Autism and Avatars: An Investigation into the Unique Effects of Avatar Anthropomorphism on Instructor Satisfaction for People on the Autism Spectrum

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Autism and Avatars: An Investigation into the Unique Effects of Avatar Anthropomorphism on Instructor Satisfaction for People on the Autism Spectrum

Brenda Lynn Rourke, PhD
University of Connecticut
2020

Abstract

The rates of autism diagnoses are increasing, as is the use of technology and online interactions, both inside and outside of the classroom. These online interactions frequently include a digital representation of the individual, or avatar. Avatars can take a variety of forms and they can influence an individual’s perception of the source as well as the message presented (Nowak, Fox, & Ranjit, 2015). While research indicates that human-looking avatars increase learning and attention in typically developed populations, initial research suggests that this may not be true for those with autism (Begum, Serna, & Yanco, 2016; Moore & Calvert, 2000; Parsons & Mitchell, 2001). The present study will examine the effects of perceived anthropomorphism on information processing, for typically developed individuals and those with ASD. Social motivation theory predicts that those with ASD will perceive social potential differently than their typically developed peers (Chevalier et al., 2017), and this can in turn affect perceptions of anthropomorphism, homophily and copresence. Finally, both information processing theory and the theory of executive dysfunction predict that differences in perceptions of social potential and anthropomorphism can influence instructor satisfaction.

Keywords: Autism, executive dysfunction, information processing, anthropomorphism, avatars, homophily, copresence, instructor satisfaction.
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Autism and Avatars: An Investigation into the Unique Effects of Avatar Anthropomorphism on Instructor Satisfaction for People on the Autism Spectrum

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2020
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Chapter I: Introduction

Interactions and transactions involving some form of technology are now a common occurrence for most people, including both neuro-typical and neuro-diverse individuals, specifically those with autism spectrum disorders (ASD). Many of these technologies provide individuals with opportunities to interact with others using digital characters. Scientists and scholars often refer to these digital characters as avatars. Avatars are “a digital representation of a human user that facilitates interaction with other users, entities, or the environment” (Nowak & Fox, 2018 pg. 34). Research suggests there are different psychological traits and individual-level differences that affect the perception of avatars (McGloin, Nowak & Watt, 2014; Nowak & Rauh, 2005; Nowak, Fox, Ranjit, 2015). Individuals that are on the autism spectrum use avatars and robot technology to help develop their social skills and attention orientation (Georgescu, Kuzmanovic, Roth, Bente, & Vogeley, 2014; Rajendran & Mitchell, 2000). Research on typically developed populations has suggested that perceived anthropomorphism, or the attribution of human characteristics, can increase perceptions of homophily (Nowak, Hamilton, & Hammond, 2009), presence, and message clarity (Nowak et al., 2015). However, previous research findings (Begum et al., 2016; Grynszpan, Martin & Nadel, 2008; Moore & Calvert, 2000; Parsons & Mitchell, 2001) and the theories of executive dysfunction and social motivation suggest that those with ASD process these digital entities differently from typically developed individuals.

Those with ASD characteristically process information differently than their typically developed peers (Carter, Williams, Hodgins, & Lehman, 2014; Jarrold, et al., 2013; Moore, Cheng, McGrath, & Powell, 2005; Parsons, 2016), and this influences how they use and react to technology (Carter et al, 2014; Jarrold, et al., 2013; Moore et al., 2005; Parsons, 2016).
Furthermore, when individuals with ASD are presented with information in a mediated context, it can positively affect their performance outcomes (Jarrold, et al., 2013; Parsons, 2016), attention (Carter et al., 2014), social skills (Moore et al., 2005) and decision-making. However, as a social information training tool, multimedia interfaces (text with dynamic, animated avatars) were less effective as a training tool for those with ASD than simple interfaces (text with pictures) (Grynszpan et al., 2008).

When persons with ASD interact with digital characters (Georgescu et al., 2014) and text chat, they feel more confident than they do offline in their ability to communicate, and they are better able to discern social cues (Rajendran & Mitchell, 2000). Nonetheless, when presented with several variations of robots and avatars, in face-to-face and mediated interactions, those with ASD preferred non-human like characters and robots to more human-like characters (Begum et al., 2016; Parsons & Mitchell, 2001). Thus, it is important to consider individual differences and the end-users needs when it comes to developing and applying this technology (Begum et al., 2016).

Mediated communication can be effective, but the effectiveness can vary with the type of digital character. While several studies have included digital characters based on what the researcher perceives to be a more humanlike character, or their opinions of anthropomorphism (Chaminade et al., 2015; Kristen, Vuori, & Sodian, 2015; Sartorato, Przybylowski, & Sarko, 2017), but they have not explicitly measured a participant’s perceptions of anthropomorphism. Therefore, this project will measure perceptions of anthropomorphism, and the unique reactions of those with ASD to anthropomorphism as compared to a typically developed population. Furthermore, this study will test how differences in perceived anthropomorphism affect perceptions of the source of the message (affective content) or satisfaction with the instructor.
The Centers for Disease Control and Prevention 2014 report indicates that one in every six children (aged 6 to 17) will be diagnosed with one or more developmental disability, such as attention deficit disorder (ADD), autism spectrum disorders (ASD), learning disabilities, hearing or vision loss, etc. The rate of autism spectrum disorders (ASD) increased by 119.4 percent since 2000 (1 in 150) to 2010 (1 in 68) (Centers for Disease Control and Prevention, 2014), and this trend is likely to continue. While little research in communication and education has addressed the unique needs of this population, almost half of the individuals identified on the autism spectrum have average to above-average intellectual abilities (CDC, 2014), and are likely to be included in the college and university population. Thus, it is important for researchers and educators to consider how they use these digital characters for teaching those with ASD.

According to the CASA (computers as social actors’ framework) framework, individuals will process virtual entities similarly to offline entities (Nowak et al., 2015; Reeves & Nass, 1996). Therefore, it is vital to understand the underlying factors that influence the variance in perceptions of the same digital characters across individuals (Nowak et al., 2015). Thus, this research will test several relationships: i) investigate the relationship between ASD and responses to anthropomorphism when viewing human and non-human instructors ii) investigate the relationship between anthropomorphism, homophily, and perceptions of self and other-copresence for typically developed persons and those with ASD, and iii) the impact of these variables on and attitudes toward the instructor. The paper includes a discussion of the differences in information processing for typically developed individuals and those with ASD. Finally, the paper will address the theoretical and practical implications of the results for researchers and designers of educational technology, with particular attention paid to designing systems for those with ASD.
Chapter II: Literature Review

Information Processing Theory and Executive Dysfunction

Models and theories predicting the differences individuals experience processing and reacting to messages focus primarily on factors related to attention and comprehension of a message (Hamilton & Nowak, 2005; McGuire, 1968; Miller, 2011). Information processing theories and models examine the flow of information. Information processing involves multiple stages, and the process begins with some input or information that may or may not be lost at any point during processing (Miller, 2011). Universally, these theories argue that an individual’s mental processing capacity is finite and limits their ability to attend to message content (Baddeley, 2000; Munakata, 2006; Miller, 2011; McGuire, 1968). These theoretical models make two main predictions: i) people are limited in both the speed and amount of information that they attended to and, ii) thinking is a flexible process (Miller, 2011; Siegler & Alibali, 2005). Humans inherently have a limited capacity and speed at which they can attend to and process information simultaneously (Miller, 2011; McGuire, 1968). Therefore, individuals adapt and allocate resources to control the flow of information based on what they perceive to be relevant and essential stimuli (Miller, 2011; McGuire, 1968; Siegler & Alibali, 2005). The primary factor influencing comprehension is attention and how one chooses to control the allocation of their limited resources (Hamilton, 1997; Miller, 2011).

Information processing theories posit that there is a positive correlation between an individual’s ability to attend to and comprehend content, and the impact of the message’s effect (Hamilton & Nowak, 2005; Miller, 2011). Thus, individuals must first be compelled to allocate their attention to a message and a source so that information can be used in future situations or decisions. The channel (e.g., video, audio, face-to-face) one uses, message content, and
individual receiver level differences in attention and comprehension all affect changes related to perception, attitude, and opinion of a source or message (Miller, 2011; McGuire, 1968). People respond to technology with similar categorical responses that they might have to offline entities. Thus, computer users will assign social rules and expectations to a computer or stimuli that appear responsive and shows intelligence and emotion (Nowak et al., 2009; Nass & Moon, 2000). The assignment of these human categories is an example of perceptions of social potential. Accordingly, information-processing theory posits that individuals pay more attention to sources they see as dynamic or having greater social potential (McGuire, 1968). Attention allocated to the source of the message could be a distraction for some learners and take away from the resources they have to evaluate a message.

The information-processing model begins with a message or problem that requires attention and ends with a person drawing some conclusion about the information presented, or storing it in long-term memory (Miller, 2011). During the first stage of information processing, message exposure, yielding or attention to the message, and possible comprehension of the content may occur (Miller, 2011; McGuire, 1968). During the second stage, an individual may evaluate both the source and the message content (McGuire, 1968). Information processing theories hypothesize that as a person’s knowledge increases, so does their involvement in a topic. Involvement in the topic can lead to a more significant change in behaviors or attitudes (McGuire, 1968; Hamilton & Nowak, 2005). However, individuals have a fixed and limited capacity to process this information, and in order for yielding to occur, individuals must be able to inhibit attention to irrelevant stimuli (Miller, 2011; McGuire, 1968). Furthermore, individuals are motivated by “enduring dispositions or innate unconscious rules” as to how they will allocate these resources (Lachman, Butterfield, & Butterfield, 1979). However, many individual
differences influence this process, and the responses are different for individuals with issues related to executive function, such as those with ASD (Rajendran et al., 2011; Robinson et al., 2009).

**Autism Spectrum Disorders and Executive Dysfunction**

The theory of executive dysfunction focuses on the difficulties that an individual faces with tasks such as initiating, sustaining, shifting, inhibition, and stopping (Rajendran & Mitchell, 2007). Planning, decision-making, judgment, and self-perception abilities relate to these specific executive dysfunctions and those diagnosed with ASD (Landry & Taie, 2016; Miyake et al., 2000; Rajendran & Mitchell, 2007). Taken together with the limited resources that individuals have available for processing information, individuals that experience problems with these specific executive functions are at a marked disadvantage. Therefore, when individuals have trouble with these specific executive functions, and they are processing multiple streams of information targeted at affective content (a source), and task information (the message), they may struggle with shifting between the two streams of information.

Many individuals with ASD have trouble with specific executive functions, such as mental flexibility and self-monitoring (Hill, 2004; Robinson et al., 2009). These functions correspond to an individual’s planning, decision-making, and judgment skills, as well as their self-perception (Rajendran & Mitchell, 2007). Accordingly, the theory of executive dysfunction predicts that individuals who have trouble with attention switching, and those with highly focused interests, will also have trouble in planning, mental flexibility, inhibition, and self-monitoring (Hill, 2004; Robinson et al., 2009). Therefore, when individuals with ASD struggle with attention switching and mentalizing, they may have problems shifting their attention
between information directed at the source and content directed at understanding new information (Palmer, Paton, Enticott, & Hohway, 2014).

Cognitive overload and information processing theories posit that individuals not only have a limited capacity for processing information but in the presence of competing stimuli, no single message will receive sufficient attention for processing (McGuire, 1968; Jeong & Fishbein, 2007; Mayer & Moreno, 2003; Junco, 2012). When a person encounters more information than their processing capacity can manage, some of the information may not be comprehended (Miller, 2011). Thus, when persons with ASD are engaged in processing both task information (a message) and affective content (the avatar,) they may not process the information as effectively as typically developed individuals.

