Eliciting Information from Adults: Quality, Quantity, and their Willingness to Disclose to an Avatar Interviewer

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Abstract

Avatars—digital representations of humans—may be a useful tool in a wide range of areas, such as education, advertising, communication, and health. The overarching goal of the present research was to examine the use of avatars in the context of evidential and clinical interviewing, in the hope that this novel technology could facilitate adults' memory performance and enhance their disclosure of sensitive information. The first specific aim was to examine the effectiveness of an avatar interviewer on adults' accounts of a witnessed event. In this context, adults were interviewed by either a digital-human avatar or a human face-to-face using both free- and directed-recall questions. Some participants also received post-event misinformation that was presented by either the digital-human avatar or the human interviewer. In addition, I examined the impact of several individual differences, including participants' level of autism and personality traits, and their perception of the avatar's operation. Finally, I investigated the effectiveness of avatar interviewers with varying degrees of anthropomorphism on adults' accounts. The second specific aim was to explore the potential for avatar professionals in the context of the disclosure of sensitive information.

In the present thesis, I investigated the effects of two types of avatar interviewers: a more anthropomorphic, 2D cartoon-rendered digital-human avatar, and a less anthropomorphic, speech-wave avatar. The digital-human avatar resembled the appearance of the human interviewers who were also used in the present research, but the avatar's movement was restricted to eye blinks and head tilts. The speech-wave avatar interviewer resembled Apple's Siri. Both types of avatar were voiced and operated by a concealed human interviewer. The digital-human avatar's lips moved in synchrony with the human's speech; the speech-wave avatar moved up and down, also in synchrony with the human's speech. The avatar was displayed on a computer monitor that was placed on a table directly in front of the participant. The interviews involving the human interviewer were conducted face-to-face.

Overall, differences in participants' memory performance was not detected when they were interviewed only once by either a digital-human avatar or a human interviewer. When participants were interviewed twice, on the other hand, participants who were interviewed by the human interviewer were more talkative and provided more correct details than did participants who were interviewed by the digital-human avatar, but their reports were also less accurate during free recall. Still, the digital-human avatar did not protect the participants from the adverse effects of misleading information. Finally, relative to an interview with the digital-human avatar, participants' memory performance was enhanced when the speech-wave avatar interviewed them. In addition to these group-level results, participants with low conscientiousness and autism traits, or who perceived the digital-human avatar as computer-operated, were more accurate in their accounts during free recall when a digital-human avatar interviewed them.

With respect to disclosure, overall, participants preferred to disclose information to a human professional face-to-face rather than to avatar professionals. When I compared the digital-human avatar to the speech-wave avatar, participants preferred to disclose more embarrassing information, particularly sex-related topics, and reported more coherent details about an embarrassing personal event to a speech-wave avatar. In terms of the avatar's characteristics, participants indicated that they would be more comfortable disclosing embarrassing information to an avatar appearing as a female around 45- to 54-years of age.

Collectively, my findings provide initial insight of the potential value and pitfalls of using avatars in evidential and clinical interviewing. In this day and age, humans may have adapted to technology, treating non-human interviewers in much the same way as they treat human interviewers. Still, there is a place for avatars in specific populations, and in the context of disclosing stigmatising experiences. The results of the present research have important implications for designing and using avatars that might aid humans in performing specific tasks in help-seeking settings.

Acknowledgments

With the completion of my Ph.D. thesis (and my clinical training at the end of the year), I had come full circle from when my journey started—in 2001 with a degree in Computer Science. My research on avatars combines my multidisciplinary skills and experiences in technology, psychology, teaching, and clinical training. I believe in the potential value of applying avatars as a novel tool in areas such as evidential interviewing, psychological assessments and treatments, and education.

Throughout the thesis, my two supervisors, Dr. Julien Gross and Professor Harlene Hayne have supported my ideas and interests, and have provided input and guidance from the grand scheme of things to the fine details of this thesis. Their supervision has been impeccable and has taught me many essential research skills. Furthermore, under their supervision, I have learned about the importance of my research and the values of being an academic and a mentor. They are truly people who I have looked up to for the past four years. With their guidance, I am ready for the next step in my career; and as they have done for me throughout the thesis, I, too, will set a high standard for myself in my future career. I thank them for their support and time through the years.

For the past four years, I often think of myself as having resided on a scale—with my research and studies on the one end and my family on the other end. My family has been supportive of my goals and values in life. This thesis is as much mine as it is theirs in terms of the amount of time and effort that has been put into it. I fully appreciate their support, and with the completion of my thesis, I will have more time to support their needs and goals. Furthermore, I hope that I have been a good role model for my children and that, they, too, have learned good work ethics and virtues that will guide their lives.

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Preface

Technology: From This Day Forward, for Better and for Worse

The legendary lost city of Atlantis—ideal for its technological sophistication—was a prescient image of our modern society. Technology—broadly defined as advanced tools—is ubiquitous in the contemporary world. These advanced tools are an integral part of our day-to-day living. For example, driving a car, talking on the phone, or making a cup of coffee all require some form of technology. Humans have evolved to rely on technology to assist in mundane tasks; a sudden absence of technology would revert humans to the prehistoric age and inevitably lead to the extinction of the human race.

Compared to other predatory animals, humans are at the lower end of the food chain. Carnivorous animals have been selected for their physical strength, disease immunity, heightened sensory sensitivity, and the ability to maneuverer through different terrains: fish in water, cheetah on land, falcons in the sky. Animals' physical capabilities are unparalleled by humans, yet, humans dominate the Earth. Humans' mental superiority accounts for our dominance over other species. We were created with one gift—a powerful brain that allows us to overcome our physical deficiencies. We can use our mental capabilities to invent tools that overpower our animal counterparts, immunise us against diseases, heighten our sensory receptivity, and allow us to maneuverer through different terrains. By way of example, the wheel is arguably one of the greatest human inventions. The wheel has allowed us to travel farther than we could have ever imagined—farther than any other animal on Earth; the wheel has allowed us to transport essential needs, like food and water, to unreachable locations.

With the development of more advanced tools, we continue to dominate the land, the water, the sky, and even beyond the stars. Technology is responsible for a large part of our survival and dominance over other species on Earth. As we integrate technology into our lives, we progressively recreate our city of Atlantis.

The First Industrial Revolution: The Birth of Modern Technology

There is often a misconception that technology is synonymous with intricate gadgets, humanoid robots, digitalised machines, and wireless communication. Technology also encompasses simple machines that assist us in meeting fundamental needs. Tools like a hammer, a lever, an abacus, and other similar devices are simple machines adopted by humans to reduce labour. That is, we achieve more with less effort. By definition, technology is a collection of a broad range of tools, machines, devices, and systems that are implemented to solve real-world problems.

Basic forms of technology existed before the invention of modern technology and can be traced back to prehistoric eras before the first fire was lit. Pebble tools and handheld axes made out of rocks and stones existed 4.4 million years ago in the Palaeolithic era—the Old Stone Age—before Homo Sapiens appeared on Earth. Ancient civilisations dating back 3000 years have documented the existence of other forms of technology such as the abacus or an earthquake seismograph.

Modern technology blossomed during the First Industrial Revolution in the 18th century when Thomas Newcomen invented the first productive steam engine. Steam engines replaced manual labour to create more efficient production. Since then, humans have learned to coexist with technology—integrating technology into our lives and relying on it for fundamental needs and sophisticated desires. By way of examples, we can ease the job of assembling a bookshelf using a power tool instead of a handheld screwdriver; we can reach more distal locations by taking a train rather than on foot.

Three centuries have gone by since the First Industrial Revolution. With the advancement of technology, we have further reduced the need for manual labour. As we progress deeper into the 21st century, our reliance on technology in the contemporary world has raised some questions: how do humans interact with technology and what aspects of human thinking, feelings, and behaviours are affected by this advanced technological progression? Empirical evidence has demonstrated that technology may impact people in one or more of the following domains: physical, cognitive, and socio-emotional. These domains, either in isolation or in concert, govern the way people think and behave.

Physical Domain

The physical domain subsumes the structure and functions of our brain and the physiology of our body. Technology has a significant influence on different aspects of the physical domain.

Technology and brain structure. Researchers have now shown that technology can modify the structure of adults' brains. For example, in one study with London city taxi drivers, Maguire et al. (2000) examined hippocampal volume using structural magnetic resonance imaging (MRI) collected from male participants between 32- and 62-years of age who were either experienced taxi drivers (n = 16) or did not have a career driving taxis (n = 50). The two groups showed marked differences in grey matter volume of the hippocampus. Specifically, relative to participants who did not have a career driving taxis, brain imaging of taxi drivers showed larger grey matter volume in the posterior hippocampus of the brain. Furthermore, the grey matter volume of the posterior hippocampus of taxi drivers increased as a function of their number of years of driving experience. Grey matter volume of the posterior hippocampus is linked to higher performance in spatial memory (see Hartley & Harlow, 2012).

Researchers have also reported the effects of digital technology on the brain structure of adolescents. For instance, Kühn et al. (2011) examined structural differences in the brains of adolescents who were or were not regular video gamers. In that study, the researchers analysed structural MRI collected from 154 teenagers (M_{age} = 14.40 years) who were either frequent gamers (spend 9+ hours per week gaming) or infrequent gamers (spend 9 hours or less per week gaming). Relative to infrequent gamers, brain imaging of frequent gamers showed larger grey matter volume in the left ventral striatum. The left ventral striatum is associated with reward processing (see Palaus, Marron, Viejo-Sobera, & Redolar-Ripoll, 2017, for a meta-analysis). These basic findings of the effects of technology on altering brain structure have been replicated in other studies with different types of technology (Kühn, Gleich, Lorenz, Lindenberger, & Gallinat, 2014; Li, Wang, Hu, Liang, & Chen, 2013; Shams et al., 2015).

Technology and brain function. In addition to changes in brain structure, researchers have demonstrated that technology may also influence the brain's functioning. For example, in Kühn et al.'s (2011) study on the impact of playing video games on brain structure, functional MRI (fMRI) was also acquired to examine the influence of gaming on brain function. In that study, fMRI was collected when adolescents completed a reaction-time task and a judgement task. The frequent gamers not only showed larger grey matter volume but also displayed higher activity in the left ventral striatum compared to the infrequent gamers while they completed the two tasks.

In a different study of the possible link between digital gaming and adults' brain function, Han et al. (2011) asked 19 male students between 18- and 23-years of age who were frequent users of the internet and computer to play an online shooting game for 60 mins a day, for 10 consecutive days. The researchers then acquired fMRI data while the participants watched a simulation of the online shooting game. Participants also completed a self-report questionnaire that was designed to assess their desire for playing the shooting game. Functional MRI showed greater activation in participants' parietal and occipital lobes, and in their cerebellum, thalamus, parahippocampal gyrus, and prefrontal cortex as they watched the simulation of the shooting game. Significantly more activity in these regions of the brain was found for participants who indicated a stronger desire for gaming.

On the other hand, however, researchers have also shown that exposure to technology may hinder brain activity. For instance, James and Engelhardt (2012) asked 10 preliterate 5-year-old children to hand write, type on a keyboard, and trace dotted outlines of shapes and letters of the alphabet. Children were presented with a total of 12 letters and 12 shapes. Following the production of the letters and shapes, researchers acquired fMRI, while the same letters and shapes were shown to the children. Relative to hand writing and tracing, fMRI showed lower activity in the inferior frontal gyrus when children typed the letters and shapes on a keyboard. Based on their results, James and Engelhardt suggested that typing letters and shapes may hinder children's ability to recognise symbols due to the rigid and structured nature of these methods in producing shapes. On the other hand, hand writing increases the variability during the production of shapes that may aid in children's categorisation skills and perceptual capabilities of symbols. Researchers have replicated these basic findings on the effects of technology on hindering brain functioning (Longchamp et al., 2008), and on enhancing brain functioning (Wu et al., 2009).

Technology and physiology. Technology not only influences brain structure and functionality, but it may also affect our body's physiology. The area of the body that is influenced depends on the type of technology. For example, Vegad, Kacha, Varu, Mehta, and Shah (2015) investigated the effect of the presence and use of cellular phones on participants' heart rate variability (HRV). Heart rate variability is the variation in time between heartbeats and is an indirect measurement of the autonomic nervous system (i.e., sympathetic and parasympathetic systems). In that study, the HRV of 100 participants between 17- and 25-years of age was measured in the laboratory while a mobile phone was placed beside the participant. The mobile phone was switched off and then switched on, and finally, participants were asked to make a phone call. Relative to when the cellular phone was switched off, females, but not male participants showed an increase in sympathetic activity and a decrease in parasympathetic activity when the cell phone was switched on or during a phone call. These basic findings of the impact of mobile phones on people's HRV have been replicated in other studies (e.g., Ekici, Tanındı, Ekici, & Diker, 2016). Other researchers have also found that screen technology, in general, suppresses melatonin production and affects people's circadian rhythm (e.g., Chang, Aeschbach, Duffy, & Czeisler, 2015).

In another study on the effects of technology on the human body, Higuchi, Motohashi, Liu, and Maeda (2005) examined physiological changes in people who were exposed to a period of computer gaming on a bright screen just before going to sleep. In that study, the researchers randomly assigned seven males between 19- and 30-years of age to one of four conditions: video gaming on a bright screen or a dim screen, and an arithmetic task on a bright screen or a dim screen. In the gaming condition, participants played a shooting game on the computer; the arithmetic task involved participants performing a series of math questions on the computer. The activity in each condition lasted for approximately three hrs in the evening between 11 pm and 1:45 am the next day. Immediately following the activity, rectal temperature, heart rate, and electroencephalogram (EEG) were recorded. Subsequently, participants' rectal temperature was measured and a polysomnogram taken during their sleep.

For the participants in the Gaming, but not the Arithmetic, condition, there was an increase in rectal temperature, heart rate, and sleep latency; shorter rapid eye movement (REM); and lower power levels on EEG. The brightness of the screen had no effect on any of the physiological measures except for heart rate. More specifically, relative to gaming on a dim screen, participants who played the game on a bright screen showed an increase in heart rate. Similar findings on the effects of playing video games on physiological changes have been replicated in other studies (Lee et al., 2018; Liu et al., 2019).

The use of technology impacts some physical aspects of our body and mind. Depending on the cognitive task, exposure to technology may increase activity in one area of the brain but reduce activity in other regions of the brain. These changes may have long-term implications; that is, prolonged exposure to technology may modify the structure of our brain. Our body also reacts to technology in that exposure may increase some aspects of physiology. Whether these changes are an enhancement or a detriment to the physical domain is debatable, but it appears that we are evolving to adapt to the modern technological environment.

Cognitive Domain

Alterations to our brain and body may have ramifications on our cognition. Cognition—the way we process and perform mental tasks—includes knowledge and language acquisition, memory, attention, and the use of strategies to solve problems. Researchers have now shown that technology influences the way we acquire and utilise many of our cognitive abilities—for better and for worse.

Negative effects: Technology and cognition. In one study on the potential impacts of technology on cognition, Mueller and Oppenheimer (2014) investigated the effect of note-taking on laptops and students' learning. In that study, Mueller and Oppenheimer randomly assigned 67 university students to either the Typing condition or the Hand-writing condition. Participants took notes while watching five 15-min TED talks. Subsequently, participants completed two 5-min distractor tasks before being asked to recall the TED talks. Relative to the participants who took hand-written notes, participants who typed their notes on a laptop recalled less from the TED talks, even when allowed to review their notes after the lectures. Notes copied verbatim mediated the relation between the note-taking method and memory performance; that is, participants who took more notes in a less verbatim format exhibited better recall, regardless of the note-taking method. More participants who typed their notes on a laptop, however, had notes copied verbatim than did the participants who wrote their notes. On the basis of these results, the researchers concluded that students who use laptops regurgitate lecture information rather than processing and reframing the material. It can also be argued that technology per se does not impact recall, but rather, it is the function of the technology that drives this effect.

In another study, Thornton, Faires, Robbins, and Rollins (2014) examined the deleterious effects of the presence of cell phones on cognitive performance and sustained attention. In that study, Thornton et al. randomly assigned adults between 18- and 46-years of age to either the Cell phone condition or the Book condition. In the Cell phone condition, a phone was placed on the table in front of the participants while they completed a series of cognitive tasks. In the Book condition, a book—approximating the size of a cell phone—was placed on the table in front of the participants while they completed the same set of cognitive tasks. Each participant completed two timed cognitive activities of progressing difficulty. The Attention Behaviour Rating Scale was also administered to assess participants' ratings of their attention level. Relative to the participants in the Book condition, participants in the Cell phone condition performed worse on the more difficult, but not the more manageable, cognitive tasks. Self-report measures of attention did not reveal any significant associations between concentration and cognitive performance, suggesting that participants may have been unaware of the potential impact that the cell phone had on their task performance.

Researchers have also reported negative effects of prolonged exposure to technology on children's cognitive functioning. For instance, Christakis, Zimmerman, DiGiuseppe, and McCarty (2004) investigated the link between early exposure to television viewing and people's attention difficulties later in life. In that study, Christakis et al. examined data from the United States National Longitudinal Survey of Youth—Children and Young Adults. The survey included over 11,000 mother-child dyads. The data from 1279 younger children and 1345 older children were analysed at two-time points: when the mean age of the younger children 1.80 years and the mean age of the older children 3.80 years, and then again when all of the children were 7. The survey—completed by mothers—included questions from the Behavioural Problem Index that assessed attention deficit problems in their children (i.e., concentration, impulsivity, restlessness, obsessiveness, and ease of confusion), and questions about the number of hours per week that their children spent watching television.

As indicated by the scores on Behavioural Problem Index, 10% of children from both age groups assessed at the initial timepoint showed attention difficulties at age 7. Concerningly, there was a positive association between the number of hours spent watching television at ages 1 and 3 and subsequent attention problems at age 7. That is, more hours spent watching television early in life increased the probability of developing attention problems later in life. Despite the magnitude of this effect, it is impossible to infer a causal relation between watching television and attention problems. Other factors, such as parental engagement with their children, may have been linked to children's attention issues (see Storebø, Rasmussen, & Simonsen, 2016, for a review). Similarly, the causal relation may have been in the other direction. That is, children with attention difficulties may prefer television. The negative impact of technology on other aspects of cognition have been replicated in other studies (e.g., see Lillard & Peterson, 2011, for television viewing and executive functioning; see Tamana et al., 2019, for screen time and inattention; see Zimmerman, Christakis, & Meltzoff, 2007, for media exposure and language development).

Positive effects: Technology and cognition. Despite a plethora of evidence on the potential adverse effects of technology on people's cognition, researchers have discovered that there are often 'two sides to the story'—that is, empirical evidence has also shown the potential benefits of technology on people's cognition. For instance, Williams and Zahed (1996) explored the effects of computer-based training software on employees' learning in a chemical factory. In that study, Williams and Zahed randomly assigned 54 employees (M_{age} = 35.60 years) to either the Computer-Based Training condition or the Traditional Lecture condition. In the Computer-Based condition, a computer programme was used to deliver self-learning modules on workplace safety; in the Lecture condition, a lecturer taught the workplace safety modules face-to-face to the employees in a classroom. Employees were tested at three time points; during a pre-test, participants were given a series of multiple-choice questions that assessed baseline knowledge on workplace safety. Participants were then evaluated on their acquired knowledge from the lessons immediately afterwards and a month later. After controlling for baseline knowledge, participants in both learning conditions showed an increase in learning when tested immediately following the lessons. After a 1-month delay, however, those who self-learned on a computer retained more knowledge than did the participants who were taught in a classroom.

Researchers have also explored the positive effects of technology on children's cognitive functioning. For example, Giacomo, Ranieri, and Lacasa (2017) examined the cognitive performance of children who were frequent video gamers. In that study, 191 children between 7- and 10-years of age were assigned to either the Frequent Gaming condition (3+ hours per day gaming) or the Infrequent Gaming condition (3 hours or less per day gaming) based on their parent's reports. Children's cognitive performance was measured using a psychological test battery that was designed to assess visuospatial and verbal abilities. Children who were frequent gamers obtained higher scores on the measure of visuospatial and verbal abilities than did the infrequent gamers. Once again, it is impossible to infer a causal relation between the time spent on gaming and children's cognitive development from correlational data alone. For example, it is possible that gaming has an impact on children's cognitive development. Still, it is equally possible that individual differences in cognitive abilities motivate children to play games (i.e., children with better visuospatial abilities may also enjoy navigating in a 3D virtual world). The direction of the effect is still not clear and awaits additional research. Nevertheless, the positive impact of technology on different aspects of people's cognition has been replicated in other studies (see Smeets & Bus, 2015 and Verhallen & Bus, 2010, for studies on e-book and learning; see Steenbergen, Sellaro, Stock, Beste, & Colzato, 2015, for a study on action games and cognitive flexibility).

In summary, exposure to technology is related to the way that children and adults process information. This impact on our cognitive functioning can be both positive and negative. On the one hand, technology may engage people in their learning and provide more opportunities for acquiring more specific cognitive skills such as visuospatial ability. On the other hand, technology may result in more significant distraction and long-term reduction of our attention span. Balanced use of technology may help increase the positive effects that technology has on our cognition.

Socioemotional Domain

Changes in thinking and information processing may influence the way we perceive socioemotional cues and, subsequently, the way we behave and interact with other people. The socioemotional domain is composed of thoughts and behaviours that involve interpersonal relationships and communication between individuals. For instance, people's responses in social settings, understanding of social cues, development of empathy, ability to regulate and express emotions, and the development of self-identity concerning others are all encompassed in the socioemotional domain. Similar to the relation between technology and cognition, a debatable issue is whether technology can be beneficial in one way but detrimental in another way to people's socioemotional functioning (see Lomanowska & Guitton, 2016, for a review).

Negative effects: Technology and socioemotional behaviour. Researchers have identified a paradox between communication technology and people's socioemotional behaviours: the more we use technology for social purposes, the less we socialise with others face-to-face. For example, in one seminal study, Kraut et al. (1998) investigated the effects of the internet on participants' social involvement and their well-being. In that study, 169 participants aged 10 years and above from 73 families were given a pre-test questionnaire to establish baseline measures of their social activities and general well-being. Social activity measures included total communication time with other family members; the number of people who the participant contacted at least once a month in the local area, and at least once a year outside the local area; and their level of social support. Well-being measures included reports of loneliness, stress, and depression. Participants completed the same measures again a year later. Three additional measures were used to assess the level of internet usage between the pre-test and post-tests: the total hours per week spent on the internet, the number of electronic mail (email) transactions, and the number of newly-visited websites per week.

Participants' communication with family members was negatively associated with the number of hours they spent on the internet. Put another way, participants who spent more time on the internet spent less time talking to other family members. The size of participants' proximal, but not distal, social network also decreased with higher internet usage. The amount of internet usage did not influence participants' perception of social support. Still, higher internet usage was linked to an increase in loneliness and depression, but not stress.

Researchers have demonstrated similar adverse effects of social communication technology on intimate and romantic relationships. For instance, Schneider (2000) explored the impact of excessive cybersex on participants' offline romantic relationships. In that study, 94 adult participants (91 females) between 24- and 57-years of age completed a survey that was designed to capture participants' perception of their partner's online sexual behaviours. Online sexual behaviours in that study included masturbation while watching pornography, exchanging letters and stories of sexual content with another person, online and offline meetings with another person, advertising online to meet sexual partners, and chatting in online sex chat rooms.

Among the 94 participants, only 17.60% of their partner's online sexual activities had progressed to offline sexual affairs. Participants' partner's engagement in cybersex negatively impacted their relationship, however. More specifically, participants whose partners had engaged in cybersex indicated that they felt hurt, betrayed, loss of trust, fear, lacked intimacy with their partner, and lower self-esteem; many of the participants perceived online and offline affairs as a form of adultery. Among the 94 participants, 68.10% of the respondents had indicated problems in their sexual relationships with their partner, and 22.30% were subsequently separated or divorced. The common problem of inferring causality exists with these findings as well; that is, it is impossible to determine whether engaging in cybersex caused relationship problems or whether people who have relationship problems seek alternative intimacy online. These basic findings of the negative effects of technology on romantic relationships have been replicated in other studies (see Grov, Gillespie, Royce, & Lever, 2011; Weinstein, Zolek, Babkin, Cohen, & Lejoyeux, 2015).

Researchers have also explored the negative effects of digital technology on children's socioemotional functioning. For example, Hosokawa and Katsura (2018) identified associations between mobile technology and children's behaviour adjustment at school. In that study, 6-year-olds were grouped based on their parents' ratings of their behavioural and emotional adjustment (e.g., emotional regulation difficulties, hyperactivity/inattention, conduct problems). On the basis of these ratings, children were assigned to a Abnormal group (score > 90th percentile), a Borderline group (score between the 80th and 90th percentile), or a Normal group (score < 80th percentile). Children in each of these groups were assigned to one of two groups based on the time that they spent on a digital device: the Frequent-user group (60+ mins per day on devices) or the Infrequent-user group (< 60 mins per day on devices). The type of software children used on their devices was coded as Educational or Non-Educational.

Relative to infrequent users, children who were frequent users of digital devices were rated by their parents as more maladjusted. More specifically, parents of frequent device-users rated their children as displaying more conduct problems, hyperactivity/inattention, and emotional regulation difficulties. The researchers also found moderation effects; that is, relative to children who used devices for non-educational purposes, children who used devices for educational purposes were rated by their parents as having fewer emotional and behavioural difficulties. It is again impossible to infer a causal relation between psychological problems and the use of digital devices. On the one hand, technology may have caused emotional and behavioural issues; on the other hand, children who experience psychological difficulties may choose to use technology more than do children who have better developed interpersonal skills. These basic findings of the effects of digital communication on the development of psychological problems have been replicated in studies with adolescents (see Keles, McCrae, & Grealish, 2020, for a meta-analysis).

Positive effects: Technology and socioemotional behaviour. Despite some evidence showing the negative consequences of technology on interpersonal relationships and psychological well-being, it has been shown that technology may also improve people's social opportunities. For instance, Fels, Waalen, Zhai, and Weiss (2001) examined the effects of video-conferencing on promoting social interaction in chronically-ill children with their peers at school. In that case study, three students (Age: 9 years old; 12 years old; 12 years old) with severe medical conditions used video-conferencing to interact with peers and teachers at school from either their home or the hospital. Children's degree of interaction, concentration, and initiative towards learning and social interaction with peers and teachers in the classroom were measured. Chronically-ill children showed frequent interactions with their peers and teachers at school and were able to initiate learning and communication.

Furthermore, their level of attentiveness with classroom activities was comparable to other students who were physically in the classroom.

The positive effects of technology on socioemotional behaviours have also been explored in adolescents. For example, Colwell, Grady, and Rhaiti (1995) investigated the possible consequences of digital gaming on adolescents' self-esteem and their peer relationships. In that study, 120 adolescents between 11- and 17-years of age completed a questionnaire that was designed to measure the frequency and duration of time that they spent on computer games and the frequency of having face-to-face interaction with their peers outside of school hours. Adolescent boys, but not girls, who spent more time playing computer games also reported having more frequent in-person interactions with school peers outside of school hours, despite rating computer games as more enjoyable than spending time with friends.

Researchers have also demonstrated some positive effects of technology in older adults' interpersonal connections. For instance, Chopik (2016) studied the use of communication technology on reducing the feeling of loneliness and improving general well-being in older adults. In that study, Chopik examined data from a subsample of 591 older adults (M_{age} = 68.18 years) from the 2012 American National Health and Retirement Study (NSH). The NHS is a national survey conducted once every two years and collects data from more than 22,000 Americans aged 50 years or older. The survey includes a series of questions that are designed to measure general health, mental health, and general well-being, including ratings of loneliness, general well-being, chronic medical conditions, and depression. Chopik also included data from the 2012 NHS experimental module to evaluate the number of different communication technologies that people used and their attitude towards using them. Communication technology included email, social media, teleconferencing, instant messengers, and smartphones. Participants were generally satisfied with using technology for communication and indicated that technology was not difficult to learn. Relative to the participants who had fewer experiences with technology, participants who had more experience with technology rated themselves as less lonely and depressed, and showed fewer chronic medical conditions and better general health. Similar benefits of technology on people's socioemotional functioning and psychological adjustment have been replicated in other studies (see Ellison, Steinfield, & Lampe, 2007, for a study on social media and interpersonal relationship; see Griffiths, 1997, for a study on interactive technology and social development; see Whitty, 2008, for a study on internet and intimate relationships).

Other researchers have explored the potential benefits of technology on social functioning in more specific populations, for example, in individuals with Autism Spectrum Disorder (ASD) or social anxiety disorder (SAD). One of the characteristics of ASD is impairment in social communication and interaction. Gillespie-Lynch, Kapp, Shane-Simpson, Smith, and Hutman (2014) examined the potential benefits of using computer-mediated communication in adults with features of ASD. In that study, the researchers quasi-randomly assigned 602 adults between 18- and 84-years of age to either the ASD group or the Not-ASD group based on their score on the Autism Spectrum Quotient (AQ)—a self-report screening measure for identifying features of ASD. Participants were asked to complete two questionnaires: one that measured their perception of the benefits of using online communication technology (e.g., "Gives you time to think before responding"), and another that measured the number of hours per week that participants spent on the internet and in offline social activities. Participants in the ASD group were more likely than were the participants in the Not-ASD group to indicate that the internet was a helpful communication tool. Specifically, relative to those in the Not-ASD group, participants in the ASD group preferred the internet because there was more time to think before responding, more opportunities to practice their interaction with others, increased networking with other adults with ASD, a choice of partners, more opportunity to meet new people, and more opportunity to display their actual selves. Similar benefits of technology on socio-emotional functioning have been replicated in other studies that have included participants with ASD (e.g., Trepagnier, Olsen, Boteler, & Bell, 2011) or social anxiety (e.g., Esfandiari, Nouri, Golparvar, & Yarmohammadian, 2013).

Overall, technology provides opportunities for people to socialise and interact with others. More importantly, technology helps connect those who have fewer opportunities for social interaction, including people who have social difficulties, physical disabilities, and health problems. On the other hand, the use of technology for communication may isolate individuals, leading them to develop more superficial relationships, impact their existing personal and intimate relationships, and negatively affecting their abilities to regulate emotions and conform to social norms.

In summary, researchers have shown that the reliance on technology in the contemporary world impacts multiple aspects of human development: physiology, brain structure, and functioning; thought processing; feelings; and our social interaction with others. Whether this influence of technology is 'the angel' or 'the devil' in our lives continues to be unclear, and like everything else, too much or too little technology may distort the perfect equilibrium. There is one thing that we can be certain of, technology will continue to evolve and change the way that people live. One emerging piece of technology in our lives is the avatar; a digitally-generated graphical representation of real-world objects. Avatars are often used as a gateway for people to communicate with technology (or other people). The goal of the research described in the present thesis is to examine the efficacy of avatar interviewers in eliciting information from adults in specific contexts (i.e., evidential interviews and other help-seeking settings, including banking and health services). In Chapter 1, I will review the history of avatars and provide a discussion of their applications.

Chapter 1

The Birth of the Avatar

As a child, you may have drawn pictures in the corner of each page of a book, and then flipped through the book as you watched your character come alive. That character is an example of an avatar. In basic terms, an avatar is a computer-generated, animated graphical representation of a real-world object (Christensson, 2009). For example, an animated image of a talking butterfly, a ball, or a human is considered to be an avatar. An avatar can be presented on a computer screen or in a virtual world as either two-dimensional or three-dimensional. Furthermore, there are non-interactive avatars that enact a sequence of actions or interactive avatars that can respond to a human.

History of Avatars

The birth of computer-generated imagery (CGI) can be traced back to the 1800s when Parisian Emile Reynaud projected frames of pictures on a roll of paper, just as you may have done as a child. But the development of CGI blossomed in the 1940s, predominantly in the film industry. John Witney Senior and his brother James pioneered the first set of films that implemented a technological device that controlled the motion of lights and objects. Their signature production was the psychological thriller, 'The Vertigo.' In 1957, Russell Kirsch and his team created the first digital photograph by scanning a photo of Russell's 3-year-old son into a computer. This digital photo pioneered the production in 1960 of the first 2D computer-generated dynamic image—an image of a car traveling down a highway.

From then on, many CGI films were produced by Bell Labs, one of which was the 'stick figure' stereoscopic animation that was produced in 1965. Around the same time, William Fetter at the Boeing Company created a true static 3D digital object in the form of a wire-frame. He was also credited with using the term 'computer graphics.' In 1968, Nokolai Konstantinov and his team developed CGI further by creating the first dynamic 3D CGI of a walking cat. Soon after, others followed with iconic productions such as ‘The Hummingbird,’ ‘Running Cola is Africa,’ ‘The Flexipede,’ and ‘Westworld.’ In the same decade, Ivan Sutherland at Massachusetts Institute of Technology (MIT) developed a system called ‘Sketchpad I’ that permitted people to interact with a CGI.

The first solid 3D animated CGI movie—’Tron’—was created in 1982 by Walt Disney Productions and included computer-generated inanimate objects. Three years later, the first avatar or solid 3D CGI of animated objects such as people and animals were created for computer games such as ‘Ultima IV.’ The word ‘avatar’ appeared first in ancient India. The word was derived from *avatara*—a word in an ancient language of India, Sanskrit—meaning ‘descent.’ *Avatara* refers to the embodiment of sacred spiritual beings in material objects (Parrinder, 1997). According to legends from India, *Matsya* is a half-man half-fish avatar that helps bring knowledge to people. Gamers in ‘Ultima IV’ were able to represent themselves and interact with other players in a digital embodiment of themselves, just like an *avatara*.

In 1989, James Cameron’s ‘The Abyss’ was the first movie to integrate CGI with live scenes and was considered a pioneer for iconic movies like ‘Terminator 2: Judgment Day,’ ‘Jurassic Park,’ and the ‘Star Wars’ sequels. The first animated film created entirely on a computer was Walt Disney’s, ‘The Rescue Down Under’ in 1990, followed by ‘Beauty and the Beast’ in 1991.

One of the difficulties at the time, was producing realistic CGI representations of the human face. Before the 2000s, CGI films that were entirely computer-generated were ‘cartoonish.’ In 2000, Paul Debevec and his team produced photorealistic animations that led to the first photorealistic CGI movie, ‘Final Fantasy: The Spirits Within.’ Soon after, motion-capturing technology allowed the actions and facial expressions of live human actors and actresses to be captured and represented by CGI—leading to more realistic digital representations of humans. Renowned fantasy characters like Gollum from 'The Lord of the Rings' trilogy as well as multiple characters in James Cameron's 'Avatar' were created using motion-capture technology.

In the past, avatars were almost exclusively the domain of the entertainment industry, appearing as on-screen, non-interactive graphical characters that enact a sequence of actions. In recent years, however, avatars have become more interactive and consequently, the range of settings in which avatars appear has increased dramatically.

Avatars in the Classroom

Avatar educators are often referred to as pedagogical agents in the education literature, however, I will use the term *avatar* to maintain consistency. Avatars offer new opportunities for learning. By way of example, the anonymity of interacting with an avatar educator may encourage active participation and group collaboration among students in a virtual classroom; the customisable features of avatars may engage students in learning.

Researchers have reported that avatars influence motivation, engagement, and learning performance in adults. In one study, for example, Wiecha, Heyden, Sternthal, and Merialdi (2010) assigned 14 primary care physicians to attend a single 60-min seminar on Type 2 diabetes. The seminar was delivered in a virtual classroom by an avatar. In this instance, students were taught by an avatar that was controlled by a human educator from a remote location. Physicians also navigated through the virtual classroom using an avatar representation of themselves. Participants completed a questionnaire that was designed to assess their baseline knowledge of Type 2 diabetes and ratings of their confidence in treating diabetic patients. Subsequently, participants attended an hr-long course on diabetes and were then asked to complete the same questionnaire that assessed their knowledge and confidence in treating diabetic patients. Participants also rated their learning experience with an avatar educator. Participants showed an increase in their rating of confidence in treating diabetic patients after attending the course, and 83% of participants agreed that learning in a virtual classroom was more engaging and interactive than was learning in a physical classroom. Despite their positive experience, participants' knowledge of Type 2 diabetes remained unchanged after attending the seminar.

