (e.g., on the bus, train, taxi, in bed, in the bathroom) in how the desire for aloneness and leisure boredom (i.e., feelings of their experience of leisure time/non-work hours) play a role in influencing users' activities when using a tablet in solitude. Generally, findings revealed that when people were travelling alone on a bus, train, or taxi, people used a tablet for social and information-seeking activities, but not for fun/entertainment purposes. While in bed, people used a tablet for information-seeking and fun activities, but not for social purposes. Finally, while in the bathroom, people most often used a tablet for playing games and watching videos. Taken together, these findings suggest that specific contexts of solitude may be worth examining with regards to certain technology use behaviours. Perhaps functions of active technology use in relation to particular contexts of solitude could help to serve as a better moderator between time alone and indices of well-being.

Limitations, Future Directions, and Implications

The present study has uniquely contributed to the theoretical foundations of SIT, as well as extending existing studies on the links between solitude and technology use. In particular, it is among the first to investigate how context and types of technology use can influence the experience, perceptions, and feelings of solitude with adolescents. Notwithstanding these highlights, some caveats should be discussed.

First, as with most research, this study was cross-sectional in nature, therefore limiting causal conclusions between examined variables. Future studies should address this link by using longitudinal methods, which could assess if frequencies and types of technology use change across development in relation to well-being. Second, as technology continues to be intertwined into daily life (Shaw, Ellis, & Ziegler, 2018), users are becoming less reliable to accurately reflect and report on their technology behaviours and frequency of use, making the use of self-reports less than ideal (Andrews, Ellis, Shaw, & Piwek, 2015). It is also possible that the exclusive use of self-reports in this study led responses to be influenced by social desirability biases about technology use. Thus, alternative methodological considerations should be implemented. For instance, using an experience time sampling approach or end of day diary assessments, could be used to capture time spent alone and socio-emotional feelings during different types of technology use. Daily diary assessments could also help to discern between those who may not use certain forms of technology at all, or including a “Never” response choice in the technology use scale as the present study only included a “15 minutes or less” response. Indeed, these responses are qualitatively different and could impact findings. In the present study, a sufficient measure of passive technology use was unable to be formed as intended. Continuing from this methodological perspective, further research is warranted in terms of better

ways of conceptualizing types of online behaviours. In addition, the context of solitude has been noted to facilitate increased mediated activities (Larson & Csikszentmihalyi, 1978; Morahan-Martin & Schumachler, 2003). Therefore, researchers could possibly consider designing a measure or tailoring questions that specifically examine active characterizations of technology use while in the context of solitude (i.e., active solitude use). In relation to the solitude and technology vignettes, it is possible that responses could have been influenced by order effects. For instance, since the vignettes were presented in the same order for each participant from low to increasing richness of the medium, participants might also have responded in an increasing manner. Therefore, it may be important to implement a counterbalancing design in the presentation of the vignettes.

In terms of other future directions, it may be of interest to consider age effects in relation to this research. In fact, with older adults (e.g., ages 65+), technology use may help to mitigate certain consequences of aging (Schehl, Leukel, & Sugumaran, 2019). For example, being a part of the online world can help to prevent isolation and reduce feelings of loneliness (Chopik, 2016; Khosravi, Rezvani, & Wiewiora, 2016). Moreover, different motivations toward types of online behaviours and reported feelings in the experience of solitude could be revealed as a function of age (Larson, 1990). Although beyond the scope of this research, another avenue for future research is to explore the impact of multi-player video games. This context also brings rise to this notion of a *virtual presence* (Quandt & Kröger, 2014), which could perhaps be felt through headsets that facilitate chat with other gamers or interactive character components via gameplay. Research on video game use and well-being have also provided mixed findings (see Johnson, Jones, Scholes, & Carras, 2013 for a review), as such, there is clearly a need to investigate the experience, perceptions, and feelings of solitude within this technological context. Other

potentially interesting prospects for future research is to investigate other moderating or mediating factors (e.g., fear of missing out (FOMO), need to belong) in relation to solitude, technology use, and well-being. Indeed, FOMO has been found to help explain different indicators of well-being, psychological needs (Przybylski, Murayama, DeHaan, & Gladwell, 2013), and social media engagement (Alt, 2015). Finally, despite a paucity of previous research with gender differences in relation to active versus passive technology use, it should not be disregarded. For instance, females may be more likely to use active forms of this use compared to males (Pierce, 2009), which was also true in the present study. Similarly, researchers could consider using a person-oriented approach by analyzing groups of adolescents who engage in different forms of technology (e.g., high levels of video game use versus high levels of passive use) in relation to indices of well-being. Taken together, the implementation of these future suggestions are needed for advancing current knowledge about solitude and technology.

