

The Goldilocks Hypothesis: Exploring Links Between Shyness, Computer-Mediated
Communication, and Socio-Emotional Functioning in Adolescents

by

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Abstract

The aim of this study was to explore a conceptual model linking shyness, different types of computer-mediated communication (CMC), and indices of social-emotional functioning among adolescents. Participants were $N = 434$ (67% female) Ottawa high school students, age 15-18 ($M = 16.15$ years, $SD = .49$), who completed self-report assessments of shyness, CMC use (talking, texting, video chat, scrolling, liking), time spent alone, loneliness, social connectedness, and positive/negative affect. Among the results, shyness was positively related time spent alone, loneliness, and negative affect, as well as negatively related to social connectedness, positive affect, and video chat. Different types of CMC were differentially related to indices of socio-emotional functioning, but no significant interactions between shyness and technology were found in the prediction of these outcomes. Results are discussed in terms of the implication of technology use on shy adolescents.

Keywords: shyness, adolescence, technology use, active technology use, media synchronicity, wellbeing

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The Goldilocks Hypothesis: Exploring Links Between Shyness, Computer-Mediated Communication, and Socio-Emotional Functioning in Adolescents

The notion that screens have a negative impact on children and youth's socio-emotional functioning and development is compelling. In addition to the media's villanization of screens, there is ample research to suggest their attitude towards technology is warranted (e.g., Kross et al., 2013). For example, heavy social media use has been associated with poor mental health (Sampasa-Kanyinga & Lewis, 2015), stress (Samaha & Hawi, 2016), and loneliness (Skues et al., 2012) for both adolescents and emerging adults. In addition to poor mental health outcomes, high levels of screen time are associated with indices of adverse physical health, such as obesity, high blood pressure, and lower physical fitness (de Rezende et al., 2014). Based on these results, the idea that "screens are bad" is alluring. However, recent research suggests that there is little empirical support for this broad assertion (Orben & Przybylski, 2019).

Current literature on technology use provides a much more nuanced view of the impacts of technology on wellbeing (e.g., Azmitia & Whittaker, 2021). It recognizes that there are both positive and negative implications of technology use (Thomas et al., 2021), and that outcomes may vary by *type* of technology (Escobar-Viera et al., 2018). Some research, for instance, suggests that social networking sites can support the drive to belong, help maintain relationships, and allow people to receive social support (for a review, see Burke & Kraut, 2016). Additionally, self-disclosure on social media has been found to increase wellbeing by increasing perceived social support (Lee et al., 2013).

Furthermore, different *types* of interactions on social media appear to make a crucial difference for wellbeing outcomes. For example, Burke and Kraut (2016) found that targeted communication from close friends, rather than viewing status updates was tied to increased

wellbeing. Similarly, researchers found that college students that spent more time using Facebook exhibited more symptoms of social anxiety than their peers. However, this relation was stronger for students that used Facebook passively (i.e., scrolling on newsfeed, viewing photos; Shaw et al., 2015). Together, this research indicates that it is important to develop a more nuanced view of technology use that captures its complexity.

Adolescents have garnered particular interest as they are in a developmentally sensitive period and are among the top users of the Internet (Buhrmester & Prager, 1995; Vogels, 2019). Furthermore, online relationships are becoming central to adolescents' social lives (Helsper, 2008). Specifically, adolescents are using *computer mediated communication* (CMC) to connect and communicate with others (e.g., Ponti, 2019; Spies Shapiro & Margolin, 2014). Indeed, contemporary adolescents are the first to have grown up surrounded by communication technologies (Ahn, 2011). For this reason, it is unsurprising that Anderson and Jiang (2018) found that 95% of teens report owning or having access to a smartphone, with 45% of teens stating they are "always online". These staggering reports provide evidence to suggest that CMC is clearly present in adolescents' lives, with constant use likely influencing development.

Advances in technology are providing opportunities for constant social connection. This extension of face-to-face (FTF) relationships onto online platforms has led to a particular interest in how *shy* adolescents conduct themselves online (Chan, 2011). Shy adolescents experience a heightened self-consciousness and self-preoccupation in social settings, which makes communicating and forming relationships difficult (Crozier, 1979; Fatis, 1983). Some evidence suggests that shy individuals may benefit from the increased anonymity of online interactions, thus helping to facilitate relationship maintenance and formation (McKenna & Bargh, 2000). However, relatively little is known about the link between shyness and CMC use in adolescence.

Accordingly, the primary aim of this study was to explore a conceptual model linking shyness, different types of CMC, and indices of social-emotional functioning among adolescents.

Conceptualizations of Shyness

Social withdrawal is considered an umbrella term that describes removing oneself from peer interaction for a variety of different motivations (Rubin & Coplan, 2004). Individuals may be motivated by preference (i.e., unsociability), or by fear (i.e., behavioural inhibition and shyness). To understand how all these terms fit together – and where shyness “fits in” – it is helpful to look at them from a developmental perspective (Rubin & Coplan, 2010).

In infancy, a commonly accepted antecedent to shyness is known as *behavioural inhibition* (BI; Kagan et al., 1984). Infants with this biological-based disposition display high motor arousal (i.e., limb movement) and negative affect (i.e., crying) in response to novel visual or auditory stimuli (Kagan & Snidman, 1991). Highly reactive infants have a unique physiology that is characterized by an elevated heart rate and baseline cortisol, amplified EMG amplitude to a startle stimulus, and right frontal EEG activation (for review see Fox et al., 2005). Collectively, these physiological responses indicate that infants with BI are susceptible to an increased stress response and negative affect (Kagan et al., 1987; Tomarken et al., 1990). Additionally, there is evidence to suggest that high levels of BI in infants is associated with later fearful reactions to social situations in toddlers (Kagan & Snidman, 1991; Calkins et al., 1996). This is particularly important to note, as it suggests that BI may be the precursor to childhood shyness.

In early childhood wariness to novel stimuli becomes particularly pronounced when meeting new people (i.e., fearful shyness; Crozier, 1999). As they develop a self-system and the ability to take the perspective of others, this social wariness begins to include feelings of embarrassment to perceived social evaluation (self-conscious shyness; Eggum-Wilkens et al.,

2015). It is for this reason that, with the advent of formal schooling, many shy children will continue to feel socially challenged even when the school environment becomes familiar. Their feelings of ineptitude lead them to withdraw from social interactions and display overt signs of anxiety with peers at school (i.e., social reticence, Coplan et al., 2008; anxious solitude, Gazelle & Ladd, 2003). For children who experience extreme shyness it is possible that their feelings of anxiety will continue to escalate over time and develop into a debilitating psychological disorder (i.e., social anxiety disorder) in later childhood or adolescence (Sandstrom et al., 2020). Despite the multitude of terms within the social withdrawal literature, they all share conceptual overlap related to feelings of unease, wariness, fear, and embarrassment in social situations (Rubin et al., 2009).

Due to the increase in the importance of peers during adolescence, shyness becomes particularly maladaptive. In fact, it has been speculated that temperamental shyness presents a developmental vulnerability for cognitive biases, which then contributes to the emergence of more severe internalizing difficulties (Gazelle & Rubin, 2010). Although many children that are socially wary go on to be well adjusted, shyness has consistently been implicated as a contributing factor in the development of more serious mental health difficulties, particularly social anxiety (e.g., Chronis-Tuscano et al., 2009; Essex et al., 2010). Additionally, shyness has been linked with sub-clinical levels of anxiety (e.g., Coplan et al., 2008; Coplan & Armer, 2005; Coplan et al., 2009). This is problematic as, even at sub-clinical levels of anxiety, internalizing problems in childhood and adolescence are strong predictors of concurrent and subsequent socioemotional and mental health difficulties (Ashford et al., 2008; Filho et al., 2010). Furthermore, from early childhood to emerging adulthood, shyness is concurrently and

predictively associated with indices of internalizing problems and peer difficulties (Baardstu et al., 2020).

Shyness in Adolescence

In comparison to childhood (Coplan et al., 2018) and emerging adulthood (Nelson, 2013), relatively little was known about shyness in adolescence (Bowker et al., 2016). However, over the last few years, there has been increased attention to the development and implications of shyness in adolescence (e.g., Coplan et al., 2021; An & Eggum-Wilkens, 2019; Hassan et al., 2021). As in childhood, shyness in adolescence is particularly relevant in the context of social interactions. The pressures for peer interactions, however, increase substantially during this developmental period, making shyness especially important to study (Bowker et al., 2016). It is during this time that adolescents spend increasing amounts of time with peers (Lam et al., 2014), and peer influence increases (LaFontana & Cillessen, 2010). These changes create extra pressures to have successful peer interactions and relationships.

Due to shy adolescents' departure from developmental norms and expectations for peer relationships, they are particularly susceptible to poor socio-emotional outcomes (e.g., Bowker et al., 2021; Vanhalst et al., 2014;). Their avoidance of social interactions is based in fear and has been described as *reactive* solitude (Borg & Willoughby, 2021). Although solitude is not inherently negative, Borg and Willoughby (2021) found that higher reactive solitude predicted depressive symptoms, peer victimization, and lower self-esteem.

Adolescents who struggle with peer interactions are also risk for loneliness (Vanhalst et al., 2014). Indeed, the link between shyness and loneliness has been well established (e.g., Zhao et al., 2013, 2018). However, the specific mechanisms involved in the relation remain unclear (Zhao et al., 2018). There is some indication that social support acts as a mediator between

shyness and loneliness (Tan et al., 2016). To explore this relation further, Zhoa and colleagues (2018) compared the *cognitive bias* and *social network mediation models*. The cognitive bias model states that some people, such as shy adolescents, are more likely to have negative core self-evaluations. Alternatively, the social network mediation model suggests that personal dispositions can lower one's motivation and/or ability to build and maintain social relationships, resulting in loneliness. Of the two models, they found that social support was a stronger mediator in the relation between shyness and loneliness. This research highlights the importance of social support as a protective factor for shy adolescents. Additionally, it suggests that *cognitive biases* may also be important to explore.