In a different study, Moreno and Ortegano-Layne (2008) investigated student teachers' learning performance in a single 65-min lesson delivered by an avatar. The lesson consisted of theoretical knowledge and examples of how that knowledge could be applied in a classroom. That study aimed to examine students' applied knowledge in teaching. The researchers randomly assigned 80 student teachers (M_{age} = 26.75 years) to one of four content-delivery methods: text, video, animation, and control group. In the Text condition, the lesson was displayed in writing on a computer screen; in the Video condition, a human educator pre-recorded a video of the lesson; in the Animation condition, the lesson was presented by an avatar educator; and participants in the control group only received theoretical knowledge but not the teaching exemplar. Participants were tested using a 10-item multiple-choice questionnaire on the theories and applications that they acquired from the lesson. Participants also rated their satisfaction with the lesson. Relative to the Text and Control conditions, participants in the Avatar condition scored higher on the application test after controlling for the scores on the theory test. They also reported a more satisfactory learning experience than did the participants in the control group.

Researchers have also examined the effects of learning from an avatar across multiple lessons as opposed to a single lesson. For example, Veronin, Daniels, and Demps (2012) explored the effects of an avatar educator on students' learning after attending weekly 50-min lectures for a semester. In that study, 22 doctorate students attended lectures taught by an avatar in a virtual classroom. The students were taught by an avatar that was controlled by a human educator from a remote location and were allowed to navigate through the virtual classroom using an avatar representation of themselves. There was no control group in that study. Students were able to discuss case studies with other students in the virtual class by talking and texting. Throughout the semester, students' learning was assessed through assignments and written exams. At the end of the semester, students were asked to complete an evaluation form that was designed to capture their learning experience. Students performed better in their exams following the lessons taught by the avatar educator and reported that they had a positive learning experience. Specifically, they reported being more attentive in class and found the flexibility of attending lectures remotely more attractive. Despite these findings, it is impossible to infer a causal relation between an avatar-delivered lesson and doctorate students' learning experience and exam performance due to a lack of control group. These basic findings of the engaging effects and higher learning outcomes of an avatar educator for adults have been replicated in other studies (Boulos, Hetherington, & Wheeler, 2008; Hansen, Murray, & Erdley, 2009; see O'Connor, 2019, for a review on avatars and professional development in nursing; Schoonheim, Heyden, & Wiecha, 2014).

In another study, Hongpaisanwiwat and Lewis (2013) demonstrated a link between adults' personality traits and their recall of semantic knowledge with avatar educators. In that study, Hongpaisanwiwat and Lewis compared 60 university students' memory performance across avatars with different degrees of anthropomorphism (no animated character; a finger pointer; an animated human-like character) and different types of voice (synthetic voice vs. human voice). Participants who were more introverted show better recall of acquired semantic knowledge relative to individuals who were more extroverted when an avatar with a computer-synthesised voice presents the learning materials. However, this effect was only observed for the anthropomorphic avatar. The result makes sense in that Hultsch et al. (1999) found significant positive relations between introversion and fact recall; that is, more introverted individuals showed poorer recall of acquired semantic knowledge. Avatars may provide more predictable and less arousing social partner for transferring information to introverted individuals.

Taken together, despite adults showing higher learning engagement and motivation with an avatar educator, their learning outcomes with an avatar have been somewhat mixed and is dependent on several factors, including the learning environment, the avatar's and students' characteristics (see Heidig & Clarebout, 2011, for a review). In general, an avatar that is perceived as more knowledgeable and likeable (Domagk, 2010; Kim & Baylor, 2016) has a more positive effect on adults' learning performance and motivation. These positive learning and engaging effects are also observed with avatars that are more animated and interactive (Baylor & Ryu, 2003; Kim & Baylor, 2016; Lusk & Atkinson, 2007; Schroeder & Gotch, 2015). Similar benefits of an avatar on learning have been shown with lessons delivered verbally rather than using text. Furthermore, adults tend to learn better with an avatar that has a human voice as opposed to a computer-generated voice (Atkinson, Mayer, & Merrill, 2005; Craig, Gholson, & Driscoll, 2002; Moreno & Mayer, 2002; cf. Hongpaisanwiwat & Lewis, 2013). Adults also learn better from avatars presented on a computer monitor compared to avatars presented in an immersive environment (Moreno & Mayer, 2002). Overall, an avatar's visual realism does not affect adults' learning and level of engagement (Choi & Clark, 2006; Craig et al., 2002), but adults display better learning outcomes with an avatar educator that displayed gestures or facial expressions (Baylor & Kim, 2009; Clark & Choi, 2005; Johnson & Lester, 2016).

Based on these findings, it is possible to conclude that avatars are an attractive tool that engages adult students in their learning. Engaging students in lessons may increase their involvement, which in turn may improve students' learning performance. As the old proverb wisely noted, "Tell me, and I forget. Teach me, and I remember. Involve me, and I learn." The jury is still out on the impact that avatar educators have on students' information acquisition and retention, but what is known is that numerous factors can influence learning outcomes for adults when an avatar educator is involved.

Avatars in Advertising

Travel back in time to the 1940s when commercial television gained popularity. You may recall your favourite cereal box character ‘come to life’ on television. Television characters are exemplars of avatars in advertising and marketing. Avatars are often referred to as media characters or spokes-characters in the commerce and marketing literature. Prominent avatar characters that have appeared as product ambassadors include Tony the Tiger, Dora the Explorer, and Mr. Clean (see Phillips, Sedgewick, & Slobodzian, 2019, for a review)

Researchers have reported that the impact of avatars on adults’ purchasing behaviours potentially depends on multiple factors. For instance, Jin and Bolebruch (2009) explored the promotional effects of avatars’ visual realism on consumer’s behaviour in a virtual shopping environment. In that study, 116 college students watched an iPhone advertisement in an online virtual store without an avatar, and then they were presented with the same advertisement by two avatars—a more human-like avatar and then by a less human-like avatar. Participants completed a pre- and post-questionnaire that measured their shopping experience, their evaluation of the product, and their rating of the informative value of the advertisement. Participants rated their shopping experience as more enjoyable and had a more positive attitude toward the product when an avatar presented the advertisement compared to when the advertisement was presented without an avatar. Furthermore, participants rated the advertisement as more informative compared to when a more human-like avatar presented the commercial.

Researchers have also investigated the association between the type of product and the effects of an avatar ambassador on adults’ purchase intention. For example, Choi and Lee

(2012) randomly assigned 130 students to either the Avatar condition or the Control group. In the Avatar condition, a computer animation depicting a male adult provided nonverbal and verbal feedback about participants' performance during a card game (e.g., nonverbal feedback: nodding; verbal feedback: "Good job"); in the Control condition, there was no avatar present and participants did not receive any verbal or nonverbal feedback. Students were presented with a set of playing cards lying face-down on a computer screen; they were required to match the pictures of different products on each card by flipping the cards. There were two types of products presented on the cards: essential products (e.g., tissue) and non-essential products (e.g., coffee). Immediately following the card game, participants completed a series of questionnaires that were designed to evaluate their attitude towards the brand and their purchase intention of the products. The presence of the avatar significantly impacted purchase intention and people's attitude towards the brand for essential products, but not for non-essential products. Participants in the Avatar condition had higher purchase intention of the products than did the participants who did not have an avatar present, but only for items that were essential; participants' purchase intention was similar across the two presentation conditions for the non-essential products.

In another study on the relation between avatar characteristics and consumer behaviour, Holzwarth, Janiszewski, and Neumann (2006) randomly assigned 400 participants between 17- and 74-years of age to receive information about shoes in an online shop from either an attractive avatar consultant, an expert avatar consultant, or a text-only consultant. In the Attractive condition, text descriptions of a range of shoes were presented on a computer screen by an avatar that appeared young and athletic. In the Expert condition, text descriptions of a range of shoes were presented on a computer screen by an avatar that appeared relatively older, nonathletic, and wore glasses. In the Text condition, the information was displayed on the computer screen in writing without an avatar. After receiving information about shoes, participants were then asked to design their own pair of shoes. Participants then completed a series of questions that were designed to capture their ratings of the avatar based on its attractiveness, expertise, likeability, and credibility. Participants also reported how much they liked the product, their purchase intention, and their level of involvement during the design phase.

Relative to the Text condition, participants who received product information from an avatar reported that they liked the product and indicated higher purchase intention. The avatar's perceived attractiveness and expertise, and participants' level of involvement during the design phase influenced participants' consumer behaviours. More specifically, participants who showed more involvement during the design phase reported having a higher preference for, and intended to purchase, the product when the expert avatar rather than the attractive avatar presented the product. Participants rated the attractive avatar as more likable and the expert avatar as more credible. Put in another way, participants who were more involved with the product preferred an avatar that was perceived as more knowledgeable. These basic findings of the effects of avatars' characteristics, such as appearance realism, and adults' perception of the avatar ambassador on product marketing has been replicated in other studies (see Callcott & Phillips, 1996, for a study on avatars depicted personality, attractiveness, and humour; see Garretson & Niedrich, 2004, for a study on adults' perceived trust towards an avatar; see Heiser, Sierra, & Torres, 2008 and Huang, Hsieh, & Chen, 2011, for studies on a global comparison between avatars and humans promotional agents; see Hsu, Chen, Lu, & Fang, 2018, for a study on avatars' depicted gender and realism; see Manaf & Alallan, 2017, for a study on consumers' level of involvement with avatars; see Mize & Kinney, 2008, for a study on consumers' attitudes toward avatars).

Clearly, avatars can be effective ambassadors and promotion agents for both children and adults. Several factors mediate avatars' effectiveness as advertising agents, for example, consumer and avatar characteristics; consumers' perception of, and attitude towards, the avatar ambassador; and the type of marketed product. Researchers have also revealed that avatars that are perceived as attractive and human-controlled rather than computer-controlled are more persuasive agents (Fox et al., 2015; Khan & Sutcliffe, 2014). People also rate an avatar with higher anthropomorphism to be more attractive, credible, and competent (Gong, 2008; Nowak, Hamilton, & Hammond, 2009). On the basis of these findings, using familiar and knowledgeable avatars as marketing agents may be a more flexible and cheaper alternative. More work is needed, but researchers have already begun to identify possible factors that might make avatars the perfect advertising agent.

Avatars in Online Communication

Methods of exchanging messages from remote locations have existed since the 1100s, for example, communicating through messenger pigeons. Modern technology has transformed the concept of messenger pigeons into digital forms of communication. Examples of digital messengers include 'I Seek You (ICQ),' 'Facebook messenger,' and 'Snapchat.' Some of these digital messengers have incorporated avatars to facilitate social communication by allowing users to display their emotions and nonverbal gestures through their avatars. For example, Taylor (2011) examined the effects of the presence of an avatar on people's responses to questions in an online forum. In Experiment 1 of that study, Taylor assigned 132 questions that were asked on 'Yahoo! Answers'—an online forum—to either the Avatar group or Control group. The Avatar group displayed people's questions on a computer screen in text alongside an image of an avatar; the Control group displayed people's questions on a computer screen in writing only without a picture of an avatar. People's responses were categorised into one of four topics: involvement, sharing, solution, and concern. For example, a response was coded as sharing if the respondent shared a similar feeling or experience with the person who asked the question. Questions that were presented with an avatar received more responses conveying concern or sharing compared to questions presented without an avatar. These findings are suggestive of higher rates of empathetic responses when written questions were displayed alongside an avatar.

In Experiment 2, Taylor (2011) explored the avatar's characteristics and the effect that these features have on participants' responses to questions in an online forum. Taylor categorised 125 responses to questions that were asked on 'Yahoo! Answers' into one of four topics: altruism (e.g., helping others), intelligence (i.e., answers to solutions), passing time (e.g., boredom), and enjoyment (i.e., showed interest in the question). Researchers grouped each question to either the Visual group or the Control group. Questions in the Visual group were presented in writing alongside a visual stimulus (e.g., a human-like cartoon-rendered avatar, a photograph of a celebrity, a photograph of a non-celebrity, or an object). Questions in the Control group were presented in writing only. Questions that were presented with an avatar positively predicted altruistic responses compared to other visual stimuli. The findings from this experiment demonstrate that particular features of an avatar may influence participants' responses in online communication.

Researchers have also compared avatars to other digital representations in online communication. For instance, Bente, Rüggenberg, Krämer, and Eschenburg (2008) randomly assigned 71 participant-dyads between 19- and 41-years of age into one of five communication conditions: text-only, audio-only, video conferencing, cartoon-rendered 2D avatar, and 3D avatar. Participants in the two Avatar conditions communicated with their online partners through avatar representations of themselves. Participants from each dyad were separated into two rooms and were asked to collaborate on a task with their partner through online chatting software. Self-report questionnaires measured participants' satisfaction with the interaction, and their ratings of intimacy and interpersonal trust toward their partner. Two types of trust were measured: cognitive trust—trust in their partner's knowledge and competence, and affect trust—trust that their partner will be respectful and empathetic. Relative to the Text condition, participants in all other communication conditions provided higher ratings of intimacy toward their partner and higher levels of satisfaction with the interaction. For the interpersonal trust, participants provided similar ratings of cognitive trust across all communication methods but had higher levels of affective trust toward their partner when communication occurred through audio-only or a cartoon avatar, compared to the Text condition.

In a different study, Fabri and Moore (2005) explored the effect of avatars that depict basic emotions on users' responses in online messages. In that study, the researchers randomly assigned 32 participants between 21- and 63-years of age into pairs. Participants from each pair were separated into two rooms. Each pair was randomly assigned to either an interactive avatar with the function of expressing six emotions (happy, sad, fear, anger, disgust, surprise), or an interactive avatar with a neutral expression, to represent themselves. Participants were able to select the avatar's gender. Participants were asked to work with their partners in an online chatting room to develop a list of items for survival. Participants completed a questionnaire that measured their prior experience with using online chatting applications, level of involvement and enjoyment during the collaboration task, and sense of co-presence. Co-presence is defined as people's perception of existing together with another person in a virtual environment. Relative to avatars depicting a neutral expression, participants who interacted with a partner using an avatar with emotional expressions reported a higher sense of co-presence. Furthermore, those same participants were more involved in the collaboration task but rated the process as less enjoyable. Contrary to belief, participants with less previous computer experience reported a higher sense of co-presence. These basic findings of the relation between an avatar's characteristics and people's responses in online communication have been replicated in other similar studies (see Fabri, Awad Elzouki, & Moore, 2007, for a study on the effects of avatars' facial expressions; see Van Der Heide and Schumaker, Peterson, & Jones, 2012, for studies on adults' perception of an avatar's attractiveness; see Galanxhi & Nah, 2005 and Kang & Yang, 2004, for global comparisons between online communication with and without an avatar).

By and large, avatars influence people's online social experience. This social experience is dependent on a handful of factors, for example, people's perception of the avatar and avatars' characteristics (see Nowak & Fox, 2018, for review). In general, people who interact with an avatar that is perceived as more anthropomorphic may be more involved and satisfied with their online interaction, and have a higher sense of co-presence with an online communication partner (e.g., Bailenson, Yee, Merget, & Schroeder, 2006; Kang & Watt, 2013). These positive responses, however, may be partially dampened by avatars that are perceived as almost, but not entirely human (e.g., Fabri & Moore, 2005). The depicted gender of an avatar also influences people's social responses online (see Van Der Heide et al., 2012). Overall, the results across many studies have shed light on the value of using avatars in modern digital message exchange.

Avatars in Healthcare

In a fast-paced society, finding the time to visit a health professional is a luxury. Some researchers have proposed using autonomous avatars as a low-cost solution to reduce the time that people spend in healthcare systems; other researchers have explored the potential for autonomous avatars to provide healthcare for individuals living in rural areas. In addition, the appearance of an avatar can be tailored to suit each patient's preferences. The Western approach to health and wellbeing generally describes an individual's overall health as involving both physical and mental health (see Gopalkrishnan, 2018).

Avatars and physical health. Researchers have generally grouped studies on medical avatars into two main clusters: avatars that provide health information to patients, and avatars that model healthy lifestyles.

Avatar health professionals. Researchers have explored the benefits of employing avatars as digital nurses to provide health information to patients. For instance, Bickmore, Pfeifer, and Jack (2009) randomly assigned 30 outpatients between 20- and 60-years of age to one of two avatar nurses: Avatar Elizabeth or Avatar Louise. Each avatar appeared as either empathetic and warm or non-empathetic and cold. The avatar nurse was displayed on a tablet and verbally presented patients with health and discharge information. Subsequently, patients completed a questionnaire that was designed to measure their overall satisfaction with and perception of the avatar nurse. In addition, the questionnaire also captured participants' ratings of the usefulness of the health information provided by the avatar. Patients were generally satisfied with their interaction with an avatar nurse. Still, only 37% of patients indicated that the health information provided by an avatar was more useful than information provided by a health professional. Relative to the non-empathetic avatar, participants who interacted with a more empathetic avatar perceived the avatar to be more caring and reported the health information to be more useful. Bickmore et al. (2009) reported in Experiment 2 of their study that inpatients displayed similar levels of satisfaction and perception of the avatar nurses. These findings revealed that patients' experience with an avatar nurse is dependent on the depicted empathy of avatars.

In an RCT study comparing the effects of an avatar nurse to a human nurse on inpatients' discharge experience, Zhou, Bickmore, Paasche-Orlow, and Jack (2014) randomly assigned 764 patients between 18- and 90-years of age to either the Avatar Nurse condition or the Standard Care condition. Patients in the Avatar condition communicated with an avatar depicting one of two ethnicities: an African American or Caucasian. In the Avatar condition, patients also interacted with an avatar either on a single occasion or on multiple occasions. Patients in the Standard Care group received health information from a human nurse. A series of questionnaires were given to each patient. The questionnaires were designed to measure patients' computer literacy and their general knowledge of health. Immediately following the completion of the questionnaires, an avatar provided health information to the patients. Health information included the patient's diagnosis and their prescribed medication. After interacting with an avatar, patients reported on their experience with the avatar.

Relative to those in the Standard Care group, patients in the Avatar condition rated the received health information as more useful. In addition, these same patients were generally satisfied with the avatar. That is, patients found the avatar easy to use and reported having a good alliance with the avatar. Several characteristics of the avatar and patients mediated patients' experience with the avatar nurse. Specifically, only the patients whose ethnicity differed from that depicted by the avatar reported a positive alliance with the avatar. Participants with low compared to high computer literacy were more satisfied with the avatar and found the avatar easy to use; those with low health literacy trusted the avatar more and reported having a better alliance with the avatar than did the participants with high health literacy. The number of interactions with the avatar did not influence participants' ratings of the avatar.

In a nutshell, relative to a human nurse, patients who had received health information from an avatar nurse rated the information as more useful and were more satisified with an avatar delivering health information. Furthermore, researchers have shown that avatar-delivered health information improves patients' knowledge of the disease, and can also improve self-care and self-efficacy in patients with a chronic disease (see Wonggom, Tongpeth, Newman, Du, & Clark, 2019, for a meta-analysis). As with avatar educators, patients' experience with an avatar nurse is partially moderated by the avatar's characteristics and the patients' understanding of health information. These basic findings of the positive effects of delivering health information through avatar nurses (see Abbott & Shaw, 2016, for a review; Weiner, Trangenstein, McNew, & Gordon, 2016) and possible moderating effects of people's experience with an avatar nurse have been replicated in other studies (e.g., Dai & MacDorman, 2018; see Ruiz, Andrade, & Roos, 2016, for a review).

Avatar health coaches and models. Medical avatars have also been implemented as health coaches to promote and model healthy lifestyles. For instance, Napolitano et al. (2013) explored the impact of using avatars to model weight-loss behaviours to participants with a higher than average body mass index (BMI). In that study, eight adult women (M_{age} = 44.13 years) completed a series of pre-test and post-test measures that were designed to assess their confidence in exercising; their impulsive-eating behaviours, exercise plans, and goals; and satisfaction ratings of the avatar. Participants' baseline weight was also measured. Subsequently, participants attended four 30-min weekly sessions that involved 1) watching a video about weight loss, 2) reading handouts about weight loss, and 3) observing an animated avatar that modelled weight-loss behaviours (e.g., running on a treadmill). Participants had the option of customising the avatar's depicted skin colour and body build to match themselves. Towards the end of the intervention, participants' weight was measured again. Participants lost an average of 1.6 kgs following the intervention. Their confidence in exercising increased after the intervention, but their impulsive-eating behaviours and ability to plan and set exercise goals remained unchanged. Participants were generally satisfied with the intervention, with 87.5% of participants indicating that the avatar model was helpful, and approximately a third of participants preferred an avatar model that looked like themselves. Despite these promising findings of an avatar model, it is impossible to infer a causal relation between modelling weight-loss behaviours with an avatar and participants' reduced weight due to the absence of a control group. A reduction in participants' weight could also be due to the information presented on the video or handouts.

In a different study on avatar coaches, Bickmore, Caruso, Clough-Gorr, and Heeren (2005) examined the influence of avatars on older adults' exercising habits. In that study, Bickmore et al. (2005) randomly assigned 21 participants between 63- and 85-years of age to either the Avatar Trainer group or the Control group. In the Avatar group, an avatar trainer advised participants on healthy exercising behaviours every day for two months; participants in the Control group received a written form of the same exercising advice. First, participants completed a series of questionnaires that measured their general well-being and overall health status. Subsequently, they received daily information on exercising and a pedometer tracked their daily physical activity. Following the two-month intervention, participants were reassessed on their general well-being and overall health status. In addition, participants in the Avatar group rated their experience with the avatar trainer. Relative to the Control group, participants in the Avatar group were physically more active over the two months, as indicated by an increase in pedometer readings. Despite an increase in physical exercise by participants in the Avatar condition, self-ratings of general well-being were similar across the two interventions. In terms of participants' experience with the avatar trainer, 75% of participants indicated that they looked forward to future interactions with the avatar and that the avatar system was easy and enjoyable to use. Participants also reported that the avatar trainer was trustworthy, friendly, informative, and pleasant. Other researchers have replicated these positive findings of avatar health coaches on health-related outcomes, such as higher smoking abstinence (e.g., An et al., 2013), healthier body image (e.g., Kim & Sundar, 2012), and weight loss (see also, Kuo, Lee, & Chiou, 2016; LeRouge, Dickhut, Lisetti, Sangameswaran, & Malasanos, 2016).

Taken together, research by several investigators has suggested that avatars may be a low-cost alternative to, and to some extent, more effective than human health professionals. For example, patients perceive positive qualities in avatars, such as being trustworthy, attractive, enjoyable, informative, friendly, and caring. In some circumstances, people prefer avatars over a human health professional and may be more receptive to an intervention that is delivered by an avatar. These circumstances depend on several mediating factors, including characteristics of the patient and the avatar. By and large, patients with low computer literacy and high health literacy preferred a medical avatar compared to a human health professional. Avatars that are anthropomorphic, depict a distinct role (e.g., mentor, expert, motivator), that appear caring and supportive, and are similar in appearance to the patient, are more likely to increase people's motivation, self-efficacy, feelings of social support, trust towards the avatar, and enhance patients' recall of medical information (see Baylor, 2009 for a review). Researchers have only grazed the surface of understanding the exact situations in which an avatar outperforms a doctor, nurse, or health coach, but going forward, it is likely that medical avatars will become increasingly available in the healthcare system.

Avatars in mental health. In addition to physical health, psychological well-being is another important aspect of an individual's general health. In the past decade, avatar technology has crept into the field of mental health, offering an alternative to traditional methods of psychological assessment and treatment of mental health issues.

Avatars and psychological assessment. Although in its infant stages of development, researchers have demonstrated the advantages of using avatars in clinical assessments of individuals with mental health issues. For instance, Myers et al. (2016a) examined an avatar-based assessment approach in patients with post-traumatic stress disorder (PTSD). In that study, 82 war veterans (M_{age} = 54.10 years) completed two self-report measures that were designed to capture symptoms of PTSD based on the *Diagnostic and Statistical Manual of*

Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013). The two self-report measures also assessed inhibition and avoidant behaviours in response to novel and risky situations. Following completion of these measures, participants selected from one of eight avatar images to best represent themselves in a simulated social scenario. For each scenario, the avatar presented each participant with one of three written response options: to avoid the situation, engage in the situation, or remain in the situation without engaging or avoiding. For example, participants would select "You feel awkward and try to move away" if they wanted to avoid the situation. Finally, participants reported on their prior experience with computers, and on how accurate they thought their avatar represented them in the given situation.

The number of avoidant responses in each scenario was positively associated with scores from the questionnaires assessing PTSD, inhibition, and avoidant behaviours. All but two of the participants reported that the avatar that they had selected represented themselves; 82.7% of participants reported that they liked their avatar, and 67.9% reported that they cared about their avatar. These findings of participants' perception of their avatar suggest that participants potentially embodied the avatar as themselves. These basic findings on using avatars for assessing avoidant behaviours relating to PTSD, personality disorders, and anxiety disorders have been replicated in other studies (Allen, 2018; Allen, Jameson, & Myers, 2017; Myers et al., 2016b).

On the basis of these findings, researchers revealed a promising novel approach to assessing avoidant behaviours in different scenarios. Clearly, an avatar-based assessment approach is as good as using self-report questionnaires, but there may not be any incremental value of using avatar-based assessment methods. Furthermore, there is no fundamental difference between self-report measures of avoidant behaviours and using response options in the avatar task. This caveat concerning avatar-based assessments would need to be addressed before implying any difference between the avatar-task assessment and traditional self-reports of avoidant behaviours. Other researchers have replicated these basic findings of using avatars for assessing people's social skills (e.g., Miller & Bugnariu, 2016), pain (e.g., Fortier, Chung, Martinez, Gago-Masague, & Sender, 2016), persecutory ideation (e.g., Freeman et al., 2006, 2014), alcohol dependency (e.g., Lee, Kwon, Choi, & Yang, 2007), and cravings (drug craving: Saladin, Brady, Graap, & Rothbaum, 2006; cigarette craving: see Pericot-Valverda, Germeroth, & Tiffany, 2016, for a review).

In summary, the advantage of using avatar-based methods over traditional pen-and-paper methods of assessing mental disorders is that 1) avatar-based assessments provide a more objective measure compared to subjective self-report ratings; 2) behaviours can be observed rather than relying on clients' retrospective experience of an event, and 3) avatar-based assessments provide more flexibility in assessing behaviours in different scenarios.

Avatars and psychological treatment. In addition to the potential role in assessment, avatars have also been trialled in the treatment of mental disorders. For instance, Bouchard et al. (2017) explored the effects of exposing participants with a social anxiety disorder (SAD) to social situations with avatars in a virtual environment. In that study, the researchers randomly assigned 59 participants (M_{age} = 34.90 years) with a SAD diagnosis to one of three exposure conditions: *in vivo* exposure, virtual reality exposure, or a wait-list control group. *In vivo* exposure involved participants being exposed to anxiety-provoking situations, for example, public speaking in front of a group of people; virtual reality exposure involved participants speaking in front of a group of human-appearing avatars in a virtual environment. Participants in the wait-list control group did not receive any exposure treatment until the end of the study. Exposure treatment was conducted in 60-min weekly sessions for seven weeks. Participants completed a series of self-report measures before treatment, and then immediately and six months after treatment that were designed to assess symptoms of social anxiety and major depressive disorder. The same questions also measured participants' ratings of their alliance with the therapist. In addition, the therapists rated their experience of conducting exposure therapy in a virtual environment. Participants in the two treatment conditions demonstrated better outcomes in symptom reduction of social anxiety and depression than did the participants in the wait-list control group. Relative to the *in vivo* exposure, exposure in virtual reality with avatars was more effective in treating symptoms of social anxiety, with the quality of the working alliance a strong predictor of treatment outcome. These positive outcomes were maintained in the six-month follow-up. Therapists rated the virtual exposure method to be more practical and easier to implement than the *in vivo* exposure.

Researchers have also identified several features of an avatar and patients that predicted exposure treatment outcomes for patients with SAD (Price, Mehta, Tone, & Anderson, 2011). For instance, participants' level of involvement predicted treatment outcomes; the realism of the avatar and virtual environment, and participants' sense of presence in the virtual world were predictors of participants' fear ratings. These basic findings of using avatars in a virtual environment in the treatment of mental disorders have been replicated in adults with SAD (e.g., Anderson & Price, 2013; Klinger et al., 2004; Yuen et al., 2013). Furthermore, avatars have been used in emotions and social skills training in individuals with autism (see Vasquez et al., 2015, for a review; Hopkins et al., 2011; Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013; Serret et al., 2014; Yuan & Ip, 2018). An avatar's simplicity, flexibility, and predictability make it a beneficial tool for delivering interventions for individuals with ASD (see Soares et al., 2020, for a meta-analysis on social skills training for ASD using technology).

In a different study, Craig et al. (2018) investigated the effects of using avatars in treating patients with auditory hallucinations. In that study, 150 participants (M_{age} = 42.70

years) were randomly assigned to receive either Avatar therapy or supportive counselling. All of the participants had been experiencing auditory hallucinations for at least 12 months and had a diagnosis of either schizophrenia spectrum disorder or affective disorder with psychotic symptoms. In supportive counselling, a therapist conducted weekly 50-min face-to-face therapy sessions for six weeks. Participants who received therapy from an avatar created an avatar that they perceived as a visual representation of their auditory hallucinations. In other words, participants 'put a face' to their auditory hallucinations. The avatar was displayed on a computer screen and voiced by a concealed therapist during therapy sessions. Symptoms of auditory hallucination, psychotic symptoms, distress, adaptive functioning, and self-esteem were assessed before treatment and 12- and 24-weeks after treatment.

After 12 weeks, participants who were treated through an avatar representation of their hallucination showed a more significant reduction in the frequency and severity of hallucinatory symptoms and distress relative to the supportive counselling. After 24 weeks, however, there was no difference in participants' symptom presentation across the two types of interventions. These results revealed that using avatars for treating patients' auditory hallucinations may yield better outcomes when avatars are used as part of a brief intervention rather than as a comprehensive treatment. These basic findings of using avatars in psychological treatment have been replicated in studies examining the treatment of people with auditory hallucination (Dellazizzo, Potvin, Phraxayavong, Lalonde, & Dumais, 2018; Fernández-Caballero et al., 2017; Freeman et al., 2014; Leff, Williams, Huckvale, Arbuthnot, & Leff, 2013); eating disorders (e.g., Garcia et al., 2019; Keizer, van Elburg, Helms, & Dijkerman, 2016; Serino, Polli, & Riva, 2019); and specific phobias such as fear of flying (e.g., Rothbaum, Hodges, Anderson, Price, & Smith, 2002; Rothbaum, Hodges, Smith, Lee, & Price, 2000; Wiederhold & Wiederhold, 2003), or fear of spiders (e.g., EmmelKamp et al., 2002; Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002).

In sum, researchers have shown the emergence of using avatars in clinical assessment and treatment for a variety of psychopathologies (see Freeman et al., 2017, for a review). Several RCT and case studies have found that avatars can provide a more objective approach for assessing mental health symptoms; researchers have also demonstrated strong efficacy and effectiveness of using an avatar-based treatment for different mental disorders. As avatar technology improves and becomes readily available, we expect that more clinicians will jump on the 'avatar bandwagon' and provide better health care for patients.

Avatars as Digital Assistance

Avatars are also utilised in other areas like personal assistants, gaming, and forensic interviewing. For example, animated pedagogy agents such as Microsoft's *Clippy* assist users in goal-oriented tasks in Microsoft Word. Other examples of animated personal assistants include *Jess*—JetStar airline's virtual assistant that provides customer service; *Olive*—Countdown Supermarket's virtual assistance; and *Jamie*—ANZ Bank's digital assistant. Researchers have demonstrated that virtual assistants provide helpful responses to people's questions (e.g., Austerjost, 2018; Ho, 2018; Marston & Samuels, 2019).

In summary, our interaction with avatars influences us in different ways. For the most part, this interaction is dependent on a handful of variables: 1) the avatar's characteristics (e.g., anthropomorphic, perceived control, voice); 2) respondents' individual differences (e.g., their perception of the avatar; their prior knowledge and experience with avatars; their personality and autism traits); and 3) the digital platform on which the avatar is delivered (e.g., computer screen, immersive environment). In addition, people's response to an avatar has also been shown to be subject to the avatar's 'humanness.' That is, people tend to have a more positive experience and respond with more positive emotions toward the avatar when that avatar appears and behaves more human-like. This is not always the case, however. Mori, Macdorman, and Kageki (2012) coined the term 'uncanny valley effect' to describe the eerie feeling that people experience when interacting with a humanoid robot that appears ‘almost human’ (see Figure 1.1).

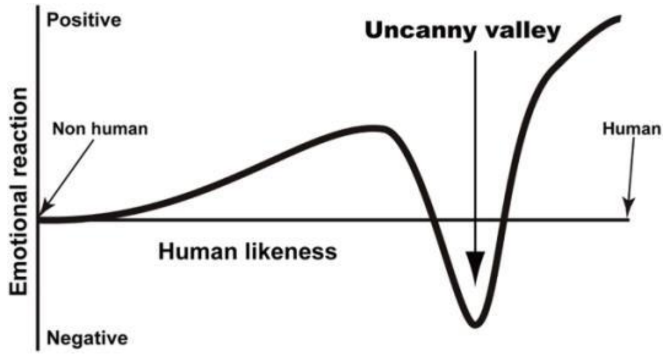

Figure 1.1. A conceptual illustration of the ‘uncanny valley effect’ (Sasaki, Ihaya, & Yamada, 2017).

Researchers have also studied this effect with avatars. By and large, similar results from human-robot interactions have also been found with human-avatar interactions (e.g., Feng et al., 2018; MacDorman & Chattopadhyay, 2016). The uncanny valley effect disrupts people’s entire experience with the avatar, and people tend to respond negatively toward the avatar.

As avatar technology continues to advance, we expect that avatars will evolve to become an invaluable tool across many settings, including education, social media, advertising, health sectors, personal assistants, and many more.

Avatars as Interviewers (The Present Thesis)

Using an avatar to conduct interviews in different contexts is another potential application that has recently received some attention. There is emerging literature on the effects of avatar interviewers in eliciting information from both children and adults. The question is: do the same factors that influence people’s performance and responses in other settings also apply to interviewing? Research in interviewing generally falls under two, interrelated categories: 1) memory performance (information quality and quantity) and 2) disclosure (willingness to disclose and the rate of information disclosure).

Memory performance in evidential interviewing. In the present thesis, I will examine the effects of avatar evidential interviewers. Avatar interviewers can optimise the interviewer's characteristics and reduce non-verbal communication cues that may (un)intentionally interfere with the interview process. Current findings from a limited number of studies on avatar evidential interviewers have revealed that, relative to human interviewers, avatar interviewers increase witness' recall (Hsu & Teoh, 2017; Taylor & Dando, 2018) and improve rapport, engagement, and trust towards the interviewer (e.g., Bickmore et al., 2010) during their interaction. These studies have guided my thesis research on exploring the practical values of avatars in evidential interviewing. In Hsu and Teoh (2017), the authors examined the effects of an avatar interviewer on typically-developing (TD) children and children with Autism Spectrum Disorder (ASD). In that study, an avatar or a human each interviewed 15 children between 6- and 8-years of age about a target event. Half of the children had a diagnosis of ASD and half were TD children. A concealed person voiced and operated the avatar interviewer. The avatar mirrored the visible appearance, gender, and ethnicity of the human interviewer in the face-to-face condition. Children participated in a treasure hunting game. A week later, a human or an avatar interviewer questioned the children on the target event using open-ended questions, specific questions, and then six misleading questions. Each of the six misleading questions included one incorrect item from the game.