**Executive dysfunction and attention switching.** Many individuals with ASD struggle with attention switching. Persons that struggle with attention switching have trouble remaining on task and focusing when trying to attend to multiple sources of information or stimuli. Those with attention switching problems cannot self-monitor. Self-monitoring helps individuals direct their attention to the essential information and disregard the less essential stimuli. Thus, those that struggle with this particular executive function are unable to inhibit themselves from paying attention to distractions or to information that is not relevant, and they fight to return their focus if they are distracted. Essentially, this means that people who struggle with attention switching have difficulty maintaining focus and adjusting behavior when alternate competing information is present (Hill, 2004; Robinson et al., 2009), and they experience greater difficulty than their typically developed peers do when moving from one task to the other (Hill, 2004; Rajendran et al., 2011). Therefore, when individuals with ASD are processing an avatar that they find difficult to process, they may struggle with staying on task and processing the
message. The competing streams of information may also reduce the satisfaction a person experiences in a learning environment, or satisfaction with the instructor.

**Executive dysfunction and mentalizing.** The ability to take into account your mental state as well as the mental state of others is the ability to mentalize (Rajendran & Mitchell, 2007). Those with ASD often struggle with their ability to discern the mental states of others. Avatars perceived as more humanlike, responsive, or those that show emotion or intelligence, are viewed as having greater social potential (Nowak et al., 2015; Nowak et al., 2009). Mentalizing requires processing information about the social potential of an interaction partner. Individuals tend to invest more resources in processing avatars that they deem higher in social potential (Nowak et al., 2009). Therefore, individuals that struggle with mentalizing may struggle more than typically developed persons when processing an avatar that has greater social potential.

The overarching central assumption of information processing is that attention is a primary factor in understating (McGuire, 1968; Miller, 2011; Hamilton, 1997). Typically-developed individuals can move easily from one task to another and will devote attention to the more difficult task. However, individuals with ASD typically struggle when moving fluidly from one task to another, and will struggle more with controlling the flow of information and allocating the appropriate level of resources (Mackinlay, Charman & Karimloff-Smith, 2006; Rajendran et al., 2011; Logie, Trawley, & Law, 2011; Woodbury-Smith & Volkmar, 2009). A source that is higher in social potential may serve as more of a distraction for those with ASD. The visual/social information from the avatar may serve as a competing stream of information for those that struggle with mentalizing. Participants that struggle with discerning the mental states of others may find an avatar that is higher in social potential difficult to process. Therefore,
increased anthropomorphism may serve as a distraction for those that express difficulty with mentalizing, and taken together, and this may reduce satisfaction with the instructor.

**Executive dysfunction and social abilities.** Those who struggle with mentalizing and attention switching may also struggle with social skills and social cognition, including processes that aid in the understanding of others (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Happé, Cook & Bird, 2017). These processes include but are not limited to, the quantity of social interaction, emotion recognition, empathy, the degree of attention paid to social stimuli (Happé et al., 2017). Persons that experience trouble with social skills tend to focus more on the self and less on engaging with others (Baron-Cohen, et al., 2001). Therefore, some individuals with ASD tend to engage in repetitive and restricted communication (Woodbury-Smith & Volkmar, 2009).

Fixation on certain social cues or tasks, and the restricted way in which some individuals with ASD communicate may inhibit their processing. Avatars provide a person with information about the interaction partner, and a person’s perception of the avatar can influence later social judgments (Blascovich & Bailenson, 2011; Hamilton & Nowak, 2010; Nowak, Watt, & Walther, 2009; Nowak & Fox, 2018). Even when individuals interact with static two-dimensional images, the more human they perceive the image to be, the more they see it as having social potential (Hamilton & Nowak, 2010; Nowak et al., 2009). Thus, individuals with diminished social skills may find processing a human-looking avatar more challenging than a less human-looking avatar. Therefore, when tasked with processing the avatar along with an informative message, those with communication or social skills problems may experience more difficulty in making source attributions than their typically developed peers may.
CASA and Social Potential

According to the computers as social actor's (CASA) framework, individuals will apply the same perception process to mediated stimuli that they would offline stimuli or persons (Reeves & Nass, 1996; Nowak & Rauh, 2008; Nowak et al., 2015). The CASA framework posits that when individuals interact with one another, it is "fundamentally social and natural" (Reeves & Nass, 1996, p. 5), whether online or offline. The first stage in perceiving a digital representation, or avatar, is determining anthropomorphism, "agency or humanity" (Nowak & Fox, 2018). People typically feel a stronger connection with avatars that visually represent a human, and this can also lead to perceptions of greater social potential (Nowak et al., 2015; Nowak & Fox, 2018). However, when atypical individuals, with social skill impairments, are processing affective and task-related content with an avatar that they perceive as more human, they may be distracted by social potential. As a result, they may be unable to provide adequate attention to both task and affective content, and involvement and working memory may be impaired. One influential variable in the perception of social potential is the perception of anthropomorphism, or humanness (Nowak & Fox, 2018). Therefore, understanding what variables influence the source perception process is vital in constructing a positive learning environment.

Anthropomorphism is the perception of the appearance or behavioral attributes of humans (Nowak, 2004; Nowak & Biocca, 2003). Anthropomorphism is a concept frequently used in avatar research with typically developed populations. The perception of humanness or anthropomorphism can influence perceptions of social potential (Nowak et al., 2009; Nowak & Fox, 2018). Furthermore, there are variations in the effects of anthropomorphism across the literature. In some instances, more anthropomorphic avatars have been deemed less credible and
likable (Mull, Wyss, Moon & Lee, 2014; Nowak, 2004), while others have found more anthropomorphic images to be more likable and credible (Bengtsson, Burgoon, Cederberg, Bonito, & Lundeberg, 1999; Khan & Sutcliffe, 2014; Luo, McGoldrick, Beatty, & Keeling, 2006; Nowak & McGloin, 2014; Wexelblat, 1998).

The differences in perceptions of anthropomorphism, and its effects, may relate to factors such as previous experience, personality, and other biases. As discussed above, typically-developed people tend to prefer anthropomorphic avatars, but this does not apply to everyone. Studies suggest that people on the autism spectrum prefer less anthropomorphic or even zoomorphic animal avatars to anthropomorphic avatars in online learning environments (Carter et al., 2014; Baron-Cohen, Golan, & Ashwin, 2009). Therefore, greater social potential may not be a positive attribute for those with ASD. The next section discusses how the social motivation theory of autism explains that deficits in social abilities and mentalizing that may account for the preference for less anthropomorphic characters (Chevalier et al., 2017).

**Anthropomorphism and ASD**

Anthropomorphism is comprised of two motivational mechanisms, effectance, and sociality (Epely, Waytz, & Cacioppo, 2007). Effectance is the motivation to interact effectively with non-human agents, and the ability for the interaction to enhance one's predictions of the stimuli's behavior in the present and future (Epely et al., 2007). The anxiety or uncertainty one feels about the interaction can influence the degree to which people tend to anthropomorphize a non-human agent (Epely et al., 2007). Sociality refers to the motivation that a person has to establish social connections with other humans (Epely et al., 2007). Individuals may perceive a non-human agent as more anthropomorphic when they feel a lack of social connection to humans and less anthropomorphic when they feel a strong sense of social connection (Epely et al., 2007).
Additionally, when individuals with ASD process information from a non-human agent, they may feel less anxiety about the interaction and a stronger social connection. The social motivation theory of autism posits that both psychological and biological mechanisms drive individuals to orient toward social interaction and to seek social reward (Chevalier et al., 2017). Thus, individuals prefer engaging in social interaction and typically find that interaction rewarding. However, some individuals with ASD are not as motivated as their typically developed peers are when engaging in social interaction, and they struggle with interpreting social cues and mentalizing (Chevalier et al., 2017). Furthermore, interactions with avatars that have lower social potential may provide those with social and mentalizing deficits the benefit of simplified social cues and less social stimulations (Chevalier et al., 2017; Scassellati, Admoni & Mataric, 2012). Therefore, those with less social motivation will experience an overall decrease in the attentional effort they put forth to interpreting social situations than typically developed persons.

Based on the social motivation theory of autism and the motivational mechanisms discussed, a person's social skills and mentalizing ability may affect perceptions of anthropomorphism. Thus, when individuals struggle more with social interactions and mentalizing, they will perceive the animal cartoon as more anthropomorphic than those that score higher in social skills and mentalizing. The following research questions are included.

**RQ1:** Will people's social skills moderate how anthropomorphic they perceive the avatars?

**RQ2:** Will people's mentalizing abilities moderate how anthropomorphic they perceive the avatars?
Previous research on the influence of avatars has also considered the importance of homophily in the perception process (Nowak et al., 2009; Nowak & Rauh, 2005). Homophily can positively influence the salience of certain attitudes, value judgments, or heuristics, and this can subsequently affect the formation of perceptions (Kennedy-Lightsey, Madlock, Horan & Booth-Butterfield, 2008). Furthermore, homophily increases one’s confidence in predicting behaviors (Rimal, Lapinski, Cook, & Real, 2005; McPherson, Smith-Lovin, Cook, 2001; Rajendran & Mitchell, 2007; Woodbury-Smith & Volkmor, 2009).

**Homophily and ASD**

Psychological homophily is an expression of similarity between a source and a receiver through like qualities with an individual or group rather than heterogeneous individuals (Yuan & Gay, 2006; McCroskey, Richmond & Daly, 1975). Previous research indicates that homophily is a multidimensional construct concerned with perceived similarity (Yuan & Gay, 2006; McCroskey et al., 1975). Furthermore, greater homophily can lead to a sense of effective communication based on perceived similarities (Kennedy-Lightsey et al., 2008).

Homophily can positively influence the connection one feels toward an individual or group and the attitudes they possess (Rimal et al., 2005; McPherson et al., 2001). The greater the sense of likeness, the more pleasant, influential, and frequent interactions will be (Prisbell & Andersen, 1980). Homophily can influence formed attitudes, and therefore, a stronger connection to an individual will facilitate stronger like attitudes (Aubrey, Behm-Morawitz & Kim, 2014; Rimal et al., 2005; McPherson et al., 2001). The stronger the connection, the more confident one is in making predictions about future behavior. As such, predictability allows individuals to more readily process interactions and reduce apprehension (Ibarra, 1992). McCroskey, Richmond, and Daly (1975) found that the more homophily a receiver feels toward
a source, the more communication is likely to occur and be effective. Homophily can also influence heuristics, or the mental scripts, that influence the formation of perceptions (Kennedy-Lightsey et al., 2008). Thus, when individuals are involved in an online interaction where they perceive the other to be more like themselves, they may feel their communication is more productive (Ibarra, 1992; Kennedy-Lightsey et al., 2008; Rourke & McGloin, 2019). Therefore, perceptions of anthropomorphism will positively influence the degree to which an individual feels the avatar is similar to them.

**H1:** Anthropomorphism will positively predict perceptions of homophily.

The implications of perceived similarities within a group and toward an individual are vast and applied in a variety of contexts by both mass and interpersonal scholars. Research examining the use of avatars includes the concept of homophily and the impact of perceived similarity to determine network ties and processes. Additionally, for typically developed participants, perceptions of anthropomorphism significantly predict their perceptions of homophily (Nowak et al., 2009; Nowak & Rauh, 2005). However, based on the theory of executive dysfunction for those that struggle with social skills and mentalizing, a more anthropomorphic avatar may decrease perceptions of homophily. Therefore, social skills and mentalizing will moderate the effect of anthropomorphism on homophily. Atypical individuals may feel a weaker connection with an avatar they perceive to be more anthropomorphic, and this can facilitate decreased homophily.

**H2a:** Participants that score higher on social skills will report less homophily when perceived anthropomorphism is higher than those that score lower on social skills.