Shy adolescents are particularly susceptible to cognitive biases that may hinder their social interactions. These include engaging in more negative self-talk, experiencing loss of concentration when feeling shy (Ishiyama, 1984), processing emotional facial expressions differently (LeMare & Rubin, 1987), having greater social threat detection sensitivity (LoBue & Pérez-Edgar, 2014), and using more self-defeating strategies for solving conflicts (Wichmann et al., 2004). These biases translate into difficulties with peer interactions. Specifically, shy adolescents expect to be evaluated more negatively by others and interpret feedback as being more negative than low socially anxious individuals (Smith & Sarason, 1975). Additionally, to minimize negative evaluation, shy adolescents are overly concerned with how they appear to others. For this reason, they enter social situations with heightened self-consciousness and self-preoccupation compared with non-shy individuals (Crozier, 1979). This has detrimental effects on behaviour and performance. For example, on the Stroop task, shyness is related to poorer performance, increased worry about performance, and increased test-irrelevant thinking (Arnold & Cheek, 1986). Furthermore, shy adolescents appear to be self-aware of their negative

cognitions during social interactions. When Fatis (1983) asked 15- to 18-year-olds to self-report their cognitive, behavioural, and physiological reactions to social situations they found that the shy group had significantly higher negative cognitions. Furthermore, the cognitive biases experienced by shy adolescents appear to mediate the relation between shyness and social anxiety (Weeks et al., 2016).

For shy individuals, a heightened self-consciousness and self-preoccupation in social settings creates difficulties when communicating and forming relationships with others (Crozier, 1979; Fatis, 1983). Therefore, it is not surprising that over the last few decades much research has been dedicated to investigating the influence of shyness on social behaviours. The relation between shyness and social behaviours started with the exploration of FTF interactions. One of the earliest studies of shyness and FTF social communication was conducted by Pilkonis (1977). In their study participants were observed in opposite-sex dyads, in interaction with the experimenter, and in the preparation and delivery of a speech. They found that shy individuals spoke less frequently, took longer to initiate conversation, spoke less, and were less likely to break any lulls in conversation when interacting with an opposite-sex confederate than their non-shy counterparts. Despite making fewer utterances, the length of shy and non-shy individuals' utterances was equivalent. Pilkonis (1977) concluded that shy individuals engage in reactive rather than initiative conversational styles. During their speech delivery, shy individuals did not differ significantly in performance from non-shy individuals despite reporting greater anxiety. This finding suggests that shyness influences verbal behaviours in social settings, but not in speaking situations in general.

Similar findings were reported by Garcia et al. (1991), who studied the influence of shyness on mixed-sex dyads. They found that shy individuals made fewer utterances and that shy

males spoke for a shorter duration. The latter difference can be explained by alternate methods of measurement. Pilkonis (1977) measured the number of words per utterance, whereas Garcia et al. (1991) used the duration of each utterance. It thus appears that although shy individuals say the same number of words per utterance (Pilkonis, 1977), shy males take much less time to say them (Garcia et al., 1991). It must be noted that shy males differed from shy females on several accounts. Male shyness was related to non-verbal behaviours, such as fewer smiles, less laughter, fewer glances, and fewer mutual gazes by the dyad (Garcia et al., 1991). Shy females, on the other hand, nodded and smiled more than non-shy females or males in general (Pilkonis, 1977). These sex differences are particularly important as not only did male shyness impact their own behaviours, but it also impacted the behaviours of their conversation partner. On the contrary, female shyness did not influence the actor's or partner's behaviours (Garcia et al., 1991). These findings have since been replicated by many others in various settings (Manning & Ray, 1993).

Additionally, FTF research has found that shy individuals are less likely to self-disclose information about themselves during conversation. For example, self-reported shyness was predictive of weaker social skills and self-disclosure (Matsushima et al., 2000). Matsushima et al. (2000) suggested that an increase in shyness was related to a decrease in social skills, which then led to less self-disclosure.

Together, this research suggests that shy individuals are less socially competent than their non-shy peers. Due to their avoidance of social interactions, they may be at risk for developmental difficulties in: (1) social competence; (2) the understanding of the self in relation to others; (3) acceptance by the peer group; and (4) supportive friendships (Rubin & Coplan, 2010). The consensus on shy individuals' social ineptitude is rather concerning as peer exclusion has been shown to exacerbate socio-emotional adjustment difficulties (Gazelle & Ladd, 2003).

Additionally, peer relationships are particularly important among adolescents (Smetana et al., 2006).

With the advent of computer mediated communication (CMC), researchers have started to explore how this medium compares to FTF interactions. This has been of particular interest in shy populations, as it is hypothesized that CMC will be more appealing than FTF interactions due to increased anonymity (Roberts et al., 2000).

Gender Differences

Finally, research has also explored *gender* differences in shyness. For example, the prevalence of shyness varies depending on the reporter (i.e., self-report, teacher-report). Whereas others tend to report null findings for gender differences, it appears as though girls are more likely to self-report being shy (e.g., Chang, 2004; Findlay et al., 2009; Vervoort et al., 2010). It is hypothesized that this difference may be due to the onset of social anxiety, or a reporting biases. For example, the onset of social anxiety is most common during adolescence (Grant et al., 2005). Furthermore, adolescent girls are more socially anxious than boys (e.g., Kendall et al., 2006; Ranta et al., 2007). Due to the conceptual overlap between shyness and social anxiety (e.g., Degnan & Fox, 2007; Rapee & Coplan, 2010), the gender difference in self-reports of shyness during this age period may reflect gender difference in social anxiety (Doey et al., 2014). On the contrary, boys may underreport as feelings of shyness are not as socially acceptable in boys (e.g., Bosacki, 2008; Rubin & Coplan, 2004).

In the extant literature there are many gender differences found in adolescents' socio-emotional functioning. For example, some research suggests that boys will be more negatively impacted by shyness than girls. This idea has gained support through exploring current gender norms that require boys to be dominant and assertive and girls to be passive and submissive. It is

believed that opposing these norms would lead to particularly negative impacts for boys. As shyness is more aligned with gender normative behaviour for girls, however, they would not be a greatly affected (Doey et al., 2014).

Although boys are expected to experience more negative impacts of shyness, there is some evidence to the contrary. Specifically, some research suggests that girls are more likely to experience loneliness than boys. This hypothesis assumes that loneliness can be categorized as an internalizing problem (Creemers et al., 2012; Romero & Epkins, 2008; Vanhalst et al., 2012), and is supported by the common finding that girls are more at risk for adolescent-onset internalizing problems (Martel, 2013). A meta-analysis by Maes and colleagues (2019), however, found a small but significant mean effect size suggesting that boys were somewhat lonelier than girls in adolescence. This may be due to differences in how adolescence spend their time. For instance, both girls and boys in adolescence spend less time with their family than children. Whereas girls replace time spent with family with time spent with peers, boys replace this time with time spent alone (Koenig & Abrams, 1999).

Additionally, girls are also more likely to be more socially connected than boys. For example, girls apply greater effort to develop social connections than boys (Rueger et al., 2010), and seek their support to help them cope (Eschenbeck et al., 2007). Furthermore, girls tend to report higher levels of peer and parent support (Wang & Eccles, 2012), parent attachment (Oldfield et al., 2016), and connectedness to peers, family, and adults at school (Kaminski et al., 2010) compared to boys.

Technology Use in Adolescence

The increase in adolescents' technology use from previous generations has been a topic of interest and concern for parents and researchers. For example, in 2018 it was estimated that

95% of adolescents had access to a smartphone, with 45% saying that they were online ‘almost constantly’ (Anderson & Jiang, 2018). This is nearly double the number of adolescents claiming near constant use in 2015, only three years prior. In addition to spending more time online than previous generations, adolescents and emerging adults spend the most time online of any age group (Anderson & Jiang, 2018). However, as compared to emerging adults, there has been less research on the socio-emotional impacts of technology use in adolescence (Hollis et al., 2020). This lack of information is concerning as adolescents have distinct developmental tasks, and therefore may be impacted differently by technology use (Larson, 1990).

The rise in public anxiety has initiated several policy reports regarding children and young people’s mental health, personal safety, and wellbeing. However, despite parents’ and policy makers’ concerns, research suggests that the relation between technology use and wellbeing is far too weak to warrant policy change (Orben & Przybylski, 2019). Furthermore, most teens do not view social media as having a negative impact on their peers. Indeed, most teens report social media use as neutral (45%), a third (31%) believed it has a positive impact, and a fourth (24%) claimed that it has a negative impact on their peers. Most interesting, however, were the reasons given for their opinions. Among adolescents who thought the social media was positive, 40% believed that it was positive because it allowed them to connect with family and friends. Conversely, those who believed that social media has a negative impact on their peers cited bullying or rumour spreading (27%) as the number one reason for this (Anderson & Jiang, 2018).

These statistics may be startling to some, but it is important to note that Internet and social media use has increased among all cohorts, although it is consistently higher among adolescents and young adults (Vogels, 2019). Furthermore, both researchers and teens recognize

that there are both negative and positive uses and impacts of the Internet (Escobar-Viera et al., 2018). It is therefore important to identify key protective and risk factors that exacerbate existing vulnerabilities and enable young people's resilience.

In empirical research, *type* of technology use has been identified as critical to whether youth experience benefits or detriments associated with technology use (Escobar-Viera et al., 2018). To assess the impact of the *type* of technology use among adolescents, it is important to be privy to current trends in technology use. For example, although Facebook was used by most teens (71%) in 2015, by 2018 Facebook didn't even make into the top three platforms used by this age group (Anderson & Jiang, 2018). This rapid change in platforms teens spend their time on has posed difficulties in studying the impacts of technology use in adolescence. For example, by the time scientists have evaluated the psychometric properties of tools for measuring screen time, technologies may have already evolved, rendering their efforts outdated (Leblanc et al., 2017). With technology evolving at such a fast pace, it is likely that much of the research on technology use is no longer applicable to the current technology landscape.

Furthermore, *offline* problems have been shown to be the largest predictors of children's online experiences of risk and harm (Odgers & Jensen, 2020). For example, despite adults' fears of social contagion, online peer interactions around self-harm tend to occur among those who are already self-harming. This seems to indicate that self-harm issues predate online discussions of self-harm. Additionally, online peers who engage in self-harming behaviours support one another by checking in regularly and commenting in ways that offer recognition, not judgement (Lavis & Winter, 2020).