Relative to the human interviewer, children with ASD who were interviewed by the avatar reported more information during free recall. Typically-developing children, on the other hand, reported the same amount of information, irrespective of the interviewer. In terms of accuracy during free recall, both groups of children were more accurate when the avatar interviewed them. When the participants were asked misleading questions, participants interviewed by the avatar were more suggestible than were the participants who were interviewed by the human interviewer face-to-face. That is, children were more likely to provide an incorrect answer to the misleading questions in the avatar condition than were children in the human condition. On the basis of their data, Hsu and Teoh (2017) concluded that the avatar interviewer helped increase the accuracy of children's accounts of a personally-experienced event without compromising the amount of information, but only under optimal interviewing conditions (i.e., in the absence of false information). When asked misleading questions, children interviewed by the avatar provided less accurate accounts relative to the children who were interviewed by the human. These findings raise an important question: Are these findings generalisable to adult eyewitnesses? Taylor and Dando (2018) addressed this question.

In their study, Taylor and Dando (2018) explored the effects of an avatar interviewer on memory recall in adults. Twenty-eight neurotypical adult participants between 18- and 38-years of age were randomly assigned to either the Human condition or Avatar condition. The avatar interviewer was similar to that of Hsu and Teoh (2017) except that Taylor and Dando used a 3D-contoured avatar projected in an immersive environment. Participants also had the option of selecting an avatar interviewer depicting either a male or female. Participants watched a pre-recorded video of a mock crime and were subsequently asked about the contents of the video two days later using open-ended and then specific questions. Relative to the Human condition, participants who were interviewed by the avatar interviewer provided similarly accurate free-recall accounts but were more accurate in response to specific questions. Unfortunately, these results cannot be directly compared to the results from Hsu and Teoh for several reasons. First, Taylor and Dando used a 3D-contoured avatar; Hsu and Teoh used a 2D-contoured avatar. Results from avatar studies in other areas of application showed that an avatar's appearance, specifically realism, may impact adults' responses and their interaction with an avatar (Seyama & Nagayama, 2007; Zibrek, Kokkinara, & McDonnell, 2018). Second, Taylor and Dando presented their avatar in an immersive virtual environment; Hsu and Teoh presented their avatar via a computer monitor. Researchers have demonstrated that adults respond and interact differently in different environments because of the level of immersion (Roettl & Terlutter, 2018; Slobounov, Ray, Johnson, Slobounov, & Newell, 2015). Immersion is the perception of being physically present in a non-physical world. Third, Taylor and Dando did not explore individual differences, including autism traits; Hsu and Teoh directly compared TD children and children with autism. The findings from avatar studies in other areas of application showed individual differences in the way people respond and interact with avatars (e.g., Soares et al., 2020). In the present thesis, I addressed these current gaps in the literature on adults' memory performance by using a 2D cartoon-rendered avatar displayed on a computer screen as the avatar interviewer. This setup resembled Hsu and Teoh. Furthermore, in the present thesis, I examined personality and autism traits as possible individual differences in adults' memory performance when they are interviewed by an avatar. These particular traits were selected on the basis of previous studies in evidential interviewing (i.e., Hsu and Teoh, 2017) and in other areas of application of avatar technology (i.e., Hongpaisanwiwat & Lewis, 2013).

Disclosure in evidential interviewing and other help-seeking settings. Disclosure of information is not only vital in evidential interviews but also important in other help-seeking settings, including topics discussed in a clinical context and the financial sector. For instance, disclosing potentially stigmatizing and embarrassing events to a doctor or a psychologist can assist health professionals in implementing effective treatments; reporting information on current financial status can help individuals to access support. Despite the importance of disclosure, it is often low, due, at least in part, to the fact that the information required in these contexts is sometimes associated with stigma (Kennedy & Prock, 2018; Mannarini & Rossi, 2019; Rössler, 2016). The anonymity of social interaction with avatar interviewers may encourage information disclosure. Findings from studies on avatars and disclosure have been mixed (cf. Baccon, Chiarovano, & MacDougall, 2019; Lind, Schober, Conrad, & Reichert, 2013; Lucas, Gratch, King, & Morency, 2014; Pickard & Roster, 2020; Pickard, Roster, & Chen, 2016; Yokotani, Takagi, & Wakashima, 2018). Specifically, some researchers have shown that adults prefer disclosing sensitive information to an avatar rather than to a human (e.g., Pickard et al., 2016). Other researchers have shown that humans outperform avatars (see Baccon et al., 2019) or are comparable to avatars (Lind et al., 2013; Pickard & Roster, 2020) in eliciting disclosure.

Several factors may have contributed to the relative effectiveness of avatars on information disclosure. These factors include; 1) perception of the avatar's control. That is, avatars that are perceived as computer-controlled rather than human-controlled elicit higher rates of disclosure (Lucas et al., 2014); 2) the avatar's appearance—participants disclose more personal information to a less realistic-appearing avatar (Bailenson et al., 2006; Lind et al., 2013; cf. Kang & Gratch, 2010) and to an avatar that appear older (Lee, Xiao, & Wells, 2018); 3) participants' interaction with the avatar (i.e., people are more likely to disclose personal information when an avatar reciprocates that disclosure; Kang & Gratch, 2011); and 4) the nature of the topic (i.e., for more sensitive topics, people tend to disclose more to an avatar than to a human; Pickard et al., 2016; Schuetzler, Giboney, Grimes, & Nunamker Jr., 2018). For example, Pickard et al. (2016) investigated adults' willingness to disclose topics of varying sensitivity. In that study, 203 undergraduate students rated the level of sensitivity of 14 topics using a 5-point scale. Subsequently, they were asked to indicate their preference for discussing each topic with either an avatar or a human face-to-face. Overall, participants indicated that they would prefer to be interviewed by an avatar rather than a human on more sensitive topics and that they would prefer to be interviewed by a human rather than an avatar on less sensitive topics. For topics of intermediate sensitivity, participants showed no preference. Despite the potential impact of these findings, they may have limited ecological validity in some contexts. In general, a large portion of the topics that Pickard et al. used reflected topics that are not often discussed in a professional, help-seeking settings (e.g., legal context, clinical settings, or financial sector). Specifically, topics on the list included computer brands, personal hobbies, homeless people, and charity.

Using topics that are more akin to those that might discussed during psychological assessment or therapy, Yokotani et al. (2018) examined participants' disclosure of different mental health issues with an avatar controlled by a computer system or with a therapist face-to-face. In that study, a male therapist and an avatar who appeared to be female talked to participants about their struggles with mental health. Participants disclosed details of sex-related topics more often with an avatar than with a therapist face-to-face; participants disclosed mood- and mental health-related topics more often with a therapist face-to-face than with an avatar. Unfortunately, it is impossible to conclude from Yokotani et al.'s results that participants preferred to discuss sex-related problems with an avatar because there was a gender difference between the therapist and the avatar. It is equally possible, for example, that participants preferred to discuss sex-related topics with a female partner, rather than with an avatar, per se.

Furthermore, the (incorrect) interchangeable use of the terms *rate or amount of disclosure* and *willingness to disclose* may account for the mixed findings across studies on avatars and disclosure. For example, Lucas et al. (2014) measured respondents' *willingness to disclose* information by examining participants' *amount of disclosure*; Pickard et al. (2016) examined respondents' *willingness to disclose* information but referenced studies that measured the *amount of disclosure* (e.g., Joinson, 2001; Kang & Gratch, 2010). It is important to distinguish between these two terms for two reasons: 1) the *amount of disclosure* does not indicate respondents' *willingness to disclose* information, 2) *rate or amount of disclosure* and *willingness to disclose* are measured differently (see Chapter 4, for a more detailed discussion).

With this background in mind, in the present thesis, I addressed the current gaps in the literature on the effects of avatars and disclosure. Building on the procedure used by Pickard et al. (2016), I examined adults' preference for discussing topics that are more akin to those that are discussed when people seek legal, medical, psychological, or financial support. Subsequently, I measured and compared adults' *willingness to disclose* information and their *amount of disclosure* of embarrassing personal events.

In sum, avatar interviewers may be an effective aid for enhancing people's memory performance during evidential interviews, especially for more vulnerable witnesses such as individuals with ASD. Furthermore, people may be more willing to discuss more sensitive and stigmatizing topics with avatars. Similar to people's response and interaction with an avatar in other settings, the effectiveness of people's response to an avatar interviewer is likely a complex process and influenced by several factors.

The Current Thesis

In the present thesis, I will explore the use of avatars as evidential interviewers to address some of the issues that are associated with a human interviewer. To date, researchers have yet to measure the possible link between witness' individual differences and their memory performance and information disclosure when interviewed by a 2D cartoon-rendered avatar under optimal and less optimal interviewing conditions (i.e., when adults are presented with post-event misinformation). In Chapter 2, I will outline some of the important aspects of evidential interviewing and provide an overview of factors that may influence the outcome of an interview. In the first empirical chapter of my thesis (Chapter 3), I will examine the effects of an avatar interviewer on adults' memory performance following a 1-day or 6-week retention interval. Additionally, I will explore potential heterogeneity in adults' memory performance when an avatar interviewed them. More specifically, my focus will be on the effects of two individual differences—personality and ASD traits—and perceptions of how an avatar is controlled, on adults' memory performance. Individual traits have been previously been found to influence people's cognitive performance (personality: Madsen & Holmberg, 2015; Madsen, 2017; autism: Maras & Bowler, 2010; McCrory, Henry, & Happé, 2007); avatars have shown to effectively improve adults' memory performance (e.g., Hongpaisanwiwat & Lewis, 2013; Soares et al., 2020). In Chapter 4, I will investigate adults' views of an avatar professional when disclosing potentially embarrassing topics that commonly appear in help-seeking settings (i.e., health sectors, banking, forensic context). In Chapter 5, I will focus on the misinformation effect when an avatar presented post-event misinformation. I will also further explore participants' views of an avatar professional for discussing potentially sensitive information after having experience with both an avatar and a human interviewer. In Chapter 6, I will investigate particular features of avatars that may influence adults' memory performance and their disclosure of an embarrassing personal event. Specifically, I will focus on the effects of the interaction between an avatar's realism and its operation (i.e., human- or computer-controlled). Finally, in Chapter 7, I will discuss the implications of my thesis research.

Chapter 2

Avatars as the Next Generation of Evidential Interviewing

An evidential interview is often the initial window into a criminal investigation, where a witness or a victim provides a declaration of the facts pertaining to an alleged crime. A witness or victim usually gives this account in narrative form—in chronological order. The interview itself involves a structured back-and-forth conversation that allows legal authorities to gather information about the facts of a crime. For some crimes like childhood sexual assault, a narrative account of the events provided by the victim is often the only available evidence. Unlike other types of forensic evidence (e.g., DNA, murder weapon, blood stains), the reports obtained during an evidential interview are more susceptible to contamination. Many wrongful convictions have been the result of unreliable eyewitness testimony (Garrett, 2011; "Innocence Project," 2017), which is partly due to poor interviewing procedures (see Loftus, 2005, for an overview).

Given the importance of evidential interviews for a criminal investigation, researchers have examined the factors that influence the content and accuracy of narrative accounts. By way of examples, researchers have shown that the details of memory may decay or change over time (see Hardt, Nader, & Nadel, 2013; Portrat, Barrouillet, & Camos, 2008, for a study on memory decay; see Inda, Muravieva, & Alberini, 2011; Simcock & Hayne, 2002, for studies on age-related changes in memory). It has also been shown that exposure to post-event misinformation may alter the original encoded memory (Loftus, 2005) There is also a handful of additional factors that could impact a person's account, for instance, interviewer bias (e.g., Quas et al., 2007), repeated questioning (e.g., Bruck, Ceci, & Hembrooke, 2002), and interviewer's demeanour (Collins, Lincoln, & Frank, 2002; Vallano & Compo, 2011).

The potential benefits of an avatar interviewer is with its flexibility in manipulating interviewer characteristics, including its appearance, gestures, and voice. In this chapter, I introduce some of the factors that impact people's narrative accounts: 1) interviewer's characteristics; 2) verbal interviewing techniques; and 3) non-verbal interviewing techniques. These factors have been used to guide my research design and inform the use of avatars as evidential interviewers during the investigative process.

The Impact of the Interviewer

Interviewers can be trained to use evidence-based, best-practice interviewing techniques to enhance people's memory performance. Still, there are elements of the interview that are more difficult to control (e.g., interviewer's gestures and characteristics). In forensic research, due to the practicality of controlling for these factors, there has been a dearth of studies investigating interviewer's characteristics. Of the limited number of studies, researchers have largely focussed on child witnesses rather than adult witnesses.

Interviewer's characteristics. To my knowledge, there have been no studies on the effects of interviewer's characteristics—gender, ethnicity, age—on adults' memory performance during an investigative interview. One clue that these factors may impact recall comes from studies on children witnesses. For example, Lamb and Garretson (2003) examined the effects of both children's and interviewer's gender on the amount of information reported by alleged victims of child sexual abuse. In that study, researchers selected 672 transcripts from cases in an archive of forensic interviews that included alleged victims between 4- and 14-years of age. Of the 672 cases, 474 female interviewers and 198 male interviewers interviewed the victims. The alleged victims in these cases included 473 girls and 199 boys. Children were reported more information with female interviewers than with male interviewers. Given the forensic nature of their data set, however, the researchers could not verify the accuracy of the children's accounts. Lamb and Garretson argued that suggestive questions might have potentially negative effects on accuracy as results showed that female interviewers used more suggestive questions than did male interviewers. In addition to these basic findings, Lamb and Garretson also reported that gender concordance might play a role in the quality of reported information, at least with girls. That is, girls, but not boys, provided more details of the alleged crime when interviewed by an interviewer of matching gender. Furthermore, relative to older children, younger children provided more information in response to suggestive questions, but only when questioned by an interviewer of the opposite sex. Other researchers have also demonstrated the impact of the interviewer's gender on children's memory performance in another study (Foster, Wyman, Tong, Colwell, & Talwar, 2018; Schaaf, Alexander, & Goodman, 2008).

On the basis of these findings, there appears to be a complex relation between the interviewer's gender and the interviewee's gender with respect to memory performance in investigative interviews. Many factors may need to be considered, for instance, behavioural and social differences across genders, the accuracy of the accusation, and the interviewee's age. Researchers have also gathered empirical support for the interaction effect between interviewer's and interviewee's ethnicity on the accuracy of children's accounts (see Fisher, Mackey, Langendoen, & Barnard, 2016). To date, there has been no study on the relation between the interviewers and the interviewees' age or appearance on individuals' memory performance.

Non-verbal cues. Evidential interviews consist of many of the same conventions that characterise any back-and-forth conversation, including non-verbal communication. Non-verbal communication includes gestures, facial expressions, and eye gaze that may appear in a conversation. Researchers have revealed that the interviewer's non-verbal communication cues affect the accuracy of people's accounts during evidential interviews. For instance, in one study, participants who were questioned by an interviewer who provided misleading gestures were less accurate in their description of a target video (Gurney, Ellis, & Vardon-Hynard, 2016). In that study, Gurney et al. randomly assigned 54 university students and participants from the community to either the Accurate-Gesture condition, Misleading-Gesture condition, or No-Gesture condition. Immediately after viewing a video depicting an assault, participants completed a 5-min distractor task. They were then provided a verbal summary of the video with either the correct gesture (i.e., *punching*) or misleading gestures (i.e., *stabbing*). In the No-Gesture condition, the interviewer provided a verbal summary with no gestures. Subsequently, participants were asked to provide a summary of the video. There was a clear association between the interviewer's gesture and the type of assault that participants described during the interview. Specifically, participants provided information concordant to the interviewer's gesture. Other researchers have also demonstrated the powerful effects of (misleading) gestures over the accuracy of participants' reports by adults (Gurney, Pine, & Wiseman, 2013).

Studies on an interviewer's eye gaze have provided further evidence that non-verbal cues influence the quality of participants' cognitive performance. For example, Buchanan et al. (2014) examined the disruptive effects of social eye gaze on participants' performance in a mental reinstatement task. Social eye gaze is a form of nonverbal communication through eye contact. Buchanan et al. hypothesised that gaze aversion aids in the recall of episodic memory because it reduces the social and cognitive demands of a face-to-face conversation—people may find it more challenging to think when someone is continuously staring at them. To test this hypothesis, the researchers randomly assigned 30 undergraduate students to one of five gaze conditions: eye-closure, eye-contact, mutual gaze, gaze aversion, and occluded face. During a cognitive task, participants were instructed to either close their eyes (Eye-closure condition), maintain eye-contact with the interviewer (Eye-contact condition), gaze towards the interviewer who was wearing a pair of dark glasses to obscure her eyes (Mutual Gaze condition), gaze towards the interviewer who did not reciprocate her gaze (Gaze Aversion condition), or maintain eye contact with the interviewer who had occluded her face with a bag (Occluded Face condition). All of the participants performed two cognitive tasks of increasing difficulty: mentally traversing through a 2D matrix and a 3D matrix. Participants in the Eye-Contact condition performed worse relative to the other four conditions on both cognitive tasks. There was also a decline in task performance for the participants in the Mutual Gaze condition as the task increased in difficulty (i.e., from the 2D to the 3D matrix). Based on their findings, the researchers argued that participants might have experienced higher levels of social pressure that were associated with the interviewer's eye gaze and so, potentially, fewer cognitive resources were available to perform the more cognitive-demanding task. Other researchers have suggested that eye-closure may reduce interference during a memory recall task (Perfect, 2008). These basic findings have been replicated in other similar studies on social eye gaze and adults' memory performance (Vredeveldt, Baddeley, & Hitch, 2014; Vredeveldt, Hitch, & Baddeley, 2011).

Even the physical presence of another individual may impact recall accuracy of more, but not less complex tasks. In a meta-analysis of 241 studies on the effects of the presence of others on adults' task performance, Bond and Titus (1983) showed that the presence of others decreased the speed and accuracy of complex task performance and increased the speed and accuracy of simple task performance. In sum, an interviewer's gesture and non-verbal communication cues can influence adults' memory performance in an evidential interview.

Impact of Questioning Techniques

The contents of an evidential interview are obtained verbally—in the form of a conversation—using structured, planned, and goal-oriented questions for optimising the content and accuracy of the report. Researchers have identified different types of questions that evidential interviewers use during interviews, for example, open-ended questions, specific or directed questions, and suggestive and misleading questions (see Geiselman, Fisher, MacKinnon, & Holland, 1988; Lamb, Orbach, Hershkowitz, Esplin, & Horowitz, 2007; Schollum, 2005).

Open-ended and specific questions. Without exception, researchers have recommended that an evidential interview begins with open-ended questions and that these questions should be used as much as possible throughout the interview (Mello & Fisher, 1996), especially with child witnesses (American Professional Society on the Abuse of Children [APSAC], 2012; Lamb, Hershkowitz, Orbach, & Esplin, 2008; Lamb et al., 2007). Open-ended questions are questions that allow the witness to provide a free-recall account of an event. Often, this type of question is in the form of a statement. For example, "Please tell me everything that happened that night." Open-ended questions do not restrict the range of answers, and they do not suggest new facts.

Once the interviewee cease to provide additional information in response to open-ended questions, specific questions are often used to prompt for further details. Specific questions use a "question-answer" format, usually in the form of the 'Five Ws'—what, where, which, who, when (e.g., "*What* time did it happen?" or "*Who* was with you that night?"), and one 'How' question. Specific questions can also be multiple-choice questions (e.g., "Who was with you that night: John, Jenny, or Jack?"), or yes-no questions that include a direct inquiry about a particular element of interest (e.g., "Was John with you that night?").

Apart from a few field and case studies (e.g., Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993; Lamb & Fauchier, 2001; Orbach & Lamb, 2001), the general consensus among researchers is that open questions elicit more detailed and accurate accounts than do other types of questioning techniques.

Suggestive questions. Interviewers, either intentionally or unintentionally, may ask questions that could negatively impact accuracy during an interview, including suggestive questions or misleading questions. These types of questions include those in which the interviewer provides additional information in the form of a question. For example, "John was with you that night, wasn't he?" or "Wasn't Jack with you that night? Similar to specific questions, suggestive questions also prompt the interviewee for an affirmative answer. Unlike specific questions, suggestive questions contain new facts—either true or false—that are introduced by the interviewer.

Researchers recommend that suggestive questions should be avoided whenever possible because they lead to reports with a large number of errors, even more so than when specific non-suggestive questions are used (e.g., Geiselman et al., 1988; Lamb et al., 2007). For instance, Roebers and Schneider (2000) studied the effects of using specific non-suggestive and suggestive questions during an interview with 284 participants of four different age groups (6-, 8-, and 10-year-olds and adults). The participants were randomly assigned to one of two conditions: Specific Non-misleading Questions and Specific Misleading Questions. All of the participants watched a short film depicting a squabble between two school-aged children. After a 3-week delay, the researchers asked each participant specific questions regarding the video. In the Misleading condition, participants were asked questions that contained an incorrect answer (e.g., "Did the boy have 60 Marks in this purse?"); in the Non-Misleading condition, participants were asked questions that did not contain any additional information (e.g., "How much money did the boy have in his purse?"). Following another one-week delay, participants were asked to complete a set of multiple-choice questions. Although adults performed better than children overall, participants who received non-misleading questions recalled the details of the video with higher accuracy than did the participants in the Misleading condition, regardless of age. These basic findings of the negative influence of suggestive interviewing on the quality of narrative accounts in both children and adults have been replicated in other studies (e.g., see Bowles & Sharman, 2014, for a review on suggestive questions and witnesses with intellectual disability; Cassel & Bjorklund, 1995).

Post-event misinformation. The misinformation effect is a memory phenomenon that refers to the interference of post-event information (PEI), including information provided in the form of suggestive questions, with the original memory trace (Loftus, 2005). For instance, false information may be presented in a discussion of a witnessed incident; the interviewer may present misinformation during an evidential interview; people may incorporate misinformation into their original memory trace upon receiving additional information through mass media.

Since the original demonstration of the phenomenon in the 1970s (see Loftus & Palmer, 1974), dozens of researchers have examined the effects of misinformation on adults' narrative accounts of a witnessed event. In Loftus and Palmer (1974), 150 students were shown a film depicting a traffic accident that did not result in broken or shattered glass. Subsequently, a third of the participants were asked "how fast the cars were going when they *hit* each other;" a third of the participants were asked "how fast the cars were going when they *smashed* into each other;" and the remaining participants were not asked about the speed of the car (i.e., control group). The words *hit* and *smashed* were introduced to assess the effects of PEI on the participants' subsequent accounts. A week following the initial interview, researchers asked each participant a series of specific questions that included a key question designed to determine the effects of misinformation on participants' description of the accident (i.e., "Did you see any broken glass?"). Relative to the *hit* group, participants who were presented with the word *smashed* reported seeing broken glass and estimated that the car was going at a higher speed. There was no difference in the number of participants who reported seeing broken glass between the *hit* group and the control group.

In another study comparing misinformation in children and adults, Sutherland and Hayne (2001) randomly assigned 24 11- and 12-year-olds and 24 adults to either a 1-day or 6-week retention interval. Participants watched a target video and were subsequently presented with PEI of specific aspects of the video either 1-day or 6-weeks later. One day following the PEI presentation, participants were interviewed about the video using open-ended questions and then were asked six directed-questions about specific aspects of the video. Two of the six directed-questions included false information about the video (i.e., misinformation); two of the questions included correct details on the video (i.e., leading details); the final two questions contained no new information. Children incorporated more post-event misinformation in their recall than did adults after a 1-day retention interval. Still, the adults' memory performance declined to the level of the children after a 6-week retention interval. The powerful impact of post-event misinformation on adult participants' original memory trace has been demonstrated in a plethora of studies (see Belli, 1989; Braun & Loftus, 1998; Loftus, 2005; Loftus & Hoffman, 1989; Loftus, Miller, & Burns, 1978; Morgan, Southwick, Steffian, Hazlett, & Loftus, 2013; Weingardt, Loftus, & Lindsay, 1995; Wright & Loftus, 1998; Zhu et al., 2012).

In summary, best practice questioning techniques should aim to increase an individual's memory performance and elicit disclosure. In reality, empirical evidence has shown that there is no "perfect" questioning technique. Evidential interviewers are often faced with a conundrum: either use open-ended questions to increase recall accuracy but sacrifice the amount of information reported or use specific and suggestive questions to increase the quantity and disclosure of information but compromise accuracy.

Impact of Non-verbal Interviewing Aids

To further improve current evidence-based interviewing protocols and elicit more detailed and accurate reports from witnesses and victims, researchers and legal professionals have turned to external aids—drawings and visual aids—to reinforce verbal interviewing methods.

Drawing. Researchers have explored the use of drawing during investigative interviews to 1) represent the details of a witnessed event, and 2) facilitate recall. In an influential study of using drawing during evidential interviews with adults, Dando, Wilcock, and Milne (2009) examined the effects of *Sketch Mental Reinstatement of Context (Sketch MRC)*. This technique allows free recall of an event through drawing. In that study, 60 undergraduates between 19- and 39-years of age watched a short video clip of a person shoplifting. Two days after viewing the video, participants were interviewed using open-ended questions with a Drawing condition. They were then asked a series of specific questions that contained some false information. Participants were randomly assigned to one of the three Drawing conditions: MRC, Sketch MRC, and no MRC. In the MRC condition, the interviewer *verbally* guided the participant first to visualise the details of the target video, and then participants provided verbal accounts of the video. In the Sketch MRC condition, the interviewer asked the participant first to draw a detailed sketch of anything they could recall from the video, and then to describe their drawing and anything that they could recall from the video. For the no MRC (control) condition, the interviewer asked the participant to describe the details of the video verbally. Participants in the Sketch condition provided more correct details, with higher accuracy than did participants in the control condition. Furthermore, these same participants recalled less false information than did participants in the other two conditions in response to the specific questions.

In a different study, Dando (2013) replicated Dando et al.'s (2009) findings with older participants. In that study, Dando randomly assigned 51 older adults between 67- and 89-years of age to one of the same three Drawing conditions: MRC, Sketch MRC, and no MRC. Participants witnessed a live event depicting an error in the allocation of a lecture room and were subsequently interviewed two days later. Again, participants in the Sketch condition provided more detailed information than did the participants in the other two conditions.

Visual aids. Visual aids, including pictures and photographs, are depictions or schematics of different aspects of an event. Unlike self-produced drawings, the interviewer provides the visual aid. Researchers have demonstrated that visual aids may increase the quantity of the information reported without compromising accuracy. For example, Jack, Martyn, and Zajac (2015) studied the effects of drawing and photographic aids on reports provided by children (9–12 years), adolescents (14–16 years), and adults (25–60 years). In that study, participants watched three short video clips depicting non-violent crimes. After watching the videos, participants were first asked to verbally free-recall the contents of the videos. Then they were provided with a visual aid: either a photograph of the crime scene or a sketch plan of the crime scene or they were asked to draw the crime scene. The control group was only asked for a free-recall account of the contents of the video. Subsequently, participants were interviewed again on the contents of the videos. Relative to the participants in the control group, participants who were presented with a visual aid provided more additional information on the videos during the second interview without compromising accuracy. Furthermore, participants who were asked to draw the crime scene provided the highest amount of information during the second interview compared to all other groups. Adults who were interviewed with visual aids reported more additional information in the subsequent interview than did children and adolescents, but only for detailed on surroundings, not people or actions. On the basis of these findings, it appears that visual aids may facilitate individuals' account of a prior event. Still, the effects of visual aids may not be as powerful as drawing in facilitating recall of an event.

Technology in Evidential Interviews

In a plethora of studies, researchers have demonstrated that even a trained interviewer may not be cognisant of subtle components of interviewing, such as an interviewer's gestures and facial expressions. This finding raises an important question: how can we minimise the negative impact of the interviewer on people's memory performance and increase disclosure during an investigative interview? One possible option is to incorporate technology in the form of a robot or an avatar. Robots and avatars have the potential to reduce the negative impact of interviewers' characteristics by removing their physical presence, reducing non-verbal communication cues, and adapting specific needs to suit individuals, without sacrificing evidence-based interviewing techniques that are associated with optimal memory performance.

Robots. Two types of robots have been extensively studied in the context of interviewing: the NAO and KASPAR humanoid robots. NAO is a 58-cm tall robot with a neutral expression and a robotic face; KASPAR is a child-sized robot with a human-like face and minimal facial expressions and gestures. In one seminal study, Bethel, Eakin, Anreddy, Stuart, and Carruth (2013) randomly assigned 101 participants between 18- and 30-years of age to either the NAO interviewer or a human interviewer, who asked either misleading or neutral questions. Participants watched an 8-min slide show twice depicting a maintenance man stealing from an office. After watching the slide show, participants in the Robot condition first interacted with NAO to overcome possible novelty effects of a robot interviewer. Subsequently, a researcher asked each participant 21 specific questions related to the slides, with six of the 21 questions designed to assess participants' susceptibility to false information. Half of the participants were asked six neutral questions that did not include any additional information; the remaining participants were asked six misleading questions that contained incorrect information. Following the interview, a written cued-recall test about the slides was administered to the participants, and participants also rated their experience with their interviewer. Overall, participants in the Human condition who were asked misleading questions scored lower on the recall test than did the participants who were asked neutral questions. In the Robot condition, participants who were asked misleading questions showed similar scores on the recall test to participants who were asked neutral questions. Participants who were interviewed by the human interviewer reported a more positive experience than did the participants who were interviewed by the robot. These findings suggest that participants preferred talking to the human interviewer, even though they were somewhat less accurate.

Based on their data, Bethel et al. (2013) concluded that human interviewers mislead adults, but not a robot. Unfortunately, Bethel et al. did not conduct the critical statistical comparison—a comparison between the two interviewer conditions. Visual inspection of their data indicated that the effect that they reported was due primarily to group differences in participants' responses to the neutral questions—not the misleading ones. That is, participants in the robot interviewing condition who were asked the neutral questions scored lower on the recall test than did the participants in the human interviewing condition; participants who were questioned by the robot performed equally poorly on both the neutral questions and the misleading questions. Thus, in contrast to the authors' conclusion, the data indicated that the robot did not protect participants from the negative effects of misleading questions. In addition, interviewing props like NAO may encourage children to fantasise, construct, and exhibit exploratory play due to its toy-like appearance (Lamb, Sternberg, & Esplin, 1994; Thierry, Lamb, Orbach, & Pipe, 2005). These play-like behaviours in children could increase the amount of false information that they report (Newlin et al., 2015; Otgaar, Horselenberg, van Kampen, & Lalleman, 2012; Poole & Bruck, 2012).

In summary, despite some researchers' enthusiasm for the value of robots in interviews with adults, thus far, the data demonstrate that they yield no better outcomes than do human interviewers. In a critical review of the research on robots as forensic interviewers, Henkel and Bethel (2017) explored the benefits and detriments of using this approach. The authors highlighted that robot interviewers could reduce any biased non-verbal cues that even a trained human interviewer potentially displays throughout an evidential interview (e.g., Bethel et al., 2013). Robot interviewers are also more adaptable to the witness' needs. For example, a robot's appearance and voice can be modified to match the preferences of any witness. Despite the potential benefits of robot interviewers, researchers in many of the robot-interviewing studies have often reported non-significant findings in their quantitative analyses and instead, reported qualitative results. Even then, in many cases, the qualitative findings were weak (see Henkel & Bethel, 2017, for a review). Still, on the basis of the current findings, researchers have suggested that robot interviewers are not better, but also not worse than human interviewers in eliciting recall of details of a prior event.

Avatar interviewers. Avatar interviewers are another alternative interviewing aid that may be used to optimise the interviewer's characteristics and reduce (misleading) non-verbal communication cues. In the next chapter (the first empirical chapter), while keeping verbal interviewing techniques constant, I explore the use of avatars as evidential interviewers on adults' memory performance following a 1-day or 6-week retention interval. Additionally, as discussed in Chapter 1, personality and autism traits, have been found to impact adults' memory performance when a human interviewed them; the perception of the avatar's control also influences people's response to an avatar. In the first empirical chapter (Chapter 3), I examine the effects of individual differences in adults' personality and ASD traits, and their perception of how an avatar is controlled, have on adults' memory performance.

Chapter 3

Avatars in the Courtroom: Individual Differences in Adults' Memory Performance with Avatar Interviewers

Avatars are increasingly being studied and utilised in a wide variety of contexts, including education (Kwok et al., 2016; Macedonia et al., 2014; Veronin et al., 2012; Wiecha et al., 2010), advertising (Ahn & Bailenson, 2011; Holzwarth et al., 2006; Kraak & Story, 2015; Neeley & Schumann, 2004; Phillips et al., 2019), instant messaging (Fabri & Moore, 2005; Galanxhi & Nah, 2005, Taylor, 2011), and health care (Allen, 2018; Bickmore et al., 2009; Bouchard et al., 2017; Rehm et al., 2016; Napolitano et al., 2013). Another potential novel application for avatars might be in the context of forensic interviews. The purpose of a forensic interview is to gather important information from a witness or victim; a well-conducted interview can determine the outcome of a criminal case (Euale & Turtle, 1998; Yeschke, 2003). Relative to human interviewers, avatar interviewers reduce non-verbal distractions, may be perceived by individuals as less authoritarian, could minimise individuals' feelings of social pressure, and provide flexibility in manipulating features of an interviewer such as gender, ethnicity, and age.

In a limited number of studies, researchers have explored the effects of avatars on adults' memory performance in the context of evidential interviewing. For example, Taylor and Dando (2018) examined the effects of a 3D avatar interviewer on adult participants' memory performance during a mock investigative interview. The researchers found that relative to a human interviewer, participants reported more accurate details of a witnessed event in response to an avatar interviewer's specific questions. In another study with child participants, Hsu and Teoh (2017) found differences in children's reports of an experienced event when they were interviewed by a human interviewer or a 2D cartoon-rendered avatar interviewer. Children from that study were either typically-developing (TD) or were diagnosed with autism spectrum disorder (ASD). The authors found that relative to a human interviewer, an avatar interviewer elicited reports with a greater number of details and with higher accuracy in children with ASD. For TD children, avatar interviewers elicited the same amount of information as human interviewers, but the accuracy of the information reported was higher when children were interviewed by the avatar.

Taken together, the data from these studies provide some evidence for a positive effect of avatar interviewers. At the same time, however, they also suggest that the effects of avatar interviewers on participants' memory performance may be stronger for some groups than for others. Furthermore, both of these studies revealed significant variations in participants' memory performance in response to an avatar interviewer, indicating possible heterogeneity in participants' responses to an avatar. On the basis of these findings, an important question is, does everyone benefit from being interviewed by an avatar? To answer this question, I compared the effects of a human interviewer and an avatar interviewer on adults' memory of a brief video. I explored possible individual differences in participants' personality traits and traits that resemble ASD. These particular features pose particular challenges for investigative interviewers. For instance, forensic interviews require sustained reciprocity and verbal exchanges between the interviewer and the interviewee (Cronch et al., 2006; Cross et al., 2007), which is the hallmark deficit of individuals with ASD. Personality traits have been found to impact cognitive performance (Madsen, 2017). In addition, I examined participants' perception of the avatar's operation (i.e., a computer- or human-controlled avatar) on their memory performance. Researchers have shown that people respond differently to avatars that they perceive as human or computer-operated (Blascovich, 2002).

