ABSTRACT

Title of dissertation:	A COMPARISON OF ADOLESCENTS' IN-PERSON AND VIRTUAL PEER INTERACTIONS IN A MULTIPLAYER VIDEO GAME
	Kelly A. Smith, Doctor of Philosophy, 2020
Dissertation directed by:	Professor Kenneth Rubin Department of Human Development and Quantitative Methodology

Virtual peer interaction is prevalent among adolescents (Anderson & Jiang, 2018), but little is known about how adolescents' virtual interactions with peers compare to their in-person interactions. The present study aimed to compare adolescents' in-person and virtual interactions in a multiplayer video game during an initial interaction with an unfamiliar peer to examine differences in social behavior, physiological responding, and perceptions of interaction quality. The study also aimed to investigate how motivations for solitude related to interaction quality, and whether these associations differed across virtual and in-person interaction.

Participants were 72 adolescents (78% male, M_{age} = 12.49) from the Washington, DC metropolitan area who interacted with an unfamiliar peer in the lab using the multiplayer game Minecraft. Pairs of participants were randomly assigned to interact with one another in-person, sitting in the same room next to each other, or virtually, able to communicate using the text-based chat feature. Participants completed questionnaires about their motivations for solitude prior to the interaction. They also completed questionnaires about their self-perceptions and affect before and after the interaction, as well as their perceptions of the interaction quality after the interaction. Participants' social engagement and their social initiations and the partner's responses were observed

during the interaction, and their respiratory sinus arrhythmia was measured before, during, and after the interaction.

Results showed that quantity of social interaction was higher in the in-person condition, but perceived quality of the interaction was higher in the virtual condition. Participants spent more time communicating with one another and made more social initiations in the in-person condition. However, participants in the virtual condition received more successful responses to their social initiations and reported enjoying the interaction marginally more, feeling less passive and more assertive, and viewing themselves as more socially competent following the interaction. Participants' physiological responding did not differ across conditions. Shyness was related to less positive emotional responses to the interaction, particularly in the in-person condition, while other motivations for solitude were less consistently related to social difficulties. These findings suggest that virtual interaction can be an engaging context that facilitates high-quality interactions between unfamiliar peers, and it may be particularly helpful for shy adolescents.

A COMPARISON OF ADOLESCENTS' IN-PERSON AND VIRTUAL PEER

INTERACTIONS IN A MULTIPLAYER VIDEO GAME

By

Kelly A. Smith

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Dissertation Committee:
Professor Kenneth Rubin, Chair
Professor Julie Bowker
Professor Paul Hastings
Professor Dennis Kivlighan
Professor Allan Wigfield

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CHAPTER 1: INTRODUCTION

The Internet and its many platforms for virtual communication have become a key context for adolescent peer interactions. Approximately 89% of American adolescents between the ages of 13 and 17 years report using the Internet several times a day or more; 97% of adolescents report using at least one major social media platform, and 90% report playing video games (Anderson & Jiang, 2018). Despite the ubiquity of adolescents' use of the Internet for virtual communication with peers, researchers have yet to thoroughly investigate how virtual interactions compare to in-person interactions and whether virtual interaction has the potential to contribute to adolescents' social relationships and well-being. Thus, it is essential to explore how adolescents react to peers both socially and emotionally during virtual interaction, and to examine whether adolescents' personality characteristics may contribute to their behavior during interaction in virtual settings. Given the recent necessity of increased virtual interaction due to the COVID-19 pandemic, it is particularly timely to investigate how virtual interactions compares to in-person interaction for adolescents.

While researchers are in the early stages of investigating virtual interactions and their significance in adolescence, an immense body of research has demonstrated the central importance of face-to-face peer interactions and relationships for adolescents' well-being (see Rubin, Bukowski, & Bowker, 2015, for a review). Hinde (1987) conceptualized children's social worlds as comprising multiple levels of analysis which are distinct but dynamically related to one another: individuals, interactions, relationships, groups, and cultures. At the *individual* level, a person's traits, skills, and beliefs guide their social behavior and shape their social interactions. Characteristics

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such as age, gender, emotion regulation capacities, social-cognitive skills, and personality traits influence how children and adolescents communicate and engage with their peers (Rubin et al., 2015). For instance, highly empathic adolescents tend to display more prosocial behavior and less aggression toward peers (e.g., Carlo et al., 2012). Extraverted, gregarious adolescents seek out frequent social interaction and often act as leaders, directing and facilitating interactions with peers (e.g., Garcia, Aluja, & Del Barrio, 2006). Meanwhile, shy and anxious adolescents may refrain from peer interaction altogether (e.g., Coplan et al., 2013).

These individual traits contribute to peer *interactions* that have generally been studied in three major forms: *moving toward* peers by demonstrating cooperative and prosocial behaviors; *moving against* peers by displaying aggressive and antagonistic behaviors; and *moving away* from peers by withdrawing and avoiding peer interaction (Rubin et al., 2015). These patterns of interaction have important consequences for adolescents' formation of friendships with peers. Prosocial and cooperative behaviors are related to the formation of high-quality friendships characterized by warmth, strong social support, and low conflict (e.g., Markiewicz, Doyle, & Brendgen, 2001). Conversely, physically and relationally aggressive behaviors are associated with poor-quality friendships that are low in support and high in conflict (e.g., Cillessen, Jiang, West, & Laszkowski, 2005). Socially withdrawn behavior is similarly associated with poor friendship quality in terms of features such as less helping, intimacy, and enjoyment (e.g., Rubin, Wojslawowicz, Rose-Krasnor, Booth-LaForce, & Burgess, 2006).

In turn, friendships are robustly associated with social and emotional functioning in adolescence. Friendship quality is positively related to perceived social competence

and global self-worth, while it is negatively related to peer rejection and victimization, externalizing problems such as aggression, and internalizing problems such as anxiety and depressive symptoms (e.g., Raboteg-Saric & Sakic, 2014; Rubin et al., 2004; Waldrip, Malcolm, & Jensen-Campbell, 2008). In addition to their direct effects on well-being, high-quality friendships can moderate associations between socioemotional risk factors and emotional adjustment. For instance, high friendship quality has been shown to weaken associations of such constructs as lack of positive parenting, rejection sensitivity (a tendency to angrily or anxiously anticipate peer rejection), and peer victimization with internalizing symptoms (e.g., Gaertner, Fite, & Colder, 2010; McDonald, Bowker, Rubin, Laursen, & Duchene, 2010; Yeung Thompson & Leadbeater, 2013). The importance of adolescent friendships may even persist into adulthood, as Bagwell, Schmidt, Newcomb, and Bukowski (2001) showed that having a friend in fifth grade was associated with better family relationships, a more active social life, and fewer internalizing symptoms in early adulthood.

Given the importance of high-quality peer relationships for adolescent socioemotional well-being, it is essential to understand how the widespread use of virtual communication technologies may be affecting adolescents' peer interactions and the friendships that they form as a result. Furthermore, given the central role of individual traits and characteristics in social behaviors and interactions, it is vital to investigate whether dispositional traits manifest themselves in similar behaviors and to similar degrees in in-person and virtual interactions. One important context for examining virtual peer interactions for young adolescents is multiplayer video games, as multiplayer games such as Minecraft are very popular among young adolescents (Mavoa, Carter, & Gibbs,

2018). Thus, the present study had three major aims: (1) The first aim was to examine the extent to which virtual interaction differed from in-person interaction in terms of the quantity and quality of the social engagement that occurred therein during an initial interaction between unfamiliar peers in a multiplayer video game. (2) The second aim was to investigate how individual characteristics such as motivations for solitude were associated with observed social behaviors and perceptions of interaction quality during an initial interaction in the context of a multiplayer video game. (3) Finally, the third aim of the study was to analyze whether the strength of the associations between motivations for solitude and social behaviors, physiological responding, and interaction perceptions differed between in-person and virtual contexts.

In keeping with Hinde's (1987) conceptual model, the present study aimed to begin to shed light on how virtual interactions compare to in-person interactions in terms of both observed and participant-perceived interaction quality, as well as the role of individual characteristics in driving social behaviors in both in-person and virtual contexts during an initial interaction between unfamiliar peers in a multiplayer video game.

CHAPTER 2: LITERATURE REVIEW

Theoretical Background on the Role of Virtual Interactions in Adolescents' Well-Being

As virtual social interactions have become increasingly prevalent for both adolescents and adults, researchers have examined the extent to which virtual interaction differs from face-to-face interaction and why potential differences might arise. For example, Ahn (2011) argued that social technologies such as social networking sites (e.g., Facebook, YouTube) do not directly cause particular social or emotional experiences and outcomes. Rather, the technology serves to structure interactions between users based on the features it offers and the mechanisms for communicating with others (e.g., public comments, private messages, "likes"). Thereafter, the behaviors that users engage in within that communication platform may ultimately affect users' well-being. Thus, Ahn posited that virtual interaction may differ from face-to-face communication as a function of the interactive features offered by a particular platform, and that any associations between use of particular communicative technologies and individuals' well-being is mediated by users' behavior on that platform.

As a result of its distinct communication features, virtual communication may provide unique opportunities for peer interaction that benefit adolescents' social relationships. Valkenburg and Peter (2011), for example, posited that online communication may provide adolescents with an opportunity to interact with others in a context that allows them greater control over self-presentation and disclosure. They pointed out that text-based online communication lacks potentially difficult-to-control nonverbal social cues, such as facial expressions and posture, giving adolescents the

opportunity to carefully control the information conveyed to their virtual interaction partners. In addition, virtual interaction is often asynchronous and allows time to carefully craft a response, further increasing control over self-presentation and information shared. Virtual interaction also provides adolescents with a wide range of interaction partners to choose from, allowing them to select those with whom they feel most comfortable. Valkenburg and Peter argued that, as a result of these affordances of virtual communication, virtual media could give adolescents the opportunity to feel more at ease and in control of their social interactions, potentially enhancing the quality of their interactions with peers in the virtual context.

However, whether adolescents reap the potential benefits of these interactive technologies may depend on how they use them. In a review of the literature on Internet use and social and emotional outcomes, Valkenburg and Peter (2009) noted that early studies revealed negative associations between Internet use and social and emotional well-being. In more recent studies, however, researchers have generally reported *positive* associations between Internet use and social connectedness when the Internet is used to interact *with existing friends*. They proposed that the early negative findings reflected the fact that it was difficult to communicate with existing friends during the initial period when Internet access was relatively rare, and that more recent positive findings arise, in part, because most adolescents now have Internet access. Valkenburg and Peter posited that online communication may provide adolescents with the opportunity to strengthen their existing friendships because the reduced social cues available in the online environment facilitate lower self-consciousness and greater intimate self-disclosure that can strengthen friendship quality and ultimately improve well-being. However, they

cautioned that these positive effects only seemed to hold for adolescents who communicated virtually with existing friends. Thus, it remains unclear whether virtual interaction is beneficial for the development of new friendships.

The impact of virtual communication on social relationships and well-being likely also depends on adolescents' individual characteristics. Kraut and colleagues (2002) described two potential models for how individuals' traits and abilities might play a role in the outcomes they experience from virtual communication. In the "rich-get-richer" model, Kraut and colleagues argued that those with traits associated with face-to-face social success, such as sociability or extraversion, might benefit the most from virtual interaction because their social strengths would translate into the virtual domain and allow them to flourish in the same way that they succeed in their face-to-face social interactions. Meanwhile, those who struggle in face-to-face interactions may continue to struggle in the virtual medium because of their underdeveloped social skills.

Alternatively, Kraut and colleagues (2002) offered the "compensation" hypothesis, positing that individuals who struggle in face-to-face interactions might be able to use the Internet to seek out new interaction partners and build satisfying relationships that are lacking in their face-to-face social networks. In this model, those with strong face-to-face relationships could risk replacing their high-quality face-to-face friendships with weaker virtual relationships, which could prove detrimental for their social and emotional well-being. Kraut and colleagues concluded that their data supported the "rich-get-richer" model, and Valkenburg and Peter's (2009) review similarly concluded that most studies showed that virtual interaction primarily benefitted socially competent individuals with robust face-to-face social networks.

In contrast to these frameworks suggesting that virtual interaction functions largely similarly to face-to-face peer interaction, Nesi, Choukas-Bradley, and Prinstein (2018a) have argued that while there may be some continuity between in-person and virtual interactions, the virtual context fundamentally transforms the nature of peer interactions. They identified seven features of virtual social interaction that differ from face-to-face interaction and may affect adolescents' social behavior and peer experiences: asynchronicity, permanence, publicness, availability, cue absence, quantifiability, and visualness. Nesi and colleagues (2018a) suggested that the ease of virtual communication and increased access to interaction partners may alter the frequency of peer interaction. The more permanent, public records of interactions that are often available in social media, as well as increased expectations for constant availability for interaction, may intensify peer processes such as peer influence and expectations for public displays of friendship and support. The lack of social cues such as facial expression and tone and the asynchronous interactions that are typical on social media may alter the nature and quality of peer interactions on a virtual platform: some adolescents may perceive online interaction as less rich and lower-quality than in-person interactions, while others may find online interaction less stressful and immediate. Virtual interaction may facilitate behaviors that are possible but difficult in in-person contexts, such as seeking out like-minded peers on the Internet to overcome low-quality in-person relationships. Finally, the structure of online platforms may create the potential for entirely new social behaviors; for instance, highly visual platforms such as Instagram may enable adolescents to create a public persona in a new way, and the quantifiability of likes and followers on such platforms may restructure peer status in novel ways. Nesi

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and colleagues (2018b) detailed how these unique features of virtual interaction may influence all domains of peer interaction, including peer influence, social status, bullying and victimization, and close friendships.

Thus, Nesi and colleagues (2018a) identified a variety of ways in which virtual peer interaction may fundamentally alter peer relationship processes, particularly in terms of the possibility of increased quantity of peer contact and new social behaviors and expectations. However, they noted that the research on the quality of virtual peer interactions and the implications for adolescent adjustment remain inconclusive. Nesi and colleagues (2018a) emphasized that simply because virtual interaction is very different from in-person interaction does not imply that it is better or worse. Virtual interaction may provide new opportunities, such as greater availability of social support, while also having downsides such as decreased interaction quality or excessive expectations for constant social contact.

In summary, researchers have largely argued that virtual communication involves many of the same processes that govern face-to-face interactions, with a handful of potential differences based on the structure of the virtual interface. However, other researchers have pointed out unique features of virtual communication that may fundamentally alter the nature of adolescents' peer experiences in virtual contexts. In particular, virtual communication technologies may offer adolescents the opportunity to carefully control the social cues and messages that they send to peers, potentially emboldening them and facilitating greater self-disclosure. Nonetheless, virtual communication has been shown to primarily benefit well-being when it occurs with

existing face-to-face friends, and some research has suggested that those who are socially successful in face-to face contexts are the most successful in virtual interaction as well.

Developmental Considerations for Virtual Peer Interactions in Adolescence

During early adolescence, children begin to tackle several new developmental challenges, including seeking increased autonomy from parents, forming close and intimate peer relationships, and generating a coherent self-identity (Cicchetti & Rogosch, 2002). Adolescents spend more time with peers than younger children, and peers represent an increasingly central source of information and social support during adolescence as intimate self-disclosure increases and membership in friendship groups and crowds become a key part of adolescents' identities (Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006). Further, neurological studies have demonstrated that the presence of peers is related to more heightened activity in reward-related brain regions for adolescents compared to adults, suggesting that peer presence and potentially peer approval are uniquely salient during adolescence (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011). Thus, early adolescence is a period in which peer relationships play a particularly important role in adolescents' social and emotional functioning, and this centrality of peer experiences to adolescents' understanding of the social world and their place in it likely extends into virtual interaction. Given that virtual interaction is highly prevalent among adolescents, virtual interactions with peers are likely a significant context in which adolescents engage in the developmental challenges of forming close peer relationships and exploring their identities. As a result, virtual peer interaction may contribute to adolescents' overall adjustment more than for younger children or adults.

Adolescents' understanding of virtual interaction may also be shaped by the fact that they were likely exposed to mobile devices and virtual media at a very young age. A sizable majority of children begin using mobile devices before the age of 8 (Reid Chassiakos, Radesky, Christakis, Moreno, & Cross, 2016), and adolescents report that they frequently teach adults about new technologies, suggesting that adolescents may often learn about new technologies before adults do (Nelissen & Van den Bulck, 2018). Adolescents' greater familiarity with a variety of contexts for virtual peer interaction, including text messaging, social media, and multiplayer games, may affect their understanding of the role of virtual interaction in peer relationships. For instance, many adolescents report frequently instant messaging and communicating on social networking sites with face-to-face friends (Reich, Subrahmanyam, & Espinoza, 2012), suggesting that adolescents are highly accustomed to multimodal friendships that span both face-to-face and virtual contexts. Therefore, adolescents' greater comfort with new virtual interaction platforms and friendship formation and maintenance on the internet may make adolescents more comfortable with virtual interaction relative to adults.

Associations between Virtual Interactions and Well-being

Instant Messaging and Social Networking Site Use.

In a review of literature on social media and adolescent well-being, Best, Manktelow, and Taylor (2014) noted that studies have yielded mixed findings on associations between online communication and adolescent well-being. Some researchers have reported positive associations between use of online communication platforms and social and emotional adjustment. It is important to note, however, that much of the extant research has focused on a young adult population (e.g., college

students), and not children or adolescents. For instance, Oh, Ozkaya, and LaRose (2014) surveyed college students and adults and found that supportive interactions on social media were positively related to positive affect after social media use, which was in turn associated with perceived social support and life satisfaction. In a similar study, Grieve, Indian, Witteveen, Tolan, & Marrington (2013) surveyed adult Facebook users and found that perceived social connectedness on Facebook was positively associated with subjective well-being and negatively associated with anxiety and depressive symptoms. And Deters and Mehl (2013) found that college students assigned to post more often than usual on Facebook showed a decrease in loneliness during the time when they increased their Facebook posting, although their happiness and depressive symptoms did not change.

In a study of Dutch adolescents, Valkenburg and Peter (2007a) surveyed 10- to 17-year-olds and found a significant indirect effect of time spent using instant messaging on adolescents' life satisfaction. Time spent on instant messaging was positively associated with time spent with offline friends, which in turn was positively associated with friendship quality; in turn, friendship quality was positively associated with life satisfaction (Valkenburg & Peter, 2007a). Lee (2009) found that parent-reported quality of their children's social relationships positively predicted child-reported time spent using online communication 5 years later, when children were aged 12 to 18. The researchers also indicated that parent-reported young adolescent internalizing problems did not predict later online communication. The frequency of online communication was positively and concurrently related to child-reported friendship quality, such that online communication partially mediated the association between earlier relationship quality

with peers and adults and later friendship quality (Lee, 2009). Ackerman and colleagues (2019) showed a similar association between warmth in interaction with parents and friends in middle childhood and lower levels of negative affect and deception in text messages with friends in adolescence. Likewise, Blais, Craig, Pepler, and Connolly (2008) conducted a longitudinal study and found that 14- to 18-year-old adolescents' use of instant messaging positively predicted facets of friendship quality including trust, intimacy, and companionship one year later.