Pre-existing psychopathologies have also been implicated in contributing to Internet gaming disorder (IGD; Wold Hygen et al., 2020). Specifically, it was found that there was a

small concurrent correlation between IGD symptoms and psychopathology. However, there was no evidence that IGD symptoms prospectively drove increased risk for later psychopathology. In fact, there was some evidence that IGD may be protective when it comes to anxiety. IGD may reduce worry/rumination and facilitate online friendships for shy people. These findings suggest that associations between IGD and other psychopathologies are the result of underlying causes, such as genes.

Ever changing technology use trends and determining the relation between technology and pre-existing conditions, however, are not the only difficulties associated with studying technology use among adolescents. Another difficulty comes with determining how technology use should be defined (Chan, 2011).

Conceptualizations of Technology Use

Unidimensional Approaches

Research conducted to establish public health guidelines often regards technology use as a unidimensional construct, defining it simply as ‘screen time’ (e.g., Twenge et al., 2017; Twenge et al., 2018). This definition has gained considerable notoriety in the media and is therefore the most widely known definition of technology use (LeBlanc et al., 2017). Its dominance in the literature may be attributed to the significant increase in screen time among adolescents. Specifically, the amount of time young people spend online has doubled in the past decade, making it imperative to examine whether this shift negatively impacts adolescents’ wellbeing (Ofcom, 2017).

Research has addressed fears of the negative impacts of virtualization, such as sedentarism, inactive lifestyles, loneliness and isolation, and fragmenting concentration and attention (e.g., Sinkkonen et al., 2014). For example, screen time is related to various indicators

of health, including obesity, higher blood pressure, higher total cholesterol, and lower physical fitness (de Rezende et al., 2014). It is important to note that high levels of screen time are more consistently associated with indices of adverse health than other sedentary behaviours. This implies that sedentary behaviours do not fully account for the poor health outcomes observed in the screen time literature (LeBlanc et al., 2017).

Furthermore, there has been considerable research looking at the association between screen time and psychological wellbeing. A systematic review, for instance, found evidence that high durations of screen time were related to hyperactivity/inattention problems, internalizing problems, and lower psychological wellbeing and perceived quality of life (Suchert et al., 2015). For this reason, guidelines have set time limits for technology use to mitigate these detrimental impacts technology has on adolescents' physical and mental health. Despite health guidelines, however, over half of 13- and 15-year-olds in Europe and North America exceed screen time guidelines (Anderson & Jiang, 2018; Bucksch et al., 2016).

This research suggests that screen time has pervasive and negative impacts on adolescents' wellbeing. It does not, however, address the mechanism by which it does so. Furthermore, due to the correlational nature of these studies it is impossible to determine whether more technology use might cause lower wellbeing, whether lower wellbeing might cause more technology use, or whether a third confounding factor underlies both (Orben & Przybylski, 2019). Additionally, studying technology use this way assumes that all uses of technology have the same impact on wellbeing (Chan, 2011). This is problematic and may attribute to the overwhelming lack of consensus in the technology literature. For example, increased Facebook use has shown positive (O'Keeffe & Clarke-Pearson, 2011; Skues et al., 2012), negative (Gentile et al., 2012; Gonzales & Hancock, 2011) and no relation to depression (Jelenchick et al., 2013).

For this reason, it is essential to define what characteristics of screens lead to these outcomes (LeBlanc et al., 2017). Accordingly, the definition of screen time must be further refined.

Multidimensional Approaches

Conceptualizing screen time as a multidimensional construct has allowed researchers to investigate the intricacies of technology use. One distinction made in the literature is between active and passive technology use (Verduyn et al., 2015). *Active technology use* refers to activities that facilitate direct exchange with others (i.e., posting status updates, commenting on posts), whereas *passive use* involves consuming information without direct exchanges (i.e., scrolling through news feeds, viewing posts; Burke et al., 2011). The purpose of making this distinction is to observe their unique impacts on wellbeing. In the extant literature, passive technology use has generally been associated with more negative outcomes when compared to active technology use (Burke et al., 2010; Frison & Eggermont, 2016; Qiu et al., 2012; Verduyn et al., 2015). For example, passive technology use is associated with reduced levels of subjective wellbeing (Krasnova et al., 2013), feelings of disconnection, and loneliness (Amichai-Hamburger & Ben-Artzi, 2003).

Conversely, active technology use, although related to more positive outcomes, varies in its impacts on wellbeing. The socio-emotional impacts of active technology use appear to be dependent on synchronicity, social presence, and personality. *Media Synchronicity Theory* focuses on the ability of media to support communication through synchronicity. Specifically, it is argued that the fit of media capabilities to the communication needs of the task influence the appropriation and use of media, which in turn influences communication performance (Dennis et al., 2008).

Communication is composed of two primary processes, conveyance of information and convergence on meaning (Miranda & Sanders, 2003). Convergence processes benefit from the use of media that facilitate synchronicity, the ability to support individuals working together at the same time with a shared pattern of coordinated behaviour, whereas conveyance processes have a lesser need for synchronicity (Dennis et al., 2008). In forming and fostering relationships it becomes imperative that there is a convergence on meaning, and thus technology that facilitates synchronicity is favoured (Dennis et al., 2008; Dennis & Valacich, 1999).

Social Presence Theory classifies different communication mediums along a continuum from low (text-based communication) to high social presence (FTF communication; Short et al., 1976). The degree of social presence is equated to the extent a communication medium enables the perception of another person's physical presence or closeness during an interaction. This perceived social presence is related to perceptions of connectedness with another person (Rettie, 2003). Additionally, Hwang and Lombard (2006) found that the more a medium can elicit feelings of *being together* the more likely university students were to report that the medium helped them achieve their social needs.

Additionally, personality appears to contribute to the impacts of active technology use on wellbeing. From Media Synchronicity Theory and Social Presence Theory, it is expected that those that engage in active technology use that is high in synchronicity and social presence will benefit more from active technology use. This, however, is not universally true. Shy individuals, who often find FTF interactions more difficult, appear to experience more benefits from active technology that has lower levels of synchronicity and social presence (Brunet & Schmidt, 2007). As is discussed later, there may be an *optimal* level of synchronicity and social presence in CMC for promoting positive social interactions among shy adolescents.

Gender Differences

Research has also suggested that digital media use and wellbeing may differ between males and females (Kelly et al., 2019). Despite this assertion, little research has explored gender differences in digital media use or its association with wellbeing (Twenge & Martin, 2020). Most studies use gender as a control variable when examining the association between digital media use and wellbeing, however, they do not examine associations separately for males and females (Przybylski & Weinstein, 2017; Twenge et al., 2018; Twenge & Campbell, 2019).

A recent study by Twenge and Martin (2020) has explored the relation between gender, digital media use, and wellbeing. They found that girls spent more time on smartphones, social media, texting, general computer use, and online. Conversely, boys spent more time gaming and on electronic devices in general. This suggests that girls spend more time engaged in active uses of technology whereas boys spend more time engaged in more passive uses of technology. For both genders, heavy users of digital media were twice as likely as low users to be low in wellbeing. Furthermore, associations between moderate or heavy digital media use and low psychological wellbeing were generally larger for girls than for boys. Light users of digital media were slightly higher in wellbeing than non-users, with larger differences among boys.

Shyness & CMCs

In the infancy of the Internet, Henderson and Zimbardo (1998) suggested that the increase in the prevalence of shyness was associated with the advances in information communication technology. They reasoned that due to a reduction in FTF communication and interaction, individuals would become more socially isolated. This is primarily because they viewed the internet as a substitute for FTF connections. It was suggested that this replacement, particularly among those who spend a great deal of time online, would prevent individuals from

acquiring or maintaining skills necessary for social interaction (Henderson & Zimbardo, 1998). This view is consistent with the *displacement hypothesis*, which states that media use replaces other meaningful activities (Nei, 2001; Putnam, 1995).

Since Henderson and Zimbardo's theory of the Internet much has changed, both in the technology itself and research's conceptualization of its impacts. Most notably, however, shyness is not considered to be associated with advances in information communication technologies (Saunders & Chester, 2008). Although technology is not viewed as an aetiology for shyness, technology does have a unique impact on shy individuals' socio-emotional functioning (Stritzke et al., 2004). In the extant literature, however, there is much contention about what the Internet's impact on shy individuals' socio-emotional functioning is.

The rapid increase in adolescents' Internet use has raised questions as to the type of adolescents who are more likely to develop Internet-related problematic behaviours (Douglas et al., 2008; Pratarelli et al., 1999). It has been suggested that shy individuals may rely on the Internet to compensate for their perceived deficit of real-life social interactions and to alleviate feelings of loneliness and depression (Chan, 2011). As technology may provide a safer space for shy adolescents to form relationships, it has been suggested that this may lead to an over reliance on technology (Chak & Leung, 2004; Roberts et al., 2000). Specifically, studies have found that high levels of shyness are related to excessive Internet dependency (Yuen & Lavin, 2004) and Internet addiction (Chak & Leung, 2004).

Conversely, some scholars believe the Internet is an empowering medium that provides an outlet for shy individuals to meet others and build enduring relationships (McKenna & Bargh, 2000). Shy people generally have smaller friendship networks, less social support, decreased social interaction, poor self-projection, weaker social ties, and deficient communication (Jones &

Carpenter, 1986; Roberts et al., 2000). The Internet provides an environment that facilitates better quality relationships for shy people because of the perceived greater control over how they interact and present themselves online, largely in text-based environments. Additionally, the absence of FTF communication or direct observation allows for anonymity, which are features of CMC that provide shy individuals with a safe and secure environment for social interaction.

Although both views provide useful insights into the relation between shyness and generic CMC use, the present literature has one major shortcoming. Specifically, CMC is characterized by individuals' adoption and concurrent use of a variety of technologies to communicate with others (Baym et al., 2004). Research on the relation between shyness and CMC, however, assumes that all technology use has a unidimensional association with personality dispositions (Chan, 2011). As a result, theoretical assumptions and distinctions are commonly made along a FTF/online dichotomy.

For example, a defining characteristic separating email and FTF communication is the asynchronous nature of message delivery and response. It is assumed that shy individuals will prefer email to FTF communication due to decreased need for spontaneity in response. This in turn will reduce anxiety, as shy individuals have increased control of how a message is framed before it is sent (Kelly & Keaton, 2007). Another popular mode of communication via Internet is instant messaging. This form of communication is more like FTF communication as it is a synchronous form of communication. Due to differences in demands, it is reasonable to assume that instant messaging will accentuate feeling of social anxiety in shy individuals (Chan, 2011).