Avatars and ASD Traits

According to the American Psychiatric Association's (2013) *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5), individuals with ASD are characterised by difficulties in social interaction and communication, and in repetitive and rigid movements or interests. These difficulties are especially problematic in investigative interviews because often these interviews rely on a back-and-forth interaction between the interviewer and the interviewee. When researchers have compared the performance of neurotypical individuals and individuals with ASD, they have reported that individuals with ASD tend to be less accurate and less detailed during their free recall of a witnessed event relative to their neurotypical counterparts (Maras & Bowler, 2010; McCrory et al., 2007). Yet, current evidence-based interviewing protocol promotes the use of open-ended questions to elicit free-recall accounts (Mattison, Dando, & Ormerod, 2015; Tanweer, Rathbone, & Souchay, 2010). The lower memory performance during investigative interviews may be due, in part, to deficits during memory encoding due to a lack of self-awareness in social contexts for individuals with ASD (Chaput et al., 2013; Tanweer et al., 2010). On the other hand, the episodic memory deficit may be due to the lack of support during memory retrieval (Bowler, Matthews, & Gardiner, 1997). This support can take many forms, including physical context reinstatement for adults (Maras & Bowler, 2012) and social support for children (Almeida, Lamb, & Weisblatt, 2019).

Technology may provide this support (for a review on the use of technology with individuals with ASD across various contexts, see Aresti-Bartolome & Garcia-Zapirain, 2014. Note that most studies have examined children with ASD not adults). Epley, Waytz, and Cacioppo (2007) proposed a three-factor theory of anthropomorphism. This theory posits that avatars may provide support and ameliorate the difficulties experienced by individuals with ASD during a social interaction (see Atherton & Cross, 2018, for a review). Individuals with ASD may anthropomorphise non-human entities, such as avatars. This allows for social engagement with less emotional risk, which in turn, reinforces the interests of individuals with ASD towards non-human entities. For instance, Silva et al. (2015) showed that, relative to TD adolescent and adult participants, individuals with ASD tended to avoid photographs of humans but readily approached cartoon images. Avatars may also offer individuals with ASD more salient social cues to increase their attention and motivation (Moore & Calvert, 2000). However, attention and responsivity are not synonymous. For example, in a study using interactive avatars, Carter, Williams, Hodgins, and Lehman (2014) showed that across interaction conditions (i.e., human therapist, cartoon video, interactive "turtle" avatar, human actor), there was no significant differences in the attention of children with ASD. The amount of gestures and verbal responses were significantly higher when children interacted with the human therapist compared to all other interaction conditions. The results suggest that a trained communication partner may be more important than the appearance of the avatar, per se. In Carter et al., the human actor, not the trained therapist teleoperated the avatar. In addition, Carter et al. used a non-human-like avatar (i.e., turtle). This might have reduced the positive effects of the avatar on the responses of children with ASD.

In another study using an interactive avatar (Tartaro & Cassell, 2008), the interactive partner was either another child or a virtual child (avatar) teleoperated by an experimenter who responded to children with ASD using pre-recorded responses. The authors showed that children were more responsive to avatars during social interactions than they were with the child partner. Again, the difference between the communication partner (i.e., experimenter vs. child) might have accounted for this difference. Moreover, the avatar's anthropomorphism might also have influenced children's responsivity; that is, the human-like appearance of the avatar in Tartaro and Cassell (2008) may explain the positive effects of the avatar partner. Based on Epley et al.'s (2007) three-factor theory of anthropomorphism, individuals with ASD may view themselves as "less human" and thus, relate more to non-human entities that appear human, such as an anthropomorphic avatar but may prefer less human-like entities (Parsons & Mitchell, 2001). Empirical support for the effects of avatars' anthropomorphism on responsivity has been replicated with adults with ASD (Rourke, 2020).

To date, only Hsu and Teoh (2017) have directly compared the effects of avatar and human interviewers on the memory performance of children with ASD during a mock investigative interview. The avatar in their study was teleoperated by the interviewer who conducted face-to-face interviews. Their results support the use of a 2D cartoon-rendered avatar interviewer for children with ASD. This supportive effect of an avatar interviewer has not been explored in the context of evidential interviews with adults with ASD. In the present experiment, one of the aims was to begin to address this gap in the literature.

Avatars and Personality Traits

There are five general domains of personality (*neuroticism*, *extraversion*, *openness*, *agreeableness*, *conscientiousness*, Costa & McCrae, 1992). To date, researchers have not yet examined the effects of adults' personality traits on their memory performance during evidential interviews with an avatar interviewer. There is, however, evidence to support the effects of personality traits on cognitive performance in the context of evidential interviews. For example, researchers have consistently found that individuals with high neuroticism tend to display poorer memory performance during a mock investigative interview (Madsen & Holmberg, 2015; Madsen, 2017). Low conscientiousness is also a predictor of poor memory performance of a witnessed event during a simulated evidential interview (Madsen, 2017). Other personality traits, such as high extraversion and openness, are associated with better memory performance during a mock investigative interview (Madsen & Holmberg, 2015; Madsen & Santtila, 2018).

With respect to personality traits, memory performance, and avatars, Hongpaisanwiwat and Lewis (2013) have shown a link between participants' personality traits and their recall of semantic knowledge presented by avatar educators. More specifically, adults who were more introverted had better recall of acquired semantic knowledge relative to individuals who were more extroverted when an avatar with a computer-synthesised voice presented the learning materials. However, this effect was only observed for an anthropomorphic avatar. Unfortunately, Hongpaisanwiwat and Lewis did not make a direct comparison between participants' memory performance with an avatar educator and a human educator. Rather, they compared participants' memory performance across avatars with different degrees of realism. Furthermore, there is a fundamental difference between the retrieval of acquired knowledge and details of a prior event.

Given the research on the relation between adults' personality traits and their performance in simulated forensic interviewers, might an avatar interviewer enhance memory performance in individuals with certain personality traits? Hongpaisanwiwat and Lewis (2013) found introverted adults performed better on a memory test when an avatar presented the testing material. Additionally, individuals with high neuroticism are likely to experience feelings of anxiety, stress, worry, and frustration (Thompson, 2008). In a forensic interview, elevated levels of stress and anxiety may compete with an individual's finite cognitive resources which are needed for completing the task (Derakshan, Smyth, & Eysenck, 2009; Eysenck & Derakshan, 2011). Given the absence of nonverbal communication cues exhibited by avatar interviewers, participants with high neuroticism may benefit from being interviewed by an avatar interviewer. That is, reduced nonverbal communication cues may reduce feelings of social pressure, and subsequently elevate task performance for a difficult task like a forensic interview (Byrne, Silasi-Mansat, & Worthy, 2015; Derakshan et al., 2009; Eysenck, Derakshan, Santos, & Calvo, 2007). Finally, individuals with low conscientiousness are characterised as unmotivated, irresponsible, and undutiful (Thompson, 2008). Thus, adults with low conscientiousness generally show less engagement in a given task (Inceoglu & Warr, 2012; Ongore, 2014). Given these tendencies, the engaging and novelty effect of a cartoon-rendered avatar interviewer may motivate individuals with low conscientiousness during interview sessions, and consequently enhance their memory performance. Another aim in the present experiment was to explore the effects of these personality traits on adults' memory performance during a mock investigative interview with either a human or an avatar interviewer.

Perceived Operation of an Avatar

An avatar's operation refers to the method of its control (also known as *agency*; in the present thesis, the terms *operation* and *agency* are used interchangeably). An avatar can either be controlled by a computer system or by a concealed human. Researchers have found that participants' perception of an avatar's operation may impact the way that they respond to an avatar and subsequently affect their performance on cognitive tasks (see Fox et al., 2015, for a meta-analysis). Specifically, when participants perceive an avatar as being operated by a concealed human, they perform poorer on tasks that are more cognitively taxing (i.e., more difficult or novel tasks). One possible explanation for this difference is that individuals may feel that they are 'being watched' when they perceive an avatar as human-operated. Researchers have demonstrated that having a sense of 'being watched by others' increases an individual's feelings of social pressure (Pereda, 2016) and negatively influences cognitive performance (Yu, Tseng, Muggleton, & Juan, 2015). A final aim in the current experiment was to investigate the effects of adults' perception of an avatar's operation on participants' memory performance.

The Present Experiment

The overarching goal of the present experiment was to answer the question: are avatar interviewers better than human interviewers in facilitating adults' recall during an interview? I hypothesised that overall, participants would show better memory performance with an avatar interviewer compared to a human interviewer because an avatar reduces non-verbal distractions and may minimise feelings of social pressure. In addition, I wanted to determine whether participants' level of ASD and personality traits and their perception of an avatar's operation would influence participants' memory performance. Similar to Hsu and Teoh's (2017) study on the effects of avatars with children with autism, I hypothesise that adults with more traits resembling ASD would show better memory performance when an avatar interviewed them. With respect to personality traits, I hypothesise that some aspects of participants' personality traits would influence memory performance when an avatar interviewed them after a 6-week, but not a 1-day delay. This prediction of the retention interval is based on the fact that recalling an event 6 weeks later is a more cognitive-demanding task, and would consequently be more susceptible to social pressure (Buchanan et al., 2014).

Participants watched a 5-min video and were subsequently interviewed about the details of the video either by an avatar interviewer presented on a 2D screen or by a human interviewer face-to-face. Participants were either interviewed 1 day or 6 weeks after watching the video. I included the longer retention interval to improve the ecological validity of the present experiment because witnesses or victims are often interviewed following long delays (Hanna, Davies, Henderson, Crothers, & Rotherham, 2010). Furthermore, the 6-week retention interval provides a more cognitively-demanding task due to forgetting over time (Sutherland & Hayne, 2001).

Method

Participants

The final sample consisted of 106 adults (88 females; M_{age} = 23.54 years; *SD* = 6.15; range 18–59); recruited through a university participant database. We based our sample size on other published literature in the field (Sutherland & Hayne, 2001). All participants provided written informed consent and were reimbursed $25 for their participation. The research was reviewed and approved by the University of Otago's Human Ethics Committee, which is accredited by the New Zealand Health Research Council and whose guidelines are consistent with those of the American Psychological Association.

Video Stimulus

The 5-min video depicted a female child—Sally—who is separated from her mother because she was distracted by a dog. In the video, Sally follows the man walking the dog and becomes lost. In the process, Sally also loses her toy monkey, which is then picked up by two delinquent teenagers—a boy and a girl—who tear the monkey apart. Sally is then approached by another man in the park who offers to help her find her toy monkey. Sally refuses this help, and the man drives away when he sees a policeman. The policeman asks Sally for her mother's name, phone number, and where she works. The policeman takes Sally to the police station and calls her mother at work. Sally's mother arrives at the police station and is reunited with Sally.

Interviewer Conditions

The human interviewer. In the Human condition, participants were interviewed face-to-face by a female human interviewer (see Figure 3.1, left). The female interviewer sat across from the participant with a table in between them.

The avatar interviewer. In the Avatar condition, participants were interviewed by an avatar interviewer that was displayed on a computer monitor on a table. To minimise the interviewer's perceived authority, I used a 2D cartoon-rendered avatar that depicted a female with anthropomorphic features. The avatar had photorealistic eyes and lips. To control for confounding effects of visual appearance, the avatar was constructed to resemble the human interviewer in facial features, hair colour and style, and body shape (see Figure 3.1, right). Furthermore, to increase the predictability of the avatar's movement and reduce non-verbal gestures during interviews, the avatar was limited to eye blinks and head tilts to one side, which occurred approximately once every 5 s in an alternate order. The rate of blinking mimicked that of a typical human adult (Bentivoglio et al., 1997).

The avatar was controlled using the "Wizard-of-Oz" technique—a technique where the avatar acts as an intermediary between the participant and a concealed human interviewer. That is, the avatar was not computer-controlled, but rather was controlled by a human. The "Wizard-of-Oz" technique is widely used in human-computer interaction studies to accommodate for the lack of spontaneous responses with artificial intelligence software (Kelley, 1983). This technique has been previously used in other similar studies (e.g., Hsu & Teoh, 2017). The concealed human interviewer provided the voice of and operated the avatar from another room via the internet. When the concealed human interviewer spoke, the avatar's lips moved in synchrony with the human's voice. At the start of the interview, the concealed human interviewer used the "space bar" on her keyboard to control the avatar to signal a "Hi" hand gesture for capturing the participants' initial attention.

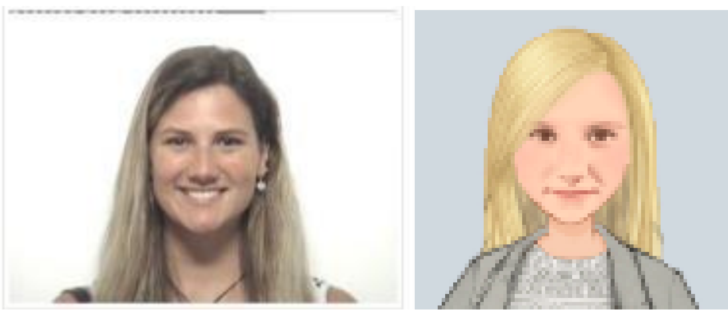

Figure 3.1. The human interviewer (left); the avatar interviewer (right).

Trait Measures

The Autism-Quotient questionnaire. The Autism-Quotient (AQ) is a 50-item self-administered screening questionnaire designed to measure level of traits resembling characteristics of autism spectrum disorder (ASD; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The questionnaire is made up of five subscales (10 items each) that include the core symptoms of autism: *social skill, attention switching, attention to detail, communication, and imagination.* Questions on the AQ include, "*I prefer to do things the same way over and over again"* and "*I am fascinated by dates*." Participants rate their agreement with each item using a 4-point scale (1 = *Definitely agree* to 4 = *Definitely disagree*). For half of the 50-items, ratings of either a 1 or 2 are scored as 0s and ratings of either a 3 or 4 are scored as 1s; for the other half of the 50-items, ratings of either a 1 or 2 are scored as 1s and ratings of either a 3 or 4 are scored as 0s. The final summed score ranges from 0–50 (higher scores indicating more characteristics resembling ASD). Although I used AQ as a continuous measure, a cut-off score of 26 (scores above 25) has been used to identify individuals experiencing significant subthreshold of characteristics of AQ (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005). The AQ is frequently used in research and has good psychometric properties. Internal consistency (Cronbach's α[1]) of the AQ in the current experiment was .73.

The NEO Five-Factor Inventory-3. The NEO-Five-Factor Inventory-3 (NEO-FFI-3; Costa & McCrae, 1992) is a 60-item self-administered inventory designed to measure the five general domains of personality: *neuroticism, extraversion, openness, agreeableness,* and *conscientiousness*. The questionnaire is made up of five subscales (12 items each) that includes each of the five personality domains. Questions on the NEO-FFI-3 include, "*I try to perform all the tasks assigned to me conscientiously*" and "*I shy away from crowds of*

[1] The conventional benchmark for adequate reliability is .70

people." Participants rate their agreement with each item using a 5-point scale (0 = *Strongly disagree* to 4 = *Strongly agree*). Responses are summed; the score for each of the five personality domains can range from 0–48, with higher scores indicating more endorsement of that personality trait. The NEO-FFI-3 is frequently used in research and has good psychometric properties. Internal consistency (Cronbach's α) of the NEO-FFI-3 in the current experiment was .88 for Neuroticism; .84 for Extraversion; .74 for Agreeableness; and .86 for Conscientiousness, with Openness (.69) being the only personality domain to fall just below the conventional benchmark of .70 for adequate reliability.

Procedure

Session 1. At the beginning of the first session, participants were informed that the purpose of the experiment was to evaluate the suitability of a video for children. Each participant watched the video on their own. Immediately after watching the video, participants completed an online questionnaire to collect demographic information (gender, ethnicity, age, level of education), and completed the NEO-FFI-3 and AQ. After participants completed the questionnaires, they were asked to return to the laboratory either the following day or six weeks later.

Session 2. One day or six weeks after watching the video, participants returned to the laboratory and were told that the real purpose of the experiment was to assess their memory for the video. Participants were assigned to one of two interviewer conditions: the human-interviewer condition (n = 52) or the avatar-interviewer condition (n = 54). For participants in the human-interviewer condition, the experimenter introduced the female human interviewer by saying, "*This is Ana, and she is going to talk to you about the video.*" Participants in the avatar-interviewer condition were seated in front of a 21.5" computer monitor that displayed the avatar interviewer. The experimenter then said, "*This is Ana. Ana is a computer animation that is going to talk to you about the video. You can talk to it, and it will respond*."

The experimenter then left the interview room.

The memory interview was conducted in two phases (see Appendix A). During the free-recall phase, the interviewer asked the participant to report everything that he or she could remember from the video by saying, "*Tell me everything that you can remember about what happened in the video, from the beginning to the end*." Both the human and the avatar interviewer kept their verbal and non-verbal responses minimal, with only neutral gestures like eye contact, smiling, head tilt, and words of encouragement to maintain the conversation. The only additional prompt given during the free-recall phase was, "*Is there anything else you can remember that you haven't already told me?*"

Once the participant indicated that he or she had no more information to report, the interviewer began the directed-recall phase of the interview. The interviewer asked participants six directed questions regarding specific aspects of the video (e.g., What colour was Sally's monkey?).

Immediately after the interview, participants in both Interviewer conditions completed a 12-item feedback questionnaire that was designed to evaluate their thoughts on the interviewer (e.g., How distracting was the interviewer?; How engaged were you when talking to the interviewer?). For questions 1–11, participants responded to each item on a 7-point rating scale (1 = the most negative experience; e.g., *very distracting*; *not-at-all engaging* and 7 = the most positive experience; e.g., *not-at-all distracting, very engaging*). For question 12, participants were asked to provide an estimate of the amount of time (in minutes) that they spent talking to the interviewer. This question was designed to measure participants' perceptions of their level of engagement during the interview. In addition, participants in the avatar-interviewer condition were asked to evaluate their thoughts of the avatar interviewer based on the question "*If you were a victim to a crime, and you felt embarrassed or scared to talk about it, would you prefer telling your secret to an avatar interviewer or a live human* *interviewer?*" Finally, these participants were asked if they perceived the avatar interviewer as being operated by a computer system or a concealed human. Participants were then thanked and debriefed.

Coding and Reliability

The interviews were all audio-recorded and transcribed verbatim.

Free-recall phase. Overall, the number of words participants said during free recall, regardless of the content, were recorded as total word count and was used as a measure of verbal interaction. To code the amount of correct information reported, participants received one point for each item of information correctly reported in response to the general, open-ended question (see Appendix B for a full description of the coding scheme). For example, for the statement, "the little girl then saw a man with a small dog," the participant would receive four points; one point each for the objects (i.e., the little girl, man, small dog) and one point for the action (i.e., saw). Repeated information was only coded the first time that it was mentioned. In instances where participants changed their responses, only their last response was coded. The same procedures were used to code errors.

One observer coded all of the free-recall accounts, and a second observer coded 25% of them. Neither observer was aware of the participants' group assignments. A Pearson's product-moment correlation yielded an inter-observer reliability coefficient of $r = .97$, $p < .001$ for the total amount of information reported. Any discrepancies between the two observers were subsequently discussed and resolved.

Directed-recall phase. One observer coded all of the participants' responses during the directed-recall phase, and a second observer coded 25% of them. There was no discrepancy in the coding of the answers to the six directed questions. Participants received one point for each correct response to the six specific questions regarding specific aspects of the video.

Analytic Strategy and Data Analysis

In the current thesis, I analysed the data using IBM SPSS Statistic 25 (IBM, USA), Amos 25.0.0 (2017) and Hayes' (2013) PROCESS macro v3.4 for SPSS. For all the analyses, $p < .05$ was set as the level of significance.

I used a moderation approach for all analyses in which I examined the influence of individual differences in personality and ASD traits (see Figure 3.2). Although an interaction effect in analyses of variance (ANOVA) is considered synonymous to moderation, for interpretation reasons, I used a moderation approach because it provides a clearer distinction between the two individual difference variables involved in my research question. Specifically, I examined whether participants' scores on the measures of personality and ASD traits (moderator variables) changed the effect of interviewer type on participants' memory performance. However, for comparison, I also analysed the data using an analysis of covariance (ANCOVA) using ASD traits as a covariate.

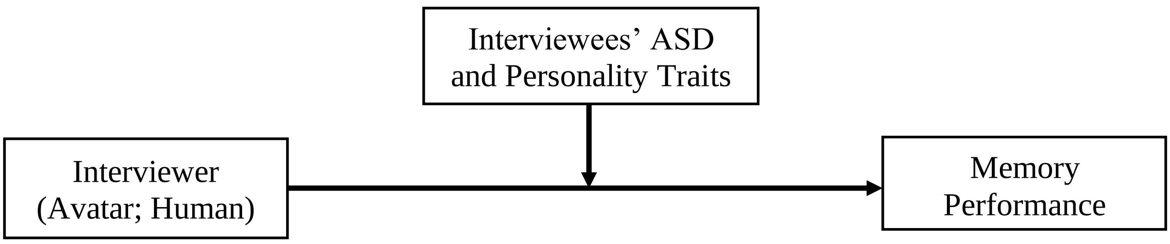

Figure 3.2. A conceptual illustration of the proposed moderation model.

Results

Preliminary Analyses

In the first part of the analysis, I established whether there were any differences in participants' scores on the Autism Quotient (AQ) or the NEO-Five-Factor Inventory-3 (NEO-FFI-3) personality measure as a function of Interview condition (see Table 3.1). Participants' AQ and NEO-FFI-3 scores were submitted to a separate 2 (Interviewer) x 2 (Retention interval) ANOVA. As shown in Table 3.1, there were no significant differences between participants' AQ scores or NEO-FFI-3 scores as a function of Interview condition (all *p*s > .05). There was, however, a main effect of Retention interval on participants' AQ scores $F(1, 102) = 28.44$, $p < .001$, $\eta_p^2 = .22$. Participants interviewed after the 1-day retention interval endorsed more traits resembling ASD than did participants who were interviewed after six weeks. There were no interactions. Given that there were no differences in participants' AQ scores or NEO-FFI-3 scores across Interview condition, I collapsed across AQ and NEO-FFI-3 scores in subsequent analyses.

I also carried out an exploratory analysis of the dependent variables (word count, amount of correct information, accuracy) to identify any outlier data points. The analysis showed outlier data points (i.e., 1.5 times the interquartile range from the upper or lower quartile) for all dependent measures and an extreme outlier (i.e., three times the interquartile range from the upper or lower quartile interquartile range) for accuracy. After examining the participants' transcripts for these outliers, the extreme outlier data were removed from all of the subsequent analyses as this particular participant had reported having no recollection of watching the target video. The other outliers were included in the analysis because a careful inspection of the 5% Trimmed Mean showed that these scores did not have a strong influence on the mean.

Table 3.1

Scores on the Autism and Personality Measures (Means and Standard Deviations) as a Function of Interviewer and Retention Interval Conditions

	1-Day Retention Interval		6-Week Retention Interval	
	Avatar Interviewer	Human Interviewer	Avatar Interviewer	Human Interviewer
AQ	26.44 (3.15)	26.26 (2.80)	19.04 (6.37)	17.72 (5.60)
NEO-FFI-3				
Neuroticism	3.70 (0.82)	3.70 (1.17)	3.70 (1.14)	3.44 (1.00)
Extraversion	3.00 (1.24)	3.22 (1.05)	3.37 (0.97)	3.16 (1.03)
Openness	3.44 (0.89)	3.59 (0.69)	3.70 (0.87)	3.92 (0.95)
Agreeableness	3.37 (0.84)	3.48 (1.05)	3.26 (1.16)	3.20 (0.82)
Conscientiousness	2.78 (1.05)	2.52 (1.05)	2.78 (1.09)	2.88 (0.93)

Memory Interview

Free-recall phase. First, I examined group differences in verbal interaction and memory performance during free recall as a function of the Interviewer condition (avatar, human) and Retention interval (1-day, 6-weeks).

Verbal interaction. The level of verbal interaction during free recall between participants and the interviewer was measured using participants' overall word count during the interview (see Figure 3.3). The data in Figure 3.3 were submitted to a 2 (Interviewer) X 2 (Retention interval) ANOVA. As shown in Figure 3.3, there was a main effect of retention interval; participants in the 1-day retention group said more (M = 561.19 words, SD = 267.30) than did participants in the 6-week retention group (M = 351.88 words, SD = 184.47), $F(1, 101) = 22.04$, $p < .001$, $\eta_p^2 = .18$. There was no difference in word count as a function of Interviewer condition, $F(1, 101) = .03$, $p = .86$, $\eta_p^2 < .001$, and no interaction, $F(1, 101) = 3.51$, $p = .06$, $\eta_p^2 = .03$

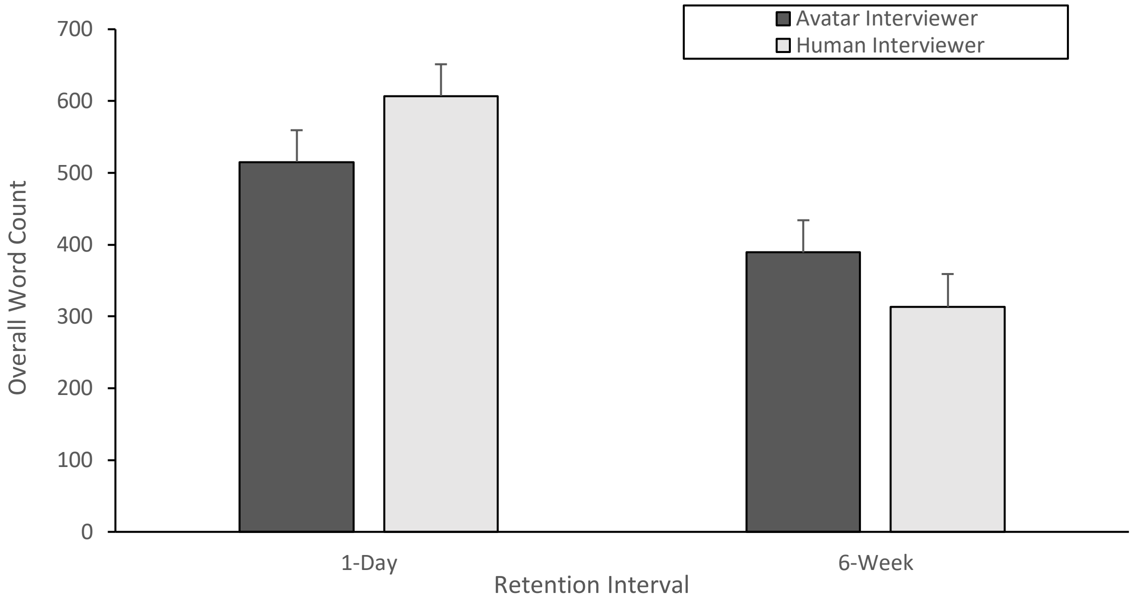

Figure 3.3. Participants' overall word count (+1SE) during free recall as a function of Interviewer condition and Retention interval.

Memory performance. I measured memory performance during free recall using the amount of correct information (see Figure 3.4, left panel) and the overall accuracy (see Figure 3.4, right panel) of participants' free-recall accounts. The data shown in Figure 3.4 (left panel) were submitted to a 2 (Interviewer) X 2 (Retention interval) ANOVA. As shown in Figure 3.4 (left panel), there was a main effect of Retention interval; participants in the 1-day retention group reported almost twice as much correct information ($M = 67.54$, $SD = 25.23$) as did participants in the 6-week retention group ($M = 37.12$, $SD = 14.96$), $F(1, 101) = 55.14$, $p < .001$, $\eta_p^2 = .35$. There was no difference in the amount of correct information reported as a function of Interviewer condition, $F(1, 101) = .27$, $p = .60$, $\eta_p^2 = .003$, and no interaction, $F(1, 101) = .53$, $p = .47$, $\eta_p^2 = .005$.

To obtain an accuracy score for each participant, I divided the total amount of correct information reported during free recall by the total amount of information reported (i.e., correct information + incorrect information). The data shown in Figure 3.4 (right panel) were submitted to a 2 (Interviewer) X 2 (Retention interval) ANOVA. As shown in Figure 3.4 (right panel), there was a main effect of retention interval; participants in the 1-day retention group reported information with higher accuracy (*M* = 93.67%, *SD* = 3.45) than did participants in the 6-week retention group (*M* = 86.50%, *SD*=6.77), $F(1, 101) = 49.30$, $p < .001$, $\eta_p^2 = .33$. There was no difference in accuracy as a function of Interviewer condition, $F(1, 101) = 2.04$, $p = .16$, $\eta_p^2 = .02$, and no interaction, $F(1, 101) = 3.03$, $p = .09$, $\eta_p^2 = .03$.

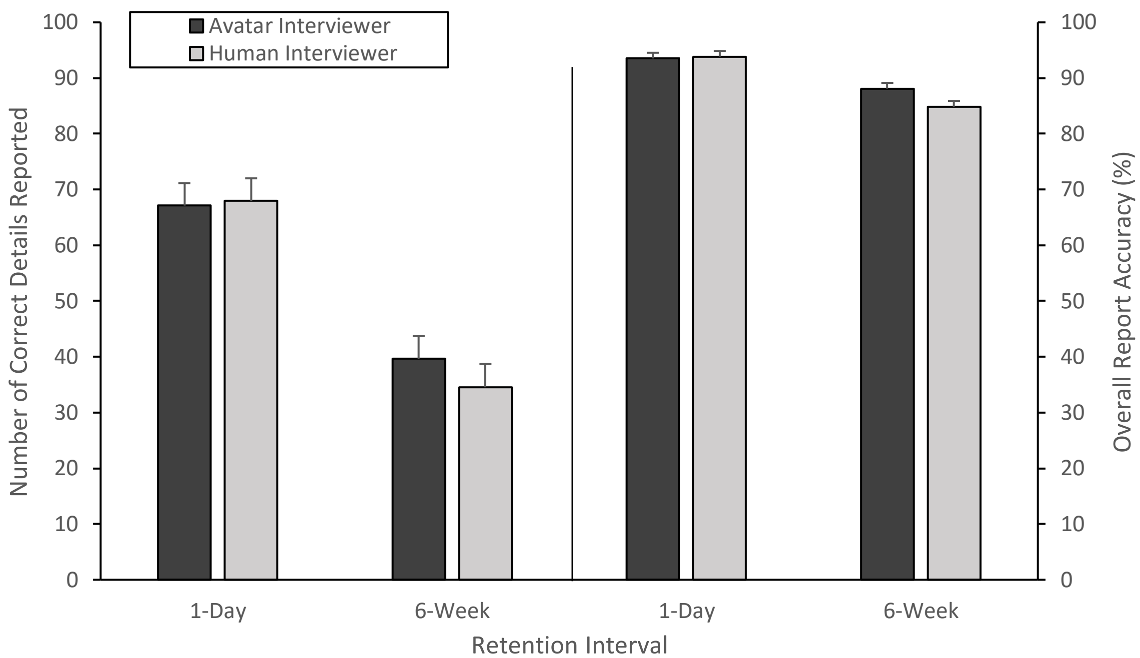

Figure 3.4. Left Panel: The amount of correct information and Right Panel: Overall accuracy (%) of information reported by participants (+1SE) during free recall as a function of Interviewer and Retention interval conditions.

Directed-recall phase. The number of correct responses to the six directed questions were submitted to a 2 (Interviewer) X 2 (Retention interval) ANOVA (see Figure 3.5). As shown in Figure 3.5, there was a main effect of retention interval; participants in the 1-day retention group correctly answered a greater number of questions (*M* = 3.69, *SD* = .89) than did participants in the 6-week retention group (*M* = 2.26, *SD* = 1.09), *F* (1,101) = 54.23, *p* < .001, η_p^2 = .35. There was no effect of Interviewer condition, *F*(1, 101) = .16, *p* = .69, η_p^2 = .002, and no interaction, *F*(1, 101) = .93, *p* = .34, η_p^2 = .001.

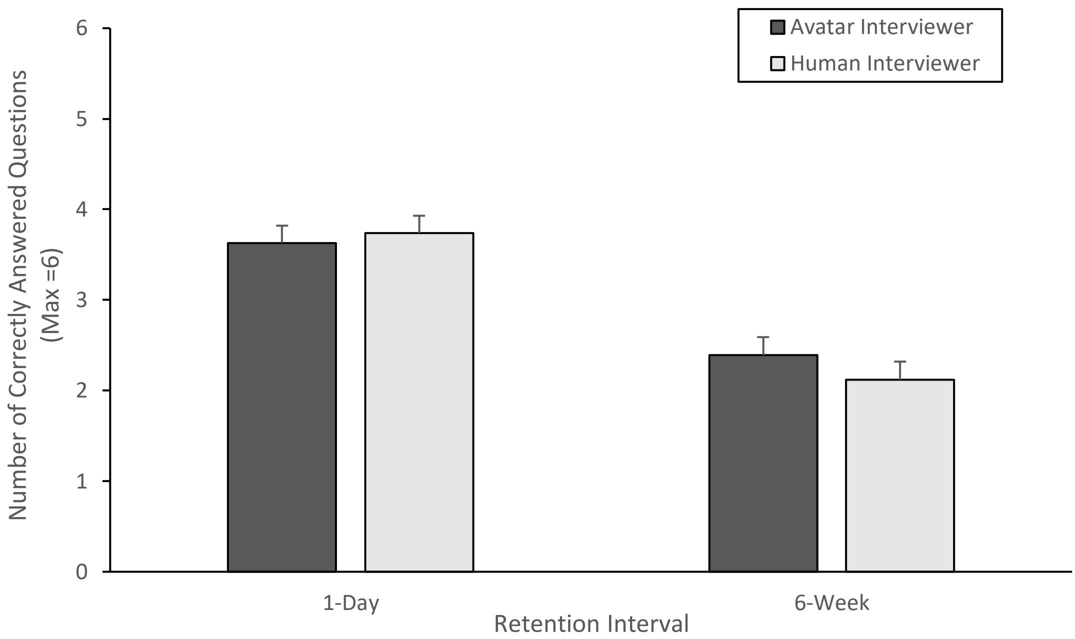

Figure 3.5. The number of questions (+1SE) answered correctly by participants during directed recall as a function of the interviewer and retention interval conditions.

In sum, participants showed similar levels of verbal interaction during free recall irrespective of whether they were interviewed by a human or an avatar. In addition, they also showed similar levels of memory performance during both free recall and in response to directed questions. Relative to the 6-week retention interval, participants interviewed after only one day showed superior memory performance and higher levels of verbal interaction.

Individual Differences in Eyewitness Accounts

The data described so far indicate that at group level, an avatar interviewer was as good as a human interviewer in generating interaction and eliciting an account of a prior event. The next question was whether there were individual differences in participants' performance as a function of their autism traits or personality characteristics.

Moderation effects: Autism traits. To examine whether participants' ASD traits (moderator variable) changed the effect of interviewer type on participants' memory performance, I first assigned participants to one of two groups based on their AQ scores. Specifically, I grouped participants to the High AQ group (n = 36) if they scored higher than 26 on the AQ and to the Low AQ group (n = 69) if they scored 26 or less on the AQ (Woodbury-Smith et al., 2005).