**H2b:** Participants that score higher on mentalizing will report less homophily when perceived anthropomorphism is higher than those that score lower on mentalizing.
Mediated communication research frequently cites presence, or the lack thereof, as an essential concept and predictor of communication satisfaction. Presence can be defined as a perception that one has of “being there” and can refer to a psychological connection that one feels with another person (Nowak & Biocca, 2003). Presence is also frequently cited as a significant predictor of student-teacher satisfaction (Richardson, Maeda, Lv, & Caskurlu, 2017; Russo & Benson, 2005; Swan & Shih, 2005) and positive learning outcomes (Elwood et al., 2014; Garrison, Cleveland-Innes, & Fung, 2010; Hostetter & Busch, 2006; Kehrwald, 2008; Richardson et al., 2017; Swan & Shih, 2005; Wei & Chen, 2012) for typically developed students.

**Copresence and ASD**

Copresence is a dimension of presence that focuses on the sense that individuals feel they can perceive others and the extent to which they feel that others can actively perceive them (Biocca, Harms, & Burgoo, 2004; Kehrwald, 2008; Nowak & Biocca, 2003; Sung & Mayer, 2012). Furthermore, copresence indicates a sense of being together and a "psychological connection of minds" (Biocca, Harms, & Burgoo, 2004; Bulu, 2012; Kehrwald, 2008; Nowak, 2001; Sung & Mayer, 2012). Thus, the term copresence refers explicitly to a psychological connection that one feels with another person (Nowak & Biocca, 2003), and does not require the feeling that the user is inside or present in the medium. Additionally, when individuals interact with an avatar that they feel a similarity, too, this can positively influence the connection that they feel, and copresence can increase. Therefore, when individuals experience a greater sense of homophily, they may also feel that the avatar is more salient or copresent.

Research in copresence indicates that measuring copresence necessitates two measures, one measure targeting their perceptions of the interaction partners' involvement (other-
copresence), and their involvement in the interaction (Nowak, 2001). Additionally, other-copresence and self-copresence are reciprocal constructs, and in typically developed populations, perceived other-copresence increases self-copresence (Nowak et al., 2009). Persons that experience the partner more in the interaction also feel more present themselves. Thus, when a participant feels the instructor is more involved in the interaction, the participant will also feel increased involvement in the interaction.

**H3:** Participants that perceive higher anthropomorphism will report more other-copresence than participants who perceive less anthropomorphism.

However, this same pattern may not replicate with atypical populations. Based on theories of information processing, typically developed individuals and atypical individuals are limited in both the speed and amount of information that they can attend to (Miller, 2011; Siegler & Alibali, 2005). Furthermore, information-processing theories posit that a set of known but unconscious rules guide where individuals choose to allocate their attention (Lachman et al., 1979). However, as indicated by the theory of executive dysfunction, this process is more challenging for individuals with issues related to executive function, such as those with ASD. Thus, those with ASD will struggle more when faced with processing multiple streams of information, such as the source (affective content) and content directed at perceived cognitive learning (task content). Therefore, increased other-copresence may not produce the same positive effect on self-copresence for those with ASD that it does for typically developed populations.

The differences in social abilities and mentalizing may account for the difficulty that those with ASD experience in processing avatars that are more anthropomorphic. Persons with ASD tend to focus more on the self and less on engaging with others. Thus, the lack of social
motivation to engage the other, or relate to the others feelings, can inhibit an individual's ability or desire to experience a sense of involvement or perceptions of other-copresence. Individuals that struggle with social skills and mentalizing that interact with a more anthropomorphic avatar may feel challenged in interpreting social cues and be less interested in engaging or feeling other-copresence. Therefore, individuals that express more difficulty with attention switching, social skills, and mentalizing will also express decreased perceptions of other-copresence.

**H4a:** Participants that score higher on attention switching will report less other-copresence when perceived anthropomorphism is higher, than those that score lower on attention switching.

**H4b:** Participants that score higher on social skills will report less other-copresence when perceived anthropomorphism is higher than those that score lower on social skills.

**H4c:** Participants that score higher on mentalizing will report less other-copresence when anthropomorphism is high than those that score lower on mentalizing.

**Executive dysfunction and self-copresence**

Based on the theory of executive dysfunction and information processing, when individuals with ASD are processing both an avatar and a message, they will struggle more than typically developed individuals. Thus, individuals with ASD will struggle with focusing on and their involvement, or self-copresence, in a mediated interaction.

**Attention switching and self-copresence.** As described above, those who struggle with attention switching find processing multiple streams of information, such as an avatar and task content, more challenging than their typically developed peers do. Additionally, inhibition and self-monitoring are what help an individual to stay on task when competing streams of information are present (Hill, 2004; Robinson et al., 2009). Attention switching is directly related
to one's self-monitoring and inhibition, and as a result, individuals with ASD may experience difficulty moving from one task to another (Hill, 2004; Rajendran et al., 2011). Accordingly, when individuals with ASD are processing an avatar that they cannot or do not wish to connect with (other-copresence), they may struggle with staying on task and processing the message. However, individuals with ASD prefer animals to humans, and this may be because they may find them more predictable and less distracting (Scassellati et al., 2012), making them feel increased self-copresence. Therefore, individuals with ASD will perceive the interaction as less effective and desire to be less engaged when the source has high social potential or is highly other-copresent; this will make them want to retreat and may decrease self-copresence.

**H5:** Other-copresence will positively predict self-copresence.

**H6a:** Participants that score higher on attention switching will report less self-copresence when other-copresence is higher than those that score lower on attention switching.

**Social skills and self-copresence.** Typically developed people feel greater self-copresence when they can experience other-copresence or that the other is more involved in the interaction (Biocca et al., 2004; Bulu, 2012; Kehrwald, 2008; Nowak, 2001; Sung & Mayer, 2012). However, as stated earlier, individuals with ASD characteristically struggle with social interactions and taking another's perspective (Klin, McPartland & Volkmar, 2005; Woodbury-Smith & Volkmar, 2009), which is predicted by CASA to transfer over to digital others. The difficulty that those with ASD experience in perspective-taking can inhibit perceptions of other-copresence and then subsequently reduce their sense of involvement in the interaction.

Individuals with ASD tend to prefer interactions with digital others that are animals rather than human. The desire to interact with these less human-like social avatars may provide those with social skills deficits fewer social cues to interpret and thereby a less stressful interaction.
Participants that express difficulty with interpreting social cues will feel less connected to the instructor when they are interacting with an avatar that they perceive as having greater social potential. Increased other-copresence should increase self-copresence (Nowak et al., 2009). However, this pattern will not be the same for those that do not excel at interpreting social cues. Participants that interact with a high anthropomorphic avatar will feel less other-copresence, and thus, self-copresence will be lower.

**H6b:** Participants that score higher on social skills will report less self-copresence when other-copresence is higher than those that score lower on social skills.

**Mentalizing and self-copresence.** Mentalizing or mental flexibility is a person's ability to move from one task to another, and switching between the two sets of rules related to multiple stimuli (Hill, 2004; Hill & Bird, 2006; Robinson et al., 2009; Mackinlay et al., 2006). Typically-developed persons move fluidly between affective and task-related content and can devote attention to more relevant stimuli when more than one stream of information is present. However, based on the theory of executive dysfunction those that struggle with mentalizing, or mental flexibility, may have difficulty controlling the flow of information from multiple sources (Mackinlay et al., 2006; Rajendran et al., 2011; Logie et al., 2011; Woodbury-Smith & Volkmar, 2009). Moreover, individuals can become fixed on one task and find it hard to move to another when they experience trouble with mental flexibility.

When processing an avatar and other stimuli, such as a message, there are competing streams of information, and this can make controlling attention difficult. As a result, when individuals with ASD that struggle with mentalizing and mental flexibility view information from a source that has greater social potential and is more present (other copresence), this creates a challenge for allocating resources and makes the person want to retreat and thereby reduce self
copresence. Individuals with mentalizing and mental flexibility deficits may find an avatar that is less present, and with less social needs more predictable (Scassellati et al., 2012). Therefore, participants that express difficulty with mentalizing may find an instructor more connected to them distracting, and this may reduce their desire to be involved in the interaction.

**H6c:** Participants that score higher on mentalizing will report less self-copresence when other-copresence is higher than those that score lower on mentalizing

**Self-Copresence, Other-Copresence and Perceived Instructor Satisfaction**

The concept of presence is cited as an important variable in perceived learning effectiveness and instructor satisfaction for typically developed populations (Lyons, Reysen, & Pierce, 2012; Wei & Chen, 2012; Weinel, Bannert, Zumbach, Hoppe, & Malzahn, 2011). The conceptualization of social presence captures the degree to which a person feels their interaction partner can create a sense of intimacy and involvement in an interaction (Short, Williams, & Christie, 1976). Increased presence is linked to greater media satisfaction (Nowak et al., 2009), learning interaction satisfaction (Wei & Chen, 2012), less stress in online tasks (Weinel et al., 2011), perceptions of better learning performance (Lyons et al., 2012; Richardson et al., 2017; Swan & Shih, 2005), and instructor satisfaction (Richardson et al., 2017; Swan & Shih, 2005). Thus, when individuals experience a greater sense of social presence, they also feel greater satisfaction.

Greater satisfaction with the learning interaction and the instructor can influence retention, student motivation, persistence, and success (Booker & Rebman, 2005; Kuo, Walker, Belland, & Schroder, 2013; Pike, 1993; Roberts & Styron, 2010; Schreiner & Nelson, 2013). However, the items used to operationalize the concept of social presence infer more about a
person's satisfaction with the medium, and less about the salience of the interaction partner (Nowak & Biocca, 2003; Nowak et al., 2009).

The concept or sense of social presence can also be conceptualized as a dual construct that captures partners in involvement in an interaction (other-copresence) and a participant's sense of involvement in the interaction (self-copresence) (Nowak, 2001). Self and other copresence are two distinct measures that capture a participant's feelings of psychological involvement. Other-copresence indicates the degree to which a participant feels a connection to their interaction partner, and self-copresence is about a participant's involvement in the interaction (Nowak, 2001). Thus, based on the previous findings, increased other copresence and self-copresence should facilitate greater instructor satisfaction (Lyons, Reysen, & Pierce, 2012; Wei & Chen, 2012; Weinel, Bannert, Zumbach, Hoppe, & Malzahn, 2011). However, individuals that have trouble with attention switching, social skills, and mentalizing may be better able to learn and pay attention when they feel less self-copresence, and this may result in increased satisfaction when their perceptions of involvement are lower. Therefore, less self-copresence may serve as a positive predictor of teaching satisfaction for those with ASD.

**H7:** Self-copresence will positively predict instructor satisfaction.

**H8a:** Participants that score higher on attention switching will report less instructor satisfaction when self-copresence is higher than those that score lower on attention switching.

**H8b:** Participants that score higher on social skills will report less instructor satisfaction when self-copresence is higher than those that score lower on social skills.

**H8c:** Participants that score higher on mentalizing will report less instructor satisfaction when self-copresence is higher than those that score lower on mentalizing.
Typically developed individuals express greater satisfaction in online learning environments when they feel their instructor is involved (Lyons, Reysen, & Pierce, 2012; Wei & Chen, 2012; Weinel, Bannert, Zumbach, Hoppe, & Malzahn, 2011). However, individuals that have trouble with attention switching, social skills, and mentalizing may be better able to learn and pay attention when they feel their instructor is less involved in their interaction. Therefore, decreased other-copresence may result in increased satisfaction when those with mentalizing, social skills, and attention switching difficulty feel less other-copresence. Therefore, less other-copresence may serve as a positive predictor of teaching satisfaction for those with ASD.