When distinguishing CMC use by media synchronicity, Chan (2011) reported that shyness was a significant predictor of increased frequency of asynchronous technology use (i.e., email and social network site use). Additionally, shyness was a significant predictor of frequency

of instant messaging, but not online chat. Therefore, the prediction of a negative relation between shyness and synchronous CMC use received only partial support. It was suggested that although the online environment may be more suitable for shy individuals, the need to interpret textual cues and provide instant feedback may make synchronous forms of online communication difficult (Chan, 2011).

Impacts on Social Functioning

With the advent of CMC, personality and experimental social psychology researchers have started to explore social behaviours online (Bargh & McKenna, 2004; Bargh et al., 2002; McKenna & Bargh, 2000; McKenna et al., 2002). Studying shyness in the context of CMC has provided researchers with the unique ability to experimentally manipulate social context in novel ways unavailable to FTF research. For example, researchers can decompose social interactions to their most basic components (i.e., exchange of information) and incorporate as many or as few of the other components (i.e., visual, and auditory cues) as needed. The latter manipulation is particularly important for studying shy individuals who find verbal and non-verbal social cues particularly salient and threatening (Jones et al., 1986). It has been suggested that the anonymity created by lack of social cues, such as seeing one another, may allow shy individuals to feel more comfortable participating in online social interactions and disclosing more online than in FTF interactions (Roberts et al., 2000).

In support of this finding, Brunet and Schmidt (2007) found that in the absence of visual cues (i.e., webcam) self-disclosure was not related to shyness. However, when using a webcam, shy individuals self-disclosed significantly less. This indicates that shyness is context dependent. Furthermore, this context dependency has the potential to be exploited to aid shy individuals in forming close relationships through increased self-disclosure.

In addition to fostering intimate relationships, self-disclosure also plays an important role in identity formation. Identity formation is a key developmental task of adolescence and is, in part, developed through their relationships with peers. Specifically, peers contribute to identity development by providing adolescents with opportunities to engage in intimate self-disclosure (Buhrmester & Prager, 1995). Peers' influence on an adolescent's identity is a key difference between childhood and adolescent friendships (Rubin et al., 2016). As adolescents' perspective-taking abilities improve, their friendships are increasingly defined by mutuality, empathy, and reciprocity (Selman, 1981). These qualities support intimacy. In intimate peer relationships, adolescents articulate their sense of themselves and provide each other with feedback on and validation of these articulations. In the process, they learn what they share with others as well as what makes them unique (Sullivan, 1953).

As self-disclosure is essential to forming intimate relationships and identity formation in adolescence, it is prudent to help those who find self-disclosure difficult. For this reason, shy adolescents are of particular interest. If given opportunities where they feel more comfortable to self-disclose, it is possible that they will reap the same benefits of social interactions as their peers.

In this regard, the *Goldilocks Hypothesis* suggests that there is an optimal (i.e., not too much, not too little, but just right) level of media synchronicity and social presence in CMC for shy adolescents. Technology that is high in synchronicity and social presence, such as video chat, may be distressing to shy adolescents. This is due to characteristics of video chat having similar gating features that are present in FTF interactions. For example, there is an expectation to provide an immediate response, and presence of verbal and non-verbal cues that are particularly salient and threatening (Jones et al., 1986).

At the other end of the spectrum is technology that is low in synchronicity and social presence, such as email. It has been suggested that shy individuals will feel more comfortable in this asynchronous environment (Kelly & Keaton, 2007). However, due to low social presence, shy adolescents will be unable to meet their social needs through this medium. Therefore, it is predicted that there will be a type of technology use that supports their need for social connection while also removing features that they find intimidating. For this reason, it is hypothesized that texting will be a medium best suited to shy adolescents. Texting can support feelings of connection (Cupples & Thompson, 2010) and potentially lessen their feelings of anxiety (Brunet & Schmidt, 2007).

The notion of finding the right fit between an individual and an activity is not novel. For example, Przybylski and Weinstein (2017) used the Goldilocks hypothesis to explore the relation between digital screen use and mental wellbeing. They found that moderate use of digital technology was not intrinsically harmful and may be advantageous in today's connected world. Similarly, the *paradox of solitude* (Galanaki, 2015) explains that there is an optimal amount of solitude whereby a balance between the positive (i.e., self-exploration; Goossens, 2014) and negative (i.e., poor wellbeing; Coplan et al., 2018) impacts of solitude is achieved (Coplan et al., 2019; Coplan et al., 2021).

Gender Differences

The relation between gender, shyness, and technology use is speculative and beyond the scope of the present study. However, it is important to address possible associations among these variables. Previous studies have suggested a negative relation between shyness and synchronous forms of CMC (Chan, 2011). With a greater use of asynchronous forms of technology, shy adolescents are more susceptible to the negative outcomes associated with this type of use

(Burke et al., 2010; Frison & Eggermont, 2016, Qui et al., 2012; Verduyn et al., 2015), such as reduced levels of subjective wellbeing (Krasnova et al., 2013), feelings of disconnection, and loneliness (Amichai-Hamburger & Ben-Artzi, 2003). Furthermore, as females tend to use more synchronous forms of technology (i.e., texting; Twenge & Martin, 2020), shy males may be more greatly negatively impacted by technology use due to their patterns of use.

The Present Study

The overarching aim of this MA Thesis research was to explore a conceptual model linking shyness, computer-mediated communication, and indices of socio-emotional functioning (i.e., positive/negative affect, loneliness, social connectedness) among adolescents. Specifically, one objective of the current study was to investigate *how* shy individuals use technology. To accomplish this goal, adolescents were asked to indicate how much time they spent engaging in different types of technology use on average, per day. Following this, different types of technology use were evaluated to determine their impacts on indices of socio-emotional functioning among shy adolescents. It was expected that shy adolescents would engage in less synchronous forms of technology use than their non-shy counterparts. However, it was also believed that shy children who spend more time “texting” and/or “messaging people directly, interacting, etc.” would experience greater wellbeing.

Detailed Hypotheses

1. Shyness will be positively associated with time spent alone;
2. Shyness will be positively associated with negative affect and loneliness, and negatively associated with positive affect and social connectedness;
3. Shyness will be positively related to passive social media and texting, and negatively related to computer-mediated verbal and audio-visual communication;

4. Passive technology (social media) use will be positively associated with negative affect and loneliness, and negatively associated with positive affect and social connectedness; Active technology use (texting, verbal, audio-visual) will be negatively associated with negative affect and loneliness, and positively associated with positive affect and social connectedness;
5. Females will report higher shyness than males;
6. Females will report higher negative and positive outcomes than males;
7. Males will report a greater frequency and amount of time spent alone;
8. Females will engage in more active technology use compared to males, whereas males will engage in more passive technology use compared to females;
9. Text-based communication use will moderate (protective factor) the relations between shyness and indices of socio-emotional functioning.

Method

Participants

Participants were $N = 434$ adolescents (292 females) aged 15-18 years-old ($M = 16.15$ years, $SD = .49$). Adolescents were recruited from high schools in the Ottawa Catholic School Board (OCSB) and the Ottawa-Carleton District School Board (OCDSB). Students from this sample were enrolled in an introductory Psychology/Sociology/Anthropology class, which was primarily offered to grade 11 students (although some grade 10 and grade 12 students were also in attendance). Data collection took place over two semesters, in the Fall 2018 (late October to December) and Winter-Spring of 2019 (February to May). Generally, the teachers taught the course in both terms with different students each semester. The data collection was part of a

larger ongoing research project investigating adolescents' attitudes, beliefs, and individual preferences about spending time alone. The overall consent rate was approximately 70%.

Measures

Solitude. The *Time Spent Alone and Solitary Activities* measure (Coplan et al., 2019 – see Appendix E) 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. This scale has been shown to be reliable and valid among samples of university students (Coplan, et al., 2019) and adolescents (Coplan et al., 2021; Hipson et al. 2021).

Technology Use. To assess 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 validated by Watanabe (2019) and modelled after a previous technology scale by Perkins (2014). The development of this scale drew upon the extant literature on active and passive technology use (Burke et al., 2011; Burke et al., 2010; Verduyn et al., 2015). Active technology use included items, such as texting, talking (e.g., phone calls), and video chatting (e.g., FaceTime, Skype), whereas passive use included browsing the Internet for news and information. Other items were concerned with both active (e.g., posting, sharing, “liking” content) and passive (e.g., scrolling on newsfeed, watching videos) social media use (e.g., Facebook, Instagram, Snapchat). 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 by Watanabe (2019).

Shyness. Participants were asked to complete the 13-item *Revised Cheek & Buss Shyness Scale (RCBS)* (Cheek & Buss, 1981 – see Appendix G) to assess shyness. Items (e.g., “I feel inhibited in social situations.”) were rated on a five-point scale (1 = “very uncharacteristic or untrue, strongly disagree” to 5 = “very characteristic or true, strongly agree”) and coded so that higher scores represent higher levels of the construct. Furthermore, the present study regarded shyness as a continuous variable and therefore cut-off scores were not used. The RCBS is strongly correlated with the original 9-item scale ($r = .96$; Cheek, 1983), and has strong internal consistency ($\alpha = .90$) and 45-day, test-retest reliability ($r = .88$) (Hopko et al., 2005). In a sample of Chinese adolescents, the RCBS similarly showed strong internal consistency ($\alpha = .85$) (Tan et al., 2016).

Indices of Socio-Emotional Functioning. To assess loneliness, participants completed the *Loneliness and Aloneness Scale for Children and Adolescents (LAKA)* (Goossens et al., 2009 – see Appendix H). This 48-item measure assesses the four-factor model of loneliness. This model includes peer-related loneliness, family loneliness, negative attitude toward solitude, and positive attitude towards solitude (Goossens et al., 2009). This measure has been widely used with adolescents (i.e., Danneel et al., 2018; Maes et al., 2015) and has displayed evidence of reliability (average $\alpha \geq .80$ for all subscales; Maes et al., 2015) and validity (Goossens et al., 2009). For this study, however, only the subscale assessing loneliness in peer relationships with peers was used. 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”) with higher scores indicating more loneliness. The subscale has been shown to have high internal consistency ($\alpha = .87$) (Marcoen et al., 1987) and excellent reliability ($\alpha = .91$; Watanabe, 2019).