I then conducted separate moderation analyses using the PROCESS macro for SPSS (Hayes, 2013), with Interviewer type (categorical variable: *avatar* vs *human interviewer*) as the independent variable; participants' memory performance (*word count, amount of correct information reported, accuracy, number of correct responses to directed questions*) as the dependent variable; participants' level of ASD traits (*low AQ*, *high AQ*) as the moderator variable. Contrary to my hypothesis, the moderation analyses revealed that ASD traits did not influence the effect of the type of interviewer on word count, $R^2 = .03$, $F(1, 101) = .04$, $p = .84$, on the amount of correct information, $R^2 = .07$, $F(1, 101) = .01$, $p = .90$, or on the number of correct responses to directed questions, $R^2 = .07$, $F(1, 101) = .50$, $p = .48$. There was, however, a moderation effect of ASD traits on the relation between interviewer type and accuracy. The level of ASD traits explained 6.6% of the total increase in variation of the overall model, $R^2 = 0.11$, $F(1, 101) = 7.44$, $p = .008$. Simple slopes analysis revealed that there was a significant negative linear relation between report accuracy and interviewer type in the Low AQ group, $b = -3.72$, $SE = 1.48$, 95% CI [-6.66, -.79], $t(101) = -2.52$, $p = .01$;

there was no significant but not in the High AQ group, *b* = 3.17, *SE* = 2.05, 95% CI [-.90, 3.23], *t*(101) = 1.55, *p* = .13. That is, participants in the Low AQ group showed greater accuracy in their accounts with the avatar interviewer (*M* = 91.22%, *SD* = 6.24) compared to the human interviewer (*M* = 87.5%, *SD* = 6.61). Contrary to my hypothesis, however, participants in the High AQ group showed similar accuracy in their accounts with both the avatar (*M* = 90.14%, *SD* = 7.06) and the human interviewer (*M* = 93.31%, *SD* = 3.46).

Traditional analysis. Given that participants' ASD traits had some impact over the effects of interviewer type on participants' report accuracy, I examined these same variables using a 2 (Interviewer Type) X 2 (Retention Interval) ANCOVA while controlling for ASD scores. There was no difference in accuracy as a function of Interviewer type, *F*(1, 100) = 2.29, $p = .13$, $\eta_p^2 = .02$, however, there was a significant difference in accuracy as a function of retention interval, *F*(1, 100) = 35.66, $p < .001$, $\eta_p^2 = .26$; participants provided more accurate reports after the 1-day delay compared to after the 6-week delay. There was no interaction, *F*(1, 100) = 3.26, $p = .07$, $\eta_p^2 = .03$. These findings are different from the findings obtained through the moderation analysis, suggesting that ASD traits may not have a significant impact on interviewer type and report accuracy beyond the *p* value.

Moderation effects: Personality traits. To examine whether participants' personality traits (moderator variable) changed the effect of interviewer type on participants' memory performance, I first assigned participants to one of three groups based on their ranking on each of the NEO-FFI-3 personality traits. Specifically, I assigned participants to the *Low* group (*neuroticism:* n = 13, *extraversion*: n = 28, *openness*: n = 7, *agreeableness*: n = 21, and *conscientiousness*: n = 40) if their ranking on the NEO measure was "Extremely Low" or "Low;" to the *Average* group (*neuroticism:* n = 38, *extraversion*: n = 35, *openness*: n = 38, *agreeableness*: n = 41, and *conscientiousness*: n = 39) if their ranking on the NEO measure was "Average;" and to the *High* group (*neuroticism:* n = 54, *extraversion*: n = 42, *openness*: n = 60, *agreeableness*: n = 43, and *conscientiousness*: n = 26) if their ranking on the NEO measure was "High" or "Extremely High."

I conducted separate moderation analyses for the 6-week delay group using the PROCESS macro for SPSS (Hayes, 2013), with Interviewer type as the independent variable; participants' memory performance as the dependent variable; participants' personality traits (*neuroticism, extraversion, openness, agreeableness,* and *conscientiousness*) as the moderator variable.

Personality and verbal interaction. The moderation analysis revealed that conscientiousness was the only personality trait found to moderate the relation between interviewer type and participants' verbal interaction following a 6-week retention interval. Conscientiousness explained some (13%) of the total increase in variation of the overall model, R^2= .21, *F*(2, 45) = 3.71, *p* = .03. Simple slopes analysis revealed that there was a significant negative linear relation between word count and interviewer type in the Low Conscientious group, *b* = -250.35, *SE* = 81.78, 95% CI [-415.06, -.85.64], *t*(45) = -3.06, *p* = .004, but not in Average Conscientious group, *b* = 22.70, *SE* = 77.10, 95% CI [-132.59, 177.99], *t*(45) = .29, *p* = .77, or the High Conscientious group, *b* = 30.93, *SE* = 95.91, 95% CI [-162.25, 224.11], *t*(45) = .32, *p* = .75. That is, participants with low conscientiousness were considerably more verbose when they were interviewed by the avatar interviewer (*M* = 497.1 words, *SD* = 180.42) compared to the human interviewer (*M* = 246.75 words, *SD* = 101.46); participants with average to high conscientiousness showed similar levels of verbal interaction with both types of interviewers.

Personality and memory performance. Similar to the findings on verbal interaction, the moderation analysis revealed that conscientiousness was the only personality trait found to moderate the relation between interviewer type and memory performance following a 6-week but not following a 1-day retention interval (see Figure 3.6). The moderation analysis revealed that conscientiousness did not influence the effect of interviewer type on accuracy, $R^2 = .13$, $F(2, 45) = 1.03$, $p = .37$ nor on the number of correct responses to directed questions, $R^2 = .17$, $F(2, 45) = 2.28$, $p = .11$. There was, however, a moderation effect of conscientiousness on the relation between interviewer type and the amount of correct information reported. The level of conscientiousness explained some (19.6%) of the total increase in variation of the overall model, $R^2 = .30$, $F(2, 45) = 6.34$, $p = .004$.

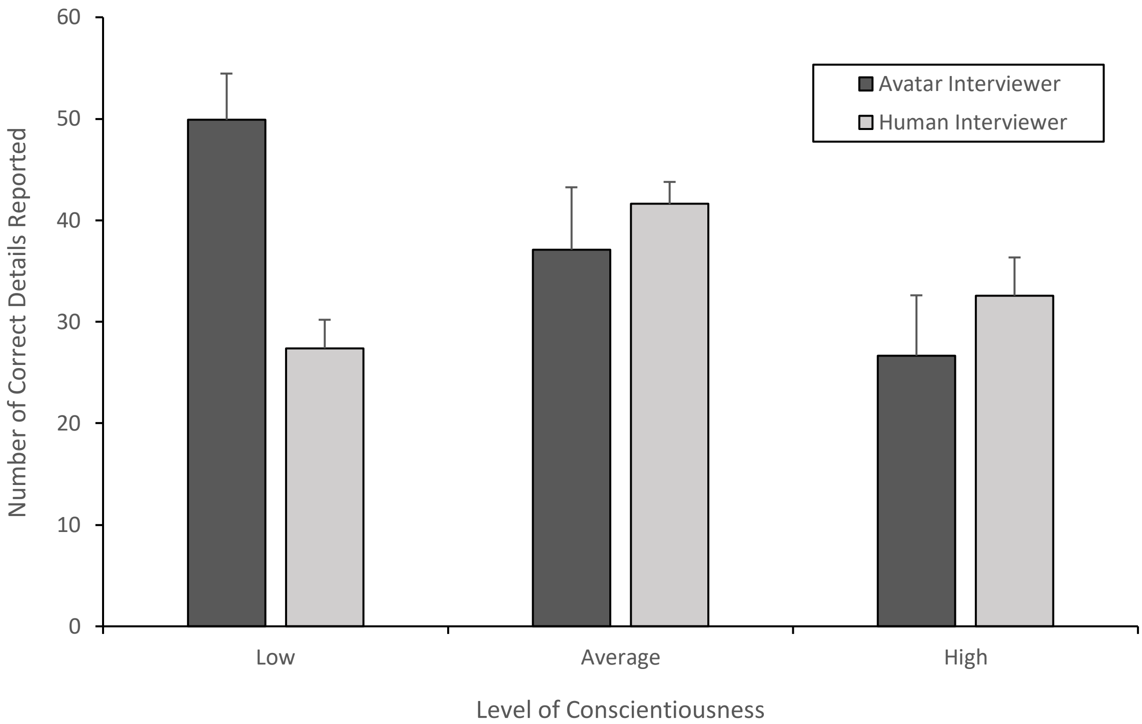

Figure 3.6. The amount of correct information (+1SE) reported by participants during free recall following a 6-week retention interval as a function of interviewer condition and level of conscientious trait.

Simple slopes analysis revealed that there was a significant negative linear relation between the amount of correct information and interviewer type in the Low Conscientious group, $b = -22.53$, $SE = 6.24$, 95% CI [-35.10, -9.95], $t(45) = -3.61$, $p < .001$, but not in Average Conscientious group, $b = 4.50$, $SE = 5.89$, 95% CI [-7.36, 16.36], $t(45) = .76$, p

= .45, or the High Conscientious group, *b* = 5.90, *SE* = 7.32, 95% CI [-8.85, 20.66], *t*(45) = .81, *p* = .42. That is, as expected, participants with low conscientiousness reported more correct details of the target video with the avatar (*M* = 49.9, *SD* = 14.4) compared to the human interviewer (*M* = 27.38, *SD* = 7.96); participants with average to high conscientiousness reported a similar number of correct details with both types of interviewers.

Perception of control: Computer- or human-operated avatar. Recall that at the end of the interview session, participants in the Avatar condition (*n* = 54) were asked if they thought the avatar was operated by a computer system or a concealed human. In the final part of the analysis, I investigated the effects of participants' perception of the avatar's operation on their verbal interaction and memory performance. To do this, first, I assigned participants to one of two Operation groups: the Computer-operation group (*n* = 14) if they thought the avatar was controlled by a computer system or the Human-operation group (*n* = 39) if they thought that a concealed human controlled the avatar.

A 2 (Operation group) X 2 (Retention interval) ANOVA indicated that there were no effect of Operation group on word count, $F(1, 49) = .09$, $p = .76$, $\eta_p^2 < .002$; amount of correct information reported, $F(1, 49) = .01$, $p = .92$, $\eta_p^2 < .001$; nor number of correct responses to directed questions, $F(1, 49) = .92$, $p = .34$, $\eta_p^2 = .02$. There was, however, a main effect of Operation group on accuracy during free recall, $F(1, 49) = 6.43$, $p = .01$, $\eta_p^2 = .12$. Participants who perceived the avatar interviewer as computer-operated provided free-recall accounts with greater accuracy (*M* = 93.57%, *SD* = 5.22) than did participants who perceived the avatar interviewer as human-operated (*M* = 89.88%, *SD* = 6.66)[2].

Taken together, several individual differences in participants' verbal interaction and memory performance in response to the avatar interviewer were identified. Specifically, participants with low conscientiousness reported more correct details of the target video during free recall following a 6-week retention interval. They were also more verbose when an avatar interviewed them. Furthermore, participants who perceived the avatar interviewer as computer-operated showed greater accuracy in their free-recall accounts of the target video with an avatar interviewer.

Feedback on the Interviewer

Table 3.2 shows participants' ratings on each of the 12 feedback questions collapsed over retention interval as a function of interview condition. A series of independent-samples t-tests indicated that participants who were interviewed by the human interviewer provided a more positive evaluation of their interview experience than did the participants who were interviewed by the avatar interviewer. Specifically, relative to the avatar interviewer, participants who were interviewed by the human felt more comfortable, more engaged, less distracted, and found their interviewer was easier to interact with and to understand. In contrast, those who were interviewed by the avatar interviewer indicated that they felt less

[2] There was no effect of retention interval on word count, $F(1, 49) = .99$, $p = .33$, $\eta_p^2 < .02$. Consistent with the earlier analyses across the whole sample, within the avatar condition alone, there was a main effect of retention interval on the amount of correct information reported, $F(1, 49) = 8.8$, $p = .005$, $\eta_p^2 = .15$, on accuracy during free recall, $F(1, 49) = 7.59$, $p = .008$, $\eta_p^2 = .13$, and on the number of correct responses to the directed questions, $F(1, 49) = 11.88$, $p = .001$, $\eta_p^2 = .01$. That is, participants in the 1-day retention group reported a greater amount of information (*M* = 67.11, *SD* = 26.75) and information with higher accuracy during free recall (*M* = 93.51%, *SD* = 3.74), and correctly answered a greater number of questions in response to directed questions (*M* = 3.63, *SD* = .69) compared to participants in the 6-week retention group [amount of correct information (*M* = 35.82, *SD* = 17.66); accuracy (*M* = 88.09%, *SD* = 7.56); number of correct responses to directed questions: (*M* = 2.39, *SD* = 1.2)]. There were no interaction effects for any of the dependent measures.

obligated to please their interviewer with the correct answer than did the participants who were interviewed by the human interviewer.

For participants in the Avatar condition, recall that I asked an additional question "*If you were a victim to a crime, and you felt embarrassed or scared to talk about it, would you prefer telling your secret to an avatar interviewer or a live human interviewer?*" to examine participants' preference for the avatar interviewer in the context of being interviewed as a victim or witness. For participants' responses to this question, I calculated the percentage of participants who selected the avatar interviewer and the percentage of participants who selected the human interviewer. More participants indicated that they would prefer to disclose details of an embarrassing incident to an avatar (60%) rather than to a human interviewer (36%), with 4% of participants who indicated that they had no preference.

Table 3.2

Participants' Ratings (Mean and Standard Deviations) on the Feedback Questions (Max score = 7) as a Function of Interviewer Condition

	Human	Avatar	*t*-value
Comfortableness of interaction	**5.08 (1.61)**	**4.33 (1.59)**	**2.42***
Distraction of interviewer	**5.69 (1.63)**	**5.08 (1.54)**	**1.94***
Ease of interaction	**5.52 (1.45)**	**4.74 (1.68)**	**2.56***
Engagement with interviewer	**5.23 (1.23)**	**4.17 (1.57)**	**3.86****
Willingness to share deepest secrets	3.00 (1.54)	2.87 (1.83)	0.40
Believability of the interviewer	5.06 (1.23)	4.64 (1.47)	1.58
Stress of interaction	4.62 (1.51)	4.51 (1.77)	0.33
Understandability of interviewer	**6.50 (1.11)**	**5.76 (1.41)**	**3.00****
Frustration towards the interviewer	6.04 (1.47)	5.57 (1.66)	1.54
Perceived pressure of interaction	3.90 (1.77)	4.49 (1.75)	-1.71
Desire to please the interviewer	**5.12 (1.37)**	**4.38 (1.69)**	**2.46***
Amount of time (in minutes) of interaction	6.85 (3.41)	6.99 (3.81)	-0.21

Note. Significant differences are shown in bold; $*p < .05$, $**p < .01$.

Discussion

There was no overall impact of interviewer condition on participants' verbal interaction or memory performance. These findings are partially consistent with results from other avatar studies with adults. For instance, Heyselaar, Hagoort, and Segaert (2017) demonstrated that participants produced similar linguistic responses during a syntactic priming task with both a 3D human-like avatar and a live human interviewer. In that study, the avatar was displayed in a virtual environment and was operated by a computer system. With respect to memory performance in particular, Taylor and Dando (2018) found that the adult participants in their study were more accurate in response to specific questions with an avatar interviewer.

One possible explanation for these inconsistent findings between previous studies and the present experiment could be the difference in the avatar's realism, and how the avatar was presented to the participants. For instance, studies have shown that an avatar's visual appearance and behavioural realism (Seyama & Nagayama, 2007; Zibrek, Kokkinara, & McDonnell, 2018), and the digital platform on which the avatar is delivered (e.g., flat-screen, immersive environment; Roettl & Terlutter, 2018; Slobounov et al., 2015) influence participants' responses to an avatar. Taylor and Dando (2018) interviewed their participants with a 3D avatar interviewer displayed in an immersive, virtual reality environment; participants in the current experiment were interviewed by a 2D cartoon-rendered avatar interviewer displayed on a flat computer screen. These procedural differences between the two studies may account for the different pattern of results.

Consistent with a large body of literature (see Ricker, Vergauwe, & Cowan, 2014, for a comprehensive review), the delay between the target video and interview session in the present experiment had a significant impact on participants' verbosity and memory performance. Relative to a 6-week retention interval, participants who were interviewed after one day were more verbose, provided more correct details and were more accurate during free recall and in response to specific questions.

Another possible explanation for the inconsistent findings between previous studies and the present experiment could be that the question "*Are avatar interviewers better than human interviewers in facilitating adults' recall of an event during an investigative interview*?" is too broad. That is, such global-level comparisons—comparing avatar interviewers to human interviewers—do not take into account the heterogeneity in characteristics of participants that might impact memory performance. Recall that researchers have shown that individuals with ASD may respond more positively to an avatar (e.g., Bernard-Opitz et al., 2001; Moore & Calvert, 2000; Stendal & Balandin, 2015), and that avatars may enhance memory performance in children with ASD during investigative interviews (Hsu & Teoh, 2017).

In the current experiment, I explored whether traits resembling ASD contributed to the effect of an avatar interviewer on adults' memory performance. Results showed that only participants with less traits resembling ASD influenced the effect of interviewer type on the accuracy of their reports. These findings are somewhat inconsistent with those reported by Hsu and Teoh (2017), who found that both typically-developing (TD) children and children with ASD provided more accurate reports during free recall when an avatar interviewed them. Recall, however, that the participants in the Hsu and Teoh study were children, not adults. As such, age-related differences in participants' perception of and responses to a cartoon-rendered avatar may account for the different pattern of findings. In particular, some researchers have shown that cartoon characters increase children's attention; that is, children are more attentive to the exaggerated appearance such as the rendered colours and facial features of a cartoon character (Neeley & Schumann, 2004). Other researchers have shown that children perceive information presented with photographs as more credible but may be persuaded more by information presented with cartoon illustrations (e.g., Rodriguez & Lin, 2017). Additionally, there is empirical support that children prefer products that are accompanied by a cartoon character over products without a cartoon character (see Kraak & Story, 2015, for a review). On the other hand, cartoon characters have less influence on older children (Letona, Chacon, Roberto, & Barnoya, 2014; Wansink, Just, & Payne, 2012) and adolescents (Velazquez & Pasch, 2014), suggesting that a cartoon-rendered avatar may have similar (or even less) of an effect on adults. Hence, it is possible that age-related differences in participants' reaction to the cartoon nature of the avatar account for the differences in results reported here and by Hsu and Teoh.

Consistent with this explanation, Hsu and Teoh (2017) provided further support for age-related differences in participants' perception of a cartoon-rendered avatar. In their study, relative to a human interviewer, children were more misled by an avatar interviewer, suggesting that children may view the avatar as even more persuasive than a human. On the other hand, adults sometimes perceive avatars as being less credible than a human (de Visser et al., 2016; Nowak & Rauh, 2006; Waytz, Cacioppo, & Epley, 2014). Given these age-related differences in perceived credibility of avatars, it would be interesting to explore the misinformation effect in adults with avatar interviewers. It is possible that adults are less susceptible to misinformation that is provided by a cartoon-rendered avatar interviewer because avatars are perceived as less credible. I will investigate this possibility in Chapter 6.

Another possible explanation for the difference in findings between the present experiment and Hsu and Teoh (2017) could be that my sample was a non-clinical sample of university students whereas Hsu and Teoh's sample had all received a clinical diagnosis of ASD. Although some participants in the current sample did score above the cut-off score on the screening measure of ASD, Woodbury-Smith et al. (2005) have shown that the cut-off score on the Autism Quotient (AQ) measure does not lead to perfect identification accuracy, accurately identifying only 83% of participants who were subsequently clinically diagnosed with ASD.

However, when using a more traditional statistical analysis (ANCOVA), I did not find a difference in accuracy as a function of Interviewer type. This result suggesting that ASD traits may not have a significant impact on interviewer type and report accuracy beyond the *p* value.

Next, recall that some aspects of participants' personality traits influence their memory performance during investigative interviews with a human interviewer (e.g., Madsen & Holmberg, 2015; Madsen, 2017), and that Hongpaisanwiwat and Lewis (2013) found an association between adults' personality traits and their recall of semantic knowledge with avatar teaching agents. In the present experiment, I explored whether personality traits contributed to the effect of avatar interviewer on participants' memory performance in the context of an investigative interview. The personality trait of conscientiousness moderated the effect of interviewer type on verbal interaction and memory performance. Specifically, relative to participants with high conscientiousness, participants with low conscientiousness were more verbose in their interaction with an avatar interviewer. These same participants also reported a greater number of correct details with the same avatar interviewer during free recall following a 6-week retention interval. In studies with human interviewers, researchers have demonstrated that low conscientiousness is a predictor of low memory performance (Madsen, 2017). The engaging and novelty effects of a cartoon-rendered avatar interviewer in the present experiment may have increased the motivation in participants with low conscientiousness during the simulated interview. Higher levels of engagement and motivation may have subsequently led to the increase in the number of correct details that they reported. Participants' greater verbosity during their interaction with an avatar interviewer compared to a human interviewer provides some evidence for participants' level of engagement.

Finally, in a handful of studies, researchers have shown that participants' perception of an avatar's operation may impact the way that they respond to an avatar and subsequently affect their performance on cognitive tasks (for a meta-analysis, see Fox et al., 2015). Recall that an avatar's operation refers to the method of its control (computer- or human-operated). In the current experiment, participants who perceived the avatar interviewer as computer-operated reported more accurate details about the target video than did the participants who believed that the avatar was human-operated. The Theoretical Model of Social Influence can be used to explain this finding (Blascovich, 2002). According to this model, people's social experience with an avatar is dependent on two variables: the avatar's *realism* and its *agency* (Blascovich, 2002; see Figure 3.7). *Realism* refers to the degree to which an avatar appears and behaves in a way that is similar to the object it represents (e.g., sea turtle, human). *Agency*, on the other hand, refers to people's perception of the avatar's control—that is, whether an avatar is controlled by a computer system or a concealed human. Simply put, in theory, individuals' social experience with and responses to an avatar would be different with a more realistic (or high agency) avatar compared to a less realistic (or low agency) avatar.

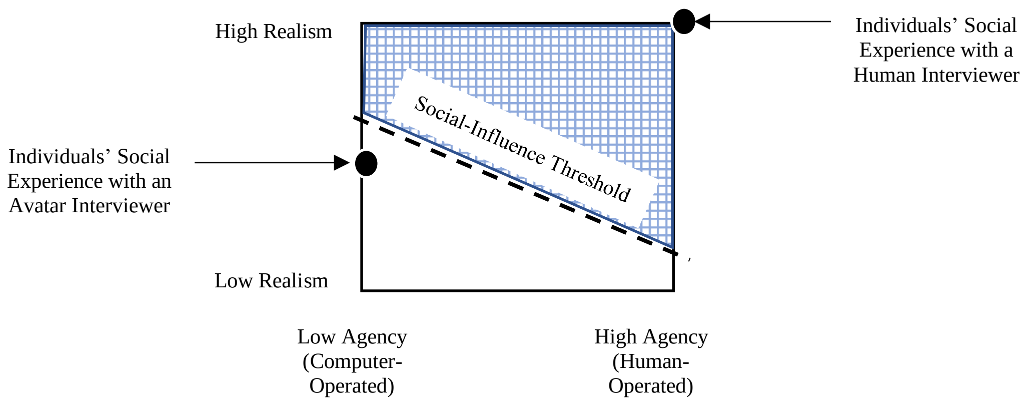

Figure 3.7. A conceptual illustration of the Theoretical Model of Social Influence (adapted from Blascovich, 2002).

However, as shown in Figure 3.7, a threshold—known as the social-influence threshold—exists during a human-avatar interaction; once the social-influence threshold is reached during an interaction with an avatar, individuals are more likely to display the same social behaviours with that avatar as they would with any other conversational partner that falls above the threshold, which includes a human (Blascovich, 2002; see Figure 3.7, shaded area).

In the present experiment, I assumed that the realism of a 2D cartoon-rendered avatar interviewer was near the mid-point of the *Realism* scale of the Social Influence model (see Figure 3.7). With the avatar's realism at the mid-point, participants who perceived the avatar as computer-operated (i.e., low agency) relative to human-operated may have had less desire to please the avatar interviewer with the correct responses than they would have to the human interviewer. This is evident from participants' responses to the feedback questions at the end of the memory interview. Participants rated having less desire to please the avatar interviewer compared to a human interviewer. I will examine, in more detail, the effects of an avatar's *agency* and *realism* on adults' memory performance in Chapter 7.

Feedback on the Interviewer

Relative to the avatar interviewer, overall, participants rated their experience with the human interviewer as more positive but they also indicated that they had less desire to please the avatar interviewer. In addition, they also indicated that they would prefer to disclose details of an embarrassing event or a crime to an avatar. It is possible that participants are primed to interact with a social being (i.e., another human) and yet still prefer to talk to an avatar about more sensitive topics and in more emotionally-charged situations. Participants' preference for an interviewer type when disclosing potentially sensitive and embarrassing issues will be explored further in Chapter 5 and subsequent chapters.

Chapter 4

As Quiet as a Mouse: Adults' Willingness to Discuss Sensitive Information with Avatars

Disclosing information can be important in several contexts. By way of examples, providing an account of sexual abuse can influence the outcome of a criminal trial; disclosing details of a traumatic event can assist clinicians in delivering treatment; and reporting information on current financial status can help individuals to access support or plan for the future. Despite its importance, disclosure is often low, due, at least in part, to the fact that the information required in these contexts is sometimes associated with stigma and shame (Kennedy & Prock, 2018; Mannarini & Rossi, 2019; Rössler, 2016). Computer-mediated communication (CMC) is one method that could potentially increase adults' willingness to disclose sensitive information (Hollenbaugh & Everett, 2013; Joinson, 2001). CMC refers to a human-to-human exchange that occurs through digital technology (e.g., email, text message, or video conferencing). One type of CMC that has gained in popularity is the use of avatars—a computer-generated representation of a person or an artificial intelligence system. The overarching goal of the present experiment was to explore adults' views about disclosing sensitive information to an avatar professional.

Traditionally, methods to increase rates of disclosure have included using paper-and-pencil surveys (Durant, Carey, & Schroder, 2002; Ong & Weiss, 2000), telephone interviews (Patrick-Miller et al., 2013; Rice, Ruschman, Martin, Manders, & Miller, 2010), or text-based CMC (Bowling, 2005; Dai, Shin, Kashian, Jang, & Walther, 2016). In general, the effects of text-based CMC on rates of disclosure exceeds other written methods, such as questionnaires (see Richman, Kiesler, Weisband, & Drasgow, 1999, for a meta-analysis). Despite the effectiveness of text-based CMC on disclosure, direct comparisons between text-based CMC and face-to-face human interviews have been less promising. People usually disclose more about themselves during face-to-face communication compared to text-based CMC (see

Ruppel et al., 2016, for a meta-analysis). Even when researchers have reported a positive correlation between CMC and disclosure, this association is usually very low (see Clark-Gordon, Bowman, Goodboy, & Wright, 2019, for a meta-analysis).

More recently, researchers have examined avatars as a promising alternative that combines the advantages of both a face-to-face human interview and text-based CMC. That is, on the one hand, avatar-based CMC provides individuals with an interface that visually resembles a human; on the other hand, avatar-based CMC provides a certain level of anonymity, specifically visual anonymity, during a social exchange. Visual anonymity is a subcategory of anonymity that is, at least in part, dependent on people's feeling of the level of co-presence (also known as social presence; Kang & Watt, 2013). Co-presence refers to an individual's sense of being present in the same space with his or her communication partner. In other words, visual anonymity may increase when people's feelings of co-presence with a communication partner during a social interaction decrease. Co-presence is partially influenced by the availability of non-verbal and contextual cues of individuals' communication partners (Cai & Tanaka, 2019).

High visual anonymity has been found to encourage disclosure (Bailenson et al., 2006). During disclosure, when the visual anonymity of the communication partner is high, individuals may experience fewer psychological constraints from disclosing stigmatizing information. For example, when there is high visual anonymity during a social exchange, people may be less anxious about being negatively evaluated, or they may feel that repercussions of the disclosure are diminished. Furthermore, when visual anonymity is high, people tend to over attribute their impression—either positive or negative—of their communication partner (Antheunis, Schouten, & Walther, 2019; Walther, 1996). Put another way, people develop biased views of their anonymous partner, and thus are more (or less) willing to share sensitive information.

Despite the potential advantages of avatars in encouraging disclosure, empirical support for using avatars for eliciting information has been mixed (cf. Baccon et al., 2019; Lind et al., 2013; Pickard & Roster, 2020; Pickard et al., 2016; Yokotani, Takagi, & Wakashima, 2018). In the present experiment, two questions are addressed: 1) Do adults prefer an avatar over a human for disclosing more sensitive topics? And 2) Do certain avatar characteristics promote adults' willingness to disclose information?

Topics and disclosure. Differences in the effectiveness of avatars in eliciting disclosure may reflect the level of sensitivity of the topic under discussion. For example, Pickard et al. (2016) investigated adults' willingness to disclose topics of varying sensitivity. In that study, 203 undergraduate students rated the level of sensitivity of 14 topics using a 5-point scale. Subsequently, they were asked to indicate their preference for discussing each topic with either an avatar or a human face-to-face. Overall, participants indicated that they would prefer to be interviewed by an avatar rather than a human on more sensitive topics and that they would prefer to be interviewed by a human rather than an avatar on less sensitive topics. For topics of intermediate sensitivity, participants showed no preference. Despite the potential impact of these findings, they may have limited ecological validity in some contexts. In general, a large portion of the topics that Pickard et al. used reflected topics that are not often discussed in a professional, help-seeking settings (e.g., legal context, clinical settings, or financial sector). Specifically, topics on the list included computer brands, personal hobbies, homeless people, and charity.

Using topics that are more akin to those that might be discussed during psychological assessment or therapy, Yokotani et al. (2018) examined participants' disclosure of different mental health issues with an avatar controlled by a computer system or with a therapist face-to-face. In that study, a male therapist and an avatar who appeared to be female talked to participants about their struggles with mental health. Participants disclosed details of sex-related topics more often with an avatar than with a therapist face-to-face; participants disclosed mood- and mental health-related topics more often with a therapist face-to-face than with an avatar. Unfortunately, it is impossible to conclude from Yokotani et al.'s results that participants preferred to discuss sex-related problems with an avatar because there was a gender difference between the therapist and the avatar. It is equally possible, for example, that participants preferred to discuss sex-related topics with a female partner, rather than with an avatar, per se. In the present experiment, I examined adults' views regarding their willingness to disclose sensitive information to an avatar.

Avatars' characteristics and disclosure. Researchers have also investigated the effects of an avatar's depicted age on disclosure. For example, Lee et al., (2018) randomly assigned adults who were 60 years or older to either a younger-appearing avatar or an older-appearing avatar to represent them in an online environment. Participants collaborated using their avatars—through a text-based chat—on a task that encouraged participants to disclose personal information (e.g., name, family status, hobbies, profession). Participants revealed more details about themselves when their avatars appeared similar in age, suggesting that participants identified with their avatar, and that participants preferred to disclose personal information to an avatar that matched their age. The effects of an avatar's depicted gender and ethnicity on disclosure have not been studied. Still, some researchers have shown that adults have a higher preference for interacting with an avatar that represents their gender (e.g., Baylor & Kim, 2003; Guadagno, Blascovich, Bailenson, & McCall, 2007) and ethnicity (e.g., Baylor & Kim, 2003).

In other studies, researchers have shown that avatars that are perceived as computer-operated rather than human-operated lead to higher rates of disclosure (Lucas et al., 2014). Participants also disclose more personal information to a less realistic-appearing avatar (e.g., Bailenson et al., 2006; cf. Kang & Gratch, 2010). I will explore these factors in Chapters 6 and 7.

In sum, when designing an avatar for a specific purpose, for instance, to elicit sensitive information, the avatar's characteristics also need to be considered. In the present experiment, I extended the research on the effects of the avatar's characteristics to information disclosure by investigating participants' preference for an avatar's depicted age, gender, and ethnicity. Specifically, I explored the impact that these avatar features might have on adults' willingness to discuss embarrassing information with an avatar.

The Present Experiment

With this background in mind, the overarching goal of the present experiment was two-fold. First, I examined adults' views regarding their willingness to disclose sensitive information to an avatar. Second, I explored whether certain characteristics of an avatar promote higher rates of disclosure. Building on the procedure used by Pickard et al. (2016), I examined adults' preference for discussing topics that are more akin to those that are discussed when people seek legal, medical, psychological, or financial support. To ascertain the relative sensitivity of each topic, I also asked participants to indicate whether each topic would be embarrassing for them to discuss. To control for potential gender effects of the professional, both the human and the avatar professionals were depicted as female (cf. Yokotani et al., 2018). I hypothesised that participants would prefer to discuss issues that they considered more embarrassing with an avatar rather than with a human professional because interactions with an avatar provide more visual anonymity. I also hypothesised that participants would prefer to discuss information with an older, more mature-appearing avatar that matched participants' gender and ethnicity because participants tend to have a more positive impression of avatars that appear older (Lee et al., 2018). Furthermore, participants tend to prefer interacting with someone of the same gender and ethnicity as them. To test these hypotheses, participants were given a list of 41 issues. They were then asked to determine whether they considered each issue as either embarrassing or not embarrassing to talk about with a professional. Participants then selected from two pictures—either the avatar or the human that they preferred to talk to about each of the 41 issues. The avatar presented in the current experiment was the same as the one used in Chapter 3. Finally, I begun to explore whether participants have particular preferences of specific features of an avatar conversational partner (i.e., age, gender, and ethnicity) for discussing embarrassing information.

Method

Participants

The final sample consisted of 296 adults (158 females; M_{age} = 37.18 years; *SD* = 11.50; range = 18-76). Participants were recruited through Amazon Mechanical Turk (MTurk), an online labour market that functions as a platform to access human participants for research. To ensure that participants could only complete the experiment once, I used an intermediary website called "Turkitron" (www.turkitron.com), which tracks MTurk worker IDs and only sends participants the experiment link if they are eligible to participate. All participants provided informed consent online and were reimbursed $1.50 for their participation. The research was reviewed and approved by the University of Otago's Human Ethics Committee, which is accredited by the New Zealand Health Research council and whose guidelines are consistent with those of the American Psychological Association.

Sensitive Information

According to Tourangeua, Rips, and Rasinski (2000), sensitive information is defined as information that is intrusive and offensive, poses a threat upon disclosure, and is socially undesirable. Invasive topics are seen as rude, inappropriate in a given situation, and an invasion of privacy (e.g., personal income). Information that poses a threat elicits negative consequences upon disclosure (e.g., incest). Socially undesirable responses are ones that violate social norms (e.g., feet fetish). The list of 41 topics presented in the current experiment was similar to that used by Tourangeau and Smith (1996), which included topics that appear in forensic contexts (e.g., drug use, victimization, sexual abuse), clinical settings (e.g., sexual activity, sexual health, general health, mental health), and financial sectors (e.g., economic topics, income, loan, employment status). Tourangeau and Smith derived their topics from the National Survey of Family Growth (NSFG; Centers for Disease Control and Prevention, 1973), the General Social Surveys (GSS; National Opinion Research Center, 1972), and the National Survey on Drug Use and Health (NHDUH; Substance Abuse and Mental Health Services Administration, 1971).

The National Survey of Family Growth. The NSFG was designed to obtain information on health- and family-related issues to be used for planning interventions and research (Centers for Disease Control and Prevention, 1973). The survey includes questions on pregnancy and infertility, use of contraception, and family and marriage status.

The General Social Surveys. The GSS was designed to obtain information on adults' general attitudes and behaviours around societal values such as cultural beliefs, politics, religion, and ethical values to be used for making policies and for research (National Opinion Research Center, 1972). The survey includes questions on law, God, marriage, employment, morality, and sexual health.

The National Survey on Drug Use and Health. The NHDUH was designed to obtain information about people's substance use and health-related issues for making policies, conducting research, and implementing preventative and intervention programmes (Substance Abuse and Mental Health Services Administration, 1971). The survey includes questions on mental health and general health issues, and drug, tobacco, and alcohol use.

Procedure

After completing informed consent online, Participants were presented with a list of 41 topics that were displayed on a computer screen from top to bottom. They were then instructed to use the computer mouse to drag each of the 41 topics into one of two boxes labelled '*Embarrassing*' and '*Not Embarrassing*' based on their personal reaction to that topic. The order of presentation of the 41 topics was counterbalanced across the participants so that half of the participants were presented with the topics ordered from 1 to 41 and the other half of participants were presented with the topics in the reverse order.