**H9:** Other-copresence will positively predict instructor effectiveness.

**H10a:** Participants that score higher on attention switching will report less instructor satisfaction when other-copresence is higher than those that score lower on attention switching.

**H10b:** Participants that score higher on social skills will report less instructor satisfaction when other-copresence is higher than those that score lower on social skills.

**H10c:** Participants that score higher on mentalizing will report less instructor satisfaction when other-copresence is higher than those that score lower on mentalizing.
CHAPTER III: METHODS

Design and Procedure

This study adopted a quasi-experimental, posttest-only two-group design. First, all of the subjects took the AQ (the autism spectrum quotient) and answered some basic demographic questions. The experiment included random assignment into one of two conditions. The source of the message in the first condition was a cartoon dolphin avatar (dolphin=1), and in the second condition was a human (male) cartoon avatar (human=2) (See Appendix A). The human and the dolphin avatar were dynamic, and they read a script aloud about the Environment Protection Act (EPA) (Appendix B) to the participants. Finally, when the avatar finished the presentation, participants completed the remaining survey questions about the variables of interest.

Study Sample

The participants for this study were all male and recruited from three sources. The typically developed participants were recruited through a Qualtrics participant pool (n = 198). The participants with ASD were recruited from two sources, an ASD Facebook group (n = 150) and the Interactive Autism Network (IAN) (n = 68). All of the participants received an Amazon gift card for their participation. Additionally, all of the ASD participants indicated they had received a clinical diagnosis of ASD from a trained professional.

Recent research in ASD has identified a potential male bias in the diagnostic tools used to capture this disorder (Loomes, Hull, & Mandy, 2017; Ratto et al., 2017). Previous research studies estimate that males are four times more likely to receive an ASD diagnosis over females (Ratto et al., 2017). However, a recent meta-analysis indicates that males are approximately three times more likely to qualify for a diagnosis, and these diagnostic tools are more likely to miss females (Loomes et al., 2017) Thus, the current tools available for non-clinical application are
not designed to address the differences in the presentation of this disorder for females. Therefore, this research examined the differences only within the male population, as males will be more likely to score on the AQ measures than females. The participants recruited were males between the ages of 18-25. These criteria helped to circumvent the gender bias inherent in the AQ and best represent college-aged students. The initial sample included 416 male participants. After removing incomplete responses and participants that did not qualify \((n=14)\), a sample of 402 responses were retained in the final sample. There were 199 male participants in the dolphin cartoon condition and 204 in the human cartoon condition.

The majority of the participants identified as completing varying degrees of college education: 36.1\% \((n=146)\), Bachelor’s degree 19.3\% \((n=78)\), Master’s degree 2.7\% \((n=11)\) or having their high school diploma 32.7\% \((n=132)\). The remaining participants indicated that they had completed their general education diploma (GED): 9.2\% \((n=37)\). The ethnical composition of the study was 51.2 \% Caucasians \((n=207)\), 21 \% African American \((n=85)\), 13.6 \% Hispanic \((n=55)\), 8.9 \% Asian \((n=36)\), 2.7 \% other \((n=11)\), and 2.5 \% Native American \((n=10)\).

**Study Stimuli**

**Pilot test**

The pilot test included four avatars. The test included measures of perceived anthropomorphism and realism. The pilot test included 183 participants from two communication courses at a large Northeastern University. The sample included 44 percent males \((N=82)\) and 54 percent females \((N=101)\). The participants first viewed still images of a human cartoon avatar and then three animal cartoon avatars: a dolphin, a manatee, or a gorilla (See Appendix C). The participants rated each of the avatars on perceptions of anthropomorphism and realism. The
scales used were 7-point Likert scales (See Appendix D). The participants all saw the human avatar first, and each of the three animal cartoons appeared in random order.

To test the differences in anthropomorphism and realism, a between-subjects ANOVA was conducted to compare the animal avatars and the human. The analysis of variance for anthropomorphism showed that the effect of anthropomorphism was significant at the p < .001 level for the four conditions, $F(3,714) = 513.1, p = .000$ (See table 1). Post hoc analyses (See Table 2) using the Fishers LSD post hoc criterion for significance indicated that the mean difference was significantly higher in the dolphin avatar condition ($M = 3.70$) than in the manatee ($M = 3.14$) or the gorilla condition ($M = 2.62$).

[INSERT TABLE 2 HERE]

Next, a one-way between-subject ANOVA compared the animal avatars on perceptions of realism. The analysis of variance for realism showed that the effect of realism was significant at the p < .001 level for the four conditions $F(3,704) = 336.7, p = .000$. Post hoc analyses (See Table 3) using the Fishers LSD post hoc criterion for significance indicated that realism was significantly higher in the manatee avatar condition ($M = 2.54$) than in the dolphin ($M = .41$) condition. There were no significant differences in the gorilla condition ($M = .10$).

[INSERT TABLE 3 HERE]

The dolphin cartoon was significantly different on perceptions of anthropomorphism, which is the primary focus of this study. Additionally, the dolphin cartoon was closest in perceptions of realism with the human cartoon avatar. The avatars needed to vary on perceptions of anthropomorphism, but both needed to be similar in perceptions of realism.
Measures

The measures used in this research underwent a confirmatory factor analysis (CFA) to determine the validity of the measure. The CFA included the items recommended by the literature for each scale. The CFA also included measures for internal and external consistency. Three criteria tested item quality (Nowak, Hamilton & Hammond, 2009). The first criterion, which concerned the content validity of the items, was homogeneity of item content (face validity), and Items had to tap into the same underlying theme. The coefficient alpha and the homogeneity of the items support the internal consistency of the measure (Williams & Monge, 2001). The second criterion was internal consistency, measured with coefficient alpha (unidimensionality), which examines whether the matrix of correlations among the items on the scale is relatively flat. The inter-item correlation for each of the following scales, and the items, is at .44 or higher. The third criterion was parallelism, also known as external consistency, which examines the extent to which each item on a scale correlates with other scales in the study to approximately the same degree (in the case of similar item quality) or forms a gradient. High inter-item correlation and parallelism determine the external consistency of the scales used (Williams & Monge, 2001).

The Autism Spectrum Quotient

The AQ is a self-reported measure used to determine the extent to which an individual identifies with traits related to this disorder (Baron-Cohen, Hoekstra, Knickmeyer, & Wheelwright, 2006). The AQ consists of 50 items measured on a seven-point metric (1 = strongly disagree to 5 = strongly agree) capturing five areas related to AQ: communication, social skills, imagination, attention to detail, and attention switching and has been summed together to form one scale in previous research (Baron-Cohen, et al 2006). Previous research
treated the AQ as a cumulative score; however, recent research (Stevenson & Hart, 2017) examined the use of this scale as a Likert measure and validated its use as a continuous variable within a neurotypical population. The AQ in this study served as a means of examining individual-level differences on the sub-dimensions of the AQ, and their relationship with outcome variables. The CFA results confirmed four dimensions of the scale identified through face validity, though only three dimensions (social skills, attention switching, mentalizing) retained sufficient items to allow the creation of a useable scale. These scales do not share a unidimensional factor structure. Therefore, the three dimensions (social skills, attention switching, and mentalizing) were treated as separate constructs.

The factors were tested based on the three-factor solution tested and applied in previous research (Palmer et al., 2014; Rourke & McGlown, 2019). The final scales for the AQ (See Table 3) retained twenty of the original items that comprise the separate subscales identified as Social Skills (items: 15, 17, 22, 26, 38, 44, & 47), Attention Switching (items: 10, 25, 32, 34, & 37), and Mentalizing (items: 3, 8, 14, 27, 31, 36, 40, & 50). The scales met the criterion to determine parallelism. The lowest correlation within factors for social skills ($r = .43$) attention switching ($r = .45$) and mentalizing ($r = .47$) met the criterion for external consistency. The scales also showed good internal consistency in this study: (social skills: $\alpha = .83$; attention switching: $\alpha = .73$; mentalizing: $\alpha = .78$).

The participants who reported having a diagnosis of ASD were significantly different on the AQ scales from those who did not have ASD (See Table 5). An analysis of variance indicates that participants without ASD scored significantly higher on social skills attention switching ($M = 3.87$, $SD$) and mentalizing.
**Anthropomorphism**

Anthropomorphism included five items (See Table 4), measured using seven points from not at all to very much (Nowak et al., 2009). The final scales for the human cartoon avatar and the dolphin cartoon avatar retained all five items. The scales met the criterion to determine parallelism. The lowest correlation within factors for dolphin cartoon anthropomorphism \( r = .67 \) and the human cartoon anthropomorphism \( r = .60 \) met the criterion for external consistency. The scales also showed good internal consistency in this study: (dolphin cartoon: \( \alpha = .88 \); human cartoon: \( \alpha = .87 \)).

**Homophily**

McCroskey, Richmond, and Daly’s (1975) measure (See Table 4) captures a participant’s perception of perceived homophily. The operational definition of the construct includes measures of attitude and background as well as status (McCroskey et al., 1975). The scale includes seven items, measured using seven points from strongly disagree to strongly agree. The scale includes items such as "This person/avatar thinks like me", and "This person/avatar is like me".

The final scale retained five items. The scale met the criterion to determine parallelism. However, two items had low internal consistency, and they were not included. The items removed were 1. My instructor thinks like me, 6. My instructor’s status is like mine. The scales met the criterion to determine parallelism. The lowest correlation within factors for the remaining dolphin cartoon homophily items \( r = .44 \) and the human cartoon homophily items \( r = .60 \) met the criterion for external consistency. The scales also showed good internal consistency in this study: (dolphin cartoon: \( \alpha = .67 \); human cartoon: \( \alpha = .80 \)).
Copresence

Nowak & Biocca’s (2003) measure captured the participant’s perceptions of copresence using two scales (See Table 4), of perceived other-copresence, and self-reported copresence.

**Perceived other-copresence.** The scale includes eleven items, measured using seven points from strongly disagree to strongly agree. The scales include items such as, “My interaction partner was intensely involved in our interaction,” “My interaction partner seemed to find our interaction stimulating,” and “My interaction partner communicated coldness rather than warmth.” Based on the inter-item correlations, the final scales for the human cartoon avatar and the dolphin cartoon avatar retained six of the original items. The items removed were, 3. My instructor communicated coldness rather than warmth. 4. My instructor created a sense of distance between us. 5. My instructor seemed detached during our interaction. 6. My instructor was unwilling to share personal information with me. 9. My instructor acted bored by our conversation. The scales met the criterion to determine parallelism. The lowest correlation within factors for the remaining dolphin cartoon other-copresence scale \( r = .59 \) and human cartoon other-copresence scale \( r = .67 \) met the criterion for external consistency. The scales also showed good internal consistency in this study: (dolphin cartoon: \( \alpha = .87 \); human cartoon: \( \alpha = .87 \)).

**Self-reported copresence.** The scale includes five items, measured using seven points from strongly disagree to strongly agree. The scales include items such as, “The avatar was intensely involved in our interaction” and “The avatar created a sense of closeness between us.” The final scales for the human cartoon avatar and the dolphin cartoon avatar retained all five items. The scales met the criterion to determine parallelism. The lowest correlation within factors for dolphin cartoon self-reported copresence \( r = .53 \) and the human cartoon self-reported
copresence \(r = .75\) met the criterion for external consistency. The scales also showed good internal consistency in this study: (dolphin cartoon: \(\alpha = .84\); human cartoon: \(\alpha = .91\)).