A common recommendation in managing technology use is the minimization of screen time (even in solitude), as online activities during this time can take away from appreciating the true benefits of solitude (Thomas, 2019). Although, this may be an important and valuable suggestion, it may not be entirely realistic or easy to implement. As echoed throughout, SIT and digital media remain to be a core part of an individual's digital identity (Ellis, 2019) and the forefront in today's contemporary society. There are many opportunities to "exist" in this virtual world, blurring boundaries between physical solitude and perhaps using technology in hopes to alleviate feelings of aloneness. Therefore, understanding *how* and *why* individuals use technology will continue to be an important avenue for proceeding research, particularly in terms of how this use impacts numerous psychological outcomes (Shaw et al., 2018).

Although adolescents' social world shift from parents to peers (and now also online) (Arnett, 2000), parents in fact play an integral and active role in helping to support and guide their youth with online SIT experiences (Divecha, 2014). For example, parents can remind their teen about the "performative" nature of social media (e.g., people often appear happier online), assist in choosing developmentally appropriate content, and in teaching how to recognize problematic or addictive online behaviours. Parents should ultimately monitor any negative emotions that their teen may express following SIT use. Moreover, it is essential for parents to also recognize their own smartphone use in efforts to model healthy technological behaviours. For instance, parents can serve to provide an example for their kids in setting limits on their own technology use and prioritizing screen time activities that are educational or social over those that are draining or unsocial (Ponti, 2019).

Perhaps a constructive way to manage technology use is to adopt what is known as "digital minimalism." This idea encourages the use of applications that only add value to one's own life (Raphael, 2017; Schwab, 2018). For instance, when considering the context of solitude, users can make conscious and deliberate decisions to choose SIT applications that espouse more active communication (e.g., Facebook messenger, FaceTime) over scrolling applications (e.g., Instagram). On a similar note, users could selectively choose to "follow" people, pages, and posts that nurture encouragement or support towards positive aspects of mental health. Thus, these behaviours could help to enforce more healthy interactions and exposure of positive viewing content while online.

Lastly, from a pedagogical standpoint, it is vital to advocate for the integration of digital literacy and screen time plans in schools, after-school programs, and community centres (Ponti, 2019), especially as technology continues to be introduced within the educational system (e.g.,

Chromebooks, tablets). Furthermore, the creation of intervention and information programs could be useful to stress the importance in the choice of rich communication mediums with regards to well-being. This may be of particular interest to individuals who are more susceptible to feelings of sadness or loneliness. As the progression of SIT rapidly continues, this current research hopes to offer promising prospects in understanding how different forms of technology use can be utilized within various contexts, in order to maximize and enrich healthy socio-emotional development and well-being.

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Appendix A: Information Letter

**LEARNING ABOUT PSYCHOLOGY:****EXPLORING THE COSTS AND BENEFITS OF SPENDING TIME ALONE IN ADOLESCENCE**

Dear Parents and Students,

In the coming weeks, researchers and graduate students from the **Psychology Department at Carleton University** will be visiting the Psychology/Anthropology/Sociology class at your high school. All students in the class will participate in a workshop where they will learn about Psychology, including some of the topics of study and research areas, university programs, and career opportunities in this field (please note, the content of this workshop has been approved by your school).

We are writing to ask permission for students to also participate in a short research study that will take place during a portion of this class. We are trying to learn more about adolescents' **attitudes, expectations, and motivations toward spending time alone**. Solitude can be both a positive and negative experience. Findings from this study will assist us and other researchers to better understand the potential costs and benefits of "too much" or "too little" solitude for our well-being. This type of research is important because it will help us understand the potentially complex relation between solitude and well-being.

Here is a more detailed description of what this project will involve (if you choose to participate):

Students will be asked to complete a series of short questionnaires in class on a laptop or tablet. This should take about 20 minutes and the questionnaires are completely anonymous (i.e., students will *not* be asked to provide their names or other identifying information). Some of the questionnaire items have to do with students' attitudes about spending time alone and how often they engage in activities by themselves. Other items ask about students' personality and feelings (e.g., how comfortable they may feel when they interact with others) or how often they use electronic devices. Please note that only students who have received parental consent – and who provide consent themselves – will be asked to complete these questionnaires (but all students in the class will receive the opportunity to participate in the workshop).