Next, participants were shown two images representing potential professionals—a human and an avatar. To control for possible confounding effects of the professionals' appearance and gender, both professionals were depicted as female and were similar to each other (see Figure 4.1). We chose a female interviewer because it is generally agreed among scholars that female interviews tend to be more likeable and is the preferred gender for conducting interviews that maximize disclosure (Collins & Miller, 1994). For each of the 41 topics, participants were asked to indicate which professional—the human or the avatar—they would prefer to talk to about that topic (i.e., "Would you prefer sitting in a room alone and talking to a computer animation that can respond to you exactly like a person? Or would you prefer talking to a human face-to-face?).

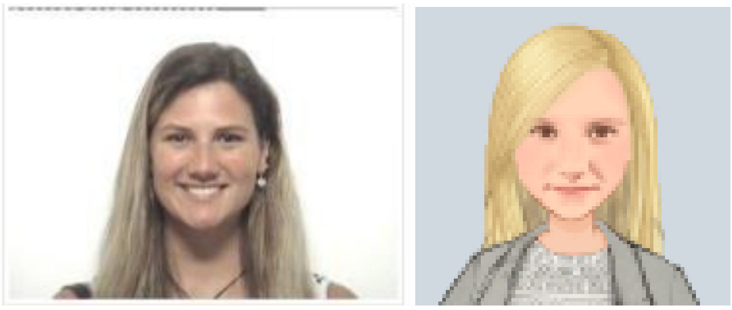

Figure 4.1. The human professional (left); the avatar professional (right).

Finally, participants were given the option of providing their preference for an avatar's attributes that would help increase their level of comfort when discussing embarrassing information with an avatar. More specifically, participants presented their preference for an avatar's depicted age, gender, and ethnicity. For exploratory reasons, not all of the participants provided a preference. Participants also completed a demographic questionnaire on their age, gender, ethnicity, and level of education.

Results

Topic sensitivity

Figure 4.2 shows the percentage of participants who indicated whether each of the topics was *embarrassing* or *not embarrassing*. The number of participants who selected a topic as *embarrassing* was divided by the total number of participants (N = 296) to obtain the percentage of participants who selected a topic as *embarrassing*. As shown in Figure 4.2, very few participants considered 'Physical pain' (4% of participants) and 'Flu' (5% of participants) to be embarrassing topics while the majority of participants (84%) considered 'Smelly private parts' to be an embarrassing topic.

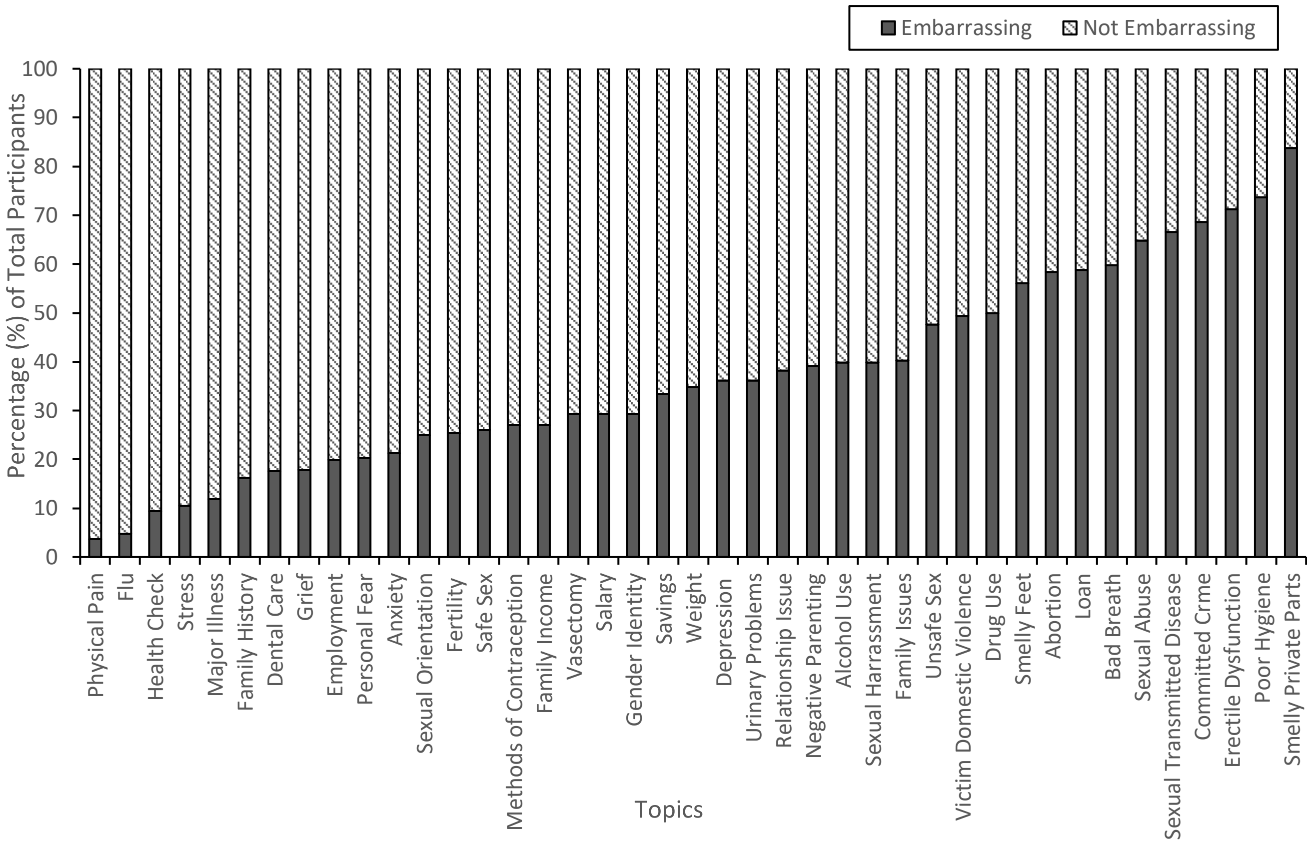

Figure 4.2. The topics are shown in order of percentage of participants who found the topic embarrassing (lowest to highest).

Preference for the Professional

Next, I examined participants' preferences for discussing the topics with either the avatar or human professional. A Chi-square goodness-of-fit test showed that, irrespective of the topic, a significantly higher percentage of participants preferred to discuss the topics with a human professional (60%) rather than with an avatar (40%), χ^2 (1) = 480.97, $p < .001$.

Preference for the professional for each topic. To examine participants' preferences more closely, I conducted a series of Chi-square goodness-of-fit tests to examine participants' professional preference for each of the 41 topics separately. The results of these analyses are shown in Table 4.1, ranked in order of topic embarrassment. As shown in Table 4.1, a human professional was preferred for 30 of the 41 topics, while an avatar was preferred for only two of the topics (*bad breath* and *smelly private parts*). There was no preference for one professional over the other for the remaining 9 topics.

Despite an overwhelming preference for the human professional, a Pearson's product-moment correlation revealed a significant positive correlation between the percentage of participants who selected an avatar and the percentage of participants who found the topic embarrassing, $r = .40$, N = 41, $p = .01$. Put another way, the more participants found a topic embarrassing, the more likely they would select an avatar to talk about that topic.

Table 4.1

Participants' Preference for an Avatar Versus Human Professional by Topic

Topic	Prefer avatar (%)	Prefer human (%)	χ^2	*p*
Physical Pain	45	55	3.04	.09
Flu	**38**	**62**	**17.51**	**< .01**
Health Check	**36**	**64**	**22.72**	**< .01**
Stress	**40**	**60**	**12.16**	**< .01**
Major Illness	**29**	**71**	**51.95**	**< .01**
Family History	**35**	**65**	**26.16**	**< .01**
Dental Care	53	47	1.09	.32
Grief	**38**	**62**	**17.51**	**< .01**
Employment	**35**	**65**	**26.16**	**< .01**
Personal Fear	**33**	**67**	**33.78**	**< .01**
Anxiety	**31**	**69**	**42.38**	**< .01**
Sexual Orientation	**35**	**65**	**26.16**	**< .01**
Fertility	**35**	**65**	**26.16**	**< .01**
Safe Sex	46	54	1.95	.18
Methods of Contraception	**44**	**56**	**4.38**	**.04**
Family Income	**40**	**60**	**12.16**	**< .01**
Vasectomy	**38**	**62**	**17.51**	**< .01**
Salary	51	49	0.12	.77
Gender Identity	**36**	**64**	**22.72**	**< .01**
Savings	**44**	**56**	**4.38**	**.04**
Weight	**44**	**56**	**4.38**	**.04**
Depression	46	54	1.95	.18
Urinary Problems	**25**	**75**	**74.00**	**< .01**
Relationship Issue	**22**	**78**	**93.09**	**< .01**
Negative Parenting	**34**	**66**	**29.85**	**< .01**
Alcohol Use	**36**	**64**	**22.16**	**< .01**
Sexual Harassment	**36**	**64**	**22.16**	**< .01**
Family Issues	**30**	**70**	**47.04**	**< .01**
Unsafe Sex	**43**	**57**	**5.96**	**.02**
Victim Domestic Violence	**32**	**68**	**37.96**	**< .01**
Drug Use	**38**	**62**	**17.51**	**< .01**
Smelly Feet	48	52	0.49	.53
Abortion	**43**	**57**	**5.96**	**.02**
Loan	45	55	3.04	.09
Bad Breath	**59**	**41**	**9.85**	**< .01**
Sexual Abuse	**38**	**62**	**17.51**	**< .01**
Sexually-Transmitted	**43**	**57**	**5.96**	**.02**
Committed Crime	**42**	**58**	**7.78**	**< .01**
Erectile Dysfunction	47	53	1.09	.32
Poor Hygiene	52	48	0.49	.53
Smelly Private Parts	**57**	**43**	**5.96**	**.02**

Note. Significant differences between interviewer preference are shown in bold. The shaded lines indicate the two topics for which an avatar was preferred over a human professional.

Preference for the professional for sex-related topics. Finally, recall that Yokotani et al. (2018) found that participants were more willing to discuss the details of sex-related topics with an avatar than with a therapist face-to-face, but that they exhibited the opposite pattern when discussing mental health-related topics. To examine potential differences in participants' preferences here, I assigned 5 of the 41 topics to the sex-related category (i.e., safe sex, contraception, unsafe sex, sexually transmitted diseases, erectile dysfunction) and 5 topics to the mental-health category (i.e., stress, anxiety, depression, grief, personal fear; see also Yokotani et al., 2018). Chi-square goodness-of-fit tests revealed that for the sex-related topics, participants preferred the human professional (55%) over the avatar professional (45%), χ^2 (1) = 17.73, $p < .001$. Similarly, for the mental health-related topics, the human professional was preferred (62%) compared to the avatar professional (38%), χ^2 (1) = 91.50, $p < .001$.

In sum, participants preferred to talk to a human professional rather than to an avatar for most of the topics on the list. Still, participants showed an increase in preference for the avatar professional with issues that were considered more embarrassing.

Preference for the Avatar's Characteristics

Next, I used a series of Chi-square tests of independence to examine whether there was an association between participants' age, gender, or ethnicity, and their preference for an avatar's depicted age, gender, or ethnicity. Recall that for exploratory reasons, not all of the participants provided a preference.

Age. There was a moderately strong association, Cramer's V = .23 (Cohen, 1988), between participants' age and their preference for an avatar's depicted age, χ^2 (20, N = 228) = 49.72, $p < .001$. As shown in Figure 4.3, overall, regardless of participants' age, they indicated that they would prefer to talk to an avatar who was depicted in age to be between

45 and 54 years; however, when I examined each age group separately, only the age preference of participants between the ages of 45 and 54 years was significant.

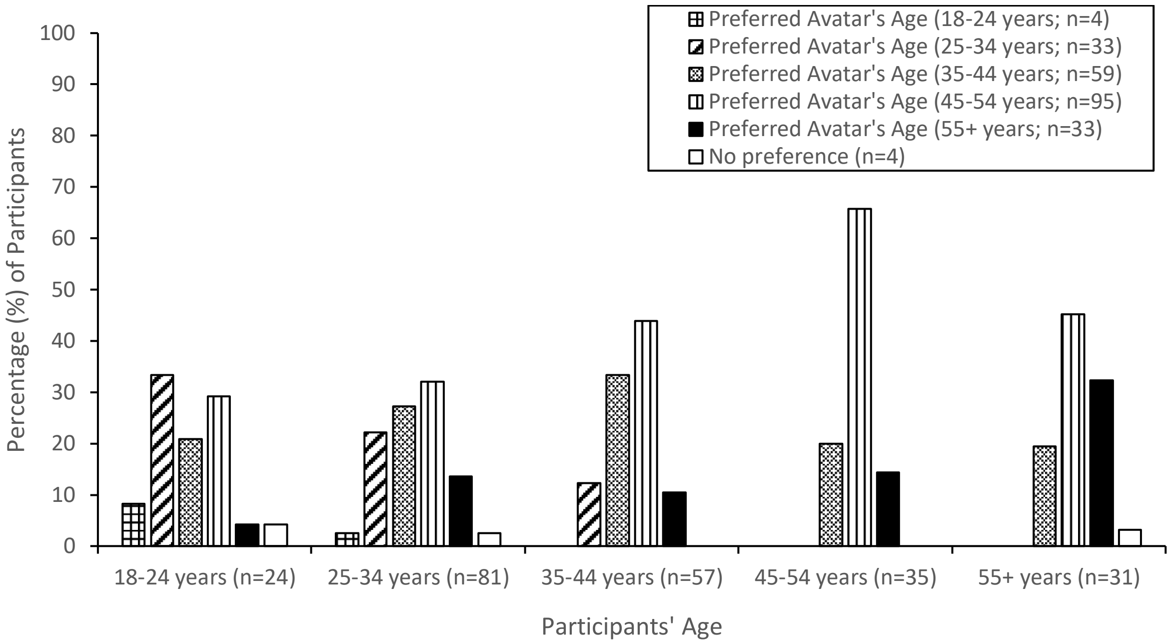

Figure 4.3. Participants' preference for an avatar's depicted age for discussing embarrassing information as a function of participants' age bracket.

Gender. There was a strong association, Cramer's V = .61 (Cohen, 1988), between participants' gender and their preference for an avatar's depicted gender, χ^2 (2, N = 264) = 98.52, p < .001. As shown in Figure 4.4, participants preferred an avatar that matched their respective gender.

Ethnicity. There was a moderately strong association, Cramer's V = .45 (Cohen, 1988), between participants' ethnicity and their preference for an avatar's depicted ethnicity, χ^2 (20, N = 201) = 161.50, p < .001. As shown in Figure 4.5, the vast majority of the sample identified as Caucasian (n = 154, 77%) and these participants preferred an avatar that matched their ethnicity. There were too few participants in any other ethnic group to do meaningful comparisons.

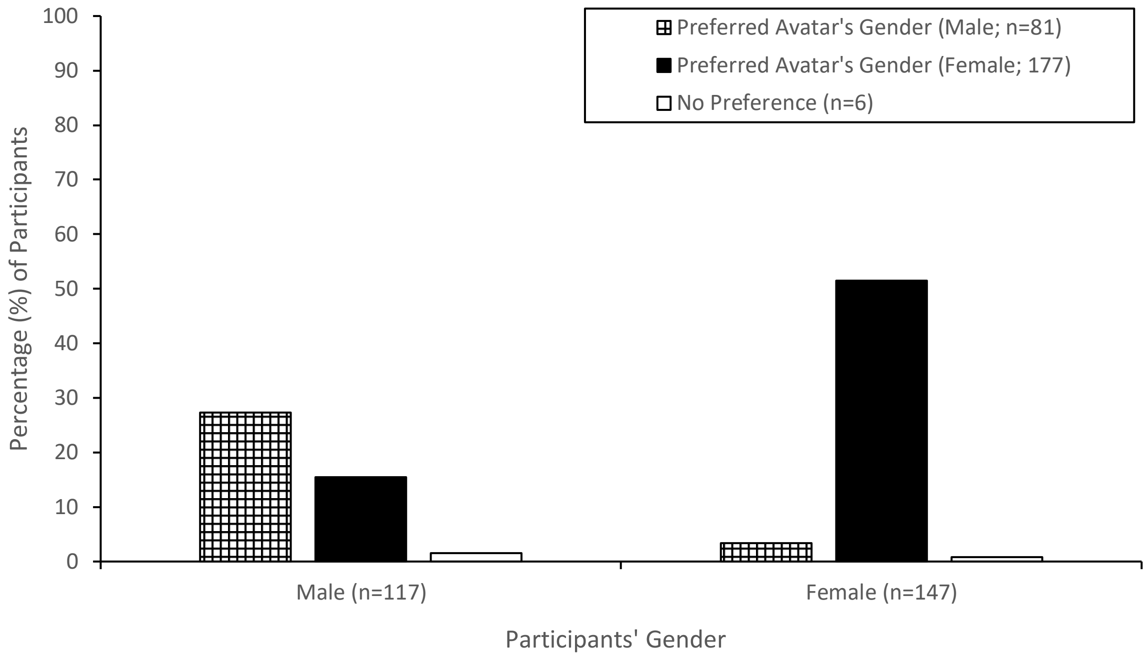

Figure 4.4. Participants' preference for an avatar's depicted gender for discussing embarrassing information as a function of participants' gender.

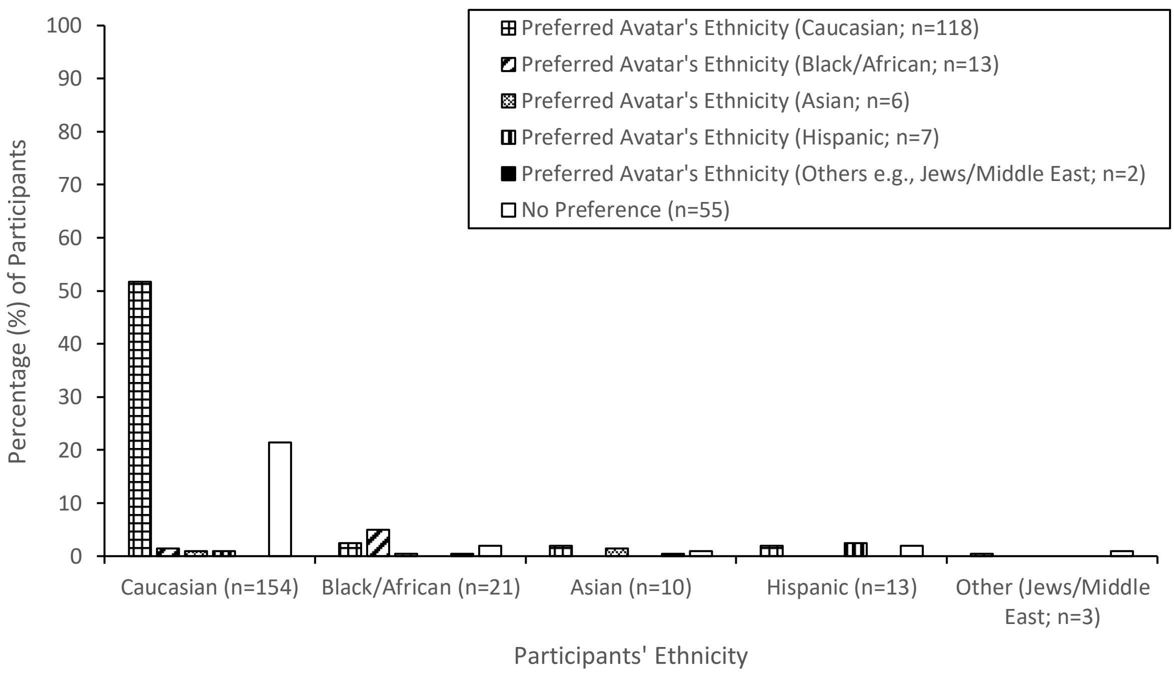

Figure 4.5. Participants' preference for an avatar's depicted ethnicity for discussing embarrassing information as a function of participants' ethnicity.

Discussion

Although the participants in the present experiment showed an increase in preference for the avatar when asked about discussing topics that were considered more embarrassing, overall, they largely indicated that they would prefer to disclose sensitive information with a human rather than with an avatar. These findings are inconsistent with those reported by both Pickard et al. (2016) and by Yokotani et al. (2018). Unlike the participants in Yokotani et al., however, the participants in the present experiment had no prior experience with an avatar, which may have impacted their choices. Furthermore, unlike Pickard et al., I did not explore participants' perceptions of the avatar's operation. Recall that the operation of an avatar refers to the method of its control; an avatar can be controlled by either a computer or a human. Researchers have shown that participants exhibit higher rates of disclosure when they were told that an avatar was computer-operated rather than human-operated (Lucas et al., 2014). Feelings of 'being watched' by others may increase people's feelings of social pressure (Pereda, 2016), and thus, may hinder their willingness to disclose to a human-operated avatar. Given these differences, the purpose of Chapter 6 was to investigate participants' preference for an avatar or a human professional following experience with an avatar. Furthermore, in Chapters 6 and 7, I explored whether participants' perception of the avatar's operation influenced their willingness to discuss information with that avatar.

Another possible explanation for the difference in findings between the current experiment and Pickard et al. (2016) involves differences between the topics presented in the two studies. The topics used in the present experiment were specifically chosen to reflect the kinds of topics that are commonly discussed in legal, medical, psychological, and financial contexts where people require help. In contrast, the topics in Pickard et al. included computer brands, personal hobbies, homeless people, and charity. On this basis, I conclude that for topics that are commonly discussed in help-seeking settings, participants express a clear choice for discussing those topics with a human interviewer.

The results of the present experiment were also inconsistent with those reported by Yokotani et al. (2018). Recall that in Yokotani et al., participants provided more details of sex-related topics when interviewed by an avatar than with a human professional face-to-face. In the present experiment, participants indicated a preference for the human professional over the avatar for discussing both sex-related and mental-health topics. By their own admission, however, Yokotani et al.'s study was severely underpowered; their conclusions regarding self-disclosure were based on a qualitative assessment, and most of the participants disclosed no information at all. In addition, the gender of the human professional and the depicted gender of the avatar were different. Here, when I held professional's gender constant, participants largely expressed a preference for the human professional.

With respect to participants' preferences for an avatar's characteristics for disclosing sensitive information, regardless of participants' age, participants indicated that they preferred to discuss information with an avatar appearing between 45- and 54-years of age that matched their gender; only Caucasians showed a preference for an avatar that matched their ethnicity. These findings are consistent with Lee at el. (2018) in that participants disclosed more personal information to a more mature-appearing avatar. Baylor and Kim (2003) showed that participants revealed more personal information to an avatar that matched participants' gender and ethnicity. Middle-aged individuals may, in general, be perceived as more mature and knowledgeable than younger people (e.g., Lim & Yu, 2015), and functioning at a more efficient pace than an older age bracket (e.g., Löckenhoff et al., 2009). Even senior participants (age 55+ years) in the present experiment preferred an avatar that appeared between the ages of 45 and 54 years.

Other aspects of an avatar's appearance may also influence disclosure. For example, Bailenson et al. (2006) examined the effects of an avatar's visual realism on information disclosure in adults. They found that less realistic avatars elicit more disclosure than that of a human professional who interviewed participants via video-conferencing; participants in this present experiment were presented with an image of a more visually-realistic, digital-human avatar. The relation between disclosure and the avatar's visual realism are explored further in Chapter 7.

Conclusion

In the past, researchers have found inconsistent empirical support for the effects of an avatar on eliciting disclosure. The findings of the present experiment suggest that many factors may impact adults' willingness to discuss information with an avatar, including the nature of the topic and features of the avatar. In subsequent chapters, I explored in more depth participants' willingness to disclose embarrassing information to an avatar. More specifically, in Chapter 6, as a part of an experiment on avatars and the misinformation effect, I also examined participants' preferences in discussing information with an avatar after experiencing both an avatar and a human professional. In Chapter 7, as a part of an experiment on avatar realism and memory performance, I explored further the effects of an avatar's appearance on participants' disclosure of sensitive information.

Chapter 5

Do You Believe a Word an Avatar Says?

The Misinformation Effect and Avatar Interviewers

An evidential interview is a common method for gathering information that can impact the outcome of a court case. These interviews—conducted under controlled conditions—involve an interviewer asking questions to obtain a witness' account of an event. Under less optimal interview conditions, an interviewer may—intentionally or unintentionally—alter a witness' memory of the event through suggestive questioning or by providing information that the witness has not described. As a result, the original memory trace may become contaminated. One variable that has been shown to increase the probability of contamination is the perceived credibility of the interviewer (Echterhoff, Hirst, & Hussy, 2005; French, Garry, & Mori, 2011; Skagerberg & Wright, 2009). Given this, avatar interviewers may buffer an adult witness from the impact of post-event misinformation because avatars, in general, are perceived as a less-credible information source (e.g., Nowak & Rauh, 2006; de Visser et al., 2016; Waytz et al., 2014). That is, a witness may not believe or take on board the information provided by an avatar and, thus, may not incorporate that information into their subsequent account of the target event. In the present experiment, I explored the effects of post-event misinformation on adults' accounts of a prior event with a 2D cartoon-rendered avatar interviewer.

Avatars as a Source of Misinformation?

In a limited number of studies, researchers have explored the effects of avatars as a source of misinformation. For example, Segovia and Bailenson (2009) examined the effects of 3D avatar interviewers on children's susceptibility to post-event misinformation. In that study, 27 children between 4- and 5-years of age and 28 children between 6- and 7-years of age were randomly assigned to one of four misinformation conditions: mental imagery, avatar-other, avatar-self, and a control group. Children received a verbal narrative of the target event and were then immediately asked to recall the event. Next, the children received false information from their respective misinformation conditions. In the Imagery condition, children were asked to imagine themselves participating in the target event containing false details; in the Avatar-other condition, children watched a child-avatar participating in the target event containing false details; in the Avatar-self condition, children watched an avatar representation of themselves participating in the target event containing false details; in the control group, children did not receive any false information. The Avatar conditions were presented in an immersive virtual environment. Immediately and five days after receiving the misinformation, children were again asked to recall the target event. Older, but not younger, children in the Avatar-self and Imagery conditions reported more false details than did the children who were presented post-event misinformation by an avatar depicting another child.

Although Segovia and Bailenson (2009) provided some evidence that avatars can be a source of misinformation, the procedure they used is far removed from that of an investigative interview in that the avatar was part of the target event. In the present experiment, I used the procedure that is commonly used to assess the impact of misinformation on adults' reports of a prior event (see Loftus, 2005). Participants initially watched a video of an event and then an avatar was employed as the potential source of misinformation and as the interviewer.

Heterogeneity in Response to Post-event Information

Following the seminal demonstration by Loftus and Palmer (1974) on the misinformation effect, researchers have subsequently explored a range of factors that might influence participants' susceptibility to misinformation. For example, a longer retention interval between the original experience and the subsequent test has been shown to increase individuals' susceptibility to misinformation (see Belli, Windschitl, McCarthy, & Winfrey, 1992; Newcombe & Siegal, 1997; Oates & Shrimpton, 1991; Saywitz et al., 1991; Sutherland & Hayne, 2001). Both children and adults with higher self-efficacy and more advanced language abilities are more resilient to the effects of misinformation (see Bruck & Melnyk, 2004, for a review of misinformation in children; see also, Eisen, Winograd, & Qin, 2002, for a review on the misinformation effect in adults). Other factors of the interviewer such as the presence of autism spectrum disorder (ASD), personality traits, and interviewer's characteristics may also influence suggestibility (see below). In the present chapter, the terms suggestibility and susceptibility to misinformation are used interchangeably.

Avatars and ASD traits. Individuals with ASD have unique cognitive and behavioural profiles that might lead us to predict that they would exhibit heightened vulnerability to post-event misinformation. For instance, individuals with ASD are characterised by theory of mind (ToM) deficits—a term referring to a person's knowledge of another person's mental state such as his or her desires or thoughts. ToM difficulties are negatively associated with suggestibility due to deficits in source monitoring (Bright-Paul, Jarrold, & Wright, 2008). Moreover, individuals with ASD are generally more compliant with an interviewer's request (North, Russell, & Gudjonsson, 2008). In contrast to the prediction that individuals with ASD would exhibit heightened vulnerability to misinformation, researchers have consistently found that individuals with ASD and their neurotypical counterparts are equally susceptible to the negative effects of misleading questions (McCrory et al., 2007; North et al., 2008) and to post-event misinformation more generally (Bruck, London, Landa, & Goodman, 2007; Maras & Bowler, 2011) when human interviewers interview them.

To date, only Hsu and Teoh (2017) have explored the link between avatar interviewers and suggestibility to misleading questions in children with ASD. In that study, typically-developing (TD) children and children who were clinically diagnosed with ASD were interviewed by an avatar interviewer or a human interviewer about a target event using misleading questions. Relative to the human interviewer, children, especially children with ASD, provided more incorrect details in response to misleading questions asked by the avatar interviewer. These findings raised an important question: are adults, in particular, adults with ASD, also more susceptible to memory contamination from post-event misinformation presented by an avatar interviewer? In the current experiment, I explored the relation between ASD traits and the misinformation effect in adults who were interviewed by a 2D cartoon-rendered avatar interviewer.

Avatars and personality traits. In addition to ASD traits, personality traits might also influence adults' susceptibility to misinformation provided by an avatar. There are five general domains of personality (*neuroticism, extraversion, openness, agreeableness, conscientiousness,* Costa & McCrae, 1992). In a handful of studies with human interviewers, researchers have explored associations between personality traits and suggestibility. For instance, openness, agreeableness, and self-directedness trait in the conscientiousness dimension are linked with higher susceptibility to post-event misinformation; adults with higher scores on these traits tend to show a propensity to consider alternative suggestions (Liebman et al., 2002; Zhu et al., 2010). On the contrary, higher scores on extraversion may be associated with lower susceptibility to post-event misinformation (Porter, Birt, Yuille, & Lehman, 2000; Zhu et al., 2010). Furthermore, adults with a higher score on the fear of negative evaluation trait on the neuroticism dimension are less susceptible to post-event misinformation (Zhu et al., 2010; cf. Liebman et al. 2002). To date, researchers have not yet examined the association between personality traits and adults' responses to post-event misinformation with an avatar interviewer. In Chapter 3 of the present thesis, adults with overall low conscientiousness provided more accurate reports with an avatar interviewer.

In the present experiment, I explored the effects of personality traits on adults' suggestibility to post-event misinformation presented by an avatar interviewer.

Perceived operation of an avatar. Another factor that might influence someone's susceptibility to misinformation provided by an avatar might be their perception of how the avatar is operated. For example, an avatar can either be controlled by a computer system or by a concealed human. Researchers have found that people's perception of an avatar's operation may impact the way that they respond to an avatar (see Fox et al., 2015, for a meta-analysis). In Chapter 3 of the present thesis, I found that participants who perceived the avatar as being operated by a concealed human (as opposed to being operated by a computer system) provided less accurate accounts. Researchers have yet to examine the effects of an avatar's perceived operation on suggestibility. In the present experiment, I investigated whether participants' perception of the avatar's operation would affect adults' susceptibility to post-event misinformation.

The Present Experiment

The overarching goal of the present experiment was to answer the question: do avatar interviewers buffer adults from the impact of post-event misinformation? In addition, I wanted to determine whether participants' level of ASD and personality traits and their perception of an avatar's operation would influence their susceptibility to misinformation with either a human or an avatar interviewer.

Participants watched a 5-min video and subsequently completed a questionnaire that was designed to assess their level of ASD traits and personality traits. Six weeks later, each participant was presented with six open-ended specific questions containing Post-event information (PEI) either by an avatar interviewer presented on a 2D screen or by a human interviewer face-to-face. The PEI questions contained misinformation, accurate information, or no additional information. A 6-week retention interval was used to improve the ecological validity of the present experiment because often, witnesses or victims are interviewed following long delays (e.g., Hanna et al., 2010). Furthermore, in Chapter 3, participants' memory performance increased with an avatar interviewer following a 6-week, but not 1-day, retention interval. One day following the PEI, participants were interviewed using open-ended and directed questions about the details of the video either by an avatar or a human interviewer.

Finally, recall that in Chapter 4, I presented participants with a list of 41 different topics that were designed to assess their preference in disclosing embarrassing information with an avatar professional. In the present experiment, I presented the same list of 41 topics to participants who interacted with both the avatar and the human professional following the memory interview. Additionally, I investigated the effects of participants' perception of an avatar's operation on their views about disclosing sensitive information to an avatar professional. When adults perceive an avatar as human-operated, they may feel a sense of 'being watched.' Researchers have shown that feelings of 'being watched' by others may increase individuals' feelings of social pressure (see Pereda, 2016). As a result, individuals' perception of an avatar's method of operation may influence their disclosure of information (Lucas et al., 2014; Pickard et al., 2016).

Method

Participants

The final sample consisted of 102 adults (77 females; M_{age} = 24.10 years; *SD* = 5.92; range 18–46); recruited through a university participant database. We based our sample size on other published literature in the field (Sutherland & Hayne, 2001). All participants provided written informed consent and were reimbursed $25 for their participation. The research was reviewed and approved by the University of Otago's Human Ethics Committee, which is accredited by the New Zealand Health Research Council and whose guidelines are consistent with those of the American Psychological Association.

Video Stimulus

I used the same target video as I used in Chapter 3.

Interview Conditions

The human interviewer. In the Human condition, participants were interviewed face-to-face by a female human interviewer (see Figure 5.1, left panel). For logistic reasons, some participants were interviewed by Emily (see Figure 5.1, left panel, left picture), and some participants were interviewed by Chelsea (see Figure 5.1, left panel, right picture). The female interviewer sat across from the participant with a table in between them.

The avatar interviewer. In the present experiment, the avatar interviewer was presented on a 21.5" computer monitor and could display the same nonverbal gestures as in Chapter 3. To control for confounding effects of visual appearance, the avatar was constructed to resemble its corresponding human interviewer in facial features, hair colour and style, and body shape (see Figure 5.1, right panel). The avatar was controlled using the "Wizard-of-Oz" technique (Kelley, 1983).


Figure 5.1. The human interviewer (left panel); the avatar interviewer (right panel).

Trait Measures

As in Chapter 3, I used the Autism-Quotient (AQ) questionnaire (Baron-Cohen et al., 2001) to measure traits resembling ASD and the NEO-Five-Factor Inventory-3 (NEO-FFI-3; Costa & McCrae, 1992) to measure the five general domains of personality: *neuroticism, extraversion, openness, agreeableness,* and *conscientiousness.* Internal consistency (Cronbach's α[3]) of the AQ in the current experiment was .76. Internal consistency (Cronbach's α) of the NEO-FFI-3 in the current experiment was .87 for Neuroticism; .85 for Extraversion; .77 for Agreeableness; and .84 for Conscientiousness, with Openness (.69) being the only personality domain to fall just below the conventional benchmark of .70 for adequate reliability.

Procedure

Session 1. At the beginning of the first session, participants were informed that the purpose of the experiment was to evaluate the suitability of a video for children. Each participant watched the video on their own. Immediately after watching the video, participants completed an online questionnaire to collect demographic information (gender, ethnicity, age, level of education), and completed the NEO-FFI-3 and AQ. After participants completed the questionnaires, they were asked to return to the laboratory six weeks later.

Session 2 (post-event information). As shown in Figure 5.2, six weeks after

[3] The conventional benchmark for adequate reliability is .70

watching the video, participants returned to the laboratory and were asked six directed-questions regarding specific aspects of the video. Two of the questions were neutral—no additional information was included (e.g., "Sally's mum met her friend. Where did they meet?"); and two of the questions were leading—additional information that was consistent with the contents of the video (e.g., "A man in the car wearing *a red shirt* talked to Sally. What did he say?"); two of the questions were misleading—additional information that was inconsistent with the contents of the video (e.g., "In the police station, a *lady* gave Sally a piggy toy. What colour was the toy?"). The questions were presented in the same sequence in which the events had occurred during the video. The neutral, leading, and misleading questions were counterbalanced across the six specific questions such that each type of question appeared equally in the first two questions, the next two questions, and the last two questions across participants.