However, some researchers have not found an association between online social interactions and social or emotional well-being, or have found mixed associations. For instance, Pollet, Roberts, and Dunbar (2011) surveyed adults and found that those who used social networking sites or instant messaging did not differ from those who did not use these media in the size of their offline social networks. The size of participants' online social networks was non-significantly correlated with the size of their offline social networks, and there was no difference between those who used social networking sites or instant messaging and those who did not on perceived closeness to offline social network members. Gross (2004) surveyed 7th- and 10th-graders and found that adolescents' most frequent online activity was instant messaging, typically with in-person friends. Time spent online was not associated with depressive symptoms, social anxiety, loneliness, or life satisfaction. Similarly, Subrahmanyam and Lin (2007) surveyed 12- to 17-year-olds and found that time spent online or on email was not associated with loneliness, perceived support from parents, or perceived support from friends. In a study of Belgian high schoolers, Frison and Eggermont (2016) found that associations between Facebook use and depressed mood varied by gender and type of Facebook activity. For

girls, communicating via private messages to friends and posting public updates were positively related to perceived online social support, which in turn was negatively associated with depressive symptoms. Time spent simply looking at others' posts and profiles, however, was positively associated with depressive symptoms for girls. Among boys, posting public updates was positively associated with both perceived online social support and depressive symptoms (Frison & Eggermont, 2016).

A few researchers have suggested that virtual interactions may relate to psychological *maladjustment*. For instance, Kross and colleagues (2013) conducted a short-term longitudinal study of young adults and found that greater Facebook use predicted *decreases* in perceived well-being over time. Tobin, Vanman, Verreynne, and Saeri (2015) found that adults randomly assigned to refrain from posting on social networking sites or to not receive any responses to their posts reported lower feelings of social belonging than those who posted normally and received responses from others, suggesting that feeling sidelined or ignored on social networking sites may relate negatively to socioemotional well-being. Wolak, Mitchell, and Finkelhor (2003) surveyed adolescents aged 10 to 17 and showed that girls who reported close online relationships reported high levels of conflict with parents, depression, victimization, and negative life events. Boys with close online relationships reported low levels of communication with parents and high levels of depression, victimization, and negative life events. Adolescents with problems such as high conflict with parents, depression, victimization, or negative life events were more likely to form romantic relationships online and to meet online friends in person (Wolak et al., 2003). Likewise, Ybarra, Alexander, and Mitchell (2005) surveyed adolescents aged 10 to 17 and found that adolescents reporting

depressive symptomology used the internet significantly more hours per day than

adolescents with fewer depressive symptoms and were more likely to report primarily

using the internet for chat rooms or email. Tsitsika and colleagues (2014) surveyed 14-

to 17-year-old European adolescents about their use of online communication

technologies and found that adolescents who reported particularly heavy use of social

networking sites reported lower levels of academic performance and competence in

extracurricular activities than moderate users of social networking sites. Heavy use of

networking sites also related to heightened internalizing symptoms compared to moderate

use, particularly among younger adolescents. Similarly, Nesi and Prinstein (2018)

surveyed adolescents and found that peer-reported online status-seeking positively

predicted substance use and number of sexual partners one year later, and Nesi, Miller,

and Prinstein (2017) showed that adolescents' depressive symptoms predicted increases

in the use of social media for social comparison over time.

In summary, there is no clear pattern of associations between social media use and

well-being among either adults or adolescents. Associations between use of social

networking sites and psychological and social functioning seem to depend on a variety of

factors, including whether one communicates with existing friends or seeks out new

friends online, what forms of communication are used (e.g., private messages, public

posts), the quality of the responses from friends, and the extent to which one engages in

social comparison. It appears that online communication may relate to friendship quality

and emotional well-being in some cases and to psychological maladjustment in other

cases, but there is little consistency across studies in terms of which conditions facilitate

positive versus negative outcomes.

Video game use.

       While many studies of virtual communication have focused on social networking sites, a few researchers have examined engagement in multiplayer video games. As with social networking site use, the results have been mixed. For example, Lo, Wang, and Fang (2005) surveyed Taiwanese college students and found that frequent online game players reported lower-quality interpersonal relationships and more social anxiety symptoms than infrequent players or non-players. In an experimental study, Smyth (2007) randomly assigned college students to play solo video games or massively multiplayer online role-playing games (MMORPGs; online games in which players create a virtual avatar in a virtual world where it is possible to communicate with large numbers of other players) and found that participants assigned to play MMORPGs reported greater interference of the game in their in-person social lives but more online friendships. MMORPG players did not report any overall differences in the quality of their social lives or their well-being compared to players of single-player games (Smyth, 2007). Kirby, Jones, and Copello (2014) surveyed adult players of MMORPGs and found a negative association between hours spent playing online multiplayer games and psychological well-being that was mediated by problematic game use and a desire to distract oneself from real-life problems. Dupuis and Ramsey (2011), however, surveyed players of MMORPGs and found that engagement in multiplayer online games was not associated with perceived social support from friends.

       Importantly, all the studies described above involved *adult* participants. Carras and colleagues (2017) surveyed a large sample of Dutch *adolescents* aged 13 to 16 and found that those who used the Internet at very high levels reported more depressive

symptoms than those who used the Internet less, and boys who used the Internet predominantly to socialize via instant messaging or social networking sites reported fewer depressive symptoms than those who predominantly played video games. Boys with high-quality friendships with online and offline friends were more likely to play video games extensively and show some signs of problematic video game use, while those with low-quality offline friendships but high-quality online friendships generally reported very high levels of problematic gaming symptoms such as playing video games so much that it interfered with their daily functioning. Girls with high-quality friendships online and offline were more likely to use the Internet extensively for both socializing and playing video games (Carras et al., 2017). In a similar study, Kowert, Domahidi, Festl, and Quandt (2014) surveyed German adolescents and found that time spent playing online multiplayer video games was negatively associated with the number of trusted friends and level of perceived social support that participants reported; time spent playing video games with friends face-to-face was not associated with the number of friends or quality of social support. In summary, the existing research on both general use of virtual communication and on engagement in video games specifically remains inconclusive on how the use of these media may be related to psychosocial adjustment, both in early adulthood and adolescence. Significantly, however, the extant relevant research on adolescents is sparse.

Friendship Formation via Virtual Interactions

In addition to examining how virtual interaction relates to adjustment, researchers have also investigated whether adolescents use the Internet to form new friendships, and how the content and quality of those friendships compares to face-to-face peer

relationships. Several researchers have shown that the majority of individuals with whom adolescents interact on the Internet are individuals who they know from face-to-face interactions (Reich et al., 2012; Subrahmanyam, Reich, Waechter, & Espinoza, 2008), and adolescents often use virtual communication such as texting to seek social support and increase emotional intimacy within their friendships (Ehrenreich, Beron, Burnell, Meter, & Underwood, 2020). Nonetheless, many adolescents and adults also report interacting with strangers and forming friendships using virtual communication. For example, Cole and Griffiths (2007) surveyed adolescent and adult players of MMORPGs and found that approximately 75% of male and female players had formed close friendships while playing games, reporting an average of seven close friends. Fifty-five percent of female players and 38% of male players had spent time with online friends in person, while 46% of respondents considered their online friendships comparable to their in-person friendships and 39% of players reported discussing sensitive topics with their online friends that they would not discuss with in-person friends.

Subrahmanyam and Lin (2007) surveyed adolescents aged 12 to 18 and found that approximately 27% of adolescents reported that someone they met online had become a close friend. Similarly, Wolak, Mitchell, and Finkelhor (2002) interviewed 10- to 17-year-old adolescents and found that 55% of respondents had interacted with someone online that they did not know in person, while 17% had formed a close online relationship. After meeting online, 41% of adolescents reported that they had met in person with their online friend. However, relevant to the proposed investigation, online friendships may differ in quality from face-to-face friendships; for example, Mesch and

Talmud (2006) interviewed Israeli adolescents aged 13 to 18 and found that the average friendship quality, duration of friendship, and number of conversation topics was lower with friends who met online compared to friends who met in person. In a similar, more recent study, Nesi, Widman, Choukas-Bradley, and Prinstein (2017) found that adolescents who communicated with their romantic partner predominantly through virtual means tended to report lower levels of assertiveness one year later.

To compare the process of relationship development online and in-person, McKenna, Green, and Gleason (2002) assigned college students to interact initially either in person or via an Internet chat room, and then interact with the same partner again in person. After the second interaction, participants who had originally interacted online reported liking their partners better than those who had interacted exclusively face-to-face. Among participants who initially interacted online, ratings of conversation quality were positively associated with the liking of the conversation partner, whereas ratings of conversation quality were unrelated to liking among participants who first interacted face-to-face. McKenna and colleagues suggested that this pattern may have arisen because superficial cues such as physical appearance dominated perceptions of the partner in initial face-to-face interactions, whereas virtual interaction stripped away those visual cues and allowed participants to focus on relevant features of the interaction itself when assessing the partner.

Sacco and Ismail (2014) similarly assigned college students to interact in-person, interact through instant messaging, or not interact with a partner and found that participants who interacted virtually reported less positive mood, less enjoyment of the interaction, and less interest in communicating with the partner again than participants

who interacted face-to-face, although participants reported more anxiety in the face-to-face interaction condition than the virtual condition. Nonetheless, virtual interaction seemed to provide some benefit over no interaction, as participants in both the face-to-face and virtual interaction conditions reported less negative mood than participants who engaged in no social interaction.

In a similar study, Sprecher (2014) assigned dyads of college students to conduct a brief initial interaction using either text-based chat, audio chat, video chat, or face-to-face interaction. Then, each dyad engaged in a longer interaction via video chat. After the initial interaction, dyads who interacted via text-based chat rated their perceived closeness to the conversation partner as significantly lower than participants in any other condition, and they rated their partner's responsiveness lower than participants who interacted face-to-face. After the second interaction, perceptions of the quality of the interaction or attitudes toward the conversation partner did not differ based on the modality of the initial interaction. In a follow-up study, Sprecher and Hampton (2017) assigned college students to interact under different conditions. Pairs of participants interacted three times: in the face-to-face condition, these interactions all took place in person, while in the computer-mediated communication condition, participants interacted first via text-based chat, then by video chat, then in person. After the first interaction period, participants who had interacted via text-based chat reported less closeness to, and liking of, the interaction partner than those who interacted in person, although the groups did not differ on perceptions of awkwardness. The groups did not differ on their ratings of enjoyment and closeness after the second or third interaction sessions, though, suggesting that participants in the computer-mediated communication condition

overcame the initial deficits in interaction quality as they interacted via video chat and in person.

In summary, these experimental studies suggest that virtual interactions may be of lower quality and result in less perceived closeness to interaction partners than face-to-face interactions. However, it is important to note that all of these studies were conducted with adult participants. It does not appear that any experimental studies have been conducted to compare the in-person and virtual interactions of adolescents.

Physiological Processing of Virtual Interactions

While examining behaviors and self-reported perceptions of virtual interactions helps to illuminate important aspects of social interaction and emotional reactions in virtual contexts, physiological reactions to virtual interactions provide a useful, objective indicator of how adolescents perceive and process virtual interaction on a biological level. Physiological responses to virtual interactions may provide important clues about the extent to which adolescents perceive virtual peer interactions as engaging or threatening. Yet, relatively little is known about physiological responding during virtual interaction.

Respiratory sinus arrhythmia (RSA) is a widely-used psychophysiological measure of the functioning of the parasympathetic nervous system, as it measures parasympathetic control of heart rate via the vagus nerve (Porges, 2007). *Baseline* RSA has been identified as an important marker of physiological emotion regulation capacity, the ability to regulate physiological responses to emotion-provoking stimuli and to maintain homeostasis (Porges, 2011). In addition, dynamic *changes* in RSA can illuminate how an individual perceives a stimulus. Perceived threats result in RSA

suppression, or a decrease in RSA as the parasympathetic nervous system withdraws its slowing influence on heart rate and prepares the body for fight or flight. In contrast, perceived social stimuli that are non-threatening result in RSA *augmentation*, an increase in RSA reflecting the strengthening of parasympathetic control to prepare the individual for social engagement (Porges, 2007). Thus, changes in RSA are thought to demonstrate the extent to which individuals perceive a situation as a threat or an opportunity for social interaction.

Although research on RSA and virtual social interaction is still in its early stages, some researchers have found that RSA will decrease in response to virtual social stressors. For example, Mauss, Wilhelm, and Gross (2003) found that adult participants' RSA decreased in response to a social stress task in which participants were videotaped making a public speech to be judged later by expert judges, indicating that they perceived this indirect social evaluation as threatening. Yet, participants with low versus high social anxiety did not differ on the magnitude of RSA suppression, showing no difference in perceiving the social stress task as threatening.

Owens and Beidel (2015) had adults complete a similar social stress task in which they were asked to give a speech to a physically present audience and to a simulated audience in virtual reality. They found that RSA decreased similarly across both settings and did not differ based on participants' social anxiety, suggesting that all participants showed physiological signs of perceiving both the in-person and the virtual tasks as a threat. Murray-Close (2011) examined adults' RSA change during a virtual rejection paradigm in which participants play a ball-passing game (Cyberball) with virtual avatars who refuse to pass the ball to the participant; RSA decreased during this rejection task,

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demonstrating that the virtual rejection was perceived as socially threatening. Furthermore, in a study designed to compare RSA responses to in-person and computer-mediated stressors, Rigoni, Morganti, and Braibanti (2017) randomly assigned adults to complete a stressful arithmetic task while either interacting face-to-face with an experimenter or receiving instructions from a computerized voice. Participants' RSA suppression during the stressful task did not differ depending on whether participants interacted with a live person or a computerized voice, suggesting similar physiological threat responses in both face-to-face and computer-based scenarios.

In a similar study with adolescents, Erath and Tu (2014) told a sample of fifth- and sixth-graders that they would be evaluated by peers watching via video chat as they completed a conversation task with a research assistant. The supposed peer judges then told the participant via chat message that they had evaluated the participant's performance poorly, simulating virtual peer rejection. Approximately half of participants demonstrated RSA suppression in response to this simulated virtual peer rejection, while the other half showed RSA augmentation. Thus, half of participants reacted to this virtual rejection as threatening, while the other half reacted as though it were a non-threatening social interaction opportunity. Erath and Tu also showed that greater RSA suppression (showing a stronger physiological response to virtual rejection as a threat) was positively related to teacher-reported social competence. This pattern potentially suggests that flexible RSA responding (i.e., appropriately suppressing RSA in response to relevant social threats) may be adaptive for adolescents' social engagement. Hadley and colleagues (2014) found that 12- to 16-year-old adolescents showed a decrease in RSA (indicating perceiving the situation as a threat) in response to a virtual reality simulation

of a party with peers in which participants were offered alcohol and drugs. This finding is notable because participants might be expected to perceive a party situation as a social interaction opportunity and show RSA augmentation, but the substance use features of the party simulation may explain why participants perceived it as potentially threatening.

In summary, there is some evidence that RSA change in response to virtual social interaction may operate similarly to face-to-face interaction, at least in the context of social stressors. It is less clear, however, whether adolescents demonstrate RSA augmentation in response to positive virtual social interactions, showing physiological signs of perceiving virtual interaction as an important opportunity for social engagement. Further, there is some evidence that individual differences in features such as social anxiety may not play a significant role in this form of physiological responding, although the existing studies have been conducted with adults.   Additional research should be conducted to examine how other individual characteristics relate to RSA responding. For example, researchers have yet to thoroughly examine how adolescents' dispositional characteristics relate to RSA responding to virtual interactions.

Motivations for Solitude and Virtual Interactions

Motivations for seeking solitude are another potentially important constellation of individual attributes related to social behavior and peer interaction. Rubin, Coplan, and Bowker (2009) described three major motivations for withdrawing from social interactions: *shyness*, which describes fear and anxiety in social situations and instances of perceived social evaluation; *unsociability*, which refers to a non-fearful lack of desire to seek out peer interaction; and *social avoidance*, which encompasses an active desire to stay away from peers. All of these motivations for solitude have been linked to

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adolescents' peer difficulties with in-person peers, although shyness and avoidance seem more consistently linked to maladjustment than unsociability and the strength of associations varies based on participants' age and the cultural contexts in which they live (e.g., Bowker & Raja, 2011; Liu et al., 2015; Nelson, 2013; Ojanen, Findley-Van Nostrand, Bowker, & Markovic, 2017; Wang, Rubin, Laursen, Booth-LaForce, & Rose-Krasnor, 2013). Another process that may motivate adolescents to withdraw from peer interactions is perceived rejection by peers. Low peer acceptance and peer rejection have been linked to increases in anxious rejection sensitivity over time, which in turn predicts higher levels of social withdrawal (London, Downey, Bonica, & Paltin, 2007; Marston, Hare, & Allen, 2010; McLachlan, Zimmer-Gembeck, & McGregor, 2010; Wang, McDonald, Rubin, & Laursen, 2012). Thus, perceived peer rejection may motivate adolescents to spend time alone rather than with peers because their experiences of rejection lead them to anticipate further rejection. Few researchers have examined how motivations that purportedly underlie the expression of solitary behavior may function in virtual contexts – contexts that may be less proximal and, therefore, less threatening to those with social fears or avoidance motivations.

Several researchers have examined social anxiety, which shares a meaningful conceptual overlap with shyness, as a correlate of virtual social interaction. For instance, McKenna and colleagues (2002) surveyed adolescents and adults who posted in online forums and found that social anxiety was positively associated with greater comfort disclosing personal information online than in person. In turn, self-disclosing more often in online communication was positively associated with the speed of developing online relationships, the closeness of those online relationships, and the frequency of

communication with online friends using more proximal forms of communication such as talking on the phone or meeting in person. Indian and Grieve (2014) similarly found that highly socially anxious adults perceived less social support in in-person contexts than adults low on social anxiety, but the social anxiety groups did not differ on perceived social support on Facebook. While perceived in-person social support was the strongest predictor of subjective well-being for the low social anxiety group, perceived social support on Facebook was the strongest predictor of well-being for those with high social anxiety, suggesting that online social support was particularly key to psychological functioning for socially anxious adults (Indian & Grieve, 2014). Valkenburg and Peter (2007b) surveyed Dutch adolescents aged 10 to 16 and showed that social anxiety was associated with perceiving online communication as particularly valuable for discussing many different topics and engaging in intimate self-disclosure, although it was also negatively associated with the amount of online communication. In contrast, Bonetti, Campbell, and Gilmore (2010) surveyed 10- to 16-year-old Australian adolescents and found that those with high social anxiety did not differ from adolescents low on social anxiety on the quantity of online communication or motivations for online interactions. And Laghi and colleagues (2013) showed that disinhibition in virtual settings may be a setback in some cases for shy adolescents, as they surveyed adolescents aged 10 to 18 and found that shy adolescents reported expressing more negative emotion to friends and experiencing more negative peer interactions during online communication compared to non-shy controls.

In the most extensive study to date on motivations for solitude and virtual interaction, Nelson, Coyne, Howard, and Clifford (2016) surveyed young adults and

found that participants high in shyness, unsociability, or avoidance spent more hours using email than non-withdrawn controls, and that avoidant participants played more video games. Avoidance was negatively associated with use of email or social networking sites. Thus, the existing research suggests that shy adolescents may feel more comfortable communicating with peers online rather than in person and may disclose feelings and information more easily, but this greater disclosure may not always be advantageous. Unsociability and avoidance have not been extensively studied in the virtual context to date, although avoidance may be associated with less online communication. Furthermore, and most compelling, the few existing studies on motivations for solitude and virtual interaction have utilized self-reports of social behavior rather than direct observations of social behaviors in virtual and in-person settings.