Participants also completed 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 (1 = “Strongly disagree” to 5 = “Strongly agree”) where higher scores indicated feeling less 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).

Lastly, as an index of general wellbeing, participants completed the *Positive and Negative Affect Schedule (PANAS)* (Watson et al., 1988 – see Appendix J). This 20-item test is rated on a 5-point scale (1 = “Very slightly or not at all” to 5 = “Extremely”) and was designed to measure two orthogonal dimensions of mood. Items consisted of both positive (e.g., enthusiastic, inspired, excited) and negative (e.g., upset, irritable, afraid) emotion words. Among adolescence, the scale has shown good internal consistency for positive ($\alpha = .89$) and negative affect ($\alpha = .87$) (Melvin & Molloy, 2000). Additionally, the PANAS has demonstrated adequate reliability, test-retest reliability, convergent, and discriminant validity (Watson & Clark, 1994).

Procedure

Prior to 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 at participating high schools were also obtained.

On the first visit to participating classes, students received consent packages (see Appendix A & B) and were briefed on the purpose of the study. Parental/guardian and student consent were required on the second visit to continue 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, a pedagogical interactive workshop module of their choice was presented to all students in the class. Modules covered research on solitude and information about studying psychology in university.

Results

Data Management

Prior to analysis, all variables were examined through various IBM SPSS Version 27 programs for accuracy of data entry, missing values, and fit between their distributions and the assumptions of univariate and multivariate analysis.

Accuracy of data entry was assessed as per Tabachnick and Fidell's (2007) instructions for large data sets. First, univariate descriptive statistics were computed. Then continuous variables were probed to ensure that all values were within range, and that means and standard deviations were plausible. Discrete variables (i.e., gender) were checked for presence of any out-of-range numbers. Missing data was assessed by following procedures from Tabachnik and Fidell (2007). First, cases that were missing over 90% of their data were removed. This resulted in two cases being removed from the analysis. Aggregate scores for time alone, positive affect, negative affect, shyness, loneliness, and social connectedness used mean substitution to handle missingness. Mean substitution was used if more than 65% of the data for a case was missing.

Due to lack of representation, those who answered "other" or "prefer not to answer" for gender were excluded from analyses. This resulted in three cases being omitted. An additional case was omitted based on extremely high z scores on four out of six items on the technology scale. All four outliers were deleted, leaving 438 cases for analysis. Univariate and multivariate assumptions of normality were met. Normality of residuals for each regression analysis are discussed in the regression section of the results.

Preliminary Analyses

Preliminary analyses, including analyses of gender effects, are presented first to establish the need to control for demographic variables in subsequent analyses. Descriptive statistics for all study variables are displayed in Table 1. Of note, due to low frequency of use, email was

omitted from further analyses. Results of evaluation of assumptions of normality, homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory.

To assess main effects of gender, a series of t-tests and MANOVAs were conducted. A significant gender effect was found for shyness, with females reporting greater levels of shyness ($M = 3.07$, $SE = .032$) than males ($M = 2.87$, $SE = .046$), $t(413) = -3.50$, $p < .001$, and represented a medium-sized effect, $d = .53$. A one-way MANOVA was then conducted to test gender differences in frequency and time spent alone. Results indicated a significant main effect of gender, $F(2, 417) = 4.03$, $p = .019$. Results from follow-up univariate analyses revealed that females ($M = 3.78$, $SD = 1.40$) reported a lower frequency of time alone compared to males ($M = 4.11$, $SD = 1.49$), $F(1, 418) = 4.96$, $p = .027$. Additionally, univariate analyses revealed that females ($M = 3.67$, $SD = 1.62$) reported a lower amount of time spent alone compared to males ($M = 4.14$, $SD = 1.64$), $F(1, 418) = 7.59$, $p = .006$.

For loneliness and negative affect, MANOVA results indicated a significant main effect of gender, $F(2, 401) = 4.03$, $p = .018$. Results from follow-up univariate analyses revealed that females ($M = 2.23$, $SD = .68$) reported higher levels loneliness compared to males ($M = 2.07$, $SD = .68$), $F(1, 402) = 2.25$, $p = .028$, and that females ($M = 2.30$, $SD = .76$) reported higher levels of negative affect compared to males ($M = 2.30$, $SD = .76$), $F(1, 402) = 4.64$, $p = .008$. For social connectedness and positive affect, MANOVA indicated the combined DVs were not significantly affected by gender $F(2, 404) = 1.56$, $p = .21$.

For active technology (texting, talking, video chat) use, results indicated a significant main effect of gender, $F(3, 406) = 2.88$, $p = .036$. Results from follow-up univariate analyses revealed that females ($M = 3.73$, $SD = 1.68$) text more than males ($M = 3.23$, $SD = 1.61$). No significant differences were found between females and males on talking or video chat.

Finally, for passive technology use (i.e., scrolling, liking), results indicated a significant main effect of gender $F(3, 413) = 5.88, p < .001$. Results from follow-up univariate analyses revealed that females ($M = 2.12, SD = 1.02$) spend less time surfing the Internet compared to males ($M = 2.40, SD = 1.30$), $F(1, 415) = 5.54, p = .019$. Additionally, univariate analyses revealed that females ($M = 2.08, SD = 1.07$) spend more time on social media - liking compared to males ($M = 1.79, SD = 1.17$), $F(1, 415) = 5.97, p = .015$. Finally, the univariate analyses revealed no significant difference between females ($M = 3.01, SD = 1.16$) and males ($M = 2.90, SD = 1.26$) on social media - scrolling, $F(1, 415) = .73, p = .39$.

Linear Associations among Study Variables

To ease presentation, inter-correlations among study variables are displayed in Tables 2, 3, and 4. Among the results, shyness was significantly and positively correlated with time spent alone, negative affect, and loneliness, as well as significantly and negatively associated with positive affect and social connectedness (see Table 2). Shyness was also significantly and negatively related to audio-visual communication, but not significantly associated with passive social media use (i.e., scrolling and liking), texting or phone calls (see Table 3).

Texting was positively associated with negative affect. Scrolling was positively associated with negative affect and loneliness. Liking was positively associated with negative affect and social connectedness. Video chat was positively associated with social connectedness and negatively associated with loneliness (see Table 4).

Table 1*Descriptive Statistics for all Study Variables*

	N	Minimum	Maximum	Mean	Std. Deviation
Gender	434	1	2	1.68	0.47
Age	414	15	18	16.15	0.5
Time Alone (Frequency)	420	1	6	3.89	1.43
Time Alone (Amount)	420	1	6	3.82	1.64
Email	417	1	6	1.22	0.74
Texting	418	1.5	9	3.57	1.67
Talking	417	1	5	1.41	0.76
Video Chat	414	1	6	1.68	0.97
Surfing	419	1	6	2.2	1.12
Social Media (Scrolling)	420	1	6	2.97	1.19
Social Media (Liking)	418	1	6	1.99	1.11
Time Alone	420	1	6	3.85	1.38
Positive Affect	415	1.1	5	3.23	0.68
Negative Affect	415	1	4.5	2.48	0.83
Shyness	415	1.75	4.3	3	0.54
Loneliness	409	1	4	2.18	0.69
Social Connectedness	415	1	5	3.11	1.04

Table 2***Correlations Between Shyness, Time Alone, & Socio-Emotional Functioning***

	1	2	3	4	5	6
1. Shyness						
2. Time Alone	.11*					
3. Positive Affect	-.44**	-.12*				
4. Negative Affect	.47**	.10	-.21**			
5. Loneliness	.62**	.14**	-.39**	.50**		
6. Social Connectedness	-.22**	.07	.19**	-.11*	-.19**	

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

Table 3*Correlations Between Shyness & Technology Use*

	1	2	3	4	5	6
1. Shyness						
2. Talking	.01					
3. Video Chat	-.14**	.50**				
4. Social Media - Liking	.08	.23**	.18**			
5. Social Media - Scrolling	.01	.22**	.28**	.58**		
6. Texting	.01	.38**	.36**	.53**	.66**	

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

Table 4***Correlations Between Technology Use & Socio-Emotional Functioning***

	1	2	3	4	5	6	7	8	9
1. Texting									
2. Talking	.38**								
3. Video Chat	.36**	.50**							
4. Social Media - Scrolling	.53**	.23**	.18**						
5. Social Media - Liking	.66**	.22**	.28**	.58**					
6. Positive Affect	-.01	-.01	.01	-.09	.03				
7. Negative Affect	.21**	.07	.07	.12*	.15**	-.21**			
8. Social Connectedness	.03	.04	.11*	.03	.10*	.19**	-.11*		
9. Loneliness	.09	.07	-.12*	.14**	.02	-.39**	.50**	.19**	

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

Links Between Technology Use, Shyness, and Indices of Wellbeing

A primary goal of the present study was to address the interactive links between shyness and technology use in the prediction of indices of wellbeing. Specifically, the moderating role of texting in the relations between shyness and indices of wellbeing was of particular interest. To examine these relations, a series of hierarchical regression analyses was conducted. Separate equations were computed for each outcome variable (positive affect, negative affect, loneliness, social connectedness). For each equation, demographic (age and gender) variables and time spent alone were entered at Step 1 (as controls), centered main effect variables (shyness, social media - scrolling, social media – liking, texting, talking, video chat) were entered at Step 2, and conceptually relevant interaction effects (shyness x gender, shyness x texting, shyness x talking, shyness x video chat, shyness x social media - scrolling, shyness x social media - liking) were entered at Step 3. Analysis was performed using IBM SPSS REGRESSION Version 27 and EXPLORE for evaluation of assumptions.

Results for *positive affect* are displayed in Table 5. Overall, results indicated that about 4% of the variability is predicted by gender, age, and time alone. As a block, shyness, texting, talking, video chat, social media – scrolling, and social media – liking contributed significantly to that prediction. However, the interaction terms add no further prediction. Of note, at Step 2 (after controlling for demographic variables and time alone), shyness and social media - scrolling remained significantly and negatively associated with positive affect.

Results for *negative affect* are displayed in Table 6. Overall, results indicated that about 6% of the variability is predicted by gender, age, and time alone. As a block, shyness, texting, talking, video chat, social media – scrolling, and social media – liking contributed significantly to that prediction. However, the interaction terms add no further prediction. Of note, at Step 2

(after controlling for demographic variables and time alone), shyness and texting remained significantly and positively associated with negative affect.