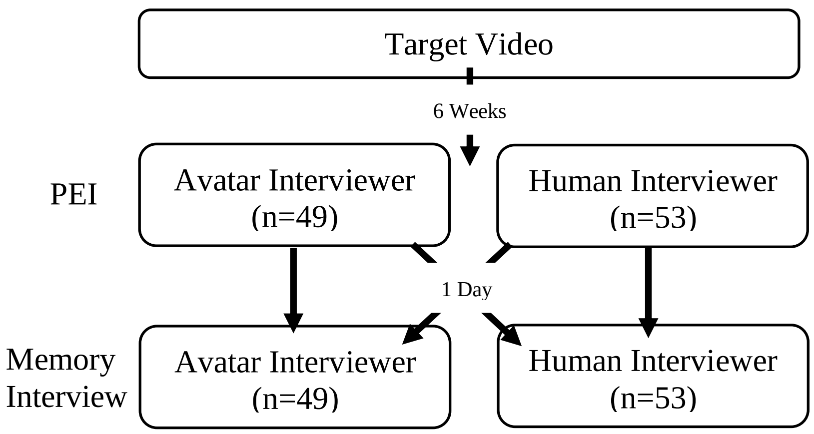

Figure 5.2. A schematic of the procedure.

Questions were asked by either the human interviewer (n = 53) or the avatar interviewer (n = 49). For participants in the human-interviewer condition, the experimenter introduced the female human interviewer by saying, "*This is Chelsea/Emily, and she is going to talk to you about the video.*" Participants in the avatar-interviewer condition were seated in front of a 21.5” computer monitor that displayed the avatar interviewer. The experimenter then said, “*This is Chelsea/Emily. Chelsea/Emily is a computer animation that is going to talk to you about the video. You can talk to it, and it will respond.*” The experimenter then left the interview room.

Session 3 (memory interview). One day after receiving the PEI, participants returned to the laboratory and were told that the real purpose of the experiment was to assess their memory for the video. Half of the participants who were presented with the PEI by the avatar interviewer were re-interviewed by the avatar and half were interviewed by the human interviewer; half of the participants who were presented with the PEI by the human interviewer were re-interviewed by the human and half were interviewed by the avatar (see Figure 5.2). Again, for participants in the human-interviewer condition, the experimenter introduced the female human interviewer by saying, “*This is Chelsea/Emily, and she is going to talk to you about the video.*” Participants in the avatar-interviewer condition were seated in front of a 21.5” computer monitor that displayed the avatar interviewer. The experimenter then said, “*This is Chelsea/Emily. Chelsea/Emily is a computer animation that is going to talk to you about the video. You can talk to it, and it will respond.*” The experimenter then left the interview room.

The memory interview was conducted in two phases. During the free-recall phase, the interviewer asked participants to report everything that they could remember from the video by saying, “*Tell me everything that you can remember about what happened in the video, from the beginning to the end.*” Both the human and the avatar interviewer kept their verbal and non-verbal responses minimal, with only neutral gestures like eye contact, smiling, head tilt, and words of encouragement to maintain the conversation. The only additional prompt given during the free-recall phase was, “*Is there anything else you can remember that you haven’t already told me?*”

Once the participant indicated that he or she had no more information to report, the interviewer began the directed-recall phase of the interview. The interviewer asked participants six directed questions regarding specific aspects of the video (e.g., What colour was Sally's monkey?).

Post-interview questionnaire. Immediately after the interview, participants who had experienced being interviewed by both the human interviewer and the avatar interviewer (n = 50) were presented with the same 41 topics displayed on a computer screen that were used in Chapter 4. The basic procedure for the present chapter was the same as that of Chapter 4. Additionally, participants were asked if they perceived the avatar interviewer as being controlled by a computer system or by a concealed human. In terms of participants' views of an avatar's characteristics, participants in the present experiment were asked if they would prefer to disclose information to an avatar that appeared older, younger, or the same age as them instead of indicating their preferred age group (e.g., 45–54 years).

Coding and Reliability

The interviews were all audio-recorded and transcribed verbatim.

Free-recall phase. I used the same coding method as I used in Chapter 3 to code participants' free-recall accounts of the video (see Appendix B). As before, the number of words that participants said during free recall, regardless of the content, were recorded as total word count and was used as a measure of verbal interaction. To code the amount of correct information reported, participants received one point for each item of information correctly reported. The same procedures were used to code errors. One observer coded all of the free-recall accounts, and a second observer coded 25% of them. Neither observer was aware of participants' group assignment. A Pearson's product-moment correlation yielded an inter-observer reliability coefficient of $r = .94$, $p < .001$ for the total amount of information reported. Any discrepancies between the two observers were subsequently discussed and resolved.

Directed-recall phase. Participants received one point for each correct response to the specific questions. Incorrect responses were coded as either *commission* errors (i.e., participants recalled misleading PEI) or *novel/other* errors (i.e., participants recalled an incorrect detail of the video other than from the PEI). One observer coded all of the participants' responses during the directed-recall phase, and a second observer coded 25% of them. Neither observer was aware of the participants' group assignments. There was no discrepancy in the coding of the answers to the six directed questions regarding specific aspects of the video.

Analytic Strategy and Data Analysis

I used the same data analytical approach as I used in Chapter 3 by conducting moderation analyses and ANCOVA to examine the influence of individual differences in personality and ASD traits on the effect of interviewer type on the number of commission errors that participants made during directed recall.

Results

Preliminary Analysis

In the first part of the analysis, I established whether there were any differences in participants' scores on the Autism Quotient (AQ) or on the NEO-Five-Factor Inventory-3 (NEO-FFI-3) personality measure as a function of Interviewer condition (see Table 5.1). Participants' AQ scores and NEO-FFI-3 scores were submitted to separate 2 (PEI interviewer: avatar, human) x 2 (Memory interviewer: avatar, human) ANOVAs. As shown in Table 5.1, there were no differences in participants' AQ or NEO-FFI-3 scores as a function of PEI interviewer. There was, however, a main effect of Memory interviewer on participants' conscientiousness score on the NEO-FFI-3, $F(1, 98) = 4.36$, $p = .04$, $\eta_p^2 = .04$. Relative to participants who were interviewed by a human interviewer, participants who were interviewed by an avatar interviewer scored higher on conscientiousness. There was also a significant PEI interviewer X Memory interviewer interaction, $F(1, 98) = 10.68$, $p = .001$, $\eta_p^2 = .10$. Participants who received PEI from an avatar and were interviewed by an avatar during the memory interview scored higher on conscientiousness than did participants in the 3 other groups. Given that there was a difference in participants' level of conscientiousness across the interviewer conditions, subsequent analyses controlled for conscientiousness. In subsequent analyses, I also collapsed across the two interviewers, Emily (n = 9) and Chelsea (n = 93), given the extremely low number of participants who were interviewed by Emily.

I also carried out an exploratory analysis of the dependent variables (accuracy, amount of correct information, word count, errors) to identify any outlier data points. The analysis showed outlier data points (i.e., 1.5 times the interquartile range from the upper or lower quartile) and extreme outliers (i.e., three times the interquartile range from the upper or lower quartile interquartile range) for word count and the amount of correct information reported. The extreme outlier data were excluded in subsequent analyses of word count and amount of correct information; the other outliers were included in the analysis because a careful inspection of the 5% Trimmed Mean showed that these scores did not have a strong influence on the mean.

Table 5.1

Scores on the Autism and Personality Measures (Means and Standard Deviations) as a Function of PEI Interviewer and Memory Interviewer Conditions

	PEI-Avatar Interviewer		PEI-Human Interviewer	
	Memory-Avatar Interviewer	Memory-Human Interviewer	Memory-Avatar Interviewer	Memory-Human Interviewer
AQ	18.50 (6.76)	18.44 (6.78)	17.88 (5.24)	18.68 (7.23)
NEO-FFI-3				
Neuroticism	3.88 (.80)	3.44 (1.12)	3.38 (.71)	3.61 (1.29)
Extraversion	2.75 (1.11)	2.80 (1.04)	3.29 (1.08)	2.82 (1.16)
Openness	3.63 (.92)	3.36 (.10)	3.71 (.75)	3.46 (.96)
Agreeableness	3.50 (.98)	3.32 (1.03)	3.46 (.98)	2.93 (1.02)
Conscientiousness	3.25 (.85)	2.20 (1.04)	2.92 (.93)	3.07 (1.05)

Memory Interview

Free-recall phase. First, I examined group differences in verbal interaction and memory performance during free recall of the memory interview as a function of PEI interviewer condition (avatar, human) and Memory interviewer condition (avatar, human).

Verbal interaction. Figure 5.3 shows the level of verbal interaction between participants and the interviewer measured using participants' overall word count during free recall. The data in Figure 5.3 were submitted to a 2 (PEI interviewer) X 2 (Memory interviewer) analysis of covariance (ANCOVA) while controlling for conscientiousness. As shown in Figure 5.3, there was no difference in word count as a function of PEI interviewer, $F(1, 95) = 3.83$, $p = .053$, $\eta_p^2 = .04$ or as a function of Memory interviewer, $F(1, 95) = 3.08$, $p = .08$, $\eta_p^2 = .03$. There was, however, a significant PEI interviewer X Memory interviewer interaction, $F(1, 95) = 5.90$, $p = .02$, $\eta_p^2 = .06$. To evaluate the interaction, I conducted three separate independent-samples t-tests with a Bonferroni adjusted alpha level of .02. As shown in Figure 5.3, participants who received PEI from the human interviewer and were interviewed by the human interviewer said significantly more during the memory interview (*M* = 419.60 words, *SD* = 164.87) than did participants in the other 3 conditions.

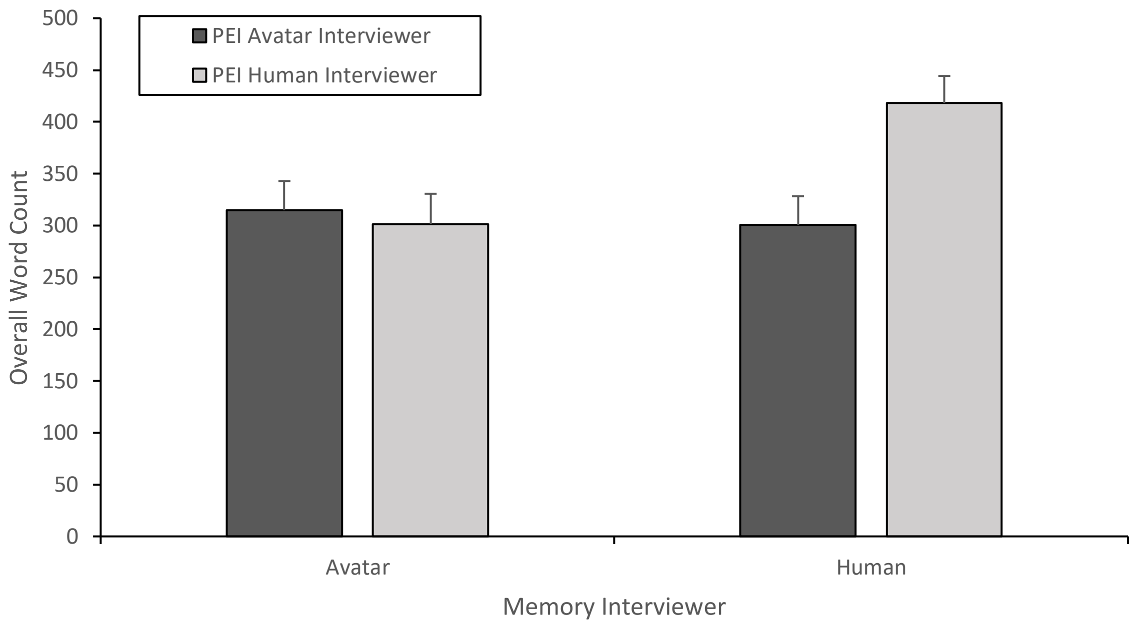

Figure 5.3. Participants' overall word count (+1SE) during free recall as a function of PEI interviewer and Memory interviewer conditions.

Memory performance. I measured memory performance during free recall using the amount of correct information (see Figure 5.4) and the overall accuracy of participants' free-recall accounts. The data in Figure 5.4 were submitted to a 2 (PEI Interviewer) X 2 (Memory interviewer) ANCOVA while controlling for conscientiousness. As shown in Figure 5.4, there was no difference in the amount of correct information reported as a function of PEI interviewer, $F(1, 96) = 3.33$, $p = .07$, $\eta_p^2 = .03$, nor as a function of Memory interviewer, $F(1, 96) = .12$, $p = .74$, $\eta_p^2 = .001$. There was, however, a significant PEI interviewer X Memory interviewer interaction, $F(1, 96) = 5.29$, $p = .02$, $\eta_p^2 = .05$. To evaluate the interaction, I conducted three separate independent-samples t-tests with a Bonferroni adjusted alpha level of .02. As shown in Figure 5.3, participants who received PEI from the human interviewer and were interviewed by the human interviewer said significantly more during the memory interview (*M* = 44.46, *SD* = 14.42) than did participants in the other 3 conditions.

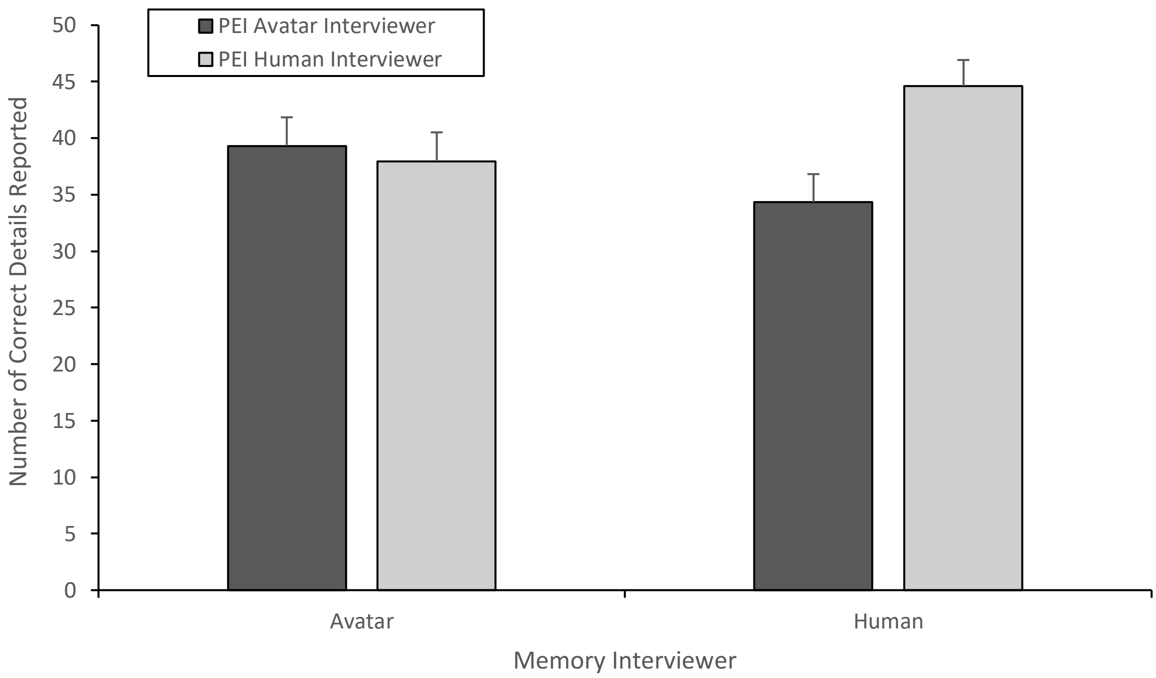

Figure 5.4. The amount of correct information (+1SE) reported by participants during free recall as a function of PEI interviewer and Memory interviewer conditions.

To obtain an accuracy score for each participant, I divided the total amount of correct information reported during free recall by the total amount of information reported (i.e., correct information + incorrect information). A 2 (PEI Interviewer) X 2 (Memory interviewer) ANCOVA while controlling for conscientiousness showed that there was a main effect of Memory interviewer; participants who were interviewed by the avatar during the memory interview were more accurate (*M* = 92.42%, *SD* = 4.68) than were participants who were interviewed by a human interviewer (*M* = 89.57%, *SD* = 4.61), $F(1, 98) = 9.22$, $p = .003$, $\eta_p^2 = .09$. There was no difference in accuracy as a function of PEI interviewer, $F(1, 98) = .33$, $p = .57$, $\eta_p^2 = .003$, and no interaction, $F(1, 98) = 1.11$, $p = .30$, $\eta_p^2 = .01$.

Errors of commission. Recall that errors during free recall were coded as either *commission* errors (i.e., participants recalled misleading PEI) or *novel/other* errors (i.e., participants recalled an incorrect detail of the video other than from the PEI). To determine whether the type of interviewer was associated with the number of commission errors that participants reported during free recall, the number of commission errors were submitted to a 2 (PEI Interviewer) X 2 (Memory Interviewer) X 3 (PEI Type: neutral, leading, misleading) ANCOVA with repeated measures over PEI Type (Greenhouse-Geisser correction factor), while controlling for conscientiousness. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated, $\chi^2(2) = 8.70$, $p = .01$, hence I used the Greenhouse-Geisser correction. Participants made similar number of commission errors regardless of the PEI type (Misleading PEI: *M* = .10, *SD* = .30; Leading PEI: *M* = .03, *SD* = .17; Neutral PEI: *M* = .05, *SD* = .22), $F(1.84, 180.51) = 2.11$, $p > .05$, $\eta_p^2 = .02$. There was no effect of PEI interviewer nor Memory interviewer and no interactions, largest $F(1.84, 180.51) = 1.07$, $p > .05$, $\eta_p^2 = .01$.

Directed-Recall Phase. A one-way ANOVA revealed that there were no differences in the number of correct responses as a function of the order of presentation, $F(2, 99) = 2.77$,

$p = .07$, $\eta_{\mathrm{p}} = .05$. Therefore, subsequent analyses collapsed across the order of presentation.

Correct responses. The number of correct responses to the six directed questions were submitted to a 2 (PEI Interviewer) X 2 (Memory Interviewer) ANCOVA while controlling for conscientiousness. Participants who received PEI from an avatar interviewer correctly answered a similar number of questions (*M* = 2.60, *SD* = .93) as did participants who received PEI from a human interviewer (*M* = 2.97, *SD* = 1.07), $F(1, 98) = 3.23$, $p = .08$, $\eta_p^2 = .03$. Similarly, participants who were interviewed by an avatar during the memory interview correctly answered a similar number of questions (*M* = 2.74, *SD* = 1.06) as did participants who were interviewed by a human interviewer (*M* = 2.81, *SD* = .99), $F(1, 98) = .36$, $p = .55$, $\eta_p^2 = .004$. There was no interaction, $F(1, 98) = .86$, $p = .36$, $\eta_p^2 = .009$.

Errors of commission. Figure 5.5 shows the number of commission errors participants reported in response to the six directed questions. The data in Figure 5.5 were submitted to a 2 (PEI Interviewer) X 2 (Memory Interviewer) X 3 (PEI Type) ANCOVA with repeated measures over PEI Type while controlling for conscientiousness. Mauchly's Test of Sphericity indicated that the assumption of sphericity was not violated ($p > .05$) so in this analysis, the Greenhouse-Geisser correction was not needed.

As shown in Figure 5.5, participants were more likely to make a commission error if they had been provided with misleading PEI (*M* = .70, *SD* = .71) than they were if they were provided with leading (*M* = .37, *SD* = .56) or neutral PEI (*M* = .32, *SD* = .51), $F(2, 194) = 10.92$, $p < .001$, $\eta_p^2 = .10$. That is, post-event misinformation increased the number of errors that participants made during the directed-recall phase of the memory interview. There was no effect of PEI interviewer nor Memory interviewer and no interactions, largest $F(1, 194) = 2.21$, $p = .11$, $\eta_p^2 = .03$.

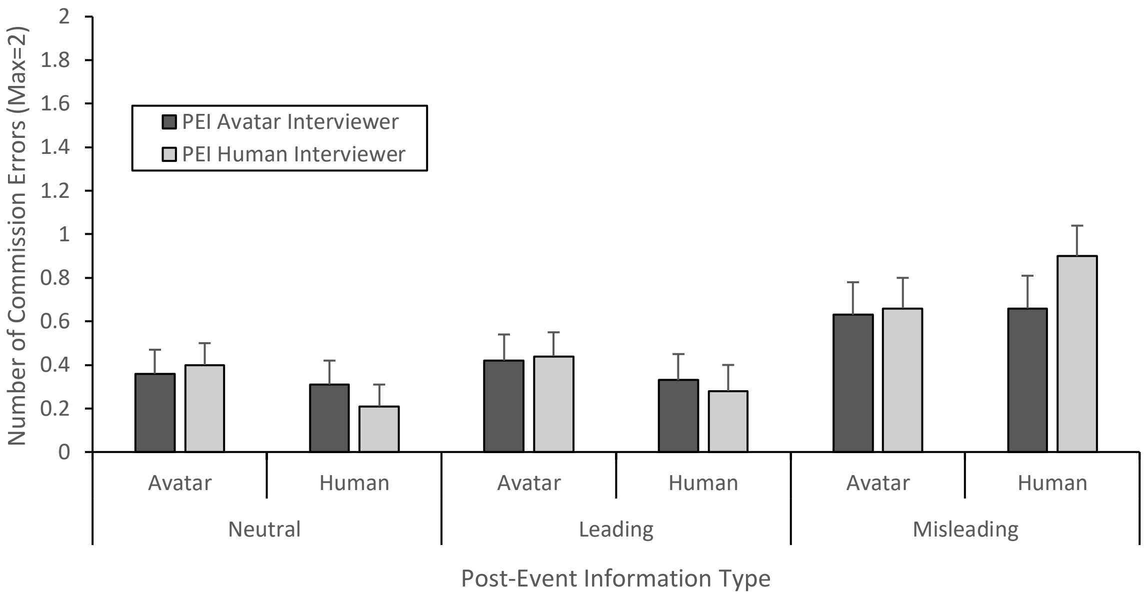

Figure 5.5. The number of commission errors (+1SE) reported during the directed-recall phase of the memory interview as a function of PEI and Memory interviewer and PEI Type.

In sum, overall, participants were more talkative and provided more correct details of the target event during free recall when they were interviewed by a human interviewer both in the PEI phase and memory interviewer. Despite reporting more correct details during free recall, however, participants who were interviewed by a human interviewer were also less accurate. There were no differences in participants' memory performance across interviewer type in response to directed questions; participants in all groups were equally susceptible to the PEI, irrespective of the interviewer who provided the misinformation or conducted the memory interview.

Individual Differences in Misinformation Effect with Avatars

Autism Spectrum Disorder (ASD) traits. To examine whether participants' ASD traits (moderator variable) changed the effect of PEI and Memory interviewer type on the number of commission errors participants made during directed recall, I first assigned participants to one of two groups based on their AQ scores. Specifically, I grouped participants to the High AQ group (n = 11) if they scored higher than the cut-off score of 26 on the AQ and to the Low AQ group (n = 91) if they scored 26 or less on the AQ (Woodbury-Smith et al., 2005).

I then conducted a moderation analysis using the PROCESS macro for SPSS (Hayes, 2013), with (PEI/Memory) Interviewer type (categorical variable: *avatar/avatar* vs *human/avatar* vs *avatar/human* vs *human/human*) as the independent variable; participants' memory performance (*number of commission errors made during directed recall*) as the dependent variable; participants' level of ASD traits (*low AQ*, *high AQ*) as the moderator variable[4]. Contrary to my hypothesis, the moderation analysis revealed that ASD traits did not influence the effect of the type of interviewer on the number of commission errors participants made during directed recall, $R^2 = .01$, $F(1, 98) = .27$, $p = .60$. A 4 (Interviewer Type) ANCOVA controlling for ASD traits also produced no significant effects.

Personality traits. To examine whether participants' personality traits (moderator variable) changed the effect of interviewer type on the number of commission errors that participants made during directed recall, I first assigned participants to one of three groups based on their ranking on each of the NEO-FFI-3 personality traits. Specifically, I assigned participants to the *Low* group (*neuroticism:* n = 14, *extraversion*: n = 38, *openness*: n = 9, *agreeableness*: n = 18, and *conscientiousness*: n = 36) if their ranking on the NEO measure was "Extremely Low" or "Low;" to the *Average* group (*neuroticism:* n = 33, *extraversion*: n = 32, *openness*: n = 44, *agreeableness*: n = 45, and *conscientiousness*: n = 39) if their ranking on the NEO measure was "Average;" and to the *High* group (*neuroticism:* n = 55, *extraversion*: n = 32, *openness*: n = 49, *agreeableness*: n = 39, and *conscientiousness*: n = 27) if their ranking on the NEO measure was "High" or "Extremely High."

[4] The unequal number of participants in each AQ group may reduce the power to detect ASD traits as a moderator (see Aguinis, 1995, for a review).

Again, by using the PROCESS macro for SPSS (Hayes, 2013), I conducted a series of moderation analyses for each of the five personality traits (*neuroticism, extraversion, openness, agreeableness,* and *conscientiousness*) as the moderator variable, with (PEI/Memory) Interviewer type as the independent variable; participants' memory performance as the dependent variable. The moderation analyses revealed that conscientiousness was the only personality trait found to moderate the relation between interviewer type and the number of commission errors that participants made during directed recall (see Figure 5.6).

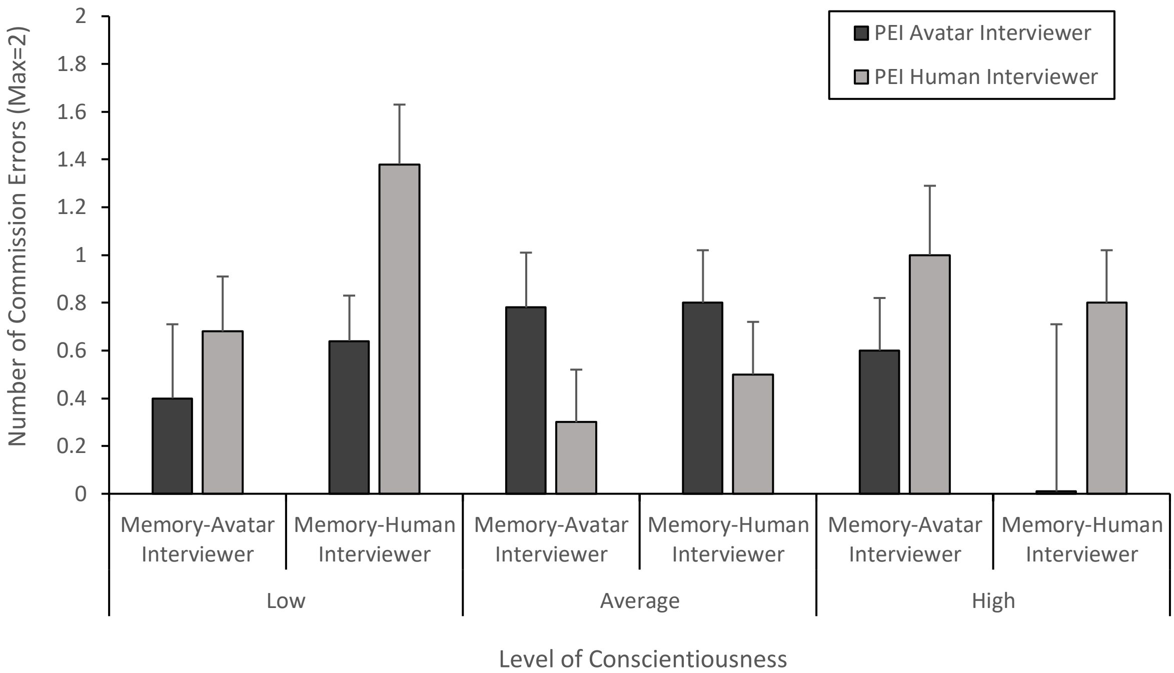

Figure 5.6. The number of commission errors (+1SE) reported by participants during the directed-recall phase of the memory interview as a function of interview conditions and level of conscientious trait.

Conscientiousness explained some (7.1%) of the total increase in variation of the overall model, $R^2 = .09$, $F(2, 96) = 3.77$, $p = .03$. Simple slopes analysis revealed that there was a significant negative linear relation between word count and interviewer type in the Low Conscientious group, *b* = .05, *SE* = .02, 95% CI [0.00, -.09], *t*(96) = 1.99, *p* = .049, but not in Average Conscientious group, *b* = -.04, *SE* = .02, 95% CI [-.08, .007], *t*(96) = -1.68, *p* = .10, or the High Conscientious group, *b* = .03, *SE* = .03, 95% CI [-.02, .08], *t*(96) = 1.13, *p* = .26. That is, relative to other interview conditions [Avatar/Avatar (PEI/Memory): *M* = 0.40, *SD* = 0.55; Avatar/Human: *M* = 0.64, *SD* = 0.74; Human/Avatar: *M* = 0.67, *SD* = 0.71], participants with low conscientiousness were generally more susceptible to misleading PEI when they were interviewed by the human interviewer on two occasions (*M* = 1.4, *SD* = 0.92). Participants with average to high conscientiousness made a similar number of commission errors as a function of interview conditions.

Perception of control: Computer- or human-operated avatar. In the final part of the analysis, I investigated the effects of participants' perception of the avatar's operation on the number of commission errors that participants made during directed recall. Recall that at the end of the post-interview questionnaire, participants who were interviewed by the Avatar either during the PEI interview (n = 25), during the memory interview (n = 25), or during both interview conditions (n = 24) were asked whether they thought that a computer system or a concealed human controlled the Avatar. Participants were assigned to either the Computer-operation group (n = 36; if they thought that a computer system controlled the avatar) or the Human-operation group (n = 38; if they thought that a concealed human controlled the avatar). There was no difference in the number of commission errors made in response to the directed questions as a function of operation group, *t*(72) = 0.38, *p* = .71; that is, there was no difference in the number of commission errors depending on whether participants perceived an avatar as computer-operated or as human-operated.

Taken together, the avatar interviewer buffered participants with low levels of conscientiousness against the adverse effects of post-event misinformation. The association between the type of interviewer and participants' traits resembling ASD did not affect their susceptibility to post-event misinformation. Similarly, the relation between the type of interviewer and participants' perception of the avatar's operation did not influence their suggestibility to post-event misinformation.

Post-Interview Questionnaire: Interviewer Preference For Disclosure

Recall that immediately after the memory interview, participants who were interviewed by both types of interviewers (Avatar/Human; Human/Avatar) were presented with the same 41 topics displayed on a computer screen that were used in Chapter 4 to explore their views about disclosing sensitive information to the interviewer.

Topic sensitivity. Figure 5.7 shows the percentage of participants who selected each of the 41 topics on the list as *embarrassing* or *not embarrassing.* The number of participants who selected each topic as *embarrassing* was divided by the total number of participants (N = 50) to obtain the percentage of participants who selected a topic as *embarrassing*. Consistent with Chapter 4, very few participants considered 'Flu' (8% of participants) and 'Physical pain' (10% of total participants) to be embarrassing topics while the majority of participants (82%) considered 'Smelly private parts' to be an embarrassing topic.

Preference for the professional. Consistent with the findings of Chapter 4, overall, a Chi-square goodness-of-fit test showed that, irrespective of the topic, a significantly higher percentage of participants preferred to discuss topics with a human professional (66%) rather than with an avatar (34%), χ^2 (1) = 206.10, p < .001.

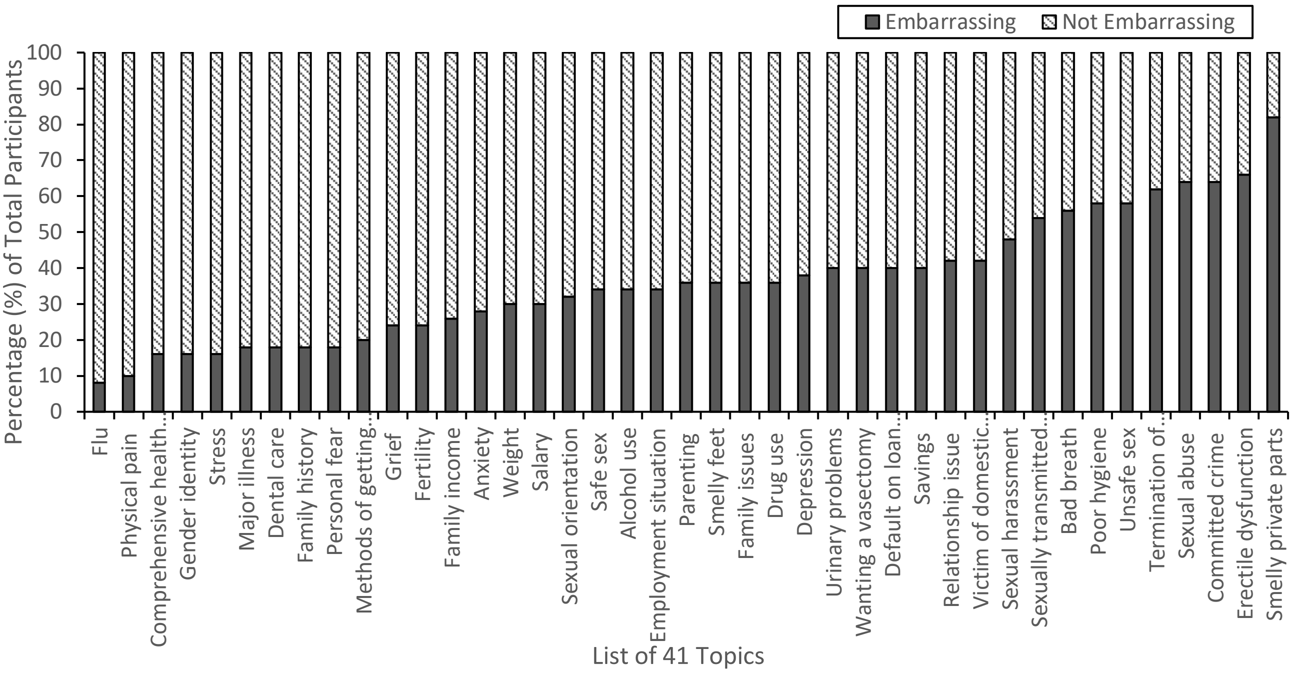

Figure 5.7. The topics are shown in order of percentage of participants who found the topic embarrassing (lowest to highest).

Preference for the professional for each topic. Next, a series of Chi-Square goodness-of-fit tests were conducted to examine participants' preference for the professional for each of the 41 topics separately. The results of these analyses are shown in Table 5.2, ranked in order of topic embarrassment. As shown in Table 5.2, for 21 of the 41 topics, participants preferred talking to a human professional, while an avatar was not preferred for any of the 41 topics. There was no preference for one professional over the other for the remaining 20 topics. These findings are virtually identical to that seen in Chapter 4.