The Current Study

The existing research literature suggests that virtual interactions are linked to social and emotional adjustment, and that they may provide opportunities for developing and strengthening relationships with others. It also appears as if dispositional characteristics may play a role in how individuals interact in virtual contexts. However, most studies of virtual interactions have examined the use of platforms such as social media or texting, rather than a more synchronous virtual context such as a multiplayer video game. In addition, the few experimental studies that have directly compared in-person and virtual interactions have involved college students; in those studies, the researchers did not examine whether motivations for solitude are associated with social behavior in each context. Further, researchers, to date, have not directly examined

physiological responses to in-person and virtual social interaction with peers. Most importantly, very few studies of virtual interaction have involved young adolescent participants, who may differ from adults in terms of the salience of peer relationships to their social and emotional well-being and their comfort using virtual technology.

The present study addressed the issues raised above by comparing *adolescents'* in-person and virtual interactions during an initial interaction with an unfamiliar peer in the context of a multiplayer video game. The first aim of the proposed study was to examine whether adolescents' in-person and virtual interactions differed in terms of (a) the quantity and quality of social interaction; (b) physiological responses to social engagement; and (c) the participants' perceptions of the quality of the interaction.

I hypothesized the following with regard to Aim 1:

1a. Participants would spend more time interacting with one another in the in-person than the virtual condition.

1b. Participants would initiate more social interactions and receive more successful responses to social initiations in the in-person condition than the virtual condition.

1c. Participants' RSA would augment more strongly in the in-person condition than in the virtual condition, thus demonstrating that participants reacted to in-person interaction as a more stimulating social context that virtual interaction.

1d. Participants would enjoy the interaction more and perceive the interaction as higher-quality in the in-person condition.

1e. Participants' emotions and perceived social competence would change more from pre-interaction to post-interaction in the in-person condition than in the

virtual condition, such that in-person interaction has a greater effect on participants' mood and self-perceptions.

Aim 2 of the study was to investigate how motivations for solitude related to adolescents' social behavior in the context of a multiplayer video game across both in-person and virtual interaction. I hypothesized the following:

2a. Shyness, avoidance, and perceived peer rejection would be associated with fewer responses to the partner's social initiations. As suggested by prior research (e.g., Bowker & Raja, 2011), I expected that unsociability may not relate as strongly to this asocial behavior as other motivations for solitude.

2b. Shyness, avoidance, and perceived peer rejection would be related to RSA suppression during the interaction rather than augmentation – that is, adolescents high on these particular motivations for solitude would show physiological signs of perceiving social interactions with novel peers as threatening rather than engaging. However, unsociability would not show this pattern of association with RSA suppression.

2c. Participants' shyness and avoidance would relate negatively to their own and their partner's enjoyment of the interaction. Unsociability might also relate negatively to enjoyment of the interaction, as those who prefer to be alone may not value social interaction as much as those who are highly sociable. However, I expected that unsociability may not be related to discomfort during the interaction, in accordance with prior research suggesting that unsociability is less consistently related to social and emotional difficulties than the other motivations for solitude (e.g., Ojanen et al., 2017).

Aim 3 of the study was to examine whether the experimental condition moderated associations between individual dispositions and social behavior. I hypothesized that the associations between motivations for solitude and social behavior hypothesized for Aim 2 would be stronger in the virtual condition than in the in-person condition. Although this prediction contrasts with a few studies suggesting that personality is displayed less clearly in such virtual media as social networking sites, virtual interaction may be driven more heavily by individual traits because external social cues are weaker. For instance, a shy adolescent may feel anxious about engaging with the partner but will respond when an in-person partner speaks to her or him so as not to appear rude. In the virtual condition, the shy adolescent may feel more comfortable ignoring the partner because the partner is not present, so the demand for a response is not as immediate. Given the lack of a physically present partner to respond to, adolescents' internal dispositions may guide their behavior more strongly. Furthermore, condition may moderate associations between RSA reactivity and motivations for solitude. In particular, adolescents high in shyness, avoidance, or perceived peer rejection may suppress RSA less in the virtual condition than in the in-person condition because the virtual interaction feels less immediate and potentially threatening. Similarly, adolescents high in shyness, avoidance, or perceived peer rejection may enjoy the interaction more and perceive the interaction more positively in the virtual condition because they find the virtual interaction less stressful. Unsociability may not show this pattern, because unsociable adolescents may not find either in-person or virtual interaction threatening or stressful.

CHAPTER 3: METHOD

Participants

A sample of 72 adolescents (77.8% male) was recruited from the Washington, D.C. metropolitan area. Participants ranged in age from 11 to 14 years (M_{age} =12.49 years) and were entering or enrolled in 7th or 8th grade. To be included in the study, participants must have never been diagnosed with an Autism Spectrum Disorder or a delay or disability in reading or writing. 58% of participants identified as White, 25% identified as African American, 19% identified as Asian, 7% identified as Latinx, 3% identified as American Indian or Alaska Native, and 10% identified as other (percentages sum to more than 100% because participants could identify as more than one ethnicity). All participants had played the game Minecraft before: parents' estimates of the maximum number of hours that participants had ever played Minecraft in a week ranged from 0.5 hours to 128 hours. On average, participants had played a maximum of 18.1 hours of Minecraft in a week. Participants rated their knowledge and skill at Minecraft; on average, participants rated themselves a 5.86 on a 7-point scale in terms of Minecraft knowledge and a 5.37 out of 7 in terms of Minecraft skill, with a range of 3 to 7 for both scales.

Procedure

Flyers advertising the study were posted in the Washington, D.C. metropolitan area in such venues as schools, community centers, and pediatricians' offices. Information about the study was also sent to local email listservs in order to recruit participants.

Eligible adolescents were paired with another adolescent, and both adolescents were invited to the *Laboratory for the Study of Child and Family Relationships* at the University of Maryland – College Park. Adolescents were paired with an adolescent from a different school and/or summer camp to minimize the chances of the participants being familiar with one another prior to the interaction in the laboratory. All participants reported being unfamiliar with their partner prior to the interaction. Participants were paired with an adolescent of the same gender in order to control for potential differences between same-gender and opposite-gender interactions (e.g., Lempers & Clark-Lempers, 1993).

Parents were asked to indicate whether their child had ever played Minecraft, how many hours per week their child currently played Minecraft, and the maximum number of hours per week that the child had ever played Minecraft. Adolescents were paired with an adolescent with a similar level of lifetime experience with Minecraft to minimize the influence of experience with the game on participants' interactions. Participants who had played fewer than 30 hours per week were paired with a partner whose lifetime maximum of Minecraft play was within 6 hours of theirs. For example, an adolescent with lifetime Minecraft experience of 10 hours per week could be paired with someone with between 4 and 16 lifetime Minecraft hours. Participants who had played 30 or more hours per week were paired with another participant who had played more than 30 hours per week.

Upon arriving in the lab, parents and adolescents signed consent and assent forms, respectively. Then, each adolescent's parent was asked to complete a brief demographics form. Each adolescent was brought into a separate room and simultaneously asked to complete some initial online questionnaires about their shyness, unsociability, social

avoidance, perceived peer rejection, self-esteem, and background information including their demographics and familiarity with technology. Adolescents also completed a brief assessment of their typing ability and a task assessing their reading comprehension skills.

Then, after both adolescents completed the initial questionnaires and took a short break, a Biopac photoplethysmography (PPG) sensor was placed on the adolescent's earlobe to record his or her heart rate variability. Adolescents spent 3 minutes alone in the room looking at a fixation cross to allow for assessment of their baseline heart rate.

Dyads were randomly assigned to one of two experimental conditions. Dyads were block-randomized based on gender and Minecraft expertise. Nineteen dyads were randomized to the in-person condition, and 17 dyads were randomized to the virtual condition. In the in-person condition, adolescents played Minecraft while sitting next to each other *in the same room*. In the virtual condition, adolescents played Minecraft *in separate rooms* but were able to interact using the virtual text-based chat function and in-game interactions using their virtual avatars. After each participant was assessed for baseline heart rate variability, the adolescent was informed of the experimental condition in which she or he was placed (i.e., told whether she or he would be interacting with the other child in-person or virtually) and asked to complete a questionnaire about her or his current emotional state.

Once both participants had completed the initial questionnaires and activities, they interacted using the online game Minecraft (Persson & Bergensten, 2011). Minecraft is an online video game in which players can collect resources such as wood and stone and create buildings and other objects using building and crafting functions. It is a "sandbox"-style game which presents no specific objectives to players. Thus,

Minecraft approximates a free play context, in that players are free to determine their own goals and to explore the virtual environment, engage with computer-generated animals and characters, and build anything that interests them. In particular, Minecraft was selected for this study because it allows players to cooperate and collaborate on building and collecting resources if they wish, but they may also choose to play independently. Participants interacted while playing Minecraft in both conditions in order to ensure that the conditions were as comparable as possible. The only difference between conditions was whether the participants were in the same room together or not, so any differences across conditions could be clearly attributed to the interaction modality.

For this study, the game was set to "survival" mode, which meant that players began the game with no resources or building tools. This initial lack of resources was intended to provide some incentive for players to cooperate with their partner, as participants could collect more resources and build much more complex and interesting structures with assistance from their interaction partner. Although survival mode generally includes the appearance of computer-generated monsters such as zombies and skeletons that attack players, the monsters were disabled for this study so as to avoid making the game excessively difficult for less experienced players.

Researchers opened the Minecraft game on both adolescents' computers and provided a brief demonstration of the main features of the game, including how to walk around, how to collect resources, and how to build a crafting table (an essential piece of equipment for crafting new items). Adolescents were also shown how to use the text-

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based chat feature and asked to send a brief chat message to the other child saying "Hi" and introducing themselves by first name.

Then, in the in-person condition, one child was led into a room where the other child was seated at a computer and asked to sit at a computer next to the other child. The adolescents were introduced to one another by first name. The adolescents were left alone in the room to play for approximately 20 minutes. Their interaction was video-recorded, the screens of their computers were recorded, and their heart rate was recorded.

In the virtual condition, each child remained in his or her own separate room during the interaction. The adolescents were able to communicate via the text-based chat function and were able to see a generic avatar representing the other person. The adolescents were left alone in their rooms to play for approximately 20 minutes. All activity was video-recorded, as were the screens of their computers. Heart rate was also recorded.

After the interaction, a researcher entered and told the adolescents that the interaction was finished. In the in-person condition, the child who was initially in another room was led back to that original room, so that all adolescents were alone again. Adolescents spent 3 minutes alone in that room looking at a fixation cross as a second assessment of their baseline heart rate. Then, researchers asked adolescents to complete some online questionnaires about their emotional state during the interaction, their perceived social competence, and their perceptions of the quality of the interaction.

Measures

Questionnaires

Self-Perceptions of Social Competence and Self-esteem. *The Self-Perception*

Profile for Adolescents (Harter, 2012) was used to assess adolescents' perceptions of

their social competence with general peers and friends, as well as their overall self-worth.

Adolescents were asked to indicate whether they agree or disagree with statements about

their competence and how strongly they agree or disagree on a 4-point scale. The 5-item

perceived social competence subscale (e.g., "Some teenagers understand how to get peers

to accept them, but other teenagers don't understand how to get peers to accept them"),

the 5-item perceived close friendship competence subscale (e.g., "Some teenagers find it

hard to make friends they can really trust, but other teenagers are able to make close

friends that they can really trust"), and the 5-item global self-worth (e.g., "Some

teenagers like the kind of person they are, but other teenagers often wish they were

someone else") subscales were used in this study. Prior to the interaction, alpha was .843

for social competence, .679 for close friendship competence, and .816 for global self-

worth. After the interaction, alpha was .869 for social competence, .670 for close

friendship competence, and .883 for global self-worth.

Unsociability. *The Child Social Preference Questionnaire* (Coplan et al., 2013)

was used to assess adolescents' unsociability, or affinity for spending time alone.

Adolescents rated how strongly they agreed with 7 statements (e.g., "I usually prefer

doing things alone") on a 5-point scale (α = .781).

Shyness. *The Children's Shyness Questionnaire* (Crozier, 1995) was used to

assess adolescents' shyness. The questionnaire consists of 26 statements about reactions

to potentially stressful social situations (e.g., "I find it hard to talk to someone I don't

know," "I feel nervous when I am with important people") and adolescents indicated whether each statement was true or not true for them on a 3-point scale ($\alpha = .901$).

Experience with Technology. Adolescents completed a 34-item demographic questionnaire asking for demographic information and detailed questions about experience with video games and Minecraft, including rating approximately how many hours per week they typically spend on the Internet, playing video games, playing online multiplayer games, and playing Minecraft. Adolescents who indicated that they have played online multiplayer games were asked how often they play these games with strangers, friends they met online, or friends they know in person.

Social Avoidance and Perceived Rejection. Adolescents rated their social avoidance and perceived peer rejection using a subset of seven items from the *Child Social Preference Scale – Revised* (Bowker & Raja, 2011). Adolescents rated how strongly four statements about peer rejection (e.g., "I want to play with others but often they don't want to play with me"; $\alpha = .896$) and three statements about social avoidance (e.g., "When given the choice, I always choose to play by myself because I don't like playing with others"; $\alpha = .853$) applied to them on a 5-point scale.

Current Emotional State. *The Positive and Negative Affect Scale for Children* (Laurent et al., 1999) is a 27-item questionnaire that was used to assess adolescents' emotional state before the interaction and during the interaction (adolescents completed the questionnaire after the interaction, but they were asked to rate how they felt during the interaction). Adolescents were presented with a list of 27 emotions and are asked to rate the extent to which they felt each emotion on a 5-point scale. Positive emotion descriptors included "interested," "excited," and "delighted," while negative emotion

descriptors included "sad," "nervous," and "lonely." Alpha for positive affect was .927 prior to the interaction and .950 after the interaction. Alpha for negative affect was .743 prior to the interaction and .363 after the interaction, perhaps because there was relatively little variability in post-interaction negative affect, as few adolescents reported negative affect. As a result, the findings related to post-interaction negative affect should be interpreted with caution.

Typing Ability. Adolescents completed a 2-minute typing test on speedtypingonline.com (Groeber, n.d.) to assess their typing speed and accuracy. Adolescents were presented with a text passage ("The Three Little Pigs") and asked to type it as quickly and accurately as possible. This assessment of typing ability served as a control variable to account for differences in adolescents' ability to use the text-based chat feature in Minecraft.

Reading Comprehension Ability. The *EasyCBM* online reading assessment tool (Alonzo, Tindal, Ulmer, & Glasgow, 2006) was used to measure adolescents' reading comprehension. Adolescents read an age-appropriate passage designed at an 8th-grade reading level and answered 20 multiple-choice questions about what they read. This measure served as a control variable to account for variation in adolescents' ability to read and comprehend text-based chat messages in Minecraft.

Perceptions of the Dyadic Interaction. *The Perception of Interaction Questionnaire* (adapted from Cuperman, 2008) was used to assess adolescents' perceptions of the quality of the interaction. Adolescents were asked whether they knew their interaction partner prior to the interaction and then presented with 27 statements and asked to rate their agreement with each statement on a 10-point Likert scale. These

statements described aspects of the interaction such as how comfortable they felt interacting with their partner (e.g., "How much did the interaction seem *smooth, natural, and relaxed* to you?"), how much they liked their partner (e.g., "How comfortable did you feel around the other person?"), and how comfortable and enjoyable they think their partner found the interaction (e.g., "How interesting and fun do you think the other person found the interaction?").

A factor analysis using principal axis factoring with direct oblimin rotation extracted three factors with eigenvalues greater than 1 for the perception of interaction items related to the participants' own experience. The scree plot for the factor analysis is shown in Figure 1. Factor loadings are shown in Table 1. Items were considered to load on a factor if they had a loading above 0.4 and they did not have a stronger loading on a different factor. Factor 1, which had an eigenvalue of 6.836, included the majority of the perception of interaction items. Items measuring enjoyment and liking of the interaction partner loaded positively, while items related to unpleasant experiences loaded negatively. Thus, Factor 1 represented the *overall perception of interaction quality*. Factor 2, which had an eigenvalue of 1.662, included two items describing feeling uncomfortable and trying to emulate the partner's behavior, making Factor 2 a measure *of discomfort-related passivity*. Factor 3, which had an eigenvalue of 1.429, included two items referring to trying to communicate with the partner and take the lead, suggesting that factor 3 represented *assertiveness*. These factors will be referred to as enjoyment, passivity, and assertiveness, respectively. Scores for these scales were calculated by averaging the relevant items. Alpha for enjoyment was .934. The Spearman-Brown coefficient was .408 for passivity and .718 for assertiveness.

Observational Measures

Physiological Regulation and Reactivity. Adolescents' baseline physiological regulatory ability and their reactivity to social interaction was assessed using respiratory sinus arrhythmia (RSA). RSA was recorded using a Biopac MP150 data acquisition system with a sampling rate of 2000Hz. Adolescents wore a wireless Bio-Nomadix PPG-ED transmitter with a sensor that clipped onto their earlobe (Biopac Systems, 2018). During heart rate data collection, a video stream was recorded from a wall-mounted camera in the room so that research assistants could identify the beginning and end of each phase.

Heart rate data were collected (a) during an initial 3-minute baseline phase while adolescents looked at a fixation cross on the screen, (b) during the entire 20-minute Minecraft interaction phase while adolescents were playing together, and (c) during a final 3-minute baseline phase immediately following the Minecraft interaction. Heart rate data was visually edited by trained, reliable editors using the VizEdit program (Barstead, 2018), and RSA was calculated using the Porges (1985) algorithm in the CardioBatch program (Brain-body Center, 2007a). Baseline RSA was calculated as the mean RSA value across 30-second epochs during the initial 3-minute baseline task. RSA during the interaction was calculated as the mean RSA value across 30-second epochs during the 20-minute Minecraft interaction. RSA change in response to the Minecraft interaction was calculated by subtracting the mean RSA during the initial baseline task from the mean RSA during the Minecraft, creating a score for which negative values indicated RSA suppression and positive values indicated RSA augmentation. RSA recovery was calculated by subtracting the mean RSA value across 30-second epochs

during the initial baseline task from the mean RSA value during the post-interaction baseline task, creating a score for which negative values suggest a lack of recovery from RSA suppression and positive values suggest continued RSA augmentation.

Observed Activity During Minecraft Interaction. Adolescents' social and nonsocial behavior during the Minecraft interaction were coded using an adapted version of the time-sampled codes from the *Play Observation Scale* (Rubin, 2001). Coders recorded the amount of time that adolescents spend engaging in non-play behaviors (spending time unoccupied or watching without engaging); playing alone; independently pursuing a goal shared with the partner (e.g., building a structure together); interacting with the partner using the virtual interface; and directly interacting with the partner in-person. Coders established reliability on a set of 13 cases, and the mean kappa value was 0.764. The total time spent in each behavior was divided by the total length of the interaction to calculate the proportion of time spent in each behavior. The behaviors analyzed in this study were: (1) independent pursuit of a common goal; (2) communication (the sum of virtual and direct interaction); and (3) overall collaborative play (the sum of virtual interaction, direct interaction, and independent pursuit of a common goal).

Observed Social Problem-Solving During Minecraft Interaction. Adolescents' social initiations and the partner's responses to those initiations were coded using an adapted version of the *Social Problem Solving Observational Coding Taxonomy – Revised* (Rubin & Rose-Krasnor, 2000). Coders noted when adolescents made initiations that (1) requested various actions from their partner (e.g., asking the partner to join them in an activity or provide an object); (2) asked for information (e.g., inquiring

about features of Minecraft); (3) offered help (e.g., proposing a solution when the child is experiencing difficulties); (4) announced plans (e.g., stating that they will go collect additional materials); or (5) started a conversation (e.g., commenting on something they found in Minecraft).