Results for *loneliness* are displayed in Table 7. Overall, results indicated that about 5% of the variability is predicted by gender, age, and time alone. As a block, shyness, texting, talking, video chat, social media – scrolling, and social media – liking contributed significantly to that prediction. However, the interaction terms add no further prediction. Of note, at Step 2 (after controlling for demographic variables and time alone), shyness and texting remained significantly and positively associated with loneliness.

Finally, results for *social connectedness* are displayed in Table 8. Overall, results indicated that gender, age, and time alone did not significantly predict variability in social connectedness. As a block, shyness, texting, talking, video chat, social media – scrolling, and social media – liking contributed significantly to the prediction. However, the interaction terms add no further prediction. Of note, at Step 2 (after controlling for demographic variables and time alone), shyness was significantly and negatively associated with social connectedness.

Table 5***Technology Use, Shyness, & Positive Affect***

	<i>B</i>	<i>SE B</i>	β	F_{inc}	ΔR^2
Step 1				4.53	.035*
Gender	0.13	0.08	0.09		
Age	-0.07	0.07	-0.05		
Time Alone	-0.08**	0.02	-0.17**		
Step 2				12.78	.19**
Gender	0.01	0.07	0.01		
Age	-0.06	0.06	-0.05		
Time Alone	-0.05*	0.02	-0.11*		
Shyness	-0.52**	0.06	-0.42**		
Talk	0.05	0.05	0.05		
Video Chat	-0.04	0.04	-0.06		
Social Media (Scroll)	-0.07*	0.03	-0.13*		
Social Media (Like)	0.07	0.04	0.12		
Texting	-0.02	0.03	-0.06		
Step 3				.97	.014
Gender	-0.01	0.07	-0.01		
Age	-0.06	0.06	-0.04		
Time Alone	-0.05*	0.02	-0.11*		
Shyness	-0.47**	0.07	-0.38**		
Talk	0.04	0.05	0.05		
Video Chat	-0.04	0.04	-0.06		
Internet Use	0.04	0.03	0.07		
Social Media (Scroll)	-0.06	0.03	-0.1		
Social Media (Like)	0.06	0.04	0.1		
Texting	-0.03	0.03	-0.07		
Shyness x Texting	0.01	0.06	0.02		
Shyness x Talking	0.09	0.1	0.06		
Shyness x Video Chat	-0.03	0.08	-0.02		
Shyness x Gender	-0.19	0.14	-0.08		
Shyness x Scrolling	0.02	0.07	0.02		
Shyness x Liking	-0.03	0.08	-0.03		

Note. * $p < .05$; ** $p < .001$.

Table 6

Technology Use, Shyness, & Negative Affect

	<i>B</i>	<i>SE B</i>	β	F_{inc}	ΔR^2
Step 1				7.28	.056**
Gender	-0.18	0.09	-0.1		
Age	-0.27*	0.09	-0.16*		
Time Alone	0.07*	0.03	0.13*		
Step 2				16.84	.23**
Gender	0	0.08	0		
Age	-0.26**	0.08	-0.15**		
Time Alone	0.05	0.03	0.08		
Shyness	0.71**	0.07	0.46**		
Talk	-0.03	0.06	-0.03		
Video Chat	0.09	0.05	0.1		
Social Media (Scroll)	-0.03	0.04	-0.04		
Social Media (Like)	0	0.05	0		
Texting	0.09*	0.03	0.18*		
Step 3				1.11	.015
Gender	0.01	0.09	0		
Age	-0.24*	0.08	-0.15*		
Time Alone	0.06*	0.03	0.1*		
Shyness	0.77**	0.09	0.5**		
Talk	-0.04	0.06	-0.03		
Video Chat	0.1*	0.05	0.12*		
Internet Use	0.02	0.04	0.03		
Social Media (Scroll)	-0.03	0.04	-0.04		
Social Media (Like)	-0.01	0.05	-0.01		
Texting	0.1*	0.03	0.21*		
Shyness x Texting	0.02	0.07	0.02		
Shyness x Talking	-0.18	0.12	-0.08		
Shyness x Video Chat	0.11	0.09	0.07		
Shyness x Gender	-0.17	0.16	-0.06		
Shyness x Scrolling	-0.09	0.08	-0.08		
Shyness x Liking	0.09	0.09	0.07		

Note. * $p < .05$; ** $p < .001$.

Table 7***Technology Use, Shyness, & Loneliness***

		<i>B</i>	<i>SE B</i>	β	F_{inc}	ΔR^2
Step 1					5.94	.046**
	Gender	-0.16*	0.08	-0.1*		
	Age	-0.09	0.07	-0.07		
	Time Alone	0.09**	0.02	0.18**		
Step 2					33.40	.37**
	Gender	-0.02	0.06	-0.01		
	Age	-0.1	0.06	-0.07		
	Time Alone	0.04	0.02	0.08		
	Shyness	0.73**	0.05	0.58**		
	Talk	0.06	0.05	0.06		
	Video Chat	-0.07*	0.03	-0.1*		
	Social Media (Scroll)	0.04	0.03	0.07		
	Social Media (Like)	-0.09*	0.04	-0.14*		
	Texting	0.05*	0.02	0.13*		
Step 3					.90	.010
	Gender	-0.01	0.07	0		
	Age	-0.09	0.06	-0.07		
	Time Alone	0.04*	0.02	0.09*		
	Shyness	0.75**	0.06	0.59**		
	Talk	0.06	0.05	0.07		
	Video Chat	-0.07	0.04	-0.1		
	Internet Use	0.04	0.03	0.07		
	Social Media (Scroll)	0.04*	0.03	0.06*		
	Social Media (Like)	-0.08*	0.04	-0.13*		
	Texting	0.06	0.03	0.15		
	Shyness x Texting	-0.05	0.05	-0.07		
	Shyness x Talking	-0.09	0.09	-0.05		
	Shyness x Video Chat	0.06	0.07	0.04		
	Shyness x Gender	-0.07	0.12	-0.03		
	Shyness x Scrolling	-0.01	0.06	-0.01		
	Shyness x Liking	0.07	0.07	0.07		

Note. * $p < .05$; ** $p < .001$.

Table 8***Technology Use, Shyness, & Social Connectedness***

		<i>B</i>	<i>SE B</i>	β	F_{inc}	ΔR^2
Step 1					1.49	.012
	Gender	-0.02	0.12	-0.01		
	Age	-0.15	0.11	-0.07		
	Time Alone	0.06	0.04	0.08		
Step 2					4.52	.079**
	Gender	-0.07	0.12	-0.03		
	Age	-0.17	0.11	-0.08		
	Time Alone	0.09*	0.04	0.12*		
	Shyness	-0.45**	0.1	-0.23**		
	Talk	0.02	0.09	0.01		
	Video Chat	0.12	0.07	0.11		
	Social Media (Scroll)	0	0.06	0.01		
	Social Media (Like)	0.12	0.07	0.13		
	Texting	-0.06	0.05	-0.1		
Step 3					.96	.017
	Gender	-0.08	0.12	-0.04		
	Age	-0.17	0.11	-0.08		
	Time Alone	0.08*	0.04	0.11*		
	Shyness	-0.42**	0.12	-0.22**		
	Talk	0.03	0.09	0.02		
	Video Chat	0.1	0.07	0.09		
	Internet Use	-0.02	0.05	-0.02		
	Social Media (Scroll)	0	0.06	0		
	Social Media (Like)	0.14*	0.07	0.15*		
	Texting	-0.08	0.05	-0.12		
	Shyness x Texting	-0.02	0.09	-0.02		
	Shyness x Talking	0.28	0.17	0.1		
	Shyness x Video Chat	-0.16	0.13	-0.08		
	Shyness x Gender	-0.1	0.23	-0.03		
	Shyness x Scrolling	0.08	0.11	0.05		
	Shyness x Liking	-0.17	0.13	-0.11		

Note. * $p < .05$; ** $p < .001$.

Discussion

Adolescents are among the top users of the Internet (Vogels, 2019), with online relationships being central to adolescents' social lives (Helsper, 2008). Due to its potential to support and maintain relationships (Burke & Kraut, 2016), shy adolescents have been of particular interest (Chan, 2011). It has been suggested that the increased anonymity of online interactions may help facilitate relationship maintenance and formation for shy adolescents (McKenna & Bargh, 2000). This study extended on the previously limited research in this area (e.g., Chan, 2011; Brunet & Schmidt, 2007) by directly exploring the links between shyness and different types of technology use. As well, a conceptual model linking shyness, CMC, and indices of social-emotional functioning was explored.

Among the results, more shyness was associated with greater time spent alone, poorer perceptions of peer relationships (i.e., greater loneliness and lower social connectedness), emotional difficulties (i.e., high negative affect, low positive affect), and less frequent use of specific types of technology (i.e., video chat). Different types of technology were also differentially associated with indices of socio-emotional functioning (e.g., scrolling was positively related to loneliness, whereas video chat was negatively related to loneliness), but technology use was not found to significantly moderate links between shyness and outcome variables. Some gender differences were also found. Overall, these findings significantly contribute to the growing knowledge of how adolescents are impacted by the digital world, particularly in the context of shyness. In the following sections, each of these results are discussed in turn.

Implications of Shyness in Adolescence

Due to the increased expectations for peer interactions, adolescence is a key developmental period for exploring the implications of shyness. Despite this, shyness in adolescence remains somewhat understudied (Bowker et al., 2016). Results from the present study add to the growing recent literature linking shyness with negative outcomes (Baardstu et al., 2020; Borg & Willoughby, 2021; Bowker et al., 2021; Coplan et al., 2021; Zhao et al., 2018). Developing a deeper understanding of the intricacies of these associations is necessary to find solutions to minimize the deleterious impacts of shyness. Therefore, one aim of the present study was to determine the correlates of shyness.