**Perceived instructor satisfaction**

The measure is a modified scale (See Table 4) from Nowak, Watt, & Walther (2009). The scale includes eight items, measured using seven points from strongly disagree to strongly agree. The scales include items such as, “To what extent did you feel you got a good enough idea of how your instructor was reacting?”, “Do you think you got a ‘‘feel’’ for your instructor at the other end?” The final scales for the human cartoon avatar and the dolphin cartoon avatar retained all eight items. The scales met the criterion to determine parallelism. The lowest correlation within factors for dolphin anthropomorphism \(r = .57\) and for the human anthropomorphism \(r = .47\) met the criterion for external consistency. The scales also showed good internal consistency in this study: (dolphin cartoon: \(\alpha = .87\); human cartoon: \(\alpha = .89\)).

[INSERT TABLE 4 HERE]
CHAPTER IV: RESULTS

Descriptive Statistics

Table 4 presents all of the factor loadings, means, and standard deviations for the scales used.

Manipulation Check

First, a factorial ANOVA compared perceptions of anthropomorphism in the human avatar condition to those in the dolphin avatar condition, ASD diagnosis, and no diagnosis, and the interaction effect. Table 8a shows that there is a significant effect for ASD diagnosis $F(1, 391) = 58.46, p = .000$, on perceptions of anthropomorphism. Condition is also a significant predictor $F(1, 391) = 28.00, p = .000$, of anthropomorphism (see Table 8b). However, there is no significant interaction between condition and ASD diagnosis on perceptions of anthropomorphism. This study is largely concerned with perceptions of anthropomorphism and not the effect of condition.

Additionally, while having a diagnosis of autism may affect these perceptions, most of the hypotheses in this study look at the sub-dimension of the AQ. However, it is essential to look at the diagnosis in totality first and then examine the unique contribution of each sub-scale. Previous research indicates that the subscales do not always correlate with one another and therefore are not a unidimensional construct (Palmer et al., 2014; Rourke & McGloin, 2019). Furthermore, each scale provides a unique explanatory power that would be lost by examining a binary measure of diagnosis.
Hypothesis Testing

The hypotheses in this study were all tested using hierarchal regression analysis. The categorical variables in the study were effect coded. The avatars were coded (human=2, and dolphin=1) (see Table 7), and the participants were coded based on diagnosis (ASD=-1, no ASD=1) (see Table 8). Hierarchical regression is the best method to see the effect of the individual AQ measures and perceived anthropomorphism, beyond the effects of condition and diagnosis. The condition and diagnosis are multiplied together to create an interaction term. The second step of the regression model included the interaction term to examine the effect of the interaction on perceptions of anthropomorphism and the (see Table 9). All of the regression analyses included two steps. The first step included the direct effect of ASD diagnosis and the direct effect on the independent variables proposed by each hypothesis. The second step included the proposed interaction term for the hypothesis. The interactions for each hypothesis were computed by first centering the variables using the appropriate z-score, and then the z-scores were multiplied to compute the interaction.

Based on the social motivation theory of autism, research question one proposed that an individual’s social skills might influence how anthropomorphic they perceive the avatars. This model was significant, but in the opposite direction than the theory predicts. The condition did have a significant effect on perceptions of anthropomorphism $F(1, 393) =22.87, p < .001$, and the human cartoon avatar significantly and positively predicted perceptions of anthropomorphism ($\beta = .24, p < .001$). Additionally, a participants social skills also significantly affected perceptions of anthropomorphism $F(2, 392) = 21.89, p < .001$. Social skills positively predicted ($\beta = .21, p < .001$) an additional 5 percent of the variance explained ($R^2 = .10, \Delta R^2 = .05$) in perceptions of anthropomorphism.
Based on the social motivation theory of autism research, question two proposed that an individual’s mentalizing abilities might also influence how anthropomorphic they perceive the avatars. However, this model was not significant. Condition was significant $F(1, 391) = 22.33, p < .001$; and it was found that the human cartoon avatar positively predicted perceptions of anthropomorphism ($\beta = .23, p < .001$). However, mentalizing did not affect perceptions of anthropomorphism.

Hypothesis 1 predicted that typically developed individuals would experience more homophily when they perceive anthropomorphism to be higher. Therefore, there will be a direct effect of anthropomorphism on homophily and the interaction between ASD diagnosis and anthropomorphism. The first model contained the direct effect for anthropomorphism and ASD diagnosis on homophily, and the model was significant $F(2, 387) = 5.28, p < .01$, and predicted 3 percent ($R^2 = .03$) of the variance explained in perceptions of homophily. Anthropomorphism was the only significant predictor ($\beta = .17, p = .001$ of homophily). The second model included the interaction effect of ASD diagnosis and perceived anthropomorphism on homophily proposed by hypothesis 1. This model was also significant $F(3, 386) = 7.34, p = .000$ and the interaction predicts an additional 2 percent ($R^2 = .05, \Delta R^2 = .02$) of the variance in perceptions of homophily. The significant predictors are anthropomorphism ($\beta = .16, p < .01$), and the interaction between ASD diagnosis and anthropomorphism ($\beta = .17, p = .001$) homophily. The regression model provides support for hypothesis 1. Thus, a follow-up test will clarify the moderation effect of ASD.

A follow-up test will clarify the relationship between anthropomorphism and perceptions of homophily as moderated by ASD – categorized as low (-1 no ASD) and high (+1 ASD). As demonstrated in Figure 1, the simple slope was statistically significant at a high level ($\beta = \ldots$
.05, \( p = .000 \)). Therefore, those with ASD expressed more homophily with the more anthropomorphic avatar than those without ASD.

Hypothesis 2a predicted that social skills would moderate the relationship between anthropomorphism and homophily. Therefore, there should be a direct effect of anthropomorphism on homophily and the interaction between social skills and anthropomorphism. The first model contained the direct effect for ASD diagnosis and anthropomorphism on homophily, and the model was significant \( F(3, 386) = 3.85, \ p = .01 \). The model predicted 3 percent \( R^2 = .03 \) of the variance explained in perceptions of homophily. The significant predictor of homophily was anthropomorphism \( (\beta = .17, \ p < .01) \). The second model included the interaction between social skills and anthropomorphism, the model was significant \( F(4, 385) = 5.11, \ p = .001 \); the interaction predicted an additional 2 percent \( R^2 = .05, \Delta R^2 = .02 \) of the variance in perceptions of homophily. The significant predictors are, anthropomorphism \( (\beta = .17, \ p < .01) \) and the interaction between social skills and anthropomorphism \( (\beta = .15, \ p < .01) \).

A follow-up test will clarify the relationship between anthropomorphism on perceptions of homophily as moderated by social skills – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 2, the simple slope was statistically significant at the medium \( (\beta = .09, \ p = .00) \) and high level \( (\beta = .22, \ p = .000) \). Therefore, those with ASD expressed more homophily with the more anthropomorphic avatar than those without ASD. This effect is in the opposite direction.

Hypothesis 2b predicted an interaction effect for mentalizing and anthropomorphism on homophily. Thus, those that struggle more with mentalizing will feel less homophily with the more anthropomorphic avatar than they will with the less anthropomorphic avatar. The first
model included anthropomorphism, mentalizing, and ASD diagnosis. The model was significant \( F(3, 384) = 6.24, p < .001 \) and predicted 5 percent \( (R^2 = .05) \) of the variance explained in perceptions of homophily. The significant predictors are anthropomorphism \( (\beta = .13, p < .05) \) and mentalizing \( (\beta = -.17, p < .01) \). The second model included the interaction between mentalizing and anthropomorphism, and the model was significant \( F(4, 383) = 6.92, p < .01 \). The interaction between mentalizing and anthropomorphism predicted an additional 2 percent \( (R^2 = .07, \Delta R^2 = .02) \) of the variance in perceptions of homophily. The significant predictors are anthropomorphism \( (\beta = .15, p < .01, p < .05) \), mentalizing \( (\beta = -.14, p < .05) \) and the interaction \( (\beta = .15, p < .01) \). The regression model provides support for hypothesis 2b.

A follow-up test will clarify (see Figure 3) the moderation effect of mentalizing at different levels – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 2, the simple slope was statistically significant at medium \( (\beta = .11, p = .001) \) and high levels \( (\beta = .22, p < .01) \). The figure and results indicate those that struggle more with mentalizing experienced more homophily with the more anthropomorphic avatar than the less anthropomorphic avatar. The results are significant but in the opposite direction predicted.

Hypothesis 3 hypothesized that typically developed individuals would experience more other-copresence when they perceive anthropomorphism to be higher. Thus, there will be a direct effect of anthropomorphism on other-copresence and the interaction between diagnosis and anthropomorphism. The first model included the direct effect for homophily, ASD diagnosis, and anthropomorphism on perceptions of other-copresence. The first model was significant \( F(3, 384) = 6.34, p = .000 \); and predicted 5 percent of the variance \( (R^2 = .05) \) in perceptions of other copresence. The significant predictors in the first model are anthropomorphism \( (\beta = .18, p = \)
.001) and homophily ($\beta = .11, p < .05$). The second model included the interaction for ASD diagnosis and anthropomorphism; the model was significant $F(4, 383) = 14.04, p = .000$, and predicted an additional 5 percent of the variance in perceptions of other copresence ($R^2 = .10, \Delta R^2 = .05$). The significant predictors in the second model are anthropomorphism ($\beta = .18, p = .001$), and the interaction ($\beta = .24, p = .000$).

A follow-up test will clarify the relationship between anthropomorphism and perceptions of other-copresence as moderated by ASD – categorized as low (-1 no ASD), and high (+1 ASD). The results (see Figure 4) indicate that those with autism experience greater other-copresence with the more anthropomorphic avatar than those with a diagnosis. The effect is significant, but the effect is in the opposite direction.

Hypothesis 4a predicted that there would be an interaction between attention switching and anthropomorphism. Thus, those that struggle more with attention switching will experience less other-copresence with the more anthropomorphic avatar. The first model included ASD diagnosis, homophily, anthropomorphism and attention switching. The model was significant $F(4, 383) = 9.12, p = .000$, and predicted 9 percent ($R^2 = .09$) of the variance in perceptions of other copresence. The significant predictors in the second model are anthropomorphism ($\beta = .16, p < .01$) and attention switching ($\beta = -.22, p = .000$). The second model included the interaction effect and the model was significant $F(5, 382) = 8.22, p < .05$. The interaction accounts for an additional 1 percent ($R^2 = .10, \Delta R^2 = .01$) of the variance explained in perceptions other-copresence. The significant predictors are anthropomorphism ($\beta = .15, p < .01$), homophily ($\beta = .10, p < .05$), attention switching ($\beta = -.23, p = .000$), and the interaction ($\beta = -.10, p < .05$).
A follow-up test will clarify the relationship between anthropomorphism and other-copresence as moderated by mentalizing – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 5, the simple slope was statistically significant at low ($\beta = .19, p = .000$) and medium levels ($\beta = .12, p < .01$). The figure indicates that those that struggle more with mentalizing will experience less other-copresence when anthropomorphism is high.

Hypothesis 4b predicted that social skills would moderate the effect of anthropomorphism on other-copresence. The first model included ASD diagnosis, homophily, anthropomorphism, and social skills. The model was significant $F(4, 383) = 7.16, p = .000$; and predicted 6 percent ($R^2 = .06$) of the variance in perceptions of other-copresence. Anthropomorphism ($\beta = .19, p = .000$), homophily ($\beta = .11, p < .05$), and social skills ($\beta = -.17, p < .01$) were significant positive predictors of other-copresence. The interaction effect of social skills and anthropomorphism proposed by 4b was not significant.