Coders then observed the partner's *response* and rated whether the initiation was (1) successful and the partner agreed to the request or acknowledged the comment in some way; (2) the request was resolved by the child before the partner could respond or withdrawn by the child before the partner could respond; (3) the request was unsuccessful and the partner either ignored or explicitly rejected the request or comment. Two coders double-coded 15 videos, and the two-way mixed intraclass correlation coefficient was above .75 for all initiation categories and all outcomes.

These categories were consolidated into the total number of action requests, questions, announcements of plans, and conversation starts. The percentage of successful initiations was calculated as the proportion of initiations that were successful out of the total number of initiations. This metric was chosen because it captures how successful each participant was when initiating, without conflating it with the overall number of initiations.

CHAPTER 4: RESULTS

Descriptive Statistics

Descriptive statistics are presented in Table 2. Some participants were missing subscales of questionnaires because participants were only assigned a score for a subscale if they had answered at least 70% of the relevant items. Sixteen participants were missing RSA change data and 21 participants were missing RSA recovery data because of recording equipment malfunctions. Because the data are structured in terms of dyads, intra-class correlations were used to test for non-independence of scores between dyad members. As recommended by Kenny, Kashy, and Cook (2006), one-way random intraclass correlations were calculated using the Inter1 SPSS program (Alferes & Kenny, 2009). None of the questionnaire variables showed significant non-independence, so the questionnaire data were analyzed at the individual level rather than the dyadic level. The RSA data likewise did not show significant non-independence. However, the observed activity scores were very strongly associated within dyads, which likely reflects the fact that partners sharing a common goal or interacting with one another was generally reciprocal. While partners differed to some extent on how much time they devoted to pursuing a shared goal or communicating virtually, dyads tended to respond to their virtual chat messages and pursue a common goal to some extent once a shared goal had been established, resulting in a very high degree of similarity among dyad members. Additionally, time spent communicating directly in the in-person condition was virtually identical between dyad members because while either partner was speaking, the other partner was coded as listening. The number of social initiations made were also significantly associated within dyads. The proportion of successful initiations did not

show non-independence. Independent samples *t*-tests revealed non-significant initial differences between participants in each condition on typing speed, reading comprehension score, shyness, unsociability, avoidance, perceived rejection, perceived social competence, perceived close friendship competence, global self-worth, or baseline RSA. Chi-square tests showed no differences between conditions on gender or Minecraft expertise.

Correlations are presented in Table 3. Notably, perceived social competence was positively correlated with perceived close friendship competence and global self-worth. Shyness was positively correlated with avoidance and perceived rejection. Unsociability and avoidance were strongly positively correlated. However, shyness was not correlated with unsociability, and avoidance was not correlated with perceived rejection. Shyness, avoidance, and perceived rejection were negatively correlated with perceived social competence, while unsociability was not. Shyness and perceived rejection were negatively correlated with perceived close friendship competence, and shyness was negatively correlated with global self-worth.

Main Effects of Interaction Condition

Saturated path models with robust standard errors and full information maximum likelihood estimation to account for missing data were estimated using the *lavaan* package in R version 3.3.3 (R Core Team, 2014; Rosseel, 2012). In each model, the effect of condition was tested using a dummy variable coded 0 for virtual and 1 for in-person. Each model included gender, typing speed, reading comprehension score, and a dichotomous variable representing Minecraft expertise (dyads in which participants had fewer than 20 hours per week of lifetime Minecraft play were considered moderate

experience dyads, while dyads including a participant with 20 hours per week or more of lifetime Minecraft play were considered expert) as control variables. Models involving variables measured both before and after the interaction (social competence, close friendship competence, global self-worth, positive affect, negative affect, RSA change, and RSA recovery) also controlled for the pre-interaction value. The three perception of interaction variables were tested in the same model, as were pre-interaction positive and negative affect and social initiation types; the variables that needed to have pre-interaction values included as a control variable were each tested in their own model, as were the observed activities. Models with outcomes that did not show non-independence were analyzed with person as the target of analysis. Outcomes that were non-independent were analyzed by dyad, with a mean of the partners' scores on the outcome used as the dependent variable and the mean reading scores and typing scores for the partners used as the reading and typing scores.

The estimates, standard errors, and p-values for each of the main effects models are shown in Tables 4 through 10. There was a strong trend for participants in the virtual condition to report enjoying the interaction more than those in the in-person condition, and participants in the virtual condition reported engaging in significantly less passivity and more assertiveness. Condition was significantly negatively associated with post-interaction social competence, controlling for pre-interaction social competence; it appears that participants in the in-person condition remained stable in their perceived social competence from pre-interaction to post-interaction, while those in the virtual condition increased slightly on average. Condition was not associated with post-interaction close friendship competence or global self-worth. Condition was also not

associated with positive or negative affect prior to the interaction or with post-interaction positive or negative affect. Likewise, condition was not associated with RSA change or RSA recovery.

Condition was significantly negatively associated with observed independent pursuit of a common goal, but it was positively associated with observed communication. Notably, when pursuit of a common goal and communication were combined into a single index, there was only a weak trend in favor of the in-person condition in overall collaborative play. Thus, participants in the virtual condition engaged in more pursuit of a common goal, in-person participants communicated with each other more, and there was no significant difference between conditions on overall collaborative play. Condition was positively associated with observed action requests, questions, announcements of plans, and conversation starts, suggesting that participants in the in-person condition made more social initiations of all types. However, condition was negatively associated with the proportion of initiations that were successful – participants in the virtual condition received positive responses to a larger proportion of their initiations.

Associations Between Motivations for Solitude and Interaction Quality

Saturated path models with robust fit indices, robust Huber-White standard errors, and full information maximum likelihood estimation to account for missing data were estimated using the *lavaan* package in R (R Core Team, 2014; Rosseel, 2012). The four motivations for solitude and the partner's four motivations for solitude were entered as predictors of each outcome of interest, controlling for gender, typing speed, reading comprehension, and Minecraft experience level. In models examining outcomes with a

pre-interaction value (i.e., affect, self-perceptions, RSA), the pre-interaction value was controlled as well. Moderation of each motivation for solitude path by condition was tested using multi-group models. First, an unconstrained model with all paths freely estimated across conditions was estimated; then, each path was constrained one by one to be equal across the in-person and virtual condition, and the model fit of the model with each path constrained was compared to the unconstrained model using a Satorra-Bentler chi-square difference test. A significant chi square difference test indicated that constraining the path to be equal across groups significantly worsened model fit, suggesting moderation by condition. Paths with non-significant chi square difference tests were constrained to be equal across conditions in the final model, while those with significant chi square difference tests were freely estimated in each condition.

In the *enjoyment* model (Table 11), the shyness path was moderated by condition, $\chi^2(1) = 6.969$, $p = .008$. Although this was the only path that showed significant moderation by condition in the initial chi-square difference tests, the model with only the shyness path freed fit the data relatively poorly, CFI = .856, RMSEA = .095, SRMR = .021. In order to improve model fit, paths with a chi square difference greater than 1 were individually tested to see whether freeing the path significantly improved the fit of the model compared to the model with all of those paths constrained. None of the freed paths resulted in a significant improvement in model fit, and neither did freeing all four paths with chi-square values greater than 1. Therefore, despite the relatively poor fit of the model with only the shyness path freed, this model was selected as the final model in the interest of parsimony because of the lack of evidence that freeing additional paths resulted in meaningful improvements in model fit. Shyness was significantly and

negatively related to enjoyment in the in-person condition only. No other motivations for solitude were significantly related to enjoyment.

In the *passivity* model (Table 12), the unsociability path was moderated by condition, $\chi^2(1) = 8.569$, $p = .003$, as was the partner avoidance path, $\chi^2(1) = 6.042$, $p = .014$. The final model fit the data well, CFI = 1.00, RMSEA = .000, SRMR = .011. Shyness was positively related to passivity, while unsociability was negatively related to passivity in the in-person condition only. Partner shyness was negatively related to passivity, while partner perceived rejection was positively associated with passivity. Partner avoidance was positively related to passivity in the in-person condition only.

In the *assertiveness* model (Table 13), all paths were constrained to be equal across conditions. The final model fit the data well, CFI = 1.00, RMSEA = .000, SRMR = .026. Shyness was negatively related to assertiveness, while perceived rejection was positively associated with assertiveness. Partner unsociability was positively associated with assertiveness.

In the *post-interaction positive affect* model (Table 14), the shyness path was moderated by condition, $\chi^2(1) = 5.223$, $p = .022$, as were the avoidance path, $\chi^2(1) = 4.981$, $p = .026$, the perceived rejection path, $\chi^2(1) = 5.863$, $p = .015$, and the partner avoidance path, $\chi^2(1) = 5.344$, $p = .021$. The final model fit the data well, CFI = 1.00, RMSEA = .000, SRMR = .004. The only significant association between motivations for solitude and positive affect was a negative association between shyness and positive affect in the in-person condition only.

In the *post-interaction negative affect* model (Table 15), the perceived rejection path was moderated by condition, $\chi^2(1) = 3.937$, $p = .047$, as was the partner avoidance

path, $\chi^2(1) = 11.486$, $p < .001$. The final model fit the data well, CFI = 1.00, RMSEA = .000, SRMR = .014. Perceived rejection and partner avoidance were positively related to negative affect in the virtual condition only.

In the *perceived social competence* model (Table 16), the partner shyness path was moderated by condition, $\chi^2(1) = 42.648$, $p < .001$. The model with only the partner shyness path freed fit the model relatively poorly, CFI = .961, RMSEA = .159, SRMR = .012. In order to improve model fit, paths whose chi square difference was greater than 1 were each tested in order to see whether freeing the path significantly improved the fit of the model compared to the model with all paths except partner shyness constrained. Freeing the partner avoidance path significantly improved model fit, $\chi^2(1) = 7.519$, $p = .006$, but freeing partner rejection, avoidance, or unsociability did not. The final model fit the data well, CFI = .996, RMSEA = .055, SRMR = .007. Unsociability was positively associated with perceived social competence, while avoidance was negatively related to perceived social competence. Partner unsociability was negatively related to perceived social competence. Partner shyness was negatively related to perceived social competence in the virtual condition only, and partner avoidance was positively related to perceived social competence in the virtual condition only.

In the *perceived close friendship competence* model (Table 17), none of the paths were moderated by condition. However, the model with all paths constrained to be equal across conditions fit the data relatively poorly, CFI = .959, RMSEA = .094, SRMR = .018. In order to improve model fit, paths whose chi square difference was greater than 1 were each tested in order to see whether freeing the path significantly improved the fit of the model compared to the model with all paths except partner shyness constrained.

Freeing the partner unsociability path significantly improved model fit, $\chi^2(1) = 5.009$, $p = .025$. The final model fit the data well, CFI = 1.00, RMSEA = .000, SRMR = .010. Partner unsociability was negatively related to perceived close friendship competence in the virtual condition.

In the *global self-worth* model (Table 18), the shyness path was moderated by condition (a likelihood ratio test based on the regular chi-square value was used because *lavaan* did not produce a robust chi-square value for the model with shyness constrained), $\chi^2(1) = 24.604$, $p < .001$. The avoidance path was also moderated by condition, $\chi^2(1) = 1171.3$, $p < .001$, as was the rejection path, $\chi^2(1) = 14.757$, $p < .001$. The model with only these paths freed fit the data moderately well, CFI = .981, RMSEA = .107, SRMR = .011. Freeing additional paths did not significantly improve model fit, so this model was selected as the final model. Shyness was negatively related to global self-worth in the in-person condition and positively related to global self-worth in the virtual condition. Unsociability was positively associated with global self-worth across both conditions. Avoidance and perceived rejection were negatively related to global self-worth in the virtual condition only. Partner unsociability was negatively related to global self-worth across both conditions.

In the *RSA change* model (Table 19), the unsociability path was moderated by condition, $\chi^2(1) = 4.688$, $p = .03$. The partner avoidance path was also moderated by condition, $\chi^2(1) = 23.461$, $p < .001$. Although these were the only paths that showed significant moderation by condition in the initial chi-square difference tests, the model with only unsociability and partner avoidance freed fit the data relatively poorly, CFI = .896, RMSEA = .188, SRMR = .027. In order to improve model fit, paths whose chi

square difference was greater than 1 were tested in order to see whether freeing the path significantly improved the fit of the model compared to the model with all of those paths constrained. Freeing the avoidance path significantly improved model fit, $\chi^2(1) = 5.109$, $p = .024$, as did freeing the partner shyness path, $\chi^2(1) = 5.497$, $p = .019$, but freeing partner unsociability or partner perceived rejection did not. The final model fit the data well, CFI = .995, RMSEA = .047, SRMR = .012. Shyness was negatively related to RSA change. Unsociability was negatively related to RSA change in the in-person condition, while there was a strong trend for avoidance to be positively related to RSA change in the in-person condition. Partner shyness was negatively related to RSA change in the in-person condition, while partner avoidance was positively related to RSA change in the in-person condition.

In the *RSA recovery* model (Table 20), the unsociability path was moderated by condition, $\chi^2(1) = 22.553$, $p < .001$. The avoidance path was also moderated, $\chi^2(1) = 4.081$, $p = .043$, as were the rejection path, $\chi^2(1) = 8.732$, $p = .003$, the partner shyness path, $\chi^2(1) = 6.760$, $p = .009$, and the partner avoidance path, $\chi^2(1) = 8.238$, $p < .001$ (the rejection and partner avoidance paths were tested using a likelihood ratio test with the non-robust chi square value because *lavaan* did not produce a robust chi-square value). The final model fit the data well, CFI = 1.00, RMSEA = .00, SRMR = .007. Unsociability was negatively related to RSA recovery in the in-person condition, while avoidance and perceived rejection were positively associated with RSA recovery in the in-person condition. Partner shyness was negatively associated with RSA recovery in the in-person condition, while partner avoidance was positively associated with RSA recovery in the in-person condition. Thus, the RSA recovery findings largely mirrored

the RSA change findings, as unsociability and partner shyness continued to be associated with lower RSA during recovery after in-person interaction, while avoidance and partner avoidance were associated with higher RSA during recovery after in-person interaction. The exceptions to this pattern are that shyness, which was related to greater RSA suppression during the interaction, was not associated with lower RSA during recovery. Also, rejection was positively associated with RSA recovery after the in-person interaction despite being unassociated with RSA change during the interaction.

In the model examining the *proportion of successful initiations* (Table 21), the rejection path was moderated by condition, $\chi^2(1) = 5.855$, $p = .016$. The model with all other paths constrained fit the data well, CFI = 1.00, RMSEA = .00, SRMR = .018. No motivations for solitude were significantly associated with successful initiation proportion, although there was a strong trend for rejection to be positively associated with success in the in-person condition.

An Exploration of Gender Differences in Social Behavior and Perceptions

Because of the sample size, the present study was underpowered to fully examine gender differences across conditions. However, gender was included as a control variable in all analyses, and it was a significant predictor of outcomes in a few of the models. Most notably, there was a strong trend for gender to be associated with enjoyment, with females reporting less enjoyment of the interaction than males. Females also reported less positive affect prior to the interaction. No gender differences were observed on any of the observed social behaviors.

CHAPTER 5: DISCUSSION

The present study aimed to compare adolescents' virtual and in-person interactions during an initial interaction with an unfamiliar peer in a multiplayer game, as well as to examine associations between motivations for solitude and interaction quality and whether these associations differed by interaction modality. The findings suggested that adolescents' virtual peer interactions while playing an online game with an unfamiliar peer are at least as high-quality as their in-person interactions. While previous research with adults has suggested that in-person interaction tends to be of higher-quality than virtual interaction (e.g., Sacco & Ismail, 2014), a similar pattern did not emerge with the adolescent sample in the present study. On several different indices of interaction quality, virtual interaction outperformed in-person interaction, and these advantages for virtual interaction were particularly pronounced among shy adolescents. Thus, contrary to hypotheses, virtual interaction may offer unique benefits for some adolescents' peer interactions.

Differences Between In-Person and Virtual Interactions

In accordance with my hypotheses, participants were observed to interact with one another more in the in-person condition: they spent more time communicating with their partner and made more social initiations in-person. However, contrary to my hypotheses, this greater quantity of social interaction did not translate into higher interaction quality, either as perceived by adolescents or as observed. First, while in-person participants spent more time communicating directly, there was no significant difference across conditions on a combination of observed communication and the pursuit of a common goal. Thus, participants in both conditions engaged in similar levels

of collaborative, partner-oriented behavior. Furthermore, while in-person participants made more social initiations, virtual participants actually received successful responses to a higher proportion of their social initiations, suggesting that virtual interaction facilitated positive exchanges between partners. Making a social initiation required more effort in the virtual condition than in the in-person condition because participants had to laboriously type out a message in the virtual context. Thus, participants may have responded more consistently to initiations in the virtual condition because they realized that their partner had made a deliberate effort to communicate with them, whereas participants in the in-person condition may have felt less obligation to respond to each of the partner's verbal comments.

Participants' perceptions of interaction quality similarly favored virtual interaction. Adolescents in the virtual condition reported enjoying the interaction more, being less uncomfortably passive, and being more assertive than those in the in-person condition. Participants who interacted virtually also reported higher perceived social competence following the interaction. Thus, participants viewed the interaction and themselves more positively after interacting virtually. This pattern may reflect their more frequent social successes in the virtual condition, or they may simply have felt more comfortable in the less proximal interaction context that placed lower demands for interaction on them as they became acquainted with an unfamiliar peer.

One possible explanation for this advantage for virtual interaction is that the lower level of immediacy in the virtual interaction allowed participants to perceive greater control over their self-presentation during the interaction, which may be of particular developmental significance to adolescents because of their focus on forming positive peer

relationships and creating and demonstrating a coherent social identity (Cicchetti & Rogosch, 2002). Valkenburg & Peter (2009) and Nesi and colleagues (2018a) proposed that virtual interaction may differ fundamentally from in-person interaction because of the relative lack of social cues present during virtual interaction and the asynchronous modality that allows adolescents to take more time to carefully craft responses, allowing greater control over self-presentation. While the text-based chat in the present study was synchronous in that both participants were using it at the same time, participants in the virtual condition nonetheless could take more time to craft an appropriate response than in-person participants who had to respond immediately to the physically present partner. Meanwhile, the lack of nonverbal social cues meant that participants in the virtual condition did not have to manage their nonverbal responses to the same extent as the in-person participants. As a result of these unique affordances of virtual interaction, participants interacting virtually may have felt less pressure on their social performance, facilitating better interactions with the unfamiliar peer that felt more comfortable and were more successful.

Another reason that adolescents may respond to virtual interaction more positively is their status as digital natives who are exposed to virtual social interactions from a young age (Reid Chassiakos et al, 2016). Adolescents are exposed to virtual media very early, and they make frequent use of media such as social networking sites, texting, and multiplayer video games to communicate with peers and their friends (Reich et al., 2012). Thus, present-day adolescents are accustomed to conducting their peer relationships at least partially online, and they have had the opportunity to develop social skills for facilitating positive, high-quality virtual interactions. Thus, the findings in the

present study may diverge from earlier studies of adults because modern adolescents have extensive experience with virtual communication with peers, while adults may be less familiar with how to interact effectively using virtual media.

The findings may also stem in part from the fact that participants were all familiar with the game Minecraft prior to the study, and using text-based chat to communicate with other players is the default multiplayer setting in Minecraft. Thus, participants may have expected that interacting with a peer using Minecraft would involve interacting virtually, since that would align with their likely prior experiences of interacting in that medium. As a result, in-person interaction while playing Minecraft may have seemed rather unusual to participants, while virtual interaction aligned with their prior experiences and expectations.