We do not anticipate any risks in participating in this study. Students will be reminded that they do not have to answer any questions they do not want to, and of course, they are free to stop participating at any time.

The information collected in this study is strictly confidential and will be made available only to researchers associated with this project. All information will be stored in a secure location (on password-protected computers or locked filing cabinets in a secure location) and only members of the research team will have access to it. All online data will be stored and protected by Qualtrics in Toronto, but may be disclosed via a court order or data breach. Documents with personal information (i.e., names and signatures from the consent form – **please see next page**) will be destroyed after a period of three years following the completion of the study. Data collected via the online survey in class is completely anonymous – and IP addresses will not be collected. This study is funded by a *Social Science and Humanities Research Council of Canada* grant to Carleton Faculty member Dr. Robert Coplan. Results from this study may be published in professional journals and presented at conferences. Such publications will use the data of the group together, ensuring that no information about a single individual is given. A summary of the research findings for the whole group will be available upon request.

This study has been approved by the Ottawa-Carleton Research Advisory Committee, the Principal of your high school, as well as the *Carleton University Research Ethics Board – B* (CUREB-B Clearance # 107297). If you have any questions or concerns related to this study please feel free to contact me directly (613-520-2600 ext. 8691 or). Should you have any ethical concerns about this study, please contact Dr. Bernadette Campbell, Chair, Carleton University Research Ethics Board-B (613-520-2600 ext. 4085 or ethics@carleton.ca).

Sincerely,

Robert Coplan, Ph.D.
Professor, Department of Psychology
Carleton University

Appendix B: Parental Consent Form



Canada's Capital University

PARENTAL CONSENT FORM

The information collected for this project is confidential and protected under the Municipal Freedom of Information and Privacy Act, 1989.

It is necessary to obtain *informed consent* from you in order for your son/daughter (under the age of 18 years) to participate in this study. This means you are willing to allow your son/daughter to participate and are aware of the procedures and purpose of this study.

Date: _____

(name of student - please print)

(name of parent or guardian - please print)

Please check one:

I give my permission for my son/daughter to participate in the **SPENDING TIME ALONE IN ADOLESCENCE** study.

I do not give my permission for my son/daughter to participate in the **SPENDING TIME ALONE IN ADOLESCENCE** study.

(signature of parent or guardian)

**Please keep the information letter (first page) and return the consent form (this page) to
the teacher of the Psychology/Anthropology/Sociology class
(sealed in the envelope provided).**

Appendix C: Student Participant Information Letter and Consent Form



Canada's Capital University

LEARNING ABOUT PSYCHOLOGY:

EXPLORING THE COSTS AND BENEFITS OF SPENDING TIME ALONE IN ADOLESCENCE

Invitation:

You are invited to participate in a study about the costs and benefits of solitude. We are trying to learn more about adolescents' attitudes, expectations, and motivations toward spending time alone. Your parent/guardian has provided consent (permission) for you to participate in this research.

What's Involved?

As a participant, you will be asked to complete an online survey containing questions about your attitudes about solitude and how often you spend time alone. Other questions ask about your personality and feelings (e.g., how comfortable you may feel when interacting with others) or how often you use electronic devices.

These questionnaires should take about 20 minutes to complete.

Potential Benefits and Risks:

There are no risks associated with participating in this study. You are free not to answer any of the questions if you do not want to and you can stop your participation at any time. If you choose to stop participating during the survey, you will be given the option of deleting all your answers up to that point. However, please note that once you have completed the survey, this option will no longer be available because your data will be submitted anonymously. Findings from this study will assist us and other researchers to better understand the potential costs and benefits of "too much" or "too little" solitude for our well-being. This type of research is important because it will help us understand the potentially complex relation between solitude and well-being.

Confidentiality/Anonymity:

This survey is anonymous. Please do not provide your name or other identifying information. Your answers to this survey are also private and should not be shared with classmates. We collect data online through Qualtrics, which uses servers with multiple layers of security to protect the privacy of the data. We also ensure that internet IP addresses are not collected.

Publication of results:

Results of this study may be published in professional journals and presented at conferences. These publications will use the data of the group together, ensuring no information about single individuals will be given. A summary of the research findings for the whole group will be available upon request.