Hypothesis 4c predicted that mentalizing would moderate the relationship between anthropomorphism and other-copresence, such that those that are lower in mentalizing will experience less other-copresence than those higher in mentalizing. The first model contained ASD diagnosis, anthropomorphism, homophily and mentalizing and the model was significant $F(4, 381) = 7.30, p =.000$. The model predicts 6 percent ($R^2 = .06$) of the variance explained in perceptions of other-copresence. Anthropomorphism ($\beta = .15, p = .01$) and mentalizing ($\beta = -.19, p < .01$) are significant predictors of other-reported copresence. The second model included the interaction effect for mentalizing and anthropomorphism on other-copresence; the model is significant $F(5, 380) = 7.15, p =.000$ and predicts an additional 1 percent ($R^2 = .07, \Delta R^2 = .01$) of the variance explained in perceptions of other-copresence. The
significant predictors in the final model are anthropomorphism ($\beta = .13, p < .05$), mentalizing ($\beta = -.22, p = .000$), and the interaction ($\beta = -.13, p = .05$).

A follow-up test will clarify the relationship between anthropomorphism and other-copresence as moderated by mentalizing – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 6, the simple slope was statistically significant at low ($\beta = .22, p = .000$) and medium levels ($\beta = .14, p = .000$). The figure indicates that those that struggle more with mentalizing will experience less other-copresence when anthropomorphism is high.

Hypothesis 5 tests the direct effect for other-copresence, on self-copresence. The first model included the direct effect for other-copresence, homophily, ASD diagnosis and anthropomorphism on perceptions of self-copresence; model is significant $F(4, 381) = 25.24, p = .000$ and accounts for 21 percent ($R^2 = .16$) of the variance explained in perceptions of self-copresence. The model included significant direct effects for ASD diagnosis ($\beta = .10, p < .05$) anthropomorphism ($\beta = .40, p = .000$) and other-copresence ($\beta = -.20, p = .000$). The final model included the interaction and the model was not significant.

Hypothesis 6a tested the interaction between attention switching and other-copresence on self-copresence. Hypothesis 6a predicts that those who struggle more with attention switching will experience less self-copresence when other-copresence is high. The first model included the main effect for ASD diagnosis homophily, attention switching, anthropomorphism, and other-copresence. The model was significant $F(5, 380) = 28.16, p = .000$ and accounts for 21 percent ($R^2 = .21$) of the variance explained in perceptions of self-copresence. The significant predictors in the model are ASD diagnosis ($\beta = .12, p < .05$), anthropomorphism ($\beta = .40, p = .000$) and other-copresence ($\beta = -.20, p = .000$). The second block included the interaction effect with
attention switching and other-copresence. The model was significant \( F(6, 379) = 26.448, p = .000 \), and predicts an additional 3 percent \( (R^2 = .24, \Delta R^2 = .03) \) of the variance explained in self-copresence. The significant predictors in the second model are anthropomorphism \( (\beta = .40, p = .000) \), other-copresence \( (\beta = -.22, p = .000) \), and the interaction was a significant predictor \( (\beta = -.17, p = .000) \). The regression model provides support for hypothesis 6a. Thus, a follow up test will clarify the moderation effect of attention switching at different levels.

A follow-up test will clarify the relationship between other-copresence on perceptions of self copresence as moderated by attention switching – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 6, the simple slope was statistically significant at medium \( (\beta = -.12, p < .05) \) and high levels \( (\beta = -.33, p = .000) \). The figure and results indicate those that struggle more with attention switching skills experienced less self copresence when other-copresence was high than those that struggle less with attention switching.

Hypothesis 6b tested the interaction between social skills and other-copresence on perceptions of self-copresence. Hypothesis 6b predicts that those who score higher on social skills will experience less self-copresence when other-copresence is high. The first model was significant \( F(5, 380) = 39.13, p = .000 \) and predicts 21 percent \( (R^2 = .21) \) of the variance explained in perceptions of self-copresence. The significant predictors are anthropomorphism \( (\beta = .40, p = .000) \) and other-copresence \( (\beta = -.19, p = .000) \). The second model included the interaction, and there were no significant interaction effects for social skills and other-copresence on self-copresence.

Hypothesis 6c tested the interaction between metalizing and other-copresence on perceptions of self-copresence. Hypothesis 6c predicts that those who score higher on
mentalizing will experience less self-copresence when other-copresence is high. The first model included the direct effects for anthropomorphism, homophily, ASD diagnosis, other-copresence, and mentalizing. The model was significant $F(5, 378) = 20.71, p = .000$ and accounts for 21 percent ($R^2 = .21$) of the variance explained in perceptions of self-copresence. The significant predictors are ASD diagnosis ($\beta = -.35, p < .05$), anthropomorphism ($\beta = .41, p = .000$), and other-copresence ($\beta = -.20, p = .000$). The second model included the interaction effect between mentalizing and other-copresence and was not significant.

Hypothesis 7 tested the direct effect of ASD diagnosis, self-copresence, and the interaction on instructor satisfaction. The first [block included the main effects of ASD diagnosis, anthropomorphism, homophily, and self-copresence. The model was significant $F(4, 378) = 14.79, p = .000$ and predicts 14 percent ($R^2 = .14$) of the variance in perceptions of instructor satisfaction. The significant predictors of instructor satisfaction are homophily ($\beta = .15, p < .01$) and self-copresence ($\beta = -.36, p = .000$). The interaction in the second model was not significant.

Hypothesis 8a tested the interaction between attention switching and perceptions of self-copresence on instructor satisfaction. The first model included the direct effect for ASD diagnosis, anthropomorphism, homophily, attention switching and self-copresence; the model was significant $F(5, 377) = 19.89, p = .000$ and predicts 15 percent ($R^2 = .15$) of the variance in perceptions of instructor satisfaction. The significant predictors of instructor satisfaction are, homophily ($\beta = .13, p < .01$), attention switching ($\beta = -.16, p < .01$), and self-copresence ($\beta = -.36, p = .000$). The second model included the interaction between attention switching and self-copresence on instructor satisfaction; the model was significant $F(6, 376) = 19.61, p = .000$ and predicts an additional 3 percent ($R^2 = .17, \Delta R^2 = .03$) of the variance explained in instructor satisfaction.
satisfaction. The predictors are; homophily ($\beta = .14, p < .01$), self-copresence ($\beta = -.37, p = .000$), attention switching ($\beta = -.16, p < .01$), and the interaction between attention switching and self-copresence ($\beta = -.17, p = .000$). The regression model provides support for hypothesis 8a. Thus, a follow up test will clarify the moderation effect of mentalizing at different levels.

A follow-up test will clarify the relationship between self-copresence on perceptions of instructor satisfaction as moderated by attention switching – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 8, the simple slope was statistically significant at the low ($\beta = -.16, p = .00$), medium ($\beta = -.30, p = .000$), and high levels ($\beta = -.46, p = .000$). The figure and results indicate those that struggle more with attention experienced greater instructor satisfaction when self copresence was low than those that struggle less with attention switching.

Hypothesis 8b tested the interaction between social skills on perceptions of self-copresence on instructor satisfaction. The first model included the direct effects for ASD diagnosis, anthropomorphism, homophily, social skills and self-copresence on instructor satisfaction; the model was significant $F(5, 377) = 16.15, p = .000$ and predicted 18 percent ($R^2 = .18$) of the variance in perceptions of instructor satisfaction. The significant predictors in the model were homophily ($\beta = .16, p = .001$), social skills ($\beta = -.23, p = .000$), self-copresence ($\beta = -.34, p = .000$). The second model included the interaction between social skills and self-copresence and was not significant.

Hypothesis 8c tested the interaction between mentalizing and self-copresence on instructor satisfaction. The first model included the direct effects for ASD diagnosis, anthropomorphism, mentalizing and self-copresence on instructor satisfaction; the model was significant $F(5, 375) = 11.82, p = .000$ and predicts 13 percent ($R^2 = .13$) of the variance. The
significant predictors are homophily ($\beta = .13, p = .01$), mentalizing ($\beta = -.11, p < .05$), and self-copresence ($\beta = -.35, p = .000$). The second model included the interaction between mentalizing and self-copresence and the model was significant $F(6, 374) = 11.61, p < .01$ and predicts an additional 2 percent ($R^2 = .16, \Delta R^2 = .02$). The significant predictors are homophily ($\beta = .14, p = .01$), mentalizing ($\beta = -.12, p < .05$), self-copresence ($\beta = -.37, p = .000$), and the interaction ($\beta = -.15, p < .01$). The regression model provides support for hypothesis 8c. Thus, a follow up test will clarify the moderation effect of mentalizing at different levels.

A follow-up test will clarify the relationship between self copresence on perceptions of instructor satisfaction as moderated by mentalizing – categorized as low (-1 SD below the mean), medium (mean), and high (+1 SD above the mean). As demonstrated in Figure 9, the simple slope was statistically significant at the low ($\beta = -.19, p = .000$), medium ($\beta = -.31, p = .000$), and high levels ($\beta = -.43, p = .000$). The figure and results indicate that those who struggle more with mentalizing experienced greater instructor satisfaction when self-copresence was low than those that struggle less with mentalizing.

Hypothesis 9 tested the main effect of ASD diagnosis, other-copresence and the interaction on instructor satisfaction. The model included the direct effects for ASD diagnosis, anthropomorphism, homophily, self-copresence, and other-copresence; the model was significant $F(5, 375) = 49.15, p = .000$ and predicts 39 percent ($R^2 = .39$) of the variance in instructor satisfaction. The significant predictors are homophily ($\beta = .10, p < .05$), self-copresence ($\beta = -.24, p = .000$) and other-copresence ($\beta = .53, p = .000$). The second model included the interaction and the model was not significant.

Hypothesis 10a tested the interaction between attention switching and other-copresence on instructor satisfaction. The first model included the direct effects for ASD diagnosis,
homophily, anthropomorphism, self-copresence, other-copresence, and attention switching; the model is significant $F(6, 374) = 41.13, p = .000$ and predicts an additional 39 percent ($R^2 = .39$) of the variance perceptions of instructor satisfaction. Self-copresence ($\beta = -.24, p = .000$) and other-copresence ($\beta = .52, p = .000$) are the significant predictors of instructor satisfaction. The final model included the interaction between mentalizing and other-copresence, and the model was not significant.

Hypothesis 10b tested the interaction between social skills and other-copresence on instructor satisfaction. The first model included the direct effects for ASD diagnosis, homophily, anthropomorphism, self-copresence, other-copresence and attention switching; the model was significant $F(6, 374) = 43.60, p = .000$ and predicts 12 percent ($R^2 = .40$) of the variance in perceptions of instructor satisfaction. The significant predictors were homophily ($\beta = -.10, p = .01$), self-copresence ($\beta = -.23, p = .000$), other-copresence ($\beta = .51, p = .000$) and social skills ($\beta = -.14, p < .01$). The second model included the interaction between attention switching and other-copresence, and the model was not significant.