It is also possible that findings in the present study differed from previous studies of initial interactions between adults because the present study focused on interactions in a multiplayer video game, whereas the studies of adults involved conversations (McKenna et al., 2002; Sacco & Ismail, 2014; Sprecher, 2014). Perhaps participants' focus on the video game in both conditions made differences in communication quality in the two conditions less salient than they would be if conversation were the only activity. Additionally, the video game context allowed for the possibility of pursuing a shared goal with the partner without verbally communicating, so it created additional opportunities for virtual social interaction that would not exist if conversation were the only possible social activity. Indeed, participants in the present study engaged in more independent pursuit of a shared goal in the virtual condition, and although they engaged in less verbal communication, they did not differ from those in the in-person condition on overall

collaborative play. Therefore, the video game context may have facilitated high-quality virtual interaction by providing additional opportunities for social engagement and teamwork beyond the ability to communicate verbally.

Unexpectedly, physiological responses to in-person and virtual interaction were similar, as RSA change and recovery did not differ across conditions. While I expected that physiological responses would be stronger in the in-person condition because of the greater richness of immediate social cues when interacting directly with a partner, researchers have previously demonstrated that individuals suppress RSA in response to a virtual social stressor to a similar extent as they suppress RSA to an in-person stressor (e.g., Owens & Beidel, 2015). The findings of the present study suggest a similar pattern.

In the present study, some participants suppressed RSA during the interaction, reacting to the interaction as threatening, while others augmented RSA and responded to the interaction as an opportunity for positive social engagement. The lack of differences across conditions implies that adolescents who perceived opportunities for interaction as engaging augmented similarly regardless of interaction modality, whereas those who perceived social interactions as stressful suppressed RSA similarly. Thus, for example, shyness was related to RSA suppression in both conditions, suggesting similar suppression in both contexts for those who tend to experience anxiety about interacting with peers. This pattern suggests that virtual interaction was perceived as sufficiently social and immediate to evoke the same physiological responses as direct, in-person interaction, further corroborating the idea that participants found both interaction modalities equally engaging.

On average, participants showed slight RSA suppression during the Minecraft interaction, perhaps because engagement in an attention-related task that involves slight motor activity has been shown to be associated with a lower average RSA value (Porges et al., 2007). Since participants in both conditions played Minecraft and experienced similar demands for task engagement and motor activity, motor-related RSA suppression is unlikely to have played a major role in the comparison of RSA change across conditions, though. Furthermore, Porges and colleagues (2007) showed that while average RSA was lower during a task involving minor motor activity compared to a passive baseline task, individual differences in RSA suppression were not related to individual differences in motor activity, suggesting that motor activity was not closely linked to RSA change at the individual level. Therefore, the task demands for motor activity during the Minecraft interaction likely did not play a key role in explaining individual variability in RSA change.

Motivations for Solitude

Shyness. Shyness refers to anxiety and wariness about social interaction and social evaluation (Coplan & Armer, 2007). Shy adolescents want to interact with others, but their anxiety leads them to frequently withdraw from social interaction and display poor social competence (Coplan & Armer, 2007). In the present study, shyness was associated with greater social difficulties across both interaction conditions. In particular, shyness was associated with being more uncomfortably passive and less assertive. Shyness was also related to RSA suppression, suggesting a perception of threat. In accordance with my hypotheses, there was some evidence that shyness was associated with greater enjoyment of the virtual condition. Specifically, shyness was related to less enjoyment,

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less positive affect, and less global-self-worth following the in-person interaction, but it was unassociated with enjoyment and positive affect in the virtual condition, and it was actually positively associated with global self-worth following the virtual interaction. Thus, my hypotheses about shyness were partially supported. While I had expected the associations between shyness and perceived interaction quality as well as RSA suppression to be moderated by condition, shyness was associated with these outcomes similarly across conditions. Nonetheless, shyness was consistently associated with lower enjoyment in the in-person condition, and this association did not emerge in the virtual condition. Thus, shyness related similarly to difficulties with social behavior and perception of threat in both conditions, but shyness was only related to decreased enjoyment in-person.

Having a shy partner was also related to some social difficulties. Specifically, having a shy partner was negatively associated with perceived social competence in the virtual condition, as well as greater RSA suppression and less RSA recovery in the in-person condition. In both conditions, having a shy partner was negatively related to passivity, suggesting that the partners of highly shy children did not tend to follow the shy child's lead. Since shy adolescents reported themselves to be more passive and less assertive, perhaps the shy adolescents were not providing their partners with very many social cues to follow.

Unsociability. Unsociability comprises a non-anxious disinterest in interacting with peers (Coplan & Armer, 2007). Unsociable individuals are thought to be able to competently engage with others when opportunities for social interaction present themselves, but they are not motivated to actively seek out frequent social interaction

(Coplan & Armer, 2007). In this study, unsociability was not associated with most indices of interaction quality, consistent with hypotheses that unsociability would be less related to social dysfunction than the other motivations for solitude. In fact, unsociability was negatively associated with uncomfortable passivity in the in-person condition and positively related to perceived social competence and global self-worth following the interaction in both conditions. On the other hand, unsociability was associated with more RSA suppression and less RSA recovery in the in-person condition. Overall, this pattern suggests that highly unsociable adolescents reacted to the in-person interaction as threatening, but they did not try to follow the partner because of discomfort, and they felt better about themselves following the interaction. Overall, then, unsociability showed no consistent links to one's own social difficulties, as anticipated, although the RSA suppression in the in-person condition suggests that highly unsociable adolescents found the in-person interaction with an unfamiliar peer at least somewhat stressful.

On the other hand, having an unsociable partner seemed to create some difficulties. Having an unsociable partner was positively associated with greater assertiveness and negatively associated with perceived social competence and global self-worth, as well as close friendship competence in the virtual condition. Thus, the partners of highly unsociable adolescents seem to have taken the lead more in the interaction and subsequently felt less confident in their social skills. This pattern was unexpected, as previous researchers have suggested that unsociability is less related to social incompetence than other motivations for solitude and I had therefore hypothesized that having an unsociable partner would not be associated with discomfort during the interaction (e.g., Ladd, Kochenderfer-Ladd, Eggum, Kochel, & McConnell, 2011).

Avoidance. Avoidance is defined as an active desire to withdraw from social interaction due to low motivation to approach social interactions and a high motivation to avoid interacting with others (Coplan & Armer, 2007). Avoidance showed no clear pattern of association with interaction quality. It was unrelated to most indices of interaction quality, although it was negatively associated with perceived social competence, as well as global self-worth in the virtual condition. On the other hand, avoidance was positively associated with RSA change and RSA recovery in the in-person condition. This would suggest that highly avoidant adolescents were augmenting RSA more in response to the in-person interaction, but they felt less confident in themselves after the interaction. All of these findings are unexpected, as avoidance was expected to operate similarly to shyness in terms of being related to several indices of social maladjustment. With the exception of the self-perception findings, avoidance was unrelated to interaction quality, and it actually related to more adaptive physiological responding.

The findings for having an avoidant partner are similarly mixed. Having an avoidant partner was associated with more passivity during in-person interaction, more negative affect following virtual interaction, but also more perceived social competence following virtual interaction. Also, having an avoidant partner was associated with more RSA augmentation and higher RSA during recovery from in-person interaction. Overall, then, there was no clear pattern of associations between partner avoidance and interaction quality.

Perceived Rejection. Perceived rejection may motivate adolescents to seek solitude because past rejection experiences have led them to anxiously anticipate future rejection (e.g., London et al, 2007). While perceived rejection is not a dispositionally-based

construct like shyness and unsociability, it may function as a motivation to withdraw from social interaction because adolescents are motivated to avoid further rejection experiences. In the present study, perceived rejection was unassociated with most indicators of interaction quality. However, the associations that did emerge between perceived rejection and interaction quality suggest that in-person interaction may have been more beneficial for adolescents who perceived themselves as highly rejected. Perceived rejection was associated with greater assertiveness, while having a perceived rejected partner was associated with greater passivity. Thus, adolescents who perceived themselves as rejected seem to have taken the lead in the interaction. In the in-person condition, this may have paid off, as perceived rejection was marginally associated with a higher proportion of successful social initiations. Perceived rejection was also associated with higher RSA at recovery in the in-person condition, suggesting that perhaps by the end of the interaction, perceived rejected adolescents augmented RSA in response to their successful social initiations. In contrast, in the virtual condition, perceived rejection was associated with more negative affect and lower global self-worth.

Summary of Motivations for Solitude Findings. Overall, the key patterns that emerged for motivations for solitude suggested that shyness was related to social difficulties in both conditions and less enjoyment in-person. Unsociability was related to better self-perceptions while having an unsociable partner was associated with lower self-confidence following the interaction. Lastly, perceived rejection was related to assertiveness and greater social success in-person.   These findings suggest that in general, shyness was the key motivation for solitude that predicted physiological responding, perceived interaction quality, and enjoyment of the interaction. This finding is consistent with previous

literature suggesting that shyness is robustly associated with social difficulties (e.g., Wang et al., 2013). Also consistent with previous literature (e.g., McKenna et al., 2002), shy adolescents seem to have felt more comfortable interacting virtually than in-person, as shyness was related to lower enjoyment of in-person but not virtual interaction. This pattern aligns to some extent with the compensation hypothesis for virtual interaction, which suggests that individuals who struggle with in-person interactions may be able to compensate for their lacking in-person social interactions with more successful interactions online (Kraut et al., 2002). Shyness was related to responding to the interaction as stressful and reporting more passive and less assertive behavior in both conditions, suggesting that shy adolescents' physiological and behavioral responses to the interaction were similar across conditions. However, shyness wasn't related to decreased enjoyment in the virtual condition, while it was related to less enjoyment in-person, suggesting that shy adolescents may have enjoyed themselves more while interacting virtually.

Another major pattern that emerged was the consistent associations between unsociability and self-perceptions. Unsociable adolescents felt more socially competent and reported higher global self-worth following the interaction, but the partners of unsociable adolescents felt less socially competent and reported lower global self-worth. It seems that unsociable children evaluated their own performance positively, but their partners seem to have found it disconcerting to interact with a partner who showed relatively little interest in interacting. Perhaps unsociable adolescents seek out fewer opportunities to engage socially, so the social interactions they do experience strongly change their self-perceptions. Since unsociable children often display socially competent

behavior when they engage with peers (see Coplan & Armer, 2007, for a review), the Minecraft interaction may have offered unsociable children a relatively rare opportunity to interact competently with an unfamiliar peer in an engaging, enjoyable context, resulting in higher perceived social competence and overall positive self-perceptions.

On the other hand, partners may have perceived the interaction with unsociable adolescents as strained because the unsociable adolescents may not have been as responsive or engaged as a more sociable adolescent, without any visible motive for this asocial behavior. Coplan, Girardi, Findlay, & Frohlick (2007) surveyed children about their perceptions of shy and unsociable peers and found that children reported greater desire to interact with the shy peer compared to the unsociable peer based on the understanding that the shy peer wanted to interact but was nervous, while the unsociable peer had little desire to interact. A similar pattern might be at play here, where those with an unsociable partner come to see themselves as less socially skilled because the partner has little desire to engage with them. Interestingly, having a shy partner was also negatively related to perceived social competence in the virtual condition only. In that case, it may be that adolescents with an identifiably shy partner in the in-person condition realize that the partner's nervousness is motivating them not to engage as strongly, so they don't make internal attributions about the partner's reactions and alter their social self-perceptions. With an unsociable partner who merely seems disinterested, though, or a partner whose motivation cannot be discerned (a shy partner in virtual interaction), the adolescent may feel that the partner's disinterest reflects on their own social skills.

Unlike the other motivations for solitude, there was no clear or coherent pattern of associations between avoidance and interaction quality. This lack of consistency may be

explained by the fact that researchers have begun to question whether avoidance functions as a unique motivation for solitude. Avoidance has been less thoroughly studied than other motivations for solitude, and it is unclear whether it functions as a distinct motivation for solitude or whether it is highly similar to shyness and unsociability (e.g., Bowker, Stotsky, & Etkin, 2017). In the present study, avoidance was correlated with shyness and very highly correlated with unsociability, suggesting considerable overlap between avoidance and other motivations for solitude. Additionally, it has been proposed that avoidance may reflect extreme shyness, depression, or previous negative peer experiences rather than a dispositional motivation to seek solitude (Ding et al., 2019). The present study is consistent with the idea that avoidance may not function as a key motivation for solitude, as once the other motivations for solitude were controlled, there were no coherent associations between avoidance and interaction quality. In the present study, it does not appear that avoidance operated as a coherent intrapersonal construct, as it had strong links to other motivations for solitude and the unique variance attributable to avoidance did not demonstrate interpretable links to interaction quality.

Finally, there were some signs that adolescents high in perceived rejection by peers were assertive in attempting to engage an unfamiliar peer, and they were relatively successful in the in-person condition. In contrast to the findings for shyness, which suggested that in-person interaction was more stressful and less enjoyable, the pattern of associations for rejection suggest that adolescents high in perceived rejection may have engaged the partner more effectively in the in-person condition, while they reported more negative feelings after virtual interaction. Interestingly, however, the greater assertiveness of perceived rejected children may suggest that perceived rejection didn't

function as a motivation to seek solitude. Rather, there is some indication that adolescents who perceived themselves as rejected felt particularly motivated to take charge of the interaction and engage with the partner, perhaps in order to compensate for their experiences of rejection in other peer contexts. Alternatively, the adolescents who perceived themselves as rejected may have been aggressive. Aggressive children are often rejected by peers (e.g., Lansford, Malone, Dodge, Petit, & Bates, 2010), and they may develop patterns of coercive interpersonal interactions in which they use forceful strategies to encourage compliance from interaction partners and the partners capitulate and reinforce the behavior (Patterson, Reid, & Dishion, 1998). This pattern resembles the behavior that occurred in the present study, in which perceived rejected adolescents reported being more assertive, their partners reported more uncomfortable passivity, and perceived rejection was associated with marginally more successful initiations in-person.

Implications

In the time of a pandemic (COVID-19), when almost all social interaction is occurring virtually, the findings of the present study may be reassuring to parents of adolescents, as they suggest that virtual interaction can be as engaging and high-quality, if not higher-quality, than in-person interactions. While virtual interaction in a multiplayer video game may not offer the quantity of direct communication as in-person interaction, the present study suggested that virtually interacting with a partner in an online multiplayer video game was a compelling, engaging opportunity for social interaction that adolescents enjoyed more than in-person interaction. Thus, virtual interaction in such contexts may be a helpful way to supplement in-person peer interactions for adolescents, although the present findings apply to interactions between

adolescents and unfamiliar peers, and the extent to which these findings would generalize to interactions between familiar peers or friends remains unknown.

The effectiveness of virtual social interaction also raises the possibility of using virtual interaction as a preliminary step in interventions designed to promote social skills and peer relationships. In particular, shy adolescents may benefit from virtual interaction, as they didn't tend to enjoy in-person interaction, but high shyness was not related to decreased enjoyment in virtual interaction. As a result, promoting virtual interaction for shy adolescents in contexts such as multiplayer games may help them reap the benefits of enjoyable social interaction while allowing them to form positive connections with peers. Helping shy adolescents engage virtually may eventually make shy adolescents feel more comfortable with peer interaction in general, allowing them to also engage more successfully during in-person interactions.

Limitations and Future Directions

While the present study had several strengths, including a diverse sample, an experimental methodology, and a combination of self-report, observational, and physiological techniques for assessing interaction quality, the study also had several limitations. First, the sample was relatively small, somewhat limiting statistical power and introducing the possibility that the present sample does not fully represent the population. Future researchers should attempt to replicate these findings in a larger sample to examine whether similar patterns emerge in a sample with stronger statistical power that represents the full population of adolescents. In particular, the present study comprised a predominantly male sample, which unfortunately prevented a thorough examination of differences in social behavior and perceptions by gender. While the

exploratory findings about gender do not generally suggest overall differences between male and female participants in terms of their social behavior or perceptions, the small number of female participants precludes drawing firm conclusions. Future researchers should recruit more female participants in order to more fully examine differences in in-person and virtual interactions by gender.

Similarly, the sample consisted exclusively of adolescents who had previously played Minecraft, meaning that the findings are specific to adolescents who frequently play online multiplayer video games such as Minecraft and it is unclear whether the findings would generalize to adolescents who are less familiar with online video games. While knowledge of this population is informative because the vast majority of adolescents play video games at least occasionally (Anderson & Jiang, 2018), future researchers should examine whether virtual interaction differs from in-person interaction to a greater extent for adolescents with less familiarity with virtual interactions such as multiplayer online games.

A sizeable number of participants were unfortunately missing RSA data in the present study due to equipment malfunctions. While this data is likely missing at random because it arose from equipment difficulties rather than participant behavior, future studies should replicate these findings with a larger, more complete sample. Also, future researchers should examine RSA change over the course of the interaction in more detail. While the present analysis examined overall RSA change for the entire interaction period, growth curve modeling could be used to make a more detailed examination of how RSA changes over the course of the interaction and how it might be related to the quality of the

interaction. For example, future researchers might examine how RSA changes in response to successful or unsuccessful social initiations in in-person and virtual settings.

Additionally, the present study focused on initial interactions with an unfamiliar peer in order to examine interactions that were not influenced by previous experience with the peer. While this provides important information about how initial contact and relationship formation may operate in a virtual context, it is also important to understand how adolescents interact with existing friends in-person versus virtually. In the future, researchers should examine how friends interact virtually and in-person, since adolescents predominantly interact with existing friends online and examining interactions with a friend may better represent adolescents' typical virtual interactions (Reich et al., 2012). Interactions with friends may be more similar across the in-person and virtual conditions compared to unfamiliar peer interaction because the friendship quality and interpersonal patterns established between the friends may drive behavior in both contexts. Also, future researchers might examine other configurations, such as mixed-gender dyads or larger groups of children, in virtual and in-person interactions to investigate to what extent these findings generalize to other kinds of peer interactions. Future researchers should also further probe associations between motivations for solitude and social interaction, with a particular focus on examining whether avoidance actually functions as a distinct motivation for solitude and considering abandoning avoidance as a meaningful motivation for solitude if it continues to fail to yield coherent findings.

Researchers might also examine how adolescents behave when presented with a more goal-oriented task to complete rather than simply being allowed to play with no

specific objective; a goal-oriented task may motivate more collaboration between participants or more conflict, depending on the nature of the task and the individual characteristics of the participants. Finally, future researchers might examine whether encouraging virtual interaction for shy adolescents in particular helps them develop confidence in their social abilities, since shyness was associated with lack of enjoyment and positive affect in-person but not virtually. Unsociable adolescents may also benefit from virtual social interaction, as unsociability was associated with RSA suppression in the in-person condition. This pattern introduces the possibility that encouraging enjoyable virtual peer interaction may be a first step in encouraging shy adolescents to engage with peers in a context that they find rewarding, which may help them build confidence and form positive relationships that might ultimately generalize to in-person interactions. A future study might be conducted in which shy adolescents are assigned to interact with an unfamiliar peer virtually and then subsequently interact with that peer in-person. This condition could be compared to a condition in which shy adolescents were assigned to interact in-person first and then interact virtually to see whether an initial virtual interaction facilitates higher-quality in-person interactions.

While there is much additional research to be done on adolescents' virtual peer interactions and its implications for their peer relationships and well-being, the present study provides a preliminary look at how adolescents engage with an unfamiliar peer in a multiplayer video game virtually versus in-person and how they perceive those interactions. The findings suggest that virtual interaction can be at least as high-quality and enjoyable as in-person interaction, and that adolescents who are highly shy may derive particular benefit from virtual interactions with new peers. The study provides

initial evidence that virtual interaction in a multiplayer video game may be a positive,

engaging social context in which adolescents can have positive peer interactions and

potentially build positive peer relationships.