Contact information and ethics clearance:

This study has been approved by the Ottawa-Carleton Research Advisory Committee, the Principal of your high school, as well as the *Carleton University Research Ethics Board – B* (CUREB-B Clearance # 107297). If you have any questions or concerns related to this study please feel free to ask one of the workshop leaders. If you have further questions that cannot be addressed by the workshop leaders please feel free to contact me directly (613-520-2600 ext. 8691 or robert.coplan@carleton.ca). Should you have any ethical concerns about this study, please contact Dr. Bernadette Campbell, Chair, Carleton University Research Ethics Board-B (613-520-2600 ext. 4085 or ethics@carleton.ca).

Consent:

I agree to be part of the study described above based on the information I have read. I have had the chance to ask questions about the study and I know that I may ask questions in the future. I understand that I may change my mind and stop being in the study at any time.

Click on “Next” if you agree to participate and you will be directed to the survey.

Click on “Exit the Survey” if you have read the above information and DO NOT agree to participate.

ALONE WITH MY PHONE

Appendix D: Participant Gender and Age

This questionnaire is anonymous (please do not enter your name anywhere).

We would like to be able to describe our sample when analysing the data. For this purpose – please indicate your gender:

- Male
- Female
- Other
- Prefer not to answer

Please indicate your age (in years)

Dropdown menu

ALONE WITH MY PHONE

Appendix E: Time Spent Alone and Solitary Activities

We are interested in the amount of time you spend **alone** (by yourself or doing something by yourself - not including sleeping).

1. How many times during the *last week* (seven days) would you say that you spent time alone lasting at least fifteen minutes? Click the box that best applies.

- Not at all during the last week.
- 1 to 2 times during the last week.
- 3 to 5 times during the last week.
- About once a day.
- About two or three times a day.
- More than three times a day.

2. During the *last week* (seven days), approximately how many **total hours** did you spend alone? Click the box that best applies.

- Less than one hour (less than 15 minutes per day)
- 1 to 2 hours (about 15 minutes per day)
- 3 to 5 hours (about 30 minutes per day)
- 6 to 9 hours (about 1 hour per day)
- 10 to 15 hours (about 2 hours per day)
- More than 15 hours (more than 2 hours per day)

What did you do most often when you were alone? List up to three things:

1. _____

2. _____

3. _____

ALONE WITH MY PHONE

Appendix F: Technology Use

On **average**, how much **time per day** do you spend using the following technology? Click the box that best applies to you.

Email

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Texting

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Talking (e.g., phone calls)

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Video Chatting (e.g., Skype, FaceTime)

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Surfing the Internet for news and information

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Social media (e.g., Facebook, Instagram, Snapchat, Twitter, YouTube etc).

ALONE WITH MY PHONE

Scrolling on newsfeed, looking at photos, watching videos, etc.

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

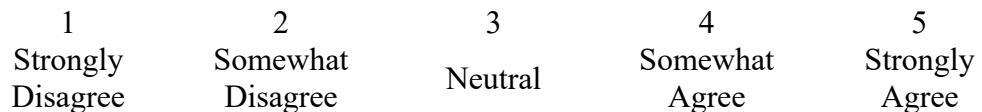
Liking statuses/photos, posting comments/statuses, sharing posts etc.

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

Messaging people directly, interacting, etc.

- Less than 15 minutes
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 6-7 hours
- 8 hours and up

When I take a break from technology, I am afraid I will miss out on what is going on.



ALONE WITH MY PHONE

Appendix G: Beliefs About Solitude and Technology

1. Imagine you are **by yourself in your room** (with the door closed). Tell us how you would feel:

Lonely

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Socially Connected

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Bored

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Content

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Sad

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

2. Now imagine you are **by yourself in your room** (with the door closed), **on social media**, but **not interacting with others** (e.g., scrolling on newsfeed, looking at photos on social media, watching videos, etc.).

In these circumstances, would you consider yourself to be “alone”?

1 Strongly Disagree	2 Somewhat Disagree	3 Neutral	4 Somewhat Agree	5 Strongly Agree
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Tell us how you would feel:

Lonely

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Socially Connected

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Bored

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Content

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Sad

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

ALONE WITH MY PHONE

3. Now imagine you are **by yourself in your room** (with the door closed) and **interacting with others via text only**. (e.g., texting on phone, direct messaging online, etc.).

In these circumstances, would you consider yourself to be “alone”?