Hypothesis 10c tested the interaction between mentalizing and other-copresence on instructor satisfaction. The first model included the direct effects for ASD diagnosis, homophily, anthropomorphism, self-copresence, mentalizing, and other-copresence. The first model was significant $F(6, 372) = 39.40, p = .000$ and predicts 38 percent ($R^2 = .38$) of the variance in instructor satisfaction. Homophily ($\beta = .09, p < .05$), self-copresence ($\beta = -.23, p = .000$), and other-copresence ($\beta = .53, p = .000$) are the significant predictors of instructor satisfaction. The final model included the interaction between mentalizing and other-copresence, and the model was not significant.
<table>
<thead>
<tr>
<th>Summary of Hypotheses</th>
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<tbody>
<tr>
<td><strong>RQ1:</strong> No Social skills will moderate perceptions of anthropomorphism.</td>
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<tr>
<td><strong>RQ2:</strong> Yes Mentalizing will moderate perceptions of anthropomorphism</td>
</tr>
<tr>
<td><strong>H1:</strong> Yes Anthropomorphism will positively predict perceptions of homophily. ASD diagnosis will moderate the effect of anthropomorphism on homophily, such that those with an ASD diagnosis will perceive less homophily than those without a diagnosis.</td>
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<tr>
<td><strong>H2a:</strong> No Participants that score higher on social skills will report less homophily when perceived anthropomorphism is higher than those that score lower on social skills.</td>
</tr>
<tr>
<td><strong>H2b:</strong> Yes Participants that score higher on mentalizing will report less homophily when perceived anthropomorphism is higher, than those that score lower on social skills.</td>
</tr>
<tr>
<td><strong>H3:</strong> Yes Anthropomorphism will positively predict other-copresence. ASD diagnosis will moderate this effect, such that those with an ASD diagnosis will perceive less other-copresence when anthropomorphism is high than those without a diagnosis.</td>
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<tr>
<td><strong>H4a:</strong> Yes Participants that score higher on attention switching will report less other-copresence when perceived anthropomorphism is higher, than those that score lower on attention switching.</td>
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<tr>
<td><strong>H4b:</strong> Yes Participants that score higher on social skills will report less other-copresence when perceived anthropomorphism is higher, than those that score lower on social skills.</td>
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<tr>
<td><strong>H4c:</strong> Yes Participants that score higher on mentalizing will report less other-copresence when anthropomorphism is high than those that score lower on mentalizing.</td>
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<tr>
<td><strong>H5:</strong> Yes Other-copresence will positively predict self-copresence. ASD diagnosis will moderate the effect of other-copresence on self-copresence, such that those with an ASD diagnosis will perceive less self-copresence when other-copresence is high than those without a diagnosis.</td>
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<tr>
<td><strong>H6a:</strong> Yes Participants that score higher on attention switching will report less self-copresence when other-copresence is higher, than those that score lower on attention switching.</td>
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<tr>
<td><strong>H6b:</strong> No Participants that score higher on social skills will report less self-copresence when other-copresence is higher, than those that score lower on social skills.</td>
</tr>
<tr>
<td><strong>H6c:</strong> No Participants that score higher on mentalizing will report less self-copresence when other-copresence is higher, than those that score lower on mentalizing.</td>
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<tr>
<td><strong>H7:</strong> Yes Self-copresence will positively predict instructor satisfaction. ASD diagnosis will moderate the effect of self-copresence on instructor satisfaction, such that those with an ASD diagnosis will perceive less instructor satisfaction when self-copresence is high than those without a diagnosis.</td>
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<tr>
<td><strong>H8a:</strong> Yes Participants that score higher on attention switching will report less instructor satisfaction when self-copresence is higher, than those that score lower on attention switching.</td>
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<tr>
<td><strong>H8b:</strong> No Participants that score higher on social skills will report less instructor satisfaction when self-copresence is higher, than those that score lower on social skills.</td>
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<tr>
<td><strong>H8c:</strong> No Participants that score higher on mentalizing will report less instructor satisfaction when self-copresence is higher, than those that score lower on mentalizing.</td>
</tr>
<tr>
<td><strong>H9:</strong> No Other-copresence will positively predict instructor effectiveness. ASD diagnosis will moderate the effect of other-copresence on instructor satisfaction, such that those with an ASD diagnosis will perceive less instructor satisfaction when other-copresence is high than those without a diagnosis.</td>
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<td>H10a:</td>
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<td>H10b:</td>
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<td>H10c:</td>
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CHAPTER V: DISCUSSION

Summary of Findings

This study is one of the first to examine the effect of perceptions and self and other-copresence with ASD participants. Based on the theory of executive dysfunction, when a person struggles with mentalizing, social skills, and attention switching, they will process information differently than their typically developed peers. The existing literature in education emphasizes the importance of presence as a significant predictor of learning satisfaction online. The results from this study indicate that presence is an important construct, but self-copresence and other-copresence are discreet constructs and should be separate measures. Furthermore, the individual measures of the AQ confirm that individual characteristics also play an essential role in the perception process.

Information processing theory and the theory of executive dysfunction taken together support the assumptions proposed by this study. Individuals have a limited capacity to process information, and for those that experience specific issues related to executive function, they process information differently than their typically developed peers. The literature on the impact of presence in education emphasizes the importance of presence in distance learning. The studies in this specific area emphasize the importance of presence as a significant predictor of student satisfaction and motivation (Booker & Rebman, 2005; Kuo, Walker, Belland, & Schroder, 2013; Pike, 1993; Roberts & Styron, 2010; Schreiner & Nelson, 2013), as well as instructor satisfaction (Lyons, Reysen, & Pierce, 2012; Wei & Chen, 2012; Weinel, Bannert, Zumbach, Hoppe, & Malzahn, 2011). However, as the results from this study indicate that presence is not a singular construct, and all participants do not respond to increased presence in the same way. Participants in the study that scored higher on the measures of the AQ specifically related to attention
switching and mentalizing experience digital environments differently than their typically developed peers. The results from this study also show that these unique individual differences can lead to less satisfaction with the instructor when the user experiences increased presence in the interaction. Additionally, the results from this study show that those on the spectrum process anthropomorphism and perceptions of copresence differently than their TD peers.

The first question posed by this study specifically examined perceptions of humanness or anthropomorphism for those with ASD. The research examining how those with ASD respond to less humanlike characters has not explicitly examined anthropomorphism as a variable. The results from this study first show that those with ASD do not perceive anthropomorphism or self-copresence in the same way that their typically developed peers do. The social motivation theory of autism explains that those with ASD may not prefer engaging with persons or, in the case of this study, digital entities that they perceive to have greater social potential. Individuals with ASD may find greater social potential less rewarding because they do not seek social rewards, and they find those interactions less rewarding. The social entities may be less rewarding because of problems with specific social skills, but also to deficits related to executive functions. The results from this study show that when participants with ASD interacted with an avatar that they rated as more anthropomorphic, they experienced increased homophily with the avatar. The results also indicate that individual differences in social skills and mentalizing predicted a stronger feeling of homophily with the more anthropomorphic avatar.

The findings are not in the predicted direction, but they make sense theoretically. The human avatar is perceived, as "more human" than the dolphin, but the human avatar is, in fact, still a digital representation of a human. The CASA paradigm has established that individuals will apply social rules when interacting with computers (Reeves & Nass, 1996). The more that
computers or digital entities exhibit greater social potential, the more likely they are to be rated as anthropomorphic. Previous research examining avatars with typically developed participants found a positive correlation between perceptions of anthropomorphism and homophily. The results from this study support those findings for those that scored higher on the AQ scales related to social skills and mentalizing.

Based on the theory of executive dysfunction, those with ASD tend to struggle with self-perception, planning, and judgment. Therefore, these specific executive dysfunctions might affect perceptions of homophily or similarity with an avatar perceived as having greater social potential. The results from the moderation analysis indicate that when individuals struggled more with social skills and mentalizing, they experienced more homophily with the more anthropomorphic avatar. Previous research indicates that those with ASD prefer robots and less humanlike characters, but these studies did not measure a participant's perceptions of anthropomorphism. The findings from this study indicate that homophily was higher with the more humanlike avatars, even for participants that are on the autism spectrum. The results signify that while individuals with ASD may prefer robots and less humanlike characters, they feel similar to humanlike representations. The human avatar is, in fact, more similar to the participants in the study than a dolphin, and thus, the effect for anthropomorphism is unaffected by a participant's social skills or mentalizing ability. The avatars used in this study were dynamic, but they cannot display emotion or to show a wide range of facial expressions. This may account for the lack of variance in homophily for those with ASD. A more "humanlike" avatar that can emote more may produce different results.

This study also supports the assertion that those with ASD may not benefit from increased social potential, specifically increased perceptions of self-copresence. The more
anthropomorphic avatar in this study did increase perceptions of self-copresence as predicted. Additionally, there is a positive direct effect for other-copresence on self-copresence. However, those that expressed trouble with attention switching and mentalizing did not feel more self-copresence when other-copresence was high. Finally, the results show that when other-copresence is high, participants felt less self-copresence, and lower self-copresence serves as a positive predictor of instructor satisfaction. The results indicate that those that expressed more difficulty with mentalizing and attention switching prefer to feel less self-copresence in the online environment.

Anthropomorphism positively correlates with greater perceptions of self and other copresence. Furthermore, when other-copresence is higher, participants also feel more self-copresence. However, based on the theory of executive dysfunction, those that struggle more with attention switching, social skills, and mentalizing will experience less self-copresence when other-copresence is higher. The theory of executive dysfunction identifies that when individuals have trouble with mental flexibility, they are not able to move fluidly from one task to another. As a result, participants must attend to the avatar in tandem with the content of the message. Therefore, they must attempt to understand the other and the message simultaneously.

Participants in this study listened to a message about the environmental protection act. However, the avatar in this study represents the second stream of content that participants must process. The avatar also represents a stream of information that contains a varying degree of social potential. A participant's ability to mentalize, or understand others can make it difficult to focus on the message and affect their ability to feel present in the learning environment. There were no significant moderation effects for social skills; however, attention switching and
mentalizing produced significant moderation effects between other-copresence and perceptions of self-copresence.

Typically, when other-copresence is high, participants also feel they are more copresent (self-copresent). However, based on the theory of executive dysfunction, individuals with ASD may process information differently than their typically developed peers. The results from this study provide support for the assertions that increased other-copresence did not increase self-copresence for those with ASD. The hierarchal regression analysis conducted included the main effect of anthropomorphism on perceptions of self-copresence. The literature indicates that when anthropomorphism is high, self-copresence will increase. However, the results from this study show that when a person struggles more with their ability to take the perspectives of others (mentalize), increased other-copresence negatively affects self-copresence. Thus, when participants expressed more difficulty mentalizing, they experienced less self-copresence when other-copresence was high. Figure 7 illustrates that when participants struggle more with mentalizing and they are with an avatar, they have rated higher in other-copresence; they feel less self-copresence—these effects held at both low med and high levels of mentalizing.

Therefore, increased other-copresence and anthropomorphism can be beneficial on their own to increase a student's sense of being present. However, an individual's ability to imagine the perspectives of others will significantly affect their sense of self-copresence. The results indicate that a participant's perception of anthropomorphism positively affects their self-copresence. However, when participants struggle more with mentalizing increased other-copresence will negatively affect self-copresence. The negative effect of self-copresence did not negatively predict instructor satisfaction. The participants that struggle with mentalizing expressed greater instructor satisfaction when they felt less presence in the interaction and, this
follows with the theory of executive dysfunction and the difficulties that those with ASD experience when processing multiple streams of information. Thus, when self-copresence is lower and the participants do not feel that they need to process themselves in the interaction, they likely feel they can concentrate more on the instructor and the content.

The participants that expressed difficulty with attention switching also felt less self-copresence when other-copresence was high. The competing streams of information that are present when presented with a dynamic avatar and a message pose a potential problem for those that struggle with staying on task and regulating the flow of information. Therefore, when other-copresence is high, participants are processing entities that also have more potential that is social. The more anthropomorphic avatar is higher in social potential and, in turn, increased perceptions of other-copresence. However, this is not true for those that struggle with attention switching. Figure four shows that those both high and low on attention switching will perceive less self-copresence when other-copresence is high. Thus, the more anthropomorphic avatar is less critical for those with ASD.

Participants that express difficulty with mentalizing and attention switching may find a source that is higher in copresence to be distracting, and this affects their ability to feel more self-copresence. The current literature in education emphasizes the importance of greater instructor presence. However, the results of this study indicate that this may not be important for all types of students. Information processing theories posit that individuals have a limited capacity to process stimuli, and allocating resources properly aids in processing information. These findings show that those with ASD are less involved when an instructor is more salient. Thus, processing an avatar perceived as more copresent, and the content aimed at understanding, can be more challenging for persons with ASD. Participants did express greater instructor
effectiveness when self-copresence was high. However, as postulated, this was not the case for those with ASD. The participants that struggle more with mentalizing and attention switching expressed greater instructor effectiveness when self-copresence was low.