Table 1. Factor loadings of perception of interaction items

Item	Loading on Factor 1: Enjoyment	Loading on Factor 2: Passivity	Loading on Factor 3: Assertiveness
2. How much did you want to communicate with the other person?	.412	.015	**.649**
4. How much did you use the other person's behavior as a guide for your own behavior?	.307	.347	.098
6. How much did you try to take the lead in the conversation?	.092	-.112	**.590**
8. How self-conscious or uncomfortable did you feel when you were with the other person?	-.425	**.653**	.066
10. How much did the interaction seem *awkward, forced,* and *strained* to you?	**-.740**	.242	-.062
12. How much did the interaction seem *smooth, natural,* and *relaxed* to you?	**.808**	-.145	.132
14. How interesting and fun did you find the interaction?	**.716**	.265	-.161
16. How much did you feel *put down*, *rejected*, or *not liked* by the other person?	**-.657**	.246	.433
18. How much did you feel *accepted* and *respected* by the other person?	**.780**	-.085	.276
20. How much would you like to interact more with the other person in the future?	**.840**	.206	.134
22. How much did you enjoy your interaction with the other person?	**.895**	.156	.078
23. How much did you try to follow the other person by changing your behavior to "fit in" with his/hers?	.101	**.491**	-.117
25. How comfortable did you feel around the other person?	**.887**	-.071	.036
27. How much did you like the other person?	**.782**	.124	.161

Table 2. Descriptive statistics

Variable	N	Mean	SD	ICC	p value for ICC
Pre-interaction Social Competence	69	3.07	0.69	-.20	.26
Pre-Interaction Close Friendship Competence	68	3.17	0.60	-.07	.71
Pre-Interaction Global Self-Worth	67	3.35	0.59	-.18	.31
Shyness	72	1.78	0.43	.10	.56
Unsociability	72	3.06	0.63	.27	.10
Avoidance	68	2.00	0.92	.08	.64
Perceived Rejection	71	1.70	0.84	.14	.42
Pre-interaction Positive Affect	71	3.25	0.89	.10	.54
Pre-interaction Negative Affect	72	1.28	0.33	-.14	.39
Baseline RSA	58	7.21	0.80	-.12	.56
RSA Change	56	-0.21	0.59	.13	.53
RSA Recovery	51	-0.13	0.66	-.13	.55
Common Goal Play	72	0.14	0.19	.84	<.001
Interaction	72	0.36	0.33	.99	<.001
Collaborative Play	72	0.50	0.33	.95	<.001
Action Requests	72	3.58	4.73	.41	.01
Questions	72	5.76	7.51	.41	.01
Declarations	72	4.17	5.50	.31	.06
Conversation Starts	72	8.96	9.81	.47	.003
Proportion of Successful Initiations	72	0.64	0.30	.18	.29

Enjoyment of Interaction	70	7.84	1.71	.03	.87
Passivity during Interaction	67	3.54	2.16	-.09	.62
Assertiveness during Interaction	71	6.27	2.14	.07	.68
Post-interaction Positive Affect	72	3.42	0.99	-.07	.69
Post-interaction Negative Affect	71	1.15	0.15	-.09	.59
Post-interaction Social Competence	69	3.13	0.71	.04	.81
Post-interaction Close Friendship	69	3.20	0.60	.09	.61
Post-interaction Global Self-worth	69	3.37	0.58	.05	.79

Table 3. Correlations between study variables

	1	2	3	4	5	6	7	8	9	10
1. Pre-Interaction Perceived Social Competence	1									
2. Pre-Interaction Close Friendship Competence	.520**	1								
3. Pre-Interaction Global Self-Worth	.303*	.226†	1							
4. Shyness	-.613**	-.513**	-.397**	1						
5. Unsociability	-.122	-.025	-.090	.085	1					
6. Avoidance	-.242*	-.130	-.183	.313**	.602**	1				
7. Perceived Rejection	-.378**	-.390**	-.052	.255*	-.062	-.038	1			
8. Pre-Interaction Positive Affect	.152	.236†	.254*	-.163	.084	-.199	.101	1		
9. Pre-Interaction Negative Affect	-.082	-.185	-.351**	.273*	-.041	.023	.131	0.44	1	
10. Post-Interaction Positive Affect	.222†	.233†	.436**	-.346**	.158	-.140	.020	.830**	-.086	1
11. Post-Interaction Negative Affect	-.175	-.115	-.241†	.166	-.035	-.012	.084	.126	.614**	.068
12. Post-Interaction Perceived Social Competence	.876**	.526**	.254*	-.680**	-.121	-.334**	-.300*	.297*	-.071	.364**
13. Post-Interaction Close Friendship Competence	.528**	.744**	.228†	-.461**	.057	-.150	-.260*	.262*	-.343**	.275*
14. Post-Interaction Global Self-Worth	.344**	.392**	.837**	-.476**	.040	-.131	-.286*	.359**	-.181	.507**
15. Enjoyment	.193	.123	.511**	-.295*	.046	-.114	.042	.403**	-.151	.642**
16. Passivity	-.327**	-.107	-.237†	.256*	-.110	-.104	.182	.086	.262*	-.087
17. Assertiveness	.031	.056	.227†	-.277*	.106	-.115	.109	.282*	-.090	.393**
18. Baseline RSA	-.234†	-.301*	-.096	.079	-.177	-.034	.386**	.073	.062	-.006
19. RSA Change	.318*	.403**	.150	-.341*	.110	-.122	-.273*	.090	-.203	.133
20. RSA Recovery	.195	.423**	.326*	-.225	.135	.054	-.309*	-.054	-.185	.050
21. Conversation Starts	.166	.122	.099	-.322**	.056	-.046	.046	-.075	-.143	.113
22. Announcements of Plans	.103	.067	.106	-.308**	.039	-.097	.087	-.067	-.133	.071
23. Action Requests	.058	-.016	-.033	-.217†	.164	-.062	-.015	.016	-.123	.144
24. Questions	.130	.156	.046	-.281*	-.056	-.135	.026	-.095	-.149	.032
25. Proportion of Successful Initiations	.036	.166	.048	-.098	.070	.082	-.042	.169	.083	.228†
26. Pursuit of a Common Goal	-.188	-.152	-.248*	.345**	.262*	.250*	.115	.054	.090	-.039
27. Communication with Partner	.232†	.182	.106	-.292*	.145	-.045	.024	.028	-.098	.205†
28. Collaborative Play	.123	.095	-.040	-.095	.297*	.100	.091	.060	-.047	.184

†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

	11	12	13	14	15	16	17	18	19	20
1. Pre-Interaction Perceived Social Competence										
2. Pre-Interaction Close Friendship Competence										
3. Pre-Interaction Global Self-Worth										
4. Shyness										
5. Unsociability										
6. Avoidance										
7. Perceived Rejection										
8. Pre-Interaction Positive Affect										
9. Pre-Interaction Negative Affect										
10. Post-Interaction Positive Affect										
11. Post-Interaction Negative Affect	1									
12. Post-Interaction Perceived Social Competence	-.153	1								
13. Post-Interaction Close Friendship Competence	-.172	.582**	1							
14. Post-Interaction Global Self-Worth	-.288*	.440**	.382**	1						
15. Enjoyment	-.164	.371**	.119	.412**	1					
16. Passivity	.178	-.288*	-.197	-.239†	-.124	1				
17. Assertiveness	.053	.281*	.287*	.309*	.430**	-.179	1			
18. Baseline RSA	.088	-.105	-.175	-.089	.084	.178	.085	1		
19. RSA Change	-.168	.305*	.180	.204	.036	-.199	.061	-.668**	1	
20. RSA Recovery	-.239	.143	.287*	.161	.187	-.284*	.116	-.600**	.661**	1
21. Conversation Starts	-.026	.133	.170	.343*	.024	-.118	.277*	.026	.122	-.059
22. Announcements of Plans	-.223†	.161	.111	.238*	.216†	-.007	.337**	.198	-.019	.044
23. Action Requests	-.096	.105	.163	.046	.086	-.214†	.335**	-.057	.098	.101
24. Questions	-.162	.182	.248*	.210†	.035	-.106	.387**	-.009	.098	.110
25. Proportion of Successful Initiations	.128	.122	.094	.093	.328**	-.080	.258*	-.137	.211	.383**
26. Pursuit of a Common Goal	.060	-.100	-.080	-.256*	.044	-.043	.114	.291*	-.267*	-.109
27. Communication with Partner	-.023	.187	.255*	.195	.175	-.023	.313**	-.031	.146	.111
28. Collaborative Play	.012	.129	.207†	.045	.205†	-.049	.379**	.157	-.045	.030

†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

	21	22	23	24	25	26	27	28
1. Pre-Interaction Perceived Social Competence								
2. Pre-Interaction Close Friendship Competence								
3. Pre-Interaction Global Self-Worth								
4. Shyness								
5. Unsociability								
6. Avoidance								
7. Perceived Rejection								
8. Pre-Interaction Positive Affect								
9. Pre-Interaction Negative Affect								
10. Post-Interaction Positive Affect								
11. Post-Interaction Negative Affect								
12. Post-Interaction Perceived Social Competence								
13. Post-Interaction Close Friendship Competence								
14. Post-Interaction Global Self-Worth								
15. Enjoyment								
16. Passivity								
17. Assertiveness								
18. Baseline RSA								
19. RSA Change								
20. RSA Recovery								
21. Conversation Starts	1							
22. Announcements of Plans	.651**	1						
23. Action Requests	.706**	.572**	1					
24. Questions	.743**	.561**	.607**	1				
25. Proportion of Successful Initiations	-.042	-.065	-.024	.049	1			
26. Pursuit of a Common Goal	-.233*	-.146	-.150	-.229†	.202†	1		
27. Communication with Partner	.749**	.641**	.601**	.684**	.086	-.298*	1	
28. Collaborative Play	.619**	.561**	.518**	.556**	.203†	.277*	.835**	1

$^{\dagger}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$

Table 4. Parameter estimates, standard errors, and *p*-values for the enjoyment, passivity, and assertiveness main effects model

Outcome	Predictor	Estimate	SE	p
Enjoyment				
	Gender	-0.966†	0.512	.059
	Typing	0.004	0.010	.687
	Reading	-0.022†	0.012	.062
	Experience	0.129	0.399	.746
	Condition	-0.714†	0.368	.053
Passivity				
	Gender	-0.498	0.555	.369
	Typing	-0.013	0.018	.487
	Reading	-0.023	0.015	.108
	Experience	0.566	0.491	.249
	Condition	1.253**	0.480	.009
Assertiveness				
	Gender	-0.633	0.610	.299
	Typing	0.020	0.014	.148
	Reading	0.004	0.016	.803
	Experience	-0.088	0.511	.864
	Condition	-0.929*	0.475	.050

$^{\dagger}p < .10$, $*p \le .05$, $**p < .01$, $***p < .001$

Table 5. Parameter estimates, standard errors, and *p*-values for the perceived social competence, close friendship competence, and global self-worth main effects models

Outcome	Predictor	Estimate	SE	p
Social Competence				
	Pre-Interaction Social Competence	0.872***	0.051	< .001
	Gender	-0.032	0.074	.665
	Typing	0.002	0.002	.337
	Reading	-0.007**	0.003	.007
	Experience	-0.058	0.073	.430
	Condition	-0.164*	0.071	.021
Close Friendship Competence				
	Pre-Interaction Friendship Competence	0.750***	0.093	< .001
	Gender	0.017	0.092	.849
	Typing	0.000	0.003	.874
	Reading	0.001	0.004	.710
	Experience	0.110	0.090	.220
	Condition	0.064	0.094	.496
Global Self-Worth				
	Pre-Interaction Global Self-Worth	0.859***	0.053	< .001
	Gender	0.027	0.093	.770
	Typing	-0.001	0.002	.685
	Reading	-0.003	0.003	.306
	Experience	-0.207**	0.070	.003
	Condition	-0.030	0.070	.667

$^{†}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$

Table 6. Parameter estimates, standard errors, and *p*-values for the pre- and post-interaction positive and negative affect main effects models

Outcome	Predictor	Estimate	SE	p
Pre-Interaction Positive Affect				
	Gender	-0.414*	0.200	.038
	Typing	-0.006	0.006	.369
	Reading	-0.014*	0.006	.029
	Experience	0.157	0.203	.440
	Condition	-0.093	0.194	.631
Pre-Interaction Negative Affect				
	Gender	-0.094	0.058	.103
	Typing	-0.001	0.002	.435
	Reading	-0.001	0.003	.793
	Experience	-0.053	0.072	.463
	Condition	-0.062	0.072	.386
Post-Interaction Positive Affect				
	Pre-Interaction Positive Affect	0.927***	0.068	< .001
	Gender	-0.121	0.180	.502
	Typing	0.004	0.004	.242
	Reading	-0.003	0.004	.508
	Experience	0.168	0.130	.196
	Condition	0.087	0.118	.459
Post-Interaction Negative Affect				
	Pre-Interaction Negative Affect	0.335***	.059	< .001
	Gender	0.005	0.035	.885
	Typing	0.001	0.001	.482
	Reading	0.001	0.001	.478
	Experience	0.017	0.029	.545
	Condition	0.001	0.028	.978

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 7. Parameter estimates, standard errors, and *p*-values for the RSA change and RSA recovery main effects models

Outcome	Predictor	Estimate	SE	p
RSA Change				
	Gender	-0.158	0.169	.348
	Typing	0.000	0.002	.914
	Reading	0.000	0.005	.974
	Experience	-0.079	0.124	.526
	Baseline RSA	-0.496***	0.071	< .001
	Condition	-0.030	0.114	.790
RSA Recovery				
	Gender	0.126	0.173	.467
	Typing	0.000	0.004	.981
	Reading	-0.002	0.007	.795
	Experience	-0.126	0.154	.415
	Baseline RSA	-0.471***	0.090	< .001
	Condition	-0.275†	0.167	.098

$^\dagger p < .10$, $*p < .05$, $**p < .01$, $***p < .001$

Table 8. Parameter estimates, standard errors, and *p*-values for the observed activity main effects models

Outcome	Predictor	Estimate	SE	p
Common Goal				
	Gender	0.032	0.072	.661
	Dyad Mean Reading	0.000	0.003	.891
	Dyad Mean Typing	0.002†	0.001	.071
	Experience	0.048	0.046	.296
	Condition	-0.176**	0.052	.001
Communication				
	Gender	0.056	0.110	.610
	Dyad Mean Reading	0.002	0.006	.683
	Dyad Mean Typing	0.004	0.003	.200
	Experience	-0.109	0.093	.238
	Condition	0.346***	0.088	< .001
Collaborative Play				
	Gender	0.088	0.126	.487
	Dyad Mean Reading	0.003	0.006	.652
	Dyad Mean Typing	0.006†	0.003	.059
	Experience	-0.061	0.099	.539
	Condition	0.171†	0.101	.089

$\dagger p < .10$, $*p < .05$, $**p < .01$, $***p < .001$

Table 9. Parameter estimates, standard errors, and *p*-values for the social initiation main effects model

	Predictor	Estimate	*SE*	*p*
Action Requests				
	Gender	-0.519	1.542	.736
	Dyad Mean Reading	0.132[†]	0.076	.082
	Dyad Mean Typing	-0.036	0.055	.521
	Experience	-0.292	1.367	.831
	Condition	2.509*	1.102	.023
Questions				
	Gender	2.895	2.656	.276
	Dyad Mean Reading	0.136	0.087	.119
	Dyad Mean Typing	0.055	0.045	.222
	Experience	-1.394	1.846	.450
	Condition	5.538**	1.609	.001
Announcements of Plans				
	Gender	-0.142	1.381	.918
	Dyad Mean Reading	0.057	0.074	.439
	Dyad Mean Typing	0.029	0.052	.578
	Experience	-2.297[†]	1.259	.068
	Condition	3.820**	1.194	.001
Conversation Starts				
	Gender	1.594	2.921	.585
	Dyad Mean Reading	0.147	0.140	.293
	Dyad Mean Typing	0.077	0.069	.262
	Experience	-3.582	2.258	.113
	Condition	9.246***	2.080	< .001

†*p* < .10, *p* < .05, **p* < .01, ***p* < .001

Table 10. Parameter estimates, standard errors, and *p*-values for successful initiation proportion main effects model

Outcome	Predictor	Estimate	*SE*	*p*
Proportion of Successful Initiations				
	Gender	0.052	0.083	.528
	Dyad Mean Reading	-0.001	0.003	.642
	Dyad Mean Typing	0.004*	0.002	.017
	Experience	0.003	0.065	.958
	Condition	-0.164*	0.067	.015

†*p* < .10, *p* < .05, **p* < .01, ***p* < .001

Table 11. Parameter estimates, standard errors, and *p*-values for the model predicting enjoyment from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	-1.930*	0.775	.013
Gender (Virtual)	0.185	0.653	.777
Typing (In-Person)	-0.017	0.015	.249
Typing (Virtual)	0.009	0.014	.554
Reading (In-Person)	-0.012	0.019	.525
Reading (Virtual)	-0.036*	0.015	.013
Experience Level (In-Person)	-0.237	0.589	.688
Experience Level (Virtual)	0.480	0.445	.280
Shyness (In-Person)	-1.938**	0.683	.005
Shyness (Virtual)	0.145	0.575	.801
Unsociability	0.490	0.335	.144
Avoidance	-0.337	0.230	.142
Rejection	-0.290	0.260	.265
Partner Shyness	-0.513	0.428	.231
Partner Unsociability	-0.417	0.341	.222
Partner Avoidance	0.166	0.243	.496
Partner Rejection	-0.098	0.213	.646

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 12. Parameter estimates, standard errors, and *p*-values for the model predicting passivity from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	-0.746	0.726	.304
Gender (Virtual)	-0.001	0.791	.999
Typing (In-Person)	-0.009	0.020	.664
Typing (Virtual)	-0.007	0.026	.803
Reading (In-Person)	0.001	0.019	.967
Reading (Virtual)	-0.025	0.021	.221
Experience Level (In-Person)	0.713	0.604	.238
Experience Level (Virtual)	-0.138	0.599	.817
Shyness	2.356***	0.493	< .001
Unsociability (In-Person)	-1.325*	0.622	.033
Unsociability (Virtual)	1.028	0.685	.134
Avoidance	-0.480	0.403	.234
Rejection	-0.064	0.243	.793
Partner Shyness	-1.946**	0.598	.001
Partner Unsociability	-0.098	0.358	.785
Partner Avoidance (In-Person)	1.204**	0.391	.002
Partner Avoidance (Virtual)	0.269	0.343	.432
Partner Rejection	0.837**	0.285	.003

†*p* < .10, *p < .05, **p < .01, ***p < .001

Table 13. Parameter estimates, standard errors, and *p*-values for the model predicting assertiveness from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.318	1.012	.753
Gender (Virtual)	0.172	0.727	.813
Typing (In-Person)	0.020	0.018	.283
Typing (Virtual)	0.020	0.022	.358
Reading (In-Person)	-0.003	0.022	.882
Reading (Virtual)	0.018	0.022	.403
Experience Level (In-Person)	-0.061	0.732	.934
Experience Level (Virtual)	0.104	0.695	.881
Shyness	-1.342**	0.513	.009
Unsociability	0.562	0.623	.367
Avoidance	-0.591	0.440	.179
Rejection	0.592*	0.236	.012
Partner Shyness	0.179	0.617	.771
Partner Unsociability	1.056*	0.506	.037
Partner Avoidance	-0.405	0.329	.218
Partner Rejection	0.028	0.255	.914