Although it is widely accepted that individuals that are more shy spend more time alone, this assertion only recently gained empirical support (Coplan et al., 2021). In this regard, the present study adds foundational knowledge to the conceptualization of shyness. Supporting previous research by Coplan and colleagues (2021), shyness was found to be significantly positively related to self-reported time alone. Of note, spending time alone in adolescence is not an inherently negative experience. In fact, solitude appears to support developmentally significant tasks, such as identity formation (Goossens, 2014). As well, choosing to spend time alone is viewed as quite normative in adolescence (Wood et al., 2021). For adolescents who experience more shyness, however, time alone is considered to be a negative experience (Borg & Willoughby, 2021; Coplan et al., 2021). It has been suggested that this may be attributed to differences in motivations for solitude. For example, higher reactive solitude (solitude that results from negative affect or an external motivation) predicted depressive symptoms, peer victimization, and lower self-esteem (Borg & Willoughby, 2021).

In addition to a lack of intrinsically motivated alone time, shyness was also found to be strongly correlated with self-reported loneliness. This is in line with previous studies (e.g., Zhao et al., 2018), and raises further concerns about adolescents with higher levels of shyness' propensity to spend more time alone. This is especially true because shyness and loneliness are both strongly associated with more negative emotions and unsatisfactory social relationships (Jones et al., 1990; Baardstu et al., 2020). Moreover, in the present study it was found that shyness was also negatively associated with social connectedness, which may be a protective factor against loneliness and depressive symptoms in adolescents (Jose & Lim, 2014). The positive impacts of social connectedness are far reaching and include fostering positive mental health outcomes, development, lifestyle, and health behaviours, as well as protecting against various risk behaviours (Beam et al., 2002; DuBois & Silverthorn, 2005; Hawkins et al., 1999; Olsson et al., 2013; Zimmerman et al., 2002).

Consistent with previous studies, shyness was associated with greater negative affect and less positive affect (Coplan et al., 2013; Laghi et al., 2013). These findings add to the growing number of studies concurrently and predictively linking shyness with internalizing problems such as anxiety and depression (e.g., Baardstu et al., 2020). Although they were not measured directly, negative affect is a core component of anxiety (Rapee & Spence, 2004), and low positive affect can be an indicator of depression (Hayden et al., 2006). Taken together, these results do not bode particularly well for adolescents who experience more shyness, who appear to be prone to negative feelings regarding themselves and their social relationships.

Gender Effects

Gender differences in shyness are not typically found in younger children when using observations, parent ratings, or teacher reports to measure shyness (Doey et al., 2014). However,

results from several studies suggest that females self-report being more shy than males among older children and adolescents (e.g., Chang, 2004; Findlay et al., 2009; Vervoort et al., 2010). Therefore, it was not surprising that this gender difference emerged in the present study. Several different explanations for this gender difference have been posited.

For example, the onset of social anxiety is most common among adolescence (Grant et al., 2005), with females being more socially anxious than boys (Kendall et al., 2006; Ranta et al., 2007). Due to the conceptual overlap between shyness and social anxiety (e.g., Degnan & Fox, 2007; Rapee & Coplan, 2010), the gender difference in self-reports of shyness during this age period may reflect gender difference in social anxiety (Doey et al., 2014). Alternatively, boys may underreport shyness due to a reporting bias. For example, boys may be less likely to report feelings of shyness because it is considered less socially acceptable for boy than girls (e.g., Coplan et al., 2007). In essence, the reporting bias may reflect a societal-level bias in the appropriateness of shyness in girls and boys.

Despite the difference in self-reported shyness, the *interaction* between shyness and gender did not significantly predict outcomes (positive affect, negative affect, loneliness, social connectedness). This may be due, in part, to a bias in self-reporting. Specifically, the observed gender differences in shyness may not reflect a true difference between the genders. Furthermore, although it is expected that boys would be more negatively impacted by shyness due to violating gender norms (Coplan et al., 2007; Coplan & Weeks, 2009), there is also evidence to the contrary (Schwartz et al., 1999; Crick & Ladd, 1993).

Finally, the current study found that males spent more time alone than females. To date, there are no known studies that explore gender differences in time alone. Therefore, the conclusions made from these results are speculative. It was hypothesized that males would spend

more time alone as they place less importance on social relationships than females (e.g., LaFontana & Cillessen, 2010).

Shyness and Technology Use

Shyer individuals experience discomfort and distress during social interactions and therefore may search for communication mediums that have a lower presence of visual and auditory cues (Caplan, 2002; Henderson et al., 2001). Therefore, it was originally speculated that the anonymous nature of the Internet may allow individuals who experience greater shyness to regulate their social fears and distress (Karabacak & Oztunc, 2014). Specifically, it has been suggested that shy individuals may find comfort in passive/asynchronous forms of technology (Chan, 2011).

Contrary to expectations, there were no significant differences between more shy adolescents and their peers in passive technology use. In support of this finding, a recent meta-analysis suggested that there may be no association between shyness and passive social media use (Appel & Gnambs, 2019). The lack of evidence for a difference in passive use may reflect the pervasive use of this technology, which may be obscuring individual differences (Laghi et al., 2013).

Conversely, it was expected that shy adolescents would avoid active/synchronous forms of technology (Chan, 2011). It was hypothesized that these forms of technology will be avoided by shy adolescents because they have similar gating features that are present in FTF interactions. For example, there is the expectation of an immediate response (Chan, 2011) and the presence of evaluative cues (e.g., been seen or heard) that are particularly difficult for individuals that experience more shyness (see Crozier & Alden, 2005, for a review).

For this reason, it was surprising that adolescents who experienced more shyness did not text or talk less than their peers. Finding similar results, Madell and Muncer (2006) concluded that shyness did not encourage a greater use of communication tools, but also did not act as a barrier. In other words, the increased anonymity afforded by these mediums may allow adolescents that experience more shyness to minimize the communication differences seen in FTF interactions. Of note, adolescents did not commonly use the talking feature of their phones. To illustrate this point, 67% of teens used the talking feature less than 15 minutes a day. Due to the dominant lack of use, it may mask shy individuals' propensity to use this medium less (Laghi et al., 2013).

Results indicated that shyness, however, was significantly and negatively associated with the use of FTF CMC (i.e., video chat). This is consistent with previous literature suggesting that active/synchronous forms of technology are difficult for shy individuals (Crozier & Alden, 2005). Video chat may be particularly challenging for shy adolescents due to the high synchronicity and social presence of this medium, which creates a situation with similar features to FTF communication. Additionally, shy adolescents may find video chat stressful due to their sensitivity to verbal and non-verbal cues and socio-evaluative concerns (Jones et al., 1986; Eggum-Wilkens et al., 2015). Although theoretically this makes sense, there was no direct previous evidence that shy adolescents used this medium less than their peers. Therefore, the present study adds foundational knowledge on how shyness impacts technology use.

Technology Use Related to Outcomes

Technology use has villainized by the media and researchers alike (e.g., Kross et al., 2013). They report findings that suggest that technology use leads to poor mental health (Sampasa-Kanyinga & Lewis, 2015), loneliness (Skues et al., 2012), and has adverse impacts on

physical health (de Rezende et al., 2014). Although these results are compelling, they fail to account for the complexity of technology use. Therefore, current literature emphasizes the importance of looking at the impacts of different *types* of technology use on wellbeing (e.g., Shaw et al., 2015). Results of the present study add to the growing literature that screen time is not universally negative (e.g., Burke & Kraut, 2016).

Passive technology use has been consistently related to more negative outcomes (Burke et al., 2010; Frison & Eggermont, 2016; Qui et al., 2012; Verduyn et al., 2015). For example, passive technology has been associated with reduced levels of subjective wellbeing (Krasnova et al., 2013), feelings of disconnection, and loneliness (Amichai-Hamburger & Ben-Artzi, 2003). For this reason, it was unsurprising that social media - scrolling was significantly positively related to loneliness and negative affect in the present study. This finding, however, was not consistent across all types of passive technology use.

In the current study, social media - liking was significantly positively associated with negative affect and social connectedness. These seemingly contradictory findings may explain why researchers are unclear what to do with this category of technology use. Specifically, some researchers may characterize this type of use as active instead of passive use. For example, some researchers view active technology use as encompassing both targeted one-on-one exchanges (i.e., directed communication) as well as non-target exchanges (i.e., broadcasting; Burke et al., 2011). Therefore, posting status updates and sharing links may be considered active use (Verduyn et al., 2017). Furthermore, research found that posting status updates was related to increased feelings of social connectedness and reduced loneliness (Tobin et al., 2015). Alternatively, some research suggests that this type of use is related to envy and depression (Tandoc Jr. et al., 2014).

Active technology use, although related to more positive outcomes, varies in its impacts on wellbeing. It appears that the socio-emotional impacts of active technology use are dependent on synchronicity and social presence (e.g., Rettie, 2003). Together, these concepts suggest that those that engage in active technology use that has high synchronicity and high social presence will benefit more from active technology use. This may explain why the present study found that texting was significantly positively related to negative affect. Although considered an active form of technology use, texting is low in synchronicity and social presence. Therefore, adolescents may not experience the benefits of active technology via this medium.

Conversely, video chat was significantly negatively associated with loneliness and significantly positively related to social connectedness. In support of this finding, previous research found that the more a medium can elicit feelings of being together (high synchronicity and social presence), the more likely individuals were to report that the medium helped them achieve their social needs (Hwang & Lombard, 2006). It is important to note that directionality of this effect cannot be determined. For this reason, it is possible adolescents who are social connected use video chat more, or that people that use video chat more feel more socially connected.

Gender Effects

It was hypothesized that females would use active technology more than males, and that males would use passive technology more than females. This was expected as females tend to prioritize affiliative goals (e.g., Rose & Rudolph, 2006) more than males (e.g., LaFontana, 2009). Furthermore, previous research has found that females indicate more frequent use of both on- and off-line communication (Laghi et al., 2013). Researchers reasoned that this difference may reflect the greater interest of females in dyadic friendships (e.g., Benenson et al., 1997).

Additionally, Pierce (2009) found that females were more likely to use active forms of technology compared to males.

The present study found mixed results for active technology use. Specifically, although females texted more than males, no significant differences were found for talking or video chat. Similar findings were reported by Twenge and Martin (2020), who found that females texted more than males. They suggested that this may be due to the greater importance females place on social relationships (e.g., Flook, 2011; LaFontana & Cillessen, 2010). Additionally, girls have been shown to use the Internet more frequently to communicate than boys (Bonetti et al., 2010; Rideout et al., 2010). Of note, adolescents did not commonly use the talking or video chat features of their phone. To illustrate this point, 67% of teens used the talking feature less than 15 minutes a day, and 54% used the video chat feature less than 15 minutes a day. It is possible that the lack of variability in the use of both these mediums masked the individual differences between females and males.