1 Strongly Disagree	2 Somewhat Disagree	3 Neutral	4 Somewhat Agree	5 Strongly Agree
---------------------------	---------------------------	--------------	------------------------	------------------------

Tell us how you would feel:

Lonely

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Socially Connected

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Bored

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Content

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Sad

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

4. Finally, imagine you are **by yourself in your room** (with the door closed) and **interacting with others with audio/visuals** (e.g., FaceTime, Skype, etc.).

In these circumstances, would you consider yourself to be “alone”?

1 Strongly Disagree	2 Somewhat Disagree	3 Neutral	4 Somewhat Agree	5 Strongly Agree
---------------------------	---------------------------	--------------	------------------------	------------------------

Tell us how you would feel:

Lonely

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Socially Connected

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Bored

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

Content

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

ALONE WITH MY PHONE

Sad

1 = Not at All 2 = A Little 3 = Moderately 4 = Quite a Bit 5 = Extremely

ALONE WITH MY PHONE

Appendix H: Loneliness and Aloneness Scale for Children and Adolescents

On the following pages you will find a number of statements. For each of these statements, please indicate how often it applies to you using the following scale

1 = never, 2 = rarely, 3 = sometimes, 4 = often

- 1 I withdraw from others to do things that can hardly be done with a large number of people.
- 2 I think I have fewer friends than others.
- 3 I feel isolated from other people.
- 4 I want to be alone.
- 5 I feel excluded by my classmates.
- 6 When I am lonely, I feel bored.
- 7 I want to be better integrated in the class group.
- 8 When I am alone, I feel bad.
- 9 When I feel lonesome, I've got to see some friends.
- 10 I am looking for a moment to be on my own.
- 11 When I feel bored, I am unhappy.
- 12 Making friends is hard for me.
- 13 I am afraid the others won't let me join in.
- 14 When I am lonely, I want to be alone to think it over.
- 15 When I am lonely, I don't know what to do.
- 16 When I have an argument with someone, I want to be alone to think it over.
- 17 To really have a good time I have to be with my friends.
- 18 I feel alone at school.
- 19 When I am lonely, time lasts long and no single activity seems attractive.
- 20 When I am alone, I quiet down.
- 21 I think there is no single friend to whom I can tell everything.
- 22 To think something over without uproar, I want to be alone.
- 23 When I am alone, I would like to have other people around.
- 24 I am happy when I am the only one at home for once, because I can do some quiet thinking then.
- 25 When I am bored I go to see a friend.
- 26 I feel abandoned by my friends.
- 27 I feel unhappy when I have to do things on my own.
- 28 I feel left out by my friends.
- 29 I want to be alone to do some things.
- 30 When I am lonely I go to see other people myself.
- 31 I keep away from others because they disturb me with their noise.
- 32 I feel sad because nobody wants to join in with me.
- 33 When I am bored, I feel lonesome.
- 34 Being alone makes me take up my courage again.
- 35 At home I look for moments to be alone, so that I can do things on my own.
- 36 I feel sad because I have no friends.

ALONE WITH MY PHONE

Appendix I: Social Connectedness Scale Revised

This scale assesses the degree to which you feel connected to others in your social environment. Please rate the degree to which you agree or disagree with each statement.

1 Strongly Disagree	2 Disagree	3 Neither Agree nor Disagree	4 Agree	5 Strongly Agree
---------------------------	---------------	------------------------------------	------------	------------------------

- 1. I feel disconnected from the world around me.
- 2. Even around people I know, I don't feel that I really belong.
- 3. I feel so distant from people.
- 4. I have no sense of togetherness with my peers.
- 5. I don't feel related to anyone.
- 6. I catch myself losing all sense of connectedness with society.
- 7. Even among my friends, there is no sense of brother/sisterhood.
- 8. I don't feel that I participate with anyone or any group.

ALONE WITH MY PHONE

Appendix J: Positive and Negative Affect Schedule

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. Indicate to what extent you feel this way in general or on average.

1 = Very Slightly or Not at All

2 = A Little

3 = Moderately

4 = Quite a Bit

5 = Extremely

_____ 1. Interested	_____ 11. Irritable
_____ 2. Distressed	_____ 12. Alert
_____ 3. Excited	_____ 13. Ashamed
_____ 4. Upset	_____ 14. Inspired
_____ 5. Strong	_____ 15. Nervous
_____ 6. Guilty	_____ 16. Determined
_____ 7. Scared	_____ 17. Attentive
_____ 8. Hostile	_____ 18. Jittery
_____ 9. Enthusiastic	_____ 19. Active
_____ 10. Proud	_____ 20. Afraid