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 14. Parameter estimates, standard errors, and *p*-values for the model predicting post-interaction positive affect from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	-0.131	0.341	.701
Gender (Virtual)	-0.315	0.210	.134
Typing (In-Person)	-0.002	0.005	.635
Typing (Virtual)	0.007	0.005	.220
Reading (In-Person)	-0.011†	0.006	.077
Reading (Virtual)	-0.000	0.004	.979
Experience Level (In-Person)	-0.326†	0.190	.086
Experience Level (Virtual)	0.041	0.164	.802
Pre Positive Affect (In-Person)	0.860***	0.097	< .001
Pre Positive Affect (Virtual)	0.862***	0.092	< .001
Shyness (In-Person)	-0.834**	0.264	.002
Shyness (Virtual)	-0.066	0.241	.785
Unsociability	0.218†	0.118	.064
Avoidance (In-Person)	0.228	0.155	.142
Avoidance (Virtual)	-0.157	0.102	.122
Rejection (In-Person)	0.091	0.088	.301
Rejection (Virtual)	-0.190†	0.112	.090
Partner Shyness	0.203	0.139	.145
Partner Unsociability	-0.059	0.107	.584
Partner Avoidance (In-Person)	-0.239†	0.136	.080
Partner Avoidance (Virtual)	.092	.073	.209
Partner Rejection	-0.071	0.065	.275

$^{\dagger}p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

Table 15. Parameter estimates, standard errors, and *p*-values for the model predicting post-interaction negative affect from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.050	0.052	.331
Gender (Virtual)	-0.152***	0.027	< .001
Typing (In-Person)	0.000	0.001	.887
Typing (Virtual)	0.000	0.001	.833
Reading (In-Person)	$0.002^{\dagger}$	0.001	.061
Reading (Virtual)	0.002*	0.001	.031
Experience Level (In-Person)	0.021	0.038	.581
Experience Level (Virtual)	0.022	0.026	.410
Pre Negative Affect (In-person)	0.370***	0.100	< .001
Pre Negative Affect (Virtual)	0.335***	0.049	< .001
Shyness	-0.051	0.033	.121
Unsociability	-0.017	0.024	.480
Avoidance	0.018	0.016	.252
Rejection (In-Person)	-0.026	0.022	.222
Rejection (Virtual)	0.038*	0.018	.036
Partner Shyness	-0.019	0.028	.496
Partner Unsociability	0.006	0.025	.804
Partner Avoidance (In-Person)	0.020	0.026	.445
Partner Avoidance (Virtual)	0.094***	0.014	< .001
Partner Rejection	-0.006	0.012	.638

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 16. Parameter estimates, standard errors, and *p*-values for the model predicting post-interaction perceived social competence from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.220*	0.104	.034
Gender (Virtual)	-0.121	0.089	.173
Typing (In-Person)	0.002	0.002	.398
Typing (Virtual)	0.003	0.003	.389
Reading (In-Person)	-0.007**	0.002	.002
Reading (Virtual)	-0.007**	0.003	.005
Experience Level (In-Person)	0.136	0.094	.147
Experience Level (Virtual)	-0.148	0.090	.100
Social Acceptance (In-Person)	0.835***	0.071	< .001
Social Acceptance (Virtual)	0.817***	0.059	< .001
Shyness	-0.143	0.093	.124
Unsociability	0.247***	0.068	< .001
Avoidance	-0.153**	0.048	.001
Rejection	0.043	0.044	.321
Partner Shyness (In-Person)	0.153	0.121	.205
Partner Shyness (Virtual)	-0.330**	0.112	.003
Partner Unsociability	-0.119*	0.057	.035
Partner Avoidance (In-Person)	0.004	0.094	.965
Partner Avoidance (Virtual)	0.231***	0.039	< .001
Partner Rejection	0.059†	0.032	.067

†*p* < .10, *p < .05, **p < .01, ***p < .001

Table 17. Parameter estimates, standard errors, and *p*-values for the model predicting post-interaction perceived close friendship competence from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.218[†]	0.120	.069
Gender (Virtual)	0.026	0.158	.869
Typing (In-Person)	-0.003	0.003	.357
Typing (Virtual)	0.016**	0.005	.002
Reading (In-Person)	0.003	0.004	.503
Reading (Virtual)	-0.003	0.005	.537
Experience Level (In-Person)	0.182[†]	0.107	.090
Experience Level (Virtual)	0.034	0.160	.830
Close Friendship (In-Person)	0.758***	0.130	< .001
Close Friendship (Virtual)	0.503**	0.155	.001
Shyness	-0.069	0.125	.578
Unsociability	0.084	0.075	.268
Avoidance	-0.115	0.078	.141
Rejection	-0.034	0.049	.487
Partner Shyness	-0.135	0.106	.203
Partner Unsociability (In-Person)	0.093	0.088	.294
Partner Unsociability (Virtual)	-0.326*	0.139	.019
Partner Avoidance	0.109	0.067	.103
Partner Rejection	0.043	0.048	.372

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 18. Parameter estimates, standard errors, and *p*-values for the model predicting post-interaction global self-worth from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.036	0.125	.770
Gender (Virtual)	-0.008	0.108	.943
Typing (In-Person)	-0.006*	0.002	.011
Typing (Virtual)	0.001	0.003	.825
Reading (In-Person)	-0.003	0.003	.337
Reading (Virtual)	-0.007**	0.003	.008
Experience Level (In-Person)	-0.138	0.097	.154
Experience Level (Virtual)	-0.237*	0.096	.014
Global Self-Worth (In-Person)	0.659***	0.075	< .001
Global Self-Worth (Virtual)	0.906***	0.065	< .001
Shyness (In-Person)	-0.597***	0.117	< .001
Shyness (Virtual)	0.333*	0.134	.013
Unsociability	0.264***	0.073	< .001
Avoidance (In-Person)	0.114	0.076	.134
Avoidance (Virtual)	-0.148*	0.062	.016
Rejection (In-Person)	-0.027	0.056	.624
Rejection (Virtual)	-0.226***	0.053	< .001
Partner Shyness	-0.050	0.073	.496
Partner Unsociability	-0.185*	0.073	.011
Partner Avoidance	0.027	0.044	.535
Partner Rejection	-0.015	0.031	.627

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 19. Parameter estimates, standard errors, and *p*-values for the model predicting RSA change from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.241	0.179	.178
Gender (Virtual)	-0.006	0.286	.984
Typing (In-Person)	0.003	0.003	.243
Typing (Virtual)	0.000	0.006	.988
Reading (In-Person)	0.003	0.004	.408
Reading (Virtual)	-0.002	0.005	.689
Experience Level (In-Person)	-0.105	0.105	.319
Experience Level (Virtual)	-0.011	0.225	.962
Baseline RSA (In-Person)	-0.364***	0.095	< .001
Baseline RSA (Virtual)	-0.582***	0.098	< .001
Shyness	-0.333*	0.153	.029
Unsociability (In-Person)	-0.359*	0.157	.022
Unsociability (Virtual)	0.238	0.160	.137
Avoidance (In-Person)	0.192^{+}	0.100	.054
Avoidance (Virtual)	-0.215	0.139	.123
Rejection	0.043	0.061	.476
Partner Shyness (In-Person)	-0.611***	0.134	< .001
Partner Shyness (Virtual)	-0.046	0.247	.852
Partner Unsociability	0.085	0.117	.470
Partner Avoidance (In-Person)	0.393***	0.099	< .001
Partner Avoidance (Virtual)	-0.031	0.127	.808
Partner Rejection	0.070	0.064	.268

$^{+}p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

Table 20. Parameter estimates, standard errors, and *p*-values for the model predicting RSA recovery from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.313	.276	.256
Gender (Virtual)	0.012	0.005	.956
Typing (In-Person)	0.005	0.004	.151
Typing (Virtual)	-0.000	0.005	.989
Reading (In-Person)	0.029***	0.006	< .001
Reading (Virtual)	-0.002	0.005	.678
Experience Level (In-Person)	0.593**	0.192	.002
Experience Level (Virtual)	-0.322*	0.155	.038
Baseline RSA (In-Person)	-0.788***	0.162	< .001
Baseline RSA (Virtual)	-0.516***	0.063	< .001
Shyness	-0.090	0.152	.555
Unsociability (In-Person)	-1.687***	0.301	< .001
Unsociability (Virtual)	-0.161	0.132	.223
Avoidance (In-Person)	0.681***	0.144	< .001
Avoidance (Virtual)	0.141	0.120	.242
Rejection (In-Person)	0.396**	0.116	.001
Rejection (Virtual)	-0.093	0.071	.193
Partner Shyness (In-Person)	-0.409*	0.191	.032
Partner Shyness (Virtual)	0.111	0.185	.550
Partner Unsociability	0.129	0.127	.312
Partner Avoidance (In-Person)	1.055***	0.151	< .001
Partner Avoidance (Virtual)	0.044	0.076	.567
Partner Rejection	0.016	0.051	.754

†*p* < .10, **p* < .05, ***p* < .01, ****p* < .001

Table 21. Parameter estimates, standard errors, and *p*-values for the model predicting successful initiations from motivations for solitude

Predictor	Estimate	SE	p
Gender (In-Person)	0.090	0.128	.483
Gender (Virtual)	0.131	0.134	.328
Typing (In-Person)	0.005*	0.002	.012
Typing (Virtual)	-0.000	0.003	.895
Reading (In-Person)	0.002	0.005	.753
Reading (Virtual)	-0.004	0.003	.160
Experience Level (In-Person)	0.023	0.104	.825
Experience Level (Virtual)	0.096	0.087	.270
Shyness	-0.057	0.108	.597
Unsociability	-0.020	0.069	.770
Avoidance	0.007	0.058	.911
Rejection (In-Person)	0.078†	0.041	.053
Rejection (Virtual)	-0.071	0.081	.377
Partner Shyness	-0.081	0.077	.295
Partner Unsociability	0.007	0.084	.938
Partner Avoidance	-0.014	0.053	.792
Partner Rejection	-0.013	0.039	.740

†*p* < .10, *p < .05, **p < .01, ***p < .001

Figure 1. Scree plot for the factor analysis of the perception of interaction items

1. *The Self-Perception Profile for Adolescents* **Perceived Social Competence, Close**

Friendship Competence, and Global Self-Worth Subscales (Harter, 2012)

What I Am Like

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
a. Sample Question			Some teenagers like to go to movies in their spare time	**BUT**	Other teenagers would rather go to sports events		
1.			Some teenagers find it hard to make friends	**BUT**	Other teenagers find it pretty easy to make friends.		
2.			Some teenagers are able to make really close friends	**BUT**	Other teenagers find it hard to make really close friends.		
3.			Some teenagers are often disappointed with themselves	**BUT**	Other teenagers are pretty pleased with themselves.		
4.			Some teenagers know how to make classmates like them	**BUT**	Other teenagers don't know how to make classmates like them.		
5.			Some teenagers don't know how to find a close friend with whom they can share secrets	**BUT**	Other teenagers do know how to find a close friend with whom they		

					can share secrets.		
6.			Some teenagers don't like the way they are leading their life	**BUT**	Other teenagers do like the way they are leading their life.		
7.			Some teenagers don't have the social skills to make friends	**BUT**	Other teenagers do have the social skills to make friends.		
8.			Some teenagers do know what it takes to develop a close friendship with a peer	**BUT**	Other teenagers don't know what to do to form a close friendship with a peer.		
9.			Some teenagers are happy with themselves most of the time	**BUT**	Other teenagers are often not happy with themselves.		
10.			Some teenagers understand how to get peers to accept them	**BUT**	Other teenagers don't understand how to get peers to accept them.		
11.			Some teenagers find it hard to make friends they can really trust	**BUT**	Other teenagers are able to make close friends they can really trust.		
12.			Some teenagers like the kind of person they are	**BUT**	Other teenagers often wish they were someone else.		
13.			Some teenagers know how to become popular	**BUT**	Other teenagers do not know how		

					to become popular.		
14.			Some teenagers don't understand what they should do to have a friend close enough to share personal thoughts with	**BUT**	Other teenagers do understand what to do to have a close friend with whom they can share personal thoughts.		
15.			Some teenagers are very happy being the way they are	**BUT**	Other teenagers often wish they were different.		

2. *The Child Social Preference Questionnaire* (Coplan et al., 2013)

SPENDING TIME ALONE AND WITH OTHERS

The next questions ask you about how you like to spend your time.
Please select the answer that **best** describes you!

1. If given the choice, I prefer to play alone rather than with other kids				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

2. I enjoy being by myself				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

3. I don't mind being alone and away from anyone				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

4. I like spending time alone in my room				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

5. I usually prefer doing things alone				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

6. It doesn't bother me to spend time by myself				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

7. I am happy when doing things alone				
1	2	3	4	5
Not ever	Hardly ever	Sometimes	Most of the time	All of the time

3. *The Children's Shyness Questionnaire* (Crozier, 1995)

The next set of questions will ask about what you do and how you feel in different situations. Please select whether each statement is true for you (Yes), sometimes true for you (Sometimes), or not true for you (No).

3	2	1	0
Yes	Sometimes	No	I don't know

1. I find it hard to talk to someone I don't know.

2. I am easily embarrassed.

3. I am usually quiet when I am with others.

4. I blush when people sing "Happy Birthday" to me.

5. I feel nervous when I am with important people.

6. I feel shy when I have to read aloud in front of the class.

7. I feel nervous about joining a new class.

8. I go red when someone teases me.

9. I say a lot when I meet someone for the first time.

10. I enjoy singing aloud when others can hear me.

11. I am usually shy in a group of people.

12.1 feel shy when I am the center of attention.

13. I blush a lot.

14. I feel shy when the teacher speaks to me.

15. If the teacher asked for someone to act in a play, I would put my hand up.

16. It is easy for me to make friends.

17. I would be embarrassed if the teacher put me in the front row on stage.

18. When grown-ups ask me about myself I often do not know what to say.

19. I go red when the teacher praises my work.

20. I feel shy when I have to go into a room full of people.

21. I am embarrassed when my friends look at photos of me when I was little.

22. 1 would be too shy to ask someone to sponsor me for a good cause.

23. I enjoy having my photograph taken.

24. I usually talk to only one or two close friends.

25. I am usually shy when I meet girls/boys.

26. I go red whenever I have to speak to a girl/boy of my age.

4. Demographics/Experience with Technology Questionnaire

1. What grade are you in?
   - Grade 7
   - Grade 8

2. How old are you?
   - 11
   - 12
   - 13
   - 14
   - 15

3. What is your date of birth (birthday) (mm/dd/yy)?

   _____

4. What is your gender?
   - Male
   - Female
   - Other

5. Are you Hispanic or Latino?
   - Yes
   - No
6. What is your race (please select all that apply)?
   - American Indian or Alaska Native
   - Asian
   - Black or African American
   - Native Hawaiian or Other Pacific Islander
   - White
   - Other: _____

7. About how many weekdays (Monday-Friday) do you usually go on the Internet?
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5

8. During a normal weekday (Monday-Friday) when you go on the Internet, about how many hours do you spend on the Internet? _____

9. About how many weekend days (Saturday or Sunday) do you usually go on the Internet?
   - 0
   - 1
   - 2

10. During a normal weekend day (Saturday or Sunday) when you go on the Internet, about how many hours do you spend on the Internet?
   _____

11. Do you ever play video games?
   - Yes
   - No

If yes:
   I.   About how many weekdays (Monday-Friday) do you usually play video games in a normal week?
       - 0
       - 1
       - 2
       - 3
       - 4
       - 5
   II. During a normal weekday (Monday-Friday) when you play video games, about how many hours do you spend playing video games? _____
   III. About how many weekend days (Saturday or Sunday) do you usually play video games in a normal week?
       - 0
       - 1
       - 2
   IV. During a normal weekend day (Saturday or Sunday) when you play video games, about how many hours do you spend playing video games? _____

12. Do you ever play online multiplayer games (games where you can play or chat with other players over the Internet)?
   - Yes
   - No

If yes:
   I.   About how many weekdays (Monday-Friday) do you usually play online multiplayer games in a normal week?
       - 0
       - 1
       - 2
       - 3

- 4
- 5

II. During a normal weekday (Monday-Friday) when you play online multiplayer games, about how many hours do you spend playing online multiplayer games? _____

III. About how many weekend days (Saturday or Sunday) do you usually play online multiplayer games in a normal week?
- 0
- 1
- 2

IV. During a normal weekend day (Saturday or Sunday) when you play online multiplayer games, about how many hours do you spend playing online multiplayer games? _____

V. When you play online multiplayer games, how often do you play with strangers or people you don't know?
- Always
- Most of the time
- Some of the time
- A little of the time
- Never

VI. When you play online multiplayer games, how often do you play with friends that you met online and don't know in person?
- Always
- Most of the time
- Some of the time
- A little of the time
- Never

VII. When you play online multiplayer games, how often do you play with friends that you know in person?
- Always
- Most of the time
- Some of the time
- A little of the time
- Never

13. Have you ever played the game Minecraft?
- Yes
- No

If yes:

I. During the time when you were playing Minecraft the most, about how many weekdays (Monday-Friday) did you usually play Minecraft in a normal week?
- 0
- 1
- 2

- 3
- 4
- 5

II. During the time when you were playing Minecraft the most, about how many hours did you spend playing Minecraft on a normal weekday (Monday-Friday)?

_____

III. During the time when you were playing Minecraft the most, about how many weekend days (Saturday or Sunday) did you usually play Minecraft in a normal week?
- 0
- 1
- 2

IV. During the time when you were playing Minecraft the most, about how many hours did you spend playing Minecraft on a normal weekend day (Saturday-Sunday)? _____

V. Currently (now), about how many weekdays (Monday-Friday) do you usually play Minecraft in a normal week?
- 0
- 1
- 2
- 3
- 4
- 5

VI. Currently (now), about how many hours do you spend playing Minecraft on a normal weekday (Monday-Friday)? _____

VII. Currently (now), about how many weekend days (Saturday or Sunday) do you usually play Minecraft in a normal week?
- 0
- 1
- 2

VIII. Currently (now), about how many hours do you spend playing Minecraft on a normal weekend day (Saturday-Sunday)? _____

14. How much do you know about how to play Minecraft?
- Almost everything
- Very much
- A lot
- Some
- A little
- Very little
- Almost nothing

15. How good are you at Minecraft?
- Extremely good
- Very good

- Pretty good
- Okay (not good, not bad)
- Pretty bad
- Very bad
- Extremely bad

5. *The Child Social Preference Scale – Revised* **Social Avoidance and Perceived Peer**

   Rejection Subscales (Bowker & Raja, 2011)

	How much are you like this? Not at All ←→ A Lot				
1. I'd like to hang out with other kids, but I'm often excluded.	1	2	3	4	5
2. I want to play with others but often they don't want to play with me.	1	2	3	4	5
3. Sometimes kids don't want me to hang out with them.	1	2	3	4	5
4. I am the happiest when I am playing with other kids.	1	2	3	4	5
5. When given the choice, I always choose to play by myself because I don't like playing with others.	1	2	3	4	5
6. I wish I could spend more time with other kids, but they don't let me.	1	2	3	4	5
7. When given the choice, I prefer to play with other kids than to play alone.	1	2	3	4	5

6. *The Positive and Negative Affect Scale for Children* (Laurent et al., 1999)

Feelings and Emotions

This survey consists of words that describe different feelings and emotions. Read each word and then choose the number that best describes how much you feel that feeling right now.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

1. Interested
2. Sad
3. Frightened
4. Excited
5. Ashamed
6. Upset
7. Happy
8. Strong
9. Nervous
10. Guilty
11. Energetic
12. Scared
13. Calm
14. Miserable
15. Jittery
16. Cheerful
17. Active
18. Proud
19. Afraid
20. Joyful
21. Lonely
22. Mad
23. Disgusted
24. Delighted
25. Blue
26. Gloomy
27. Lively

APPENDIX 2: POST-INTERACTION QUESTIONNAIRES

1. ***The Perception of Interaction Questionnaire*** (adapted from Cuperman, 2008)

We are interested in learning what you thought about your interaction with the person you just played with. Please think about how you felt during the interaction and answer each question as honestly as you can. Your answers will *not* be shown to the other person.