With regards to passive technology use, results were also mixed. The results revealed that females spent more time on social media - liking. No gender differences emerged for social media - scrolling. Gender differences in social media - liking may be due to this mode of technology use fulfilling an affiliative function.

Shyness, Technology, and Socio-Emotional Functioning

One of the primary aims of this study was to examine potential moderating effects of different types of technology in the links between shyness and indices of socio-emotional functioning. However, no empirical support was found for this postulation. There were no significant interaction effects between shyness and different types of technology use in the prediction of positive affect, negative affect, loneliness, or social connectedness.

It is possible that these results represent a correct rejection of the null hypothesis. That is, technology really does not moderate the relation between shyness and outcomes variables. It may be that technology use impacts upon all adolescents' well-being in a similar manner – regardless of individual differences in shyness. This is supported by results indicating that both shyness and technology are linearly and uniquely associated with several indices of socio-emotional functioning.

However, it is also possible that technology does indeed moderate the relation between shyness and outcomes – but this study failed to detect this significant effect. Based on the Goldilocks Hypothesis it was expected that there is an optimal level of media synchronicity and social presence for shy adolescents. Specifically, texting was hypothesized to support feelings of connection (Cupples & Thompson, 2010) and lessen their feelings of anxiety (Brunet & Schmidt, 2007). There may be several reasons why significant interaction effects did not emerge – and these will be discussed in detail as study limitations and suggestions for future research.

Limitations, Future Directions, and Implications

The present study has uniquely contributed to the theoretical foundations of CMC use in adolescents who are more shy. Despite its strengths, there are some limitations that merit discussion. These are discussed here in the context of future research.

First, the cross-sectional nature of the study prevented the inference of causal relationships between the variables. For example, scrolling through social media was found to be related to both negative affect and loneliness – and this was interpreted as potentially suggesting that scrolling may cause adolescents to feel worse and lonelier. However, it is also possible that adolescents who feel lonely and sad are more likely to spend their time scrolling through social media. Or alternatively, a third variable, such as peer victimization, may lead to both negative

emotions/loneliness, as well as the tendency to spend more time scrolling. To address this limitation, a longitudinal research design should be considered. In addition to causality, this method would allow for an exploration of changes in shyness, technology use, and outcomes over time.

Another limitation of the present study was the use of self-reports to measure technology use. As technology has become so ingrained in our daily lives (Shaw et al., 2018), users may be unable to accurately reflect and report on their technology use. This makes using self-reports less than ideal (Andrews et al., 2015). For this reason, alternative methods should be considered. A more objective measure of total screen time and time spent using specific applications may be obtained using preprogrammed phone applications. In addition to providing a more accurate measure of screen time, this method would allow screen time to be measured as a continuous variable. This would negate the potential error introduced by requiring adolescents to pick a discrete category. For example, the present method forced adolescents who spent 30 minutes a day texting to choose between the category of “less than 15 minutes” and “1-2 hours”.

Measuring screen time as a continuous variable would increase both accuracy and variability in the data. Furthermore, the use of the Experience Sampling Method (ESM) and end-of-day diaries may add more accuracy (e.g., Brandstatter, 2007) and richness to the data. ESM would allow for an assessment of concurrent socio-emotional functioning, whereas daily diaries would be able to capture how technology impacted overall wellbeing at the end-of-day. There is some research suggesting that these two time points may reflect different outcomes, with concurrent use reflecting more positive outcomes (e.g., Thomas et al., 2021) and end-of-day reports (especially for passive use) reflecting more negative outcomes (e.g., Verduyn et al., 2015). It is possible that due to our retrospective weekly measurement that we are tapping into more long-term effects.

Another limitation of the present study was the restricted range of outcome variables assessed. Although it was certainly of interest to explore variables related to affect and perceived peer relations (loneliness, social connectedness), future studies should explore a wider range of relevant outcomes. These could include other aspects of peer relations (e.g., friendships, relationship quality and satisfaction), direct assessments of internalizing problems (e.g., anxiety, depression), aspects of the self-system (e.g., self-esteem, self-identity), and indices of wellbeing (e.g., happiness, life satisfactions).

Additionally, further research is warranted in conceptualizing online behaviours. As technology use patterns are constantly changing, future researchers should adapt measures of technology to include the insights from previous research. For example, in the present study, video chat was not endorsed by many participants. This may lead to a floor effect, which reduces variability in the data. Lack of variability in the data reduces accuracy and conclusions that can be drawn from the data. Therefore, future research should consider measuring this medium as a continuous variable to increase the variability in the data. Additionally, as the category of social media - liking found mixed results it may be necessary to separate this category into its component parts (i.e., statuses/photos, posting comments/statuses, sharing posts). By separating this category it is possible to determine exactly what behaviours lead to certain outcomes.

One of the advantages of studying technology use is that both naturalistic (as in the present study) and experimental data can be obtained. Furthermore, it is easy to manipulate technology use into its component parts. Previous studies, for example, have manipulated whether a participant saw the confederate via video chat or not while communicating online (Brunet & Schmidt, 2007). This also gives the added benefit of allowing researchers to analyze the *content* of communication. For instance, Brunet and Schmidt (2007) found that the presence

or absence of visual cues from a webcam influenced certain types of CMC (e.g., personal self-disclosure), but not other aspects of online communication (e.g., the amount of conversation) in relation to self-reported shyness. Additionally, other researchers have found that adolescents who experience more shyness expressed a greater proportion of their negative affect and experience online compared to their peers. It has been suggested that this may have negative consequences on their peer relationships (Laghi et al., 2013).

An intervention that may elucidate the interaction between shyness and technology use is Social Skill Training (SST). Some research argues that social skills may be a prerequisite to being able to use technology to communicate like their more social adept peers (Subrahmanyam et al., 2008). Through a randomized control trial, researchers could explore if an improvement in social skills leads adolescents who experience more shyness to use technology differently. It would be particularly interesting to note any changes in the amount of time using video chat as this seems to be challenging for them.

Another possible future direction is to look at using technology for exposure therapy for adolescents who experience shyness (Brunet & Schmidt, 2007). As it is possible to manipulate social interactions via technology to incorporate as many or as few components (i.e., visual, and auditory cues) it is possible to gradually expose them to experiences that they may find intimidating. For example, a possible hierarchy of exposure might be no webcam, microphone voice only cue; webcam face only cue; webcam face-voice cues. The social communication skills they learn here then may be able to be generalized to FTF interactions. Taken together, the implementation of these future directions will continue to advance the literature on the relation between shyness and technology use.

A common recommendation in managing technology use is the reduction of screen time (Thomas, 2019; Orben & Przybylski, 2019). In today's technology saturated world, reducing screen time may not be realistic or easy to implement. Furthermore, the present and previous research have indicated that screen time is complex, and that it is important to consider type of technology use, as not all use is negative (Przybylski & Weinstein, 2017). Therefore, it is essential to continue to explore how and why adolescents use technology, and its impacts on psycho-social outcomes (Shaw et al., 2018).

Since reducing screen time may be both difficult and ineffective, it is important to form more realistic recommendations for how to use technology in a way that supports development and socio-emotional wellbeing in an increasingly technological world (Laghi et al., 2013). In this regard, parents may be able to guide their adolescents to more healthy uses of technology. Previous research has indicated even though adolescents' social world shifts from parents to peers (Arnett, 2000), parents can play an integral role in helping support and guide their children with their online experience (Divecha, 2014). For adolescents who experience more shyness it may be helpful for their parents to teach them how to communicate online (e.g., not ostracized peers due to overly negative content; Laghi et al., 2013), and how to recognize problematic online behaviours as adolescents who experience more shyness are at a risk for this (Huan et al., 2014).

In conclusion, the present study contributes to a growing body of literature that elucidates the complex relation between shyness, technology use, and socio-emotional wellbeing.

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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 a 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).

Sincerely,

Robert Coplan, Ph.D.

Professor, Department of Psychology Carleton University

Appendix B: Parental Consent Form



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 child (under the age of 18 years) to participate in this study. This means you are willing to allow your child 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)

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

(signature of parent or guardian)

This form is to be completed and returned to the teacher of the Psychology/Anthropology/Sociology class ONLY if I consent to my child participating in this research.
(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:

Although risks are anticipated to be rare and minimal, you may experience distress as a result of answering questions about negative feelings. Trained graduate research assistants will be present at all times to assist you if you experience distress. 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.

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

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. _____

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 (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).

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.

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

Appendix G: Revised Cheek & Buss Shyness Scale

Please read each item carefully and decide to what extent it is characteristic of your feelings and behaviour.

1 = very uncharacteristic or untrue, strongly disagree

2 = uncharacteristic

3 = neutral

4 = characteristic

5 = very characteristic or true, strongly agree

- ___ 1. I feel tense when I'm with people I don't know well.
- ___ 2. I am socially somewhat awkward.
- ___ 3. I do **not** find it difficult to ask other people for information.
- ___ 4. I am often uncomfortable at parties and other social functions.
- ___ 5. When in a group of people, I have trouble thinking of the right things to talk about.
- ___ 6. It does **not** take me long to overcome my shyness in new situations.
- ___ 7. It is hard for me to act natural when I am meeting new people.
- ___ 8. I feel nervous when speaking to someone in authority.
- ___ 9. I have **no** doubts about my social competence.
- ___ 10. I have trouble looking someone right in the eye.
- ___ 11. I feel inhibited in social situations.
- ___ 12. I do **not** find it hard to talk to strangers.
- ___ 13. I am more shy with members of the opposite sex.

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

- 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.

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	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	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.

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
- _____ 2. Distressed
- _____ 3. Excited
- _____ 4. Upset
- _____ 5. Strong
- _____ 6. Guilty
- _____ 7. Scared
- _____ 8. Hostile
- _____ 9. Enthusiastic
- _____ 10. Proud

- _____ 11. Irritable
- _____ 12. Alert
- _____ 13. Ashamed
- _____ 14. Inspired
- _____ 15. Nervous
- _____ 16. Determined
- _____ 17. Attentive
- _____ 18. Jittery
- _____ 19. Active
- _____ 20. Afraid