Information processing theory states that all individuals have a limited capacity to attend to information. Taken together with the theory of executive dysfunction, individuals that struggle with attention switching, or moving fluidly from one task to another, will experience greater difficulty than their more typically developed peers will. The results from Figure 5 support these theoretical models and the proposed hypothesis. The participants that expressed more trouble with attention switching in the low, medium, and high conditions expressed lower instructor satisfaction when self-copresence was high.

Based on the study findings, all that can be determined is that those participants that express social skills deficits rate the instructor regardless of condition or perceptions of anthropomorphism, as less satisfactory. One of the core areas that define autistic disorders is a deficit in social skills. Therefore, future research will need to disentangle which type of virtual instructor would work best for those that struggle with social skills. The conclusion delves into a more in-depth discussion of this finding.

Avatars that are more anthropomorphic are important to instructor satisfaction. However, for those that experience problems with mentalizing their self-copresence and mentalizing abilities can affect instructor satisfaction beyond perceptions of anthropomorphism. Figure 6 shows that when individuals struggle more with mentalizing, they report lower instructor satisfaction when their self-copresence is high. Based on the theory of executive dysfunction those that struggle with mentalizing, or mental flexibility, typically experience difficulty controlling the flow of information from multiple sources (Mackinlay et al., 2006; Rajendran et
al., 2011; Logie et al., 2011; Woodbury-Smith & Volkmar, 2009). Participants fixed on one a
task, perhaps perceiving themselves, will have trouble moving to another. Processing another
entity in an online setting can prove to be more difficult for those with mentalizing deficits.
Therefore, increasing self-copresence for those with mentalizing deficits decreases instructor
satisfaction.

**Theoretical Implications**

The concept of presence, despite the many varied conceptualizations, has been cited as an
essential variable in perceived learning effectiveness (Lyons, et al., 2012; Wei & Chen, 2012;
Weinel et al., 2011), learning interaction satisfaction (Wei & Chen, 2012), less stress when
completing online tasks (Weinel et al., 2011) and perceptions of better learning performance
(Lyons et al., 2012). However, as this study indicates a person's ability to mentalize and switch
attention effectively moderates this effect. This study shows that when participants struggle in
these areas and self-copresence is low, instructor effectiveness is higher. Therefore, less self-
copresence serves as a positive predictor of instructor satisfaction for those with difficulties
associated with ASD.

Social skills did have a significant main effect on perceptions of instructor satisfaction.
Participants in the study that scored higher on the social skills scale reported lower levels of
instructor satisfaction. The participants that score higher on social skills are those that express
greater trouble with social interaction. The results for this main effect should be included in
future research to understand the relationship between social skills and instructor satisfaction.

The results from this study show that creating learning environments with the notion that
increased copresence is best, may not be effective for all students. This study is just the first step
in understanding the types of avatars that influence perceptions of anthropomorphism,
homophily, and copresence for those with ASD. The findings from this study contribute to a better understanding of the mechanisms that affect the atypical processing of visual information and can inform better intervention and education programs.

**Study Limitations**

There are limitations to this study that influence the interpretation of the findings. First, this study used an all-male sample; this was systematic and was decided based on previous research findings regarding the use of the Autism Spectrum Quotient. However, this does limit the interpretations made from this work. The findings do show that males may require less self and other-copresence in mediated learning with an avatar. Increased self and other-copresence may be beneficial for females. Previous research has shown that males and females with ASD present differently and thereby there needs for copresence may vary as well. Future work should include females as both the instructor and student to compare and contrast those results with the findings from this study. Women present differently than men on the autism spectrum, and thus the results may vary for them. Women may prefer a greater sense of presence in learning interactions.

The Autism Spectrum Quotient captures the degree to which an individual identifies with the autistic phenotype. However, as this study indicates, and others before it (Palmer et al., 2014; Rourke & McGloon, 2019), this is not a unidimensional construct. The three-factor solution proposed by this work is consistent with other studies that have tested the AQ factor structure (Rourke & McGloon, 2019). Furthermore, there is a male bias that is present in the current measure that makes it difficult to capture how females vary. Individuals on the autism spectrum vary on each of these dimensions, and women specifically show different results. Future
researchers should examine these sub-dimensions and develop a more robust tool that will more accurately capture females and males that identify with this phenotype.

Next, because this study only recruited male participants and the avatars both used a male voice, the effect for this variable may be different if female participants were included in the sample. The participants may have felt they were similar to the avatar based on gender matching. Therefore, future studies should include both male and female participants, as well as instructors.

Finally, this study used information about the environmental protection agency. Participants and instructors may find that increased social potential and presence are more effective with different objectives or goals in mind. The goals set out for this study were clear in trying to identify the need for increased social presence when task-related information was present. Future studies could look at the importance of increased social potential and copresence when the focus is on social skills training or group learning. Finally, research in mediated education could benefit from an exploration into a broader range of design variables for all individuals that have trouble in processing and responding to multiple streams of information.

**Conclusion**

The growing population of individuals with an ASD diagnosis and attention deficit disorders, demands that researchers consider this unique population when investigating communication processes and technology use. Previous research has not yet addressed the differences that exist for information processing within this specific population. Finally, this area of research creates many opportunities to develop interventions utilizing mediated communication. Individuals with ASD typically struggle with detecting and interpreting social cues, but avatars and repetitive mediated interactions may help to develop these skills. Engineers
and researchers in robotics have provoked social behaviors using robots for interaction. Research in mediated communication and avatars could make these types of interventions more cost-effective and accessible for those with ASD. Researchers acknowledge that a "universally usable" interface focused on the abilities of special needs users may lead to interfaces that are easier to use for the benefit of all users (Schneiderman, 2000). The findings from this study, and future communication studies, including those with ASD, could inform better design for intervention programs and applications targeting social skills and development as well as education.
Appendicies

Appendix A: Study Stimuli
Appendix B: Avatar Script

On Feb 15th, 2017

Just barely a month into the 115th Congress—Republicans held an oversight hearing in the Senate Committee on Environment and Public Works (EPW) titled, “Modernization of the Endangered Species Act.” Of course, anyone who has followed Congress in recent years knows that this is simply a politically clever way of describing what will in reality be a hearing to discuss how to weaken or repeal the Endangered Species Act altogether.

Why is this important?

The Endangered Species Act has lists of protected plant and animal species both nationally and worldwide. As of October 2009, 1,361 plants and animals in the United States were listed as threatened or endangered. There are many additional species that are currently being evaluated for possible protection under the ESA.

Whether or not a species is listed as endangered or threatened then depends on a number of factors, including the urgency and whether adequate protections exist through other means.

Has a large percentage of the species vital habitat been degraded or destroyed?

Has the species been over-consumed by commercial, recreational, scientific or educational uses?

Is the species threatened by disease or predation?

Do current regulations or legislations inadequately protect the species?

Are there other manmade factors that threaten the long-term survival of the species?
If scientific research reveals that the answer to one or more of the above questions is yes, then the species can be listed under the Endangered Species Act.

Once a species becomes listed as "endangered" or "threatened," it receives special protections by the federal government. Animals are protected from “take” or being traded or sold. A listed plant is protected if on federal property or if federal actions are involved, such as the issuing of a federal permit on private land.

The Endangered Species Act is very important, because it saves our native fish, plants and wildlife from going extinct. Once they are gone, they are gone forever and there is no going back. Losing even a single species can have disastrous impacts on the rest of the ecosystem, because the effects will be felt throughout the food chain. From providing cures to deadly diseases to maintaining natural ecosystems and improving overall quality of life, the benefits of preserving threatened and endangered species are invaluable.

Here are a few species that have been saved due to the endangered species act:

In the 1960s, a mere 500 bald eagles could be found soaring across America's lower 48 states. By the late 1960's, only 400 breeding pairs of bald eagles were found in the lower 48 states. The outlook was not good for our national symbol. Thanks to the protections afforded by the Endangered Species Act, bald eagle numbers have rebounded to more than 7,000 breeding pairs of bald eagles today.

A 1989 census indicated that the Florida panther population had dropped to between 30 to 50 individuals. Today, the species population is still below 100 individuals, but without Endangered Species Act protections the panther would likely be extinct.
Gray wolves once ranged across the entire North American continent. However, by the mid-20th century, only a few hundred of the species remained in the entire lower 48 states. Today, thanks to Endangered Species Act protections, more than 2,500 wolves reside in Minnesota, roughly 500 wolves in Wisconsin and Michigan and another 500 individuals in western states.

These are just a few of the animals that have been saved from extinction. Many more plants and animals can be saved with continued support of this vital act.
Appendix C: Pretest Avatars
Appendix D: Pretest Questionnaire

**Anthropomorphism**
Nowak, 2006

Seven point Likert scale.

1. This image looks human
2. This image has human features
3. This image has human-like expressions
4. This image is life-like
5. This mage looks very realistic
6. This image looks very cartoon like

**Masculinity and Femininity**

Seven point Likert scale.

1. This avatar looks masculine
2. This avatar looks feminine

**Realism**

Nowak, Hamilton, & Hammond, 2009

Four bipolar adjectives on a seven point interval:

1. Real to Not Real
2. Cartoon-like to Photorealistic
3. Natural to Artificial
4. Possible to Impossible (in response to: “Do you think this image could possibly exist outside the computer screen.”).
### Table 1 Pretest Descriptives

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*Note. CI = confidence interval; LL = lower limit, UL = lower limit.*  
*p < .001*

Table 3  
*Multiple Comparisons of Avatar Realism*

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*Note. CI = confidence interval; LL = lower limit, UL = lower limit.*  
*p = .001*
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Scale Means, Standard Deviations, and Inter-item Correlations

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Table 6
Comparisons of ASD Participants and Non ASD on AQ

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Note. CI = confidence interval; LL = lower limit, UL = lower limit.
(-1 = No ASD, 1 = ASD diagnosis)
Table 7

Means for DV’s by Condition

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>COND</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
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Table 8a:

Pairwise Comparisons

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<th>(J) ASD</th>
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<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig. b</th>
<th>95% Confidence Interval for Difference b</th>
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</table>

Based on estimated marginal means

* The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).
Table 8b: 

*Pairwise Comparisons*

**Dependent Variable: ANTHRO**

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<tr>
<th>(I) COND</th>
<th>(J) COND</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval for Difference</th>
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Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).
Table 9

*Means for DV's by Diagnosis*

<table>
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<th>Dependent Variable</th>
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<th>Std. Error</th>
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<th>Lower Bound</th>
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Table 10

*Correlation Matrix*

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**. Correlation is significant at the 0.01 level (2 tailed)
*. Correlation is significant at the 0.05 level (2 tailed)
Figure 1: Hypothesis 1

Appendix F: Figures
Figure 2: Hypothesis 2a
Figure 3: Hypothesis 2b
Figure 4: Hypothesis 3
Figure 5: Hypothesis 4a
Figure 6: Hypothesis 4c
Figure 7: Hypothesis 6a
Figure 8: Hypothesis 6c
Figure 9: Hypothesis 8a
Figure 10: Hypothesis 8c
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Centers for Disease Control and Prevention (2014). Diagnostic Criteria. Retrieved from

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Centers for Disease Control and Prevention (2009). Diagnostic Criteria. Retrieved from

http://www.cdc.gov/ncbddd/autism/hcp-dsm.html


Anthropomorphic bias found in typically developing children, is not found in children