1. Did you know the other person before you played with him/her today?

   o   Yes
   o   No
   o   If yes: Where did you know them from? _____

2. How much did you want to communicate with the other person?

   1   2   3   4   5   6   7   8   9   10
   Not at   Very
   all   much

3. How much do you think the other person wanted to communicate with you?

   1   2   3   4   5   6   7   8   9   10
   Not at   Very
   all   much

4. How much did you use the other person's behavior as a guide for your own behavior?

   1   2   3   4   5   6   7   8   9   10
   Not at   Very
   all   much

5. How much do you think the other person used your behavior as a guide for his/her behavior?

   1   2   3   4   5   6   7   8   9   10
   Not at   Very
   all   much

6. How much did you try to take the lead in the conversation?

   1   2   3   4   5   6   7   8   9   10
   Not at   Very
   all   much

7. How much did the other person try to take the lead in the conversation?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

8. How self-conscious or uncomfortable did you feel when you were with the other person?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

9. How self-conscious or uncomfortable do you think the other person felt when he or she was with you?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

10. How much did the interaction seem *awkward, forced,* and *strained* to you?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

11. How much do you think the interaction seemed *awkward, forced,* and *strained* to the other person?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

12. How much did the interaction seem *smooth, natural,* and *relaxed* to you?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

13. How much do you think the interaction seemed *smooth, natural,* and *relaxed* to the other person?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

14. How interesting and fun did you find the interaction?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

15. How interesting and fun do you think the other person found the interaction?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

16. How much did you feel *put down, rejected*, or *not liked* by the other person?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

17. How much do you think the other person felt *put down, rejected,* or *not liked* by you?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

18. How much did you feel *accepted* and *respected* by the other person?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

19. How much do you think the other person felt accepted and respected by you?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

20. How much would you like to interact more with the other person in the future?

1	2	3	4	5	6	7	8	9	10
Not at all									Very much

21. How much do you think the other person would like to interact more with you in the future?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

22. How much did you enjoy your interaction with the other person?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

23. How much did you try to follow the other person by changing your behavior to "fit in" with his/hers?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

24. How much did the other person try to follow you by changing his/her behavior to "fit in" with yours?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

25. How comfortable did you feel around the other person?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

26. How comfortable do *you* think the other person felt around you?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

27. How much did you like the other person?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

28. How much do *you* think the other person liked you?

1	2	3	4	5	6	7	8	9	10

Not at
  all

Very
much

2. ***The Positive and Negative Affect Scale for Children*** (Laurent et al., 1999)

Feelings and Emotions

This survey consists of words that describe different feelings and emotions. Read each word and then choose the number that best describes how much you felt that feeling while you were playing Minecraft with your partner.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

1. Interested
2. Sad
3. Frightened
4. Excited
5. Ashamed
6. Upset
7. Happy
8. Strong
9. Nervous
10. Guilty
11. Energetic
12. Scared
13. Calm
14. Miserable
15. Jittery
16. Cheerful
17. Active
18. Proud
19. Afraid
20. Joyful
21. Lonely
22. Mad
23. Disgusted
24. Delighted
25. Blue
26. Gloomy
27. Lively

3. *The Self-Perception Profile for Adolescents* Perceived Social Competence, Close Friendship Competence, and Global Self-Worth Subscales (Harter, 2012)

What I Am Like

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
1.			Some teenagers find it hard to make friends	BUT	Other teenagers find it pretty easy to make friends.		
2.			Some teenagers are able to make really close friends	BUT	Other teenagers find it hard to make really close friends.		
3.			Some teenagers are often disappointed with themselves	BUT	Other teenagers are pretty pleased with themselves.		
4.			Some teenagers know how to make classmates like them	BUT	Other teenagers don't know how to make classmates like them.		
5.			Some teenagers don't know how to find a close friend with whom they can share secrets	BUT	Other teenagers do know how to find a close friend with whom they can share secrets.		
6.			Some teenagers don't like the way they are leading their life	BUT	Other teenagers do like the way they are leading their life.		
7.			Some teenagers don't have the social skills to make friends	BUT	Other teenagers do have the social skills to make friends.		
8.			Some teenagers do know what it takes to develop a close friendship with a peer	BUT	Other teenagers don't know what to do to form a close friendship with a peer.		
9.			Some teenagers are happy with	BUT	Other teenagers are often not		

			themselves most of the time		happy with themselves.	
10.			Some teenagers understand how to get peers to accept them	**BUT**	Other teenagers don't understand how to get peers to accept them.	
11.			Some teenagers find it hard to make friends they can really trust	**BUT**	Other teenagers are able to make close friends they can really trust.	
12.			Some teenagers like the kind of person they are	**BUT**	Other teenagers often wish they were someone else.	
13.			Some teenagers know how to become popular	**BUT**	Other teenagers do not know how to become popular.	
14.			Some teenagers don't understand what they should do to have a friend close enough to share personal thoughts with	**BUT**	Other teenagers do understand what to do to have a close friend with whom they can share personal thoughts.	
15.			Some teenagers are very happy being the way they are	**BUT**	Other teenagers often wish they were different.	

APPENDIX 3: CODING MANUAL FOR OBSERVED ACTIVITY DURING

MINECRAFT INTERACTION

Overview of Activity Coding

The goal of activity coding is to measure how children are spending their time during the Minecraft interaction. We are interested in capturing how much of the time they spend not playing, playing alone, or engaging with their partner.

All coding categories are designed to capture the amount of time that each behavior lasts (they are "state events" that have a duration). All categories are mutually exclusive.

The activity that you assign to the target child should not depend on what the child's partner is doing. For example, if the target child says something to the partner, the target child should be coded as being in direct interaction even if the partner does not respond (the partner would *not* be coded as being in direct interaction).

Definitions of Activity Codes

Uncodable

Uncodable should be marked whenever you can't see what the child is doing or there is a technical malfunction that stops Minecraft. Uncodable should also be coded any time the experimenter is in the room (e.g., the child asks for help and the experimenter comes in to help them). This code is designed to capture any time that we can't determine what the child is doing or any time the child is not playing because of logistical or technical difficulties (e.g., they need to go to the bathroom or they need help getting Minecraft to work properly).

Transition

Transition can be used to capture anything that is active, but is not playing the game. For example, the child ties their shoe, takes off their sweater, or gets a drink of water.

Reticent

Reticent behavior describes when the child is not playing and also is not involved in some kind of transition activity. The child may be passively watching their partner play, or they may be staring into space. If a child chooses to wander aimlessly around the room (although this is unlikely), that would be reticent behavior. Essentially, reticent behavior means that the child is doing nothing.

Solitary Play

Solitary play describes any time the child is playing Minecraft alone. The child is pursuing their own individual goals and is not interacting with the partner.

Solitary Play with a Common Goal

Solitary play with a common goal refers to play in which the child is pursuing a goal that is shared with the partner but is not directly interacting with the partner. Typically, this will involve a discussion between the partners (e.g., "Let's build a house. You go get wood, and I'll go get stone.") which the children then follow through on. We can also infer a common goal if the children are both building on the same structure. However, one child simply announcing what they will do (e.g., "I'm going to go find some sheep") should not be considered a common goal.

Virtual Interaction

Virtual interaction refers to direct communication with the partner that occurs using the virtual interface. This will generally take the form of chat messages, and both sending and reading chat messages should be coded as part of virtual interaction. You can tell that a child is reading chat messages if they open the chat window (when a chat message from the partner just appears on the screen, it is impossible to determine whether the child is reading it. Only code virtual interaction if the child has opened the chat window). If non-verbal communication occurs using the avatars in the game (e.g., one child has their avatar wave to the partner's or follow the partner's avatar around), then this is also coded as virtual interaction.

Direct Interaction

Direct interaction refers to direct communication with the partner that occurs by speaking out loud or interacting in person (as opposed to in Minecraft). This includes any time that participants speak or listen to one another in a spoken conversation and any non-verbal communication that occurs outside the game (e.g., pointing, gesturing).

APPENDIX 4: CODING MANUAL FOR SOCIAL INITIATIONS AND RESPONSES

(SOCIAL PROBLEM-SOLVING)

Overview of Social Problem Solving Coding

The goal of social problem solving coding is to identify the kinds of social initiations that children make during the Minecraft interaction and the responses that they receive.

Initiations are occasions when the child says something to their partner in order to elicit some sort of response from the partner. The initiations we're interested in capturing are:

- Joint Action Request
- Attention Request
- Terminate/Stop Action Request
- Help Request
- Elicit Action Request
- Minecraft Inquiry
- Location/Status Inquiry
- Question about Personal Life
- Offer of Help
- Declaration of Plans/Seeking Approval
- Conversation Start

Outcomes are the ways in which the partner responds to the target child's initiations. The responses of interest are:

- Full Success
- Partial Success
- Self-solution
- Withdrawn
- No Response/Ignored
- Rejection

Coding Notes

- Every initiation must be accompanied by an outcome. Initiations will be coded as point events, and outcomes will be coded as modifiers of those point events.
- Not all outcomes apply to all initiations. For example, a self-solution is not possible for a Joint Action Request.
- All initiations must be verbal. Non-verbal communication (e.g., handing an object to the partner, gesturing) should not be coded as an initiation.
- A child may make multiple initiations in a row. If the child leaves sufficient time between initiations for the partner to respond, then code each initiation separately. If the child makes multiple initiations one after another without leaving time for the partner to respond to each one individually, code the partner's response as applying to

both initiations. For example, if the child says "Let's build a house. I'll build the walls" [a Joint Action Request and a Declaration of Plans) and the partner replies "Okay, let's do that" and starts building a house, you would code the outcome of both the Joint Action Request and the Declaration of Plans as a full success.

Behavior Definitions: Action Requests

Joint Action Request

A Joint Action Request is an initiation in which the child asks the partner to join them in some activity or initiates social play. This may involve the target child proposing an activity for the partners to do together, or the target child asking the partner for ideas for joint activities.

- Examples of comments to code as Joint Action Request:
  - "Let's build a house"
  - "Do you want to go mining with me?"
  - "Come find me, I'm over by the lava"
  - "What do you want to do?"
  - "Follow me"
  - "We could build a tower together"

Attention Request

An Attention Request is an initiation in which the child asks the partner to direct their attention to something specific. This may involve directing the partner's attention to something the child is doing, something the child has made, or something the child has noticed in the environment. Often it will consist of a command (e.g., "Look at this"), but it may also take the form of a question designed to direct the partner's attention to something.

- Examples of comments to code as Attention Request:
  - "Listen, you can hear the people in the other room"
  - "Hey, look, it's a squid"
  - "What do you think of my castle?"
  - "Do you like the windows I made?"

Terminate/Stop Action Request

A Terminate/Stop Action Request is an initiation in which the child asks the partner to stop doing a particular action.

- Examples of comments to code as Terminate/Stop Action Request:
  - "Don't do it like that"
  - "Could you stop following me?"
  - "Don't put any more blocks on there"

o "Stop jumping in the lava"

Help Request

A Help Request is an initiation in which the child asks the partner to take action to assist them, or heavily implies that they are in need of assistance (i.e., the child mentions that they are stuck or struggling).
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- Examples of comments to code as Help Request:
  o "I'm stuck in a hole. Can you bring me a pickaxe?"
  o "I'm stuck in a hole and I can't get out"
  o "I'm lost. Come find me"
  o "I can't get out of my boat"

Elicit Action Request

An Elicit Action Request is an initiation in which the child asks the partner to take some specific action that does not fit one of the previous categories of requests. Often, this may involve asking the partner to collect resources or build a structure in a particular way.

- Examples of comments to code as Elicit Action Request:
  o "Make that wall taller"
  o "Can you go find some wood?"
  o "Why don't you go mine some stone?"
  o "Give me your pickaxe"

Outcomes Associated with Action Requests

Full Success: The partner complies with the request and completes the action requested by the partner. If the child requests a specific action, the partner completes that action. If the child proposes a goal that allows for several potential actions (e.g., the child says "Let's build a house"), the partner takes reasonable action toward achieving that goal (e.g., the partner says "Okay, I'll go get some wood" and collects wood to build the house).

Partial Success: The partner completes part of the action requested by the child, or the partner agrees to complete the action but does not follow through. For instance, the child says "Make your tower as tall as mine" and the partner adds a few blocks to their tower but leaves it noticeably shorter than the other child's. Or the child says "Let's build a house" and the partner says "Okay" but then builds a boat instead.

Withdrawn: The child changes their mind and retracts the initiation before the partner can respond. For example, the child says "Let's build a house. No, actually, let's build a castle." (In this case, "Let's build a house" would be a Joint Action Request that was

Withdrawn, and "Let's build a castle" is a Joint Action Request where the partner's response should be coded as the outcome.)

No Response: The partner ignores the child's request and does not respond in any way.

Rejection: The partner explicitly refuses to comply with the child's request. This can be anything the partner says that declines the child's request – for example, if the child suggests they build a house, "I don't want to", "Maybe later", and "Let's build a tower instead" would all be rejections.

Behavior Definitions: Inquiries/Information Requests

Minecraft Inquiry

A Minecraft Inquiry is an initiation in which the child requests information about a feature of Minecraft, such as how something in the game functions or how to do something. This does not include questions about what the partner is doing in Minecraft; rather, it is specific to questions about features of the game itself.

- Examples of comments to code as Minecraft Inquiry:
    - "How do you make a sword?"
    - "Do you know how to make paper?"
    - "I don't know how to turn off auto-jump. Do you know?"
    - "How did you ride that horse?"

Location/Status Inquiry

A Location/Status Inquiry is an initiation in which the child requests information about where the partner is or what the partner is doing.

- Examples of comments to code as Status/Location Inquiry:
    - "Where are you?"
    - "Are you still looking for stone?"
    - "Did you find any sheep?"
    - "Are you near the lava?"

Question about Personal Life

A Question about Personal Life is an initiation in which the child requests personal information about the partner. This may include biographical information about the partner (e.g., what school they go to, what grade they're in), the partner's experience or behavior (e.g., how often they play Minecraft, whether they've ever participated in a study before), or the partner's thoughts and opinions (e.g., their favorite color, their opinion of the new Minecraft version). However, asking about the partner's thoughts or opinions on something in the immediate Minecraft game would not be coded in this category (e.g., "Do you like the tower I just built?" would be an Attention Request; "Do you want me to make this wall taller?" would be Declaration of Plans/Seeking Approval).

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- Examples of comments to code as Question about Personal Life:
  - "How old are you?"
  - "Do you play Minecraft a lot?"
  - "What do you like to do when you play Minecraft at home?"
  - "Do you like basketball?"

Outcomes Associated with Inquiries/Information Requests

Full Success: The partner makes a genuine attempt to answer the question. If they do not know the answer, they may take a guess or direct the child to another resource (e.g., "I don't know how to make paper, but maybe you can look it up in the recipe book.")

Partial Success: The partner acknowledges the question without attempting an actual answer. Often, this will mean that the partner says "I don't know" without any elaboration.

Self-solution: The child figures out the answer to their question before the partner has a chance to answer.

Withdrawn: The child changes their mind and retracts the initiation before the partner can respond.

No Response: The partner ignores the child's request and does not respond in any way.

Rejection: The partner explicitly refuses to answer the child's question. For example, the partner might say "Figure it out yourself" or "I can't help you."

Behavior Definitions: Other Categories

Offer of Help

Offers of Help are initiations in which the child offers advice or assistance to the partner. They may offer to share objects or materials with the partner, or they may offer strategies for accomplishing something in Minecraft.

- Examples of comments to code as Offer of Help:
  - "I made this sword for you"
  - "Do you want me to bring you a shovel?"
  - "Maybe you can press the shift key to get out of your boat"
  - "You can jump and then place blocks under you"
  - "I'll show you how to make bricks"

Outcomes Associated with Offer of Help

Full Success: The partner attempts to implement the suggestion offered by the child or accepts any offered materials.

Partial Success: The partner acknowledges the offer of help but does not implement the child's suggestion or accept the offered materials (e.g., "I already have a sword, but thanks anyway", or "Yeah, I already tried that").

Withdrawn: The child changes their mind and retracts the initiation before the partner can respond.

No Response: The partner ignores the child's request and does not respond in any way.

Rejection: The partner explicitly refuses to implement the child's suggestion or refuses offered materials without thanks (e.g., "No, I don't want to do that" or "I don't want your sword.")

Declaration of Plans/Seeking Approval

Declaration of Plans/Seeking Approval describes an initiation in which the child seeks permission from the partner to take some action or requests the partner's input on their action. This may take the form of a statement about what the child plans to do or a question about the partner's opinion on something the child is doing, and may occur in the context of joint or solitary activity.

- Examples of comments to code as Declaration of Plans/Seeking Approval:
    - "I'm going to go mining now"
    - "Should I make this tower taller?"
    - "Why don't I make some planks?"
    - "I'll build the roof"
    - "Do you want the windows to be white or yellow?"

Outcomes Associated with Declaration of Plans/Seeking Approval

Full Success: The partner approves of the child's proposed action or shares their opinion with the child if their opinion has been requested.

Partial Success: The partner acknowledges the child's proposed action without approving it (e.g., the child says "I'm going mining" and the partner says "See you later"). If the child requests the partner's opinion, the partner gives a noncommittal answer (e.g., "I don't know" or "I don't care").

Withdrawn: The child changes their mind and retracts the initiation before the partner can respond.

No Response: The partner ignores the child's request and does not respond in any way.

Rejection: The partner rejects the child's suggestion or makes an alternative suggestion to override the child's choice.

For example, the child says "Should I make the walls white or blue?" and the partner replies "Make them green." Note that the partner saying "no" in response to a request for their opinion may not indicate rejection. For instance, if the child asks "Should I make the house bigger?" and the partner says "No, I think it's big enough," then the "no" is simply part of the opinion that was requested and should be coded as full success.

Conversation Start

A Conversation Start is an initiation in which the child says something to begin or continue a conversation with the partner but does not request action or information from the partner. Generally, these will occur after periods of silence (i.e., not every statement made as part of an ongoing conversation should be coded as a Conversation Start) and may consist of seemingly random comments intended to begin a conversation.

- Examples of comments to code as Conversation Start:
    o "I found a cave"
    o "My favorite animals in Minecraft are the turtles"
    o "It's really cold in here"
    o "Did you see that squid in the lake?"

Outcomes Associated with Conversation Start

Full Success: The partner responds verbally to the child's initiation. The response can be simple, such as "yes" or "cool".

Partial Success: The partner acknowledges the child's initiation without providing an actual verbal response. For instance, they may nod, grunt, or say "mmm".

No Response: The partner ignores the child's request and does not respond in any way.

Rejection: The partner says something mean or dismissive in response to the child's initiation. For instance, the child says "I like these sheep" and the partner replies "Sheep are stupid."

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