Despite an overwhelming preference for the human professional, a Pearson's product-moment correlation revealed a significant positive correlation between the percentage of participants who selected an avatar and the percentage of participants who considered each topic embarrassing, $r = .52$, N = 41, $p < .001$ Put another way, the more participants found a topic embarrassing, the more likely they would select an avatar to talk about that topic. A similar correlation was also observed in Chapter 4

Table 5.2

Participants' Preference for an Avatar Versus Human Professional by Topic

Topics	Prefer avatar (%)	Prefer human (%)	χ^2	*p*
Flu	**24**	**76**	**13.52**	**< .01**
Physical Pain	**20**	**80**	**18.00**	**< .01**
Health Check	**0**	**100**	**50.00**	**< .01**
Gender Identity	50	50	0.00	1.00
Stress	**12**	**88**	**28.88**	**< .01**
Major Illness	**22**	**78**	**15.68**	**< .01**
Dental Care	**32**	**68**	**6.48**	**.02**
Family History	44	56	0.72	.48
Personal Fear	**10**	**90**	**32.00**	**< .01**
Methods of Contraception	**20**	**80**	**18.00**	**< .01**
Grief	**24**	**76**	**13.52**	**< .01**
Fertility	58	42	1.28	.32
Family Income	**14**	**86**	**25.92**	**< .01**
Anxiety	**20**	**80**	**18.00**	**< .01**
Weight	46	54	.32	.67
Salary	**26**	**74**	**11.52**	**< .01**
Sexual Orientation	50	50	0.00	1.00
Safe Sex	**34**	**66**	**5.12**	**.03**
Alcohol Use	**24**	**76**	**13.52**	**< .01**
Employment	**28**	**72**	**9.68**	**< .01**
Negative Parenting	44	56	0.72	.48
Smelly Feet	38	62	2.88	.12
Family Issues	38	62	2.88	.12
Drug Use	**0**	**100**	**50.00**	**< .01**
Depression	**32**	**68**	**6.48**	**.02**
Urinary Problems	**30**	**70**	**8.00**	**< .01**
Vasectomy	44	56	0.72	.48
Loan	50	50	0.00	1.00
Savings	50	50	0.00	1.00
Relationship Issues	**18**	**82**	**20.48**	**< .01**
Victim Domestic Violence	38	62	2.88	.12
Sexual Harassment	42	58	1.28	.32
Sexually-Transmitted Disease	48	52	0.08	.89
Bad Breath	54	46	0.32	.67
Poor Hygiene	52	48	0.08	.89
Unsafe Sex	**34**	**66**	**5.12**	**.03**
Abortion	44	56	0.72	.48
Sexual Abuse	**30**	**70**	**8.00**	**< .01**
Committed crime	50	50	0.00	1.00
Erectile Dysfunction	52	48	0.08	.89
Smelly Private Parts	54	46	0.32	.67

Note. Significant differences between interviewer preference are shown in bold.

Preference for the professional for sex-related topics. As in Chapter 4, I also examined possible differences in participants' preference for discussing sex-related topics and topics relating to mental health with an avatar. Consistent with Chapter 4, Chi-square goodness-of-fit tests revealed that, for topics related to mental health (i.e., stress, anxiety, depression, grief, personal fear; see Yokotani et al., 2018), participants indicated an overall preference for the human professional (80%) compared to the avatar professional (20%), χ^2 (1) = 92.42, $p < .001$, following experience with both kinds of professionals in Chapter 5. Similarly, participants also indicated an overall preference for the human professional (62%) compared to the avatar professional (38%), χ^2 (1) = 15.38, $p < .001$, for

for discussing topics related to sex (i.e., safe sex, contraception, unsafe sex, sexually transmitted diseases, erectile dysfunction).

Preference for the professional and the avatar's perceived operation. I conducted two separate Chi-square goodness-of-fit tests to explore the relation between participants' perception of the avatar's operation (computer-operated: n=23; human-operated: n=27) and participants' preference for the type of interviewer for discussing the topics. To do this, I summed the number of topics that participants preferred to talk to with the human professional or with the avatar professional as a function of perceived operation. Participants who perceived the avatar as computer-operated preferred to discuss topics with the human (70%) compared to the avatar (30%), χ^2 (1) = 153.94, $p < .001$; similarly, participants who perceived the avatar as human-operated also preferred to discuss topics with the human (76%) compared to the avatar (24%), χ^2 (1) = 300.75, $p < .001$.

In summary, consistent with the findings in Chapter 4, participants in the present experiment indicated that they would prefer to talk to a human professional rather than to an avatar professional for more than half of the topics they were asked to consider. Even when topics were considered embarrassing by a higher percentage of participants, most either showed no preference or a preference for the human professional. Still, relative to less embarrassing topics, participants showed an increase in preference for the avatar professional regarding topics that were considered more embarrassing. Participants' perception of the avatar's operation did not impact on their overall preference for one professional over the other; that is, regardless of how they perceived the avatar's operation, participants' overwhelmingly preferred the human professional compared to the avatar.

Preference for the Avatar's Characteristics

Next, with some expected cell sizes being less than five, I used a series of Fisher's exact tests to examine whether there was an association between participants' age, gender, or ethnicity, and their preference for an avatar's depicted age, gender, or ethnicity.

Age. There was an association between participants' age and their preference for an avatar's depicted age (p = .009). As shown in Figure 5.8, the vast majority of the sample preferred an avatar that matched their age.

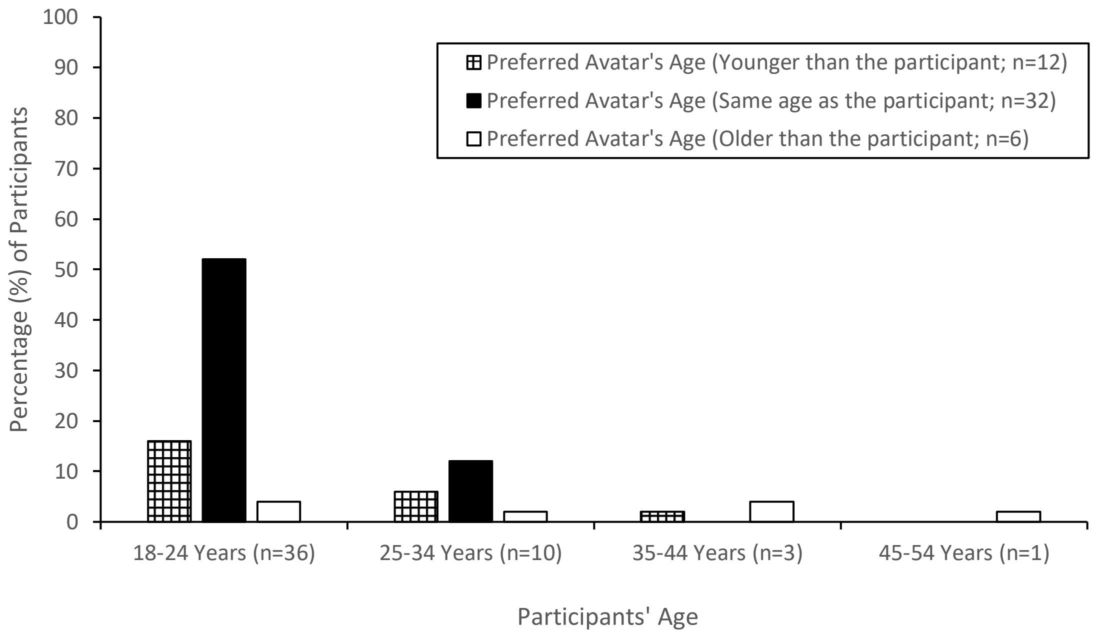

Figure 5.8. Participants' preference for an avatar's depicted age for discussing embarrassing information as a function of participants' age bracket.

Gender. There was also an association between participants' gender and their preference for an avatar's depicted gender ($p < .001$). As shown in Figure 5.9, female participants preferred a female avatar, however, male participants showed no particular preference for the avatar's depicted gender.

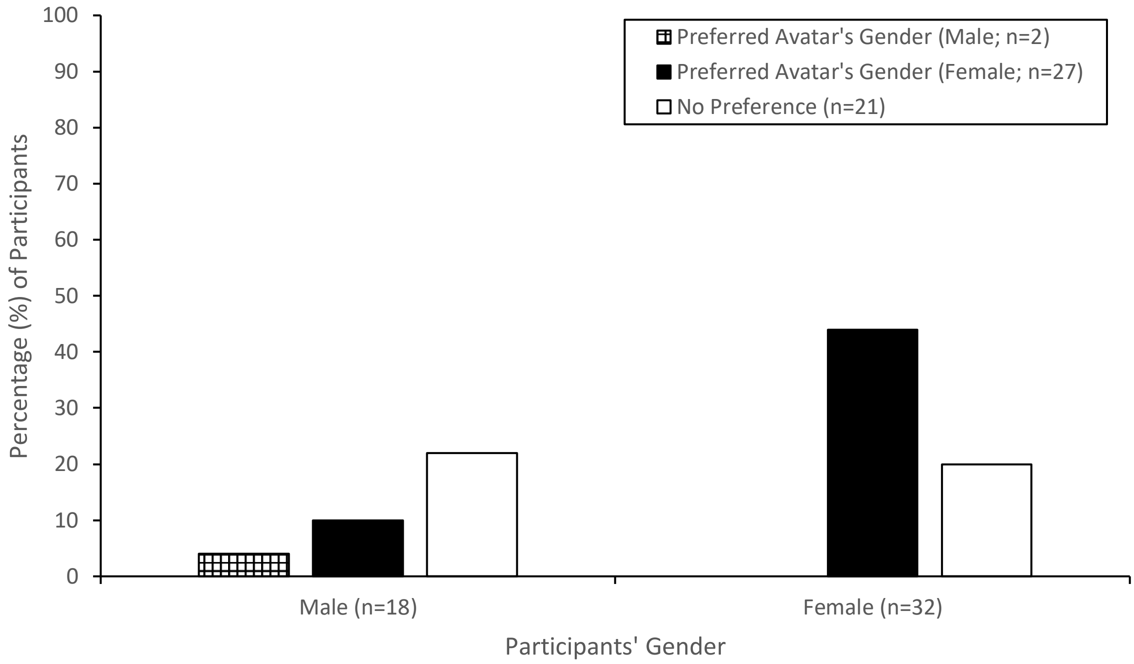

Figure 5.9. Participants' preference for an avatar's depicted gender for discussing embarrassing information as a function of participants' gender.

Ethnicity. As shown in Figure 5.10, the vast majority of the sample had no preference for the avatar's depicted ethnicity.

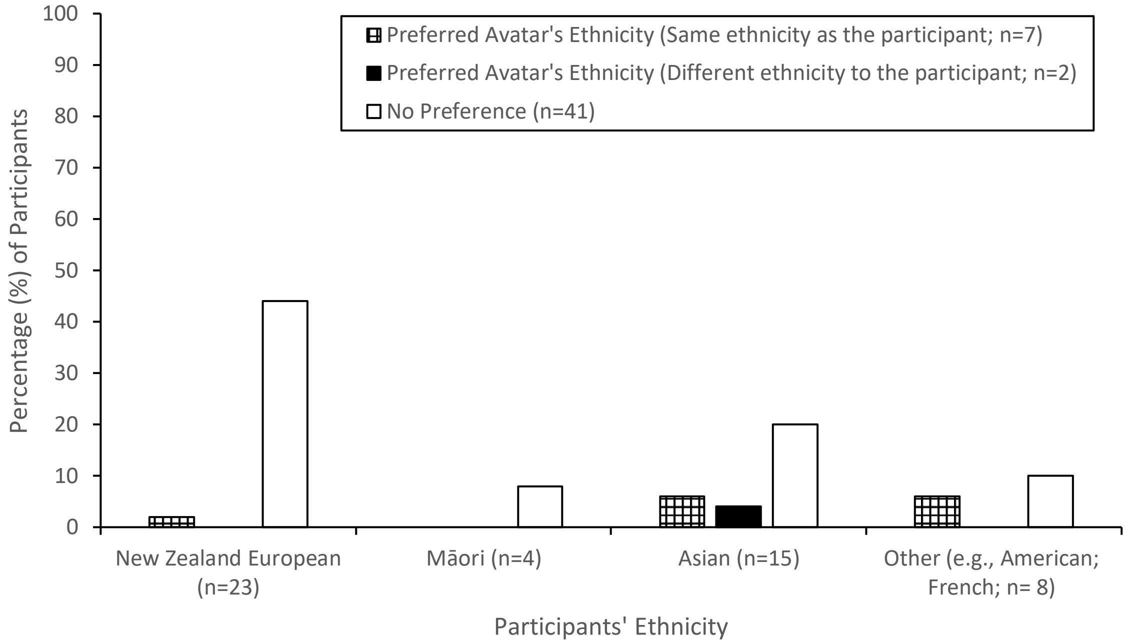

Figure 5.10. Participants' preference for an avatar's depicted ethnicity for discussing embarrassing information as a function of participants' ethnicity.

Discussion

In the present experiment, I examined the impact of an avatar on participants' memory performance and their suggestibility in the misinformation paradigm. Additionally, as in Chapter 4, I explored participants' preference in disclosing embarrassing information to an avatar. Overall, although I observed misinformation effect, the type of interviewer did not affect overall suggestibility. The avatar interviewer, however, buffered participants with low conscientiousness against the negative effects of post-event misinformation. Despite some advantages of an avatar interviewer on protecting some participants against post-event misinformation, more participants showed a higher preference for a human professional for disclosing information.

As discussed in previous chapters, the Theoretical Model of Social Influence can account for many of the memory findings in the present experiment. Recall that, according to the model, people's social experience with an avatar is dependent on the avatar's *realism* and its *agency*—people's perception of whether an avatar is controlled by a computer system or a concealed human (Blascovich, 2002; also see Figure 5.11 below).

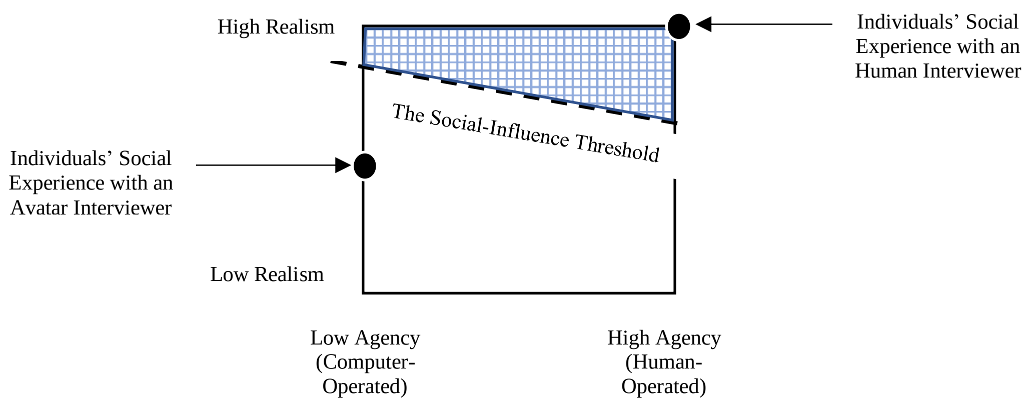

Figure 5.11. A conceptual illustration of the Theoretical Model of Social Influence (adapted from Blascovich, 2002).

During a human-avatar interaction, individuals are more likely to display the same social behaviours with or respond to an avatar that falls above the social-influence threshold as they would with another conversational partner who also falls above the same threshold, which may include a human (Blascovich, 2002; see Figure 5.11, shaded area).

In the present experiment, participants who were interviewed by a 2D cartoon-rendered avatar in either the PEI or memory interview or in both interviews had not reached the social-influence threshold. Therefore, relative to participants who were interviewed by a human interviewer in both interviews, participants who were interviewed by an avatar either the PEI or the memory interview, or both provided free-recall accounts that were qualitatively and quantitatively different (i.e., they were less talkative and reported a fewer number of correct details but with higher accuracy). These findings are inconsistent with the findings in Chapter 3 where I found that participants' memory performance and verbal interaction were comparable when they were interviewed by either the avatar or the human interviewer. One possible explanation for the difference in findings between Chapter 3 and the present experiment is that in Chapter 3, participants were only interviewed once; in the present experiment, participants were interviewed twice. According to the Theoretical Model of Social Influence, the social-influence threshold is not fixed; it changes depending on the situation or task, or on the individuals' awareness or involvement during that task with an avatar (Blascovich, 2002). Furthermore, different thresholds may exist simultaneously during a single interaction with an avatar (Blascovich, 2002). In Chapter 3, a lower social-influence threshold existed because participants were only interviewed once and may have felt less involved during the interview or were less aware of the interview process; in the present experiment, on the other hand, a higher social-influence threshold existed because participants were interviewed twice and therefore, may have felt more involved during the interview or were more aware of the interview process (e.g., Feyereisen, 1994). On this basis, for participants to reach the social-influence threshold when an avatar interviewed them in two interviews, a high realism avatar should conduct the interviews.

In future research, it would be interesting to explore adults' talkativeness and social connection with an avatar across multiple interview sessions. Furthermore, given that the human interviewer provided the voice of the avatar, it is possible that during an interaction with an avatar interviewer, participants may distribute more attention to what they see (visual) rather than what they hear (audio). That is, the level of verbal interaction between an interviewee and an avatar interviewer appears to be dependent primarily on the visual rather than the auditory modality. In Chapter 6, I will examine this possibility by exploring the visual effects of an avatar on adults' verbal interaction and memory performance during a mock interview.

The Theoretical Model of Social Influence could also explain the findings on participants' memory performance during directed recall. During the directed recall, the type of PEI interviewer and memory interviewer did not affect the number of correct or incorrect responses to the specific questions. Particularly, the type of interviewer did not affect the number of errors made in response to questions that involved misleading PEI. The process of encoding false memory is more associated with an automatic rather than a conscious process (Knott, Howe, Toffalini, Shah, & Humphreys, 2018), and thus, the social-influence threshold was low. Therefore, participants were equally susceptible to post-event misinformation when the misinformation was provided by either the avatar or the human interviewer because participants' interaction with the avatar had reached the social-influence threshold. Despite the absence in the effect of the type of interviewer on participants' suggestibility, participants made more errors on questions that involved misleading PEI. This finding is consistent with the literature on the effects of post-event misinformation (e.g., Belli, 1989; Loftus, 2005; Wright & Loftus, 1998; Zhu et al., 2012).

Individual Differences in the Misinformation Effect with Avatars

Autism Traits. Recall that in Chapter 3, I suggested that there might be an age-related difference in participants' perception of a cartoon-rendered avatar. More specifically, children may view avatars as more trustworthy than a human interviewer, and therefore, are more susceptible to false information that an avatar interviewer presents (see Hsu and Teoh, 2017). By comparison, adults may perceive avatars as being less credible than a human interviewer (de Visser et al., 2016; Nowak & Rauh, 2006; Waytz et al., 2014), and therefore are less susceptible to misinformation that an avatar interviewer provides. The results found in Hsu and Teoh and the present experiment provide some support for this explanation. Hsu and Teoh showed that children were more misled by an avatar interviewer relative to a human interviewer; in the present experiment, I found that traits resembling autism spectrum disorder (ASD) did not modify the effect of PEI and Memory interviewer type on the number of correct responses to questions involving misleading PEI. That is, adults were equally susceptible to misinformation when either an avatar or a human interviewed them. On this basis, it is likely that, compared to the children in Hsu and Teoh, adults in the present experiment may view avatars as less trustworthy.

Again, because the experimental procedures were the same between Chapters 3 and 5, another possible explanation for the difference in findings between the present experiment and Hsu and Teoh (2017) could be that my sample was a non-clinical sample of university students whereas Hsu and Teoh's sample had all received a clinical diagnosis of ASD. Recall that Woodbury-Smith et al. (2005) have shown that the cut-off score on the Autism Quotient (AQ) measure does not lead to perfect identification of adults with ASD.

Personality traits. I found that conscientiousness moderated the effect of interviewer type on the number of correct responses to questions involving misleading PEI. That is, compared to when an avatar interviewer was involved during the interviews (either during the provision of PEI or during the memory interview), participants with low conscientiousness who interacted with the human interviewer during both the PEI and memory interviews made more errors in response to questions involving misleading PEI. In Chapter 3, adults with low conscientiousness provided more correct details of an event in response to an avatar interviewer. It is possible that the novelty of an avatar interviewer was more engaging for participants with low conscientiousness during the memory interview, which subsequently increased their attention to any discrepancies between PEI and their recollection of the original event (LaPaglia & Chan, 2019; Liebman et al., 2002).

Perception of the avatar's operation. Participants' perception of the avatar's operation did not impact the number of correct responses to questions involving misleading PEI. Recall that the Theoretical Model of Social Influence is primarily dependent on the interaction between two variables: *realism* and *agency* (Blascovich, 2002). In the present experiment, there may have been a floor effect for the social-influence threshold because the process of incorporating false memory is automatic and people may be less aware of the process (Knott et al., 2018). In terms of human-avatar interaction, tasks that are processed without much awareness, in theory, has a low social-influence threshold. In this case, *agency* has no impact on participants' behaviour with an avatar (Blascovich, 2002). In Chapter 6, I will examine in more detail the interaction effects of an avatar's *agency* and *realism*.

Participants' Willingness to Discuss Information with Avatars

Recall that one of the specific aims of the present experiment was to explore adults' views about disclosing sensitive information to an avatar interviewer. Although participants were more likely to choose the avatar for topics that were considered to be more embarrassing, irrespective of the topic, most participants indicated that they preferred to talk to a human interviewer over an avatar interviewer even after they had some experience with the avatar. These same findings were obtained in Chapter 4 involving online data collection.

Despite the internal consistency between Chapter 4 and 5, they are inconsistent with Pickard et al.’s (2016) findings that participants preferred an avatar over a human interviewer when asked to discuss more sensitive topics. One possible explanation for the difference in the findings between the present experiment and those reported by Pickard et al. involves participants’ perception of the operation of the avatar. Pickard et al., for example, explicitly told participants that the avatar was computer-operated. In the current experiment, on the other hand, participants were not given information about the avatar’s operation; instead, I asked each participant about their perception of the avatar’s operation at the conclusion of their interaction with it. On the basis of these data, I did not detect a difference in interviewer preference as a function of perceived operation; specifically, participants preferred to discuss information with a human rather than an avatar interviewer. In Chapter 6, I explored the effects of providing information to participants about the avatar’s operation.

By and large, the findings in the present experiment potentially rule out differences in having prior experience with both types of interviewers as an explanation for the differences in findings between my experiment and previous studies (e.g., Yokotani et al., 2018). Therefore, there might be other possible explanations for the difference in the findings reported here and in previous studies. First, an avatar’s realism may impact participants’ information disclosure. Bailenson et al. (2006) found that less realistic avatars elicit more disclosure of information than that of a human (see also, Lind et al., 2013); participants in the present experiment were interviewed by a relatively more realistic, digital-human avatar with photorealistic eyes and lips. It could be that participants prefer to disclose to a less realistic avatar.

Second, the difference in the method of measuring disclosure may also influence the obtained responses (e.g., Bowling, 2005). Bailenson et al. (2006) asked participants a series of personal questions and subsequently examined their free-recall accounts based on the level of the disclosure, and the friendliness and honesty of their responses. Examining free-recall accounts may provide for a wider range of answers, which may capture whether there are differences in the quality of information that people would report to an avatar. By comparison, in the present experiment, I asked participants which avatar they would prefer to talk to about a range of topics. This method of measuring disclosure provides useful information about the kinds of things that people would or would not talk about with an avatar, but it does not capture whether there are differences in the quality of information that people would report to an avatar. In Chapter 6, I examined the quality and quantity of participants' reports of an embarrassing personal event when they are interviewed by avatars varying in degrees of realism.

The findings on participants' preference for an avatar's depicted age, gender, and ethnicity were inconsistent with the findings in Chapter 4. Specifically, participants' showed that participants preferred an avatar depicting their age bracket; female participants preferred an avatar depicting a female but male participants showed no preference for an avatar's depicted gender; and participants had no preference for an avatar's depicted ethnicity. One possible explanation could be social desirability bias—a phenomenon that refers to people's tendency to respond to a set of questions that is viewed favorably by others. Participants in the present experiment completed a questionnaire of their preferences in the laboratory and may be influenced by social desirability bias; in Chapter 4, on the other hand, participants completed a questionnaire of their preferences of an avatar on a computer at home so their identity remained anonymous.

Conclusion

A take-home message of the findings from the present experiment is that, despite the close resemblance in appearance and voice of the avatar and the human interviewer, participants appeared unable to familiarise themselves with and respond to the avatar interviewer across the two interview sessions as they would with a human interviewer. However, although adults were less talkative with an avatar interviewer over subsequent sessions, they were more accurate in their accounts of a target event. Furthermore, they did not perform worse in response to post-event misinformation with an avatar interviewer. These findings shed light on the potential value of avatar interviewers. Avatars can be tailored to meet individual needs to optimise their effect. For instance, avatar interviewers may enhance the accuracy of individuals who have less tendency to engage (i.e., individuals with low conscientiousness) or increase the rate of disclosure in sexual assault or sexual harassment cases. The results of the present experiment described in this chapter have raised additional questions for further research, particularly around the effects of an avatar's agency and realism on adults' verbal interaction and memory performance. These effects will be explored in my final empirical chapter—Chapter 6.

Chapter 6

"Hey Siri, help me interview an eyewitness."

The Effects of an Avatar's Anthropomorphism on Adults' Memory Performance

Apple's iPhone is potentially one of the world's most advanced technological devices, yet, the iPhone still adopts a speech-wave design rather than a digital human as the phone's digital assistant. Perhaps, simplicity is Apple's goal, or perhaps, there is more to it. Since the 1970s, there have been a plethora of studies on the effects of avatars' appearance. Mori, Macdorman, and Kageki (2012) coined the term 'uncanny valley effect' to describe the eerie feeling that people may experience when interacting with a humanoid robot that appears 'almost human.' Researchers have also studied this effect using avatars. By and large, similar results from human-robot interactions have also been found with human-avatar interactions (e.g., Feng et al., 2018; MacDorman & Chattopadhyay, 2016). Several factors may impact our response to an avatar, including that avatar's realism and its perceived control (Blascovich, 2002). As avatars become increasingly available in areas of mental health (e.g., Lucas et al., 2014), forensic interviewing (e.g., Hsu & Teoh, 2017; Taylor & Dando, 2018), and education (e.g., Kwok et al., 2016; Macedonia et al., 2014), it is important to study features of an avatar that may enhance individuals' memory performance or information disclosure. In the present experiment, I explored the effects of an avatar interviewer's realism and the information that participants received about that avatar's operation on participants' accounts of a prior event and their disclosure of embarrassing information.

Background of Avatar Characteristics

Empirical evidence has shown that people's interaction with an avatar may be influenced by certain features of an avatar, and the device that is used to display the avatar (see Kang & Watt, 2013). Figure 6.1 provides an illustration of some of the factors that may impact human-avatar interaction. Some of these characteristics are dimensional—for example, an avatar's realism can range from entirely unreal to highly realistic. As shown in Figure 6.1, three factors may be important: an avatar's *agency*, *realism*, and the *environment* in which the avatar is displayed. Given that the primary goal of the present experiment was to examine the effects of an avatar's realism, in particular, anthropomorphism and an avatar's perceived operation on memory, I will only discuss these two characteristics in detail (see Figure 6.1, highlighted boxes).

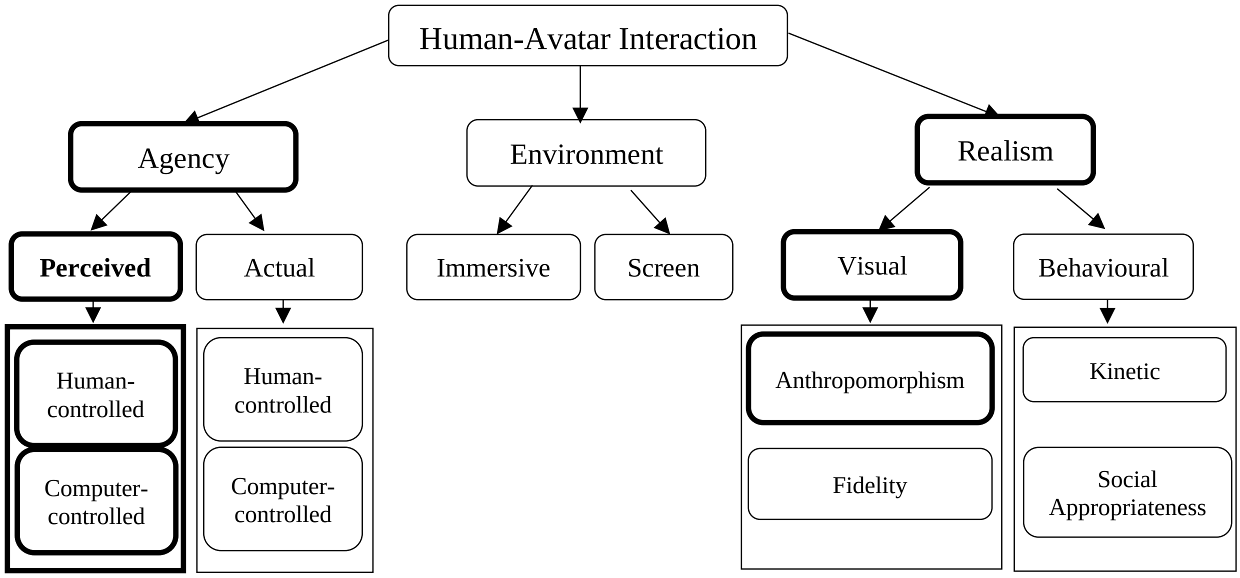

Figure 6.1. A figure illustrating some of the factors that might influence human-avatar interaction (adapted from Kang & Watt, 2013).

Avatar's operation. The operation of an avatar refers to the method of their control (also known *agency*). An avatar can be controlled by either a computer or a human. A computer-operated avatar responds automatically to human input using artificial intelligence algorithms; a human-operated avatar is controlled by a concealed human using the "Wizard-of-Oz" technique—a technique whereby the avatar acts as an intermediary between the participant and a concealed human interviewer (Kelley, 1983). Even when an avatar is operated by artificial intelligence, an individual may still perceive the computer-operated avatar as controlled by a concealed human. This situation is famously known as 'passing the Turing Test'—a test that is designed to measure the performance of automatic systems (Turing, 1950).

Individuals' perceptions of an avatar's operation have been studied extensively. For example, a meta-analysis of studies that informed participants explicitly of the avatar's operation revealed that participants perform poorer on more challenging cognitive tasks when they were told that the avatar is human-operated (see Fox et al., 2015). In studies on the relation between memory and avatars' perceived operation, researchers have found that participants who perceived the avatar interviewer as computer-operated were more accurate in their account of a prior event (for a full description of these studies, see Chapter 3, pp. 97).

Researchers have also shown that participants' threshold for self-disclosure changes when they are informed explicitly of the avatar's *agency*. For instance, Lucas et al. (2014) demonstrated that relative to participants who were told that an avatar was human-operated, participants who were explicitly told that the avatar was computer-operated reported lower levels of fear in disclosing personal information and felt less pressure to impress the avatar. In the present experiment, I investigated the impact of the information that participants received about the avatar's operation on their memory performance and information disclosure.

Avatar's realism. Realism is defined as the degree to which an avatar resembles the object that it was designed to represent. Realism can further be described in terms of visual and behavioural realism. There are two subcategories of visual realism: anthropomorphism and fidelity. Anthropomorphism refers to the extent to which an avatar's appearance resembles that of a human; fidelity simply means the quality of the avatar's image. Thus, an avatar can appear anthropomorphic, but at the same time, the quality of the image may be low (e.g., black-and-white). Similarly, an avatar representing a pony might have low anthropomorphism, but high fidelity if the animation is of high quality.

Studies on the effects of avatars' anthropomorphism on memory performance have primarily revolved around semantic (knowledge) memory rather than episodic (event) memory, and the results have been somewhat mixed. On the one hand, some researchers have shown that avatars that use gestures and have facial expressions are more effective teaching agents with adult students (Baylor & Kim, 2009; see also, Clark & Choi, 2005 and Johnson & Lester, 2016, for reviews). On the other hand, other researchers have shown that adults recall more acquired knowledge during testing when a low-anthropomorphic avatar presents the questions rather than a high-anthropomorphic avatar (Ahmadi, Sahragard, & Shalmani, 2017) and yet other researchers have found that avatars' anthropomorphism does not affect adults' memory performance at all (e.g., see Azevedo et al., 2018, for a study on recall in older adults; Choi & Clark, 2006; Hongpaisanwiwat & Lewis, 2003; Moreno, Mayer, Spires, & Lester, 2001; Sträfling, Fleischer, Polzer, Leutner, & Krämer, 2010). On the basis of these studies on semantic memory, the most critical factor appears to be the purpose of the avatar. That is, adult students only demonstrated enhanced recall of semantic knowledge when a non-anthropomorphic avatar was used as a *testing aid* rather than a *teaching aid.*

In a limited number of studies, researchers have also explored the effects of avatars' anthropomorphism on adults' reports of personal information. For example, Bailenson et al. (2006) found that relative to an avatar with high visual realism, participants' reports were of higher quality and quantity when a visually less-realistic avatar interviewed them. An important question to ask is, do adults show similar enhanced performance in episodic memory and in their reports of embarrassing personal events when a non-anthropomorphic avatar is used as a memory interviewer? In the present experiment, I examined the influence of an avatar's anthropomorphism on adults' memory of a prior event and on their disclosure of an embarrassing event.

Avatar's Operation X Realism Interaction

According to the Theoretical Model of Social Influence, an avatar's *realism* (or anthropomorphism) and its *agency* do not exist in isolation (Blascovich, 2002). Instead, these two features of an avatar interact with each other to elicit different responses from individuals during their interaction with an avatar (see Figure 6.2). For example, individuals may respond differently to a more anthropomorphic avatar that is perceived as human-operated compared to a less anthropomorphic avatar that is perceived as computer-operated. In theory, a human is considered the ceiling of the interaction between the two features—*agency* and *realism*—of the Theoretical Model of Social Influence.

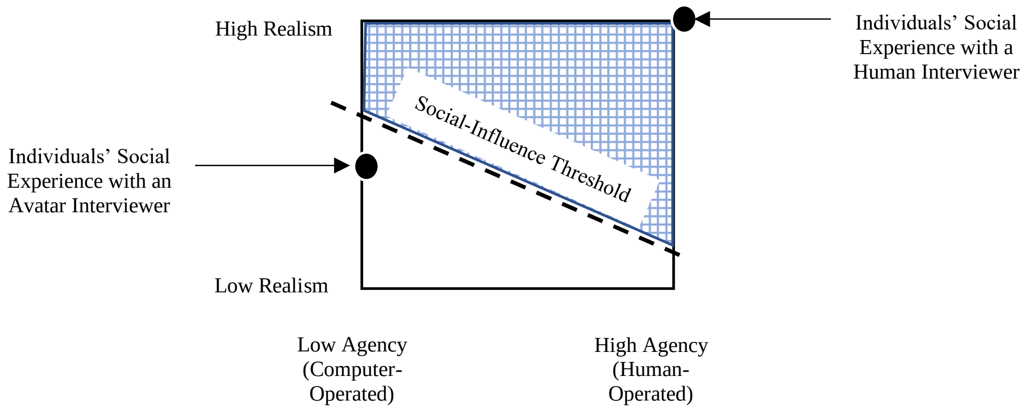

Figure 6.2. A conceptual illustration of the Theoretical Model of Social Influence (adapted from Blascovich, 2002).

As shown in Figure 6.2 (shaded area), during a human-avatar interaction, individuals are more likely to display the same social behaviours with or respond to an avatar that falls above the social-influence threshold as they would with another conversational partner that also falls above the same threshold (Blascovich, 2002). The social-influence threshold is not fixed; it changes depending on the situation or task, or the individuals' awareness or involvement during that task with an avatar (Blascovich, 2002). Simply put, when people are less in control of *their minds,* they are more likely to respond to a less visually-realistic avatar as they would with another person. Additionally, different thresholds may exist simultaneously during a single interaction with an avatar (Blascovich, 2002). For example, free recall requires a conscious recollection of an event, whereas recognition is a more automatic process (see Quamme, Yonelinas, Widaman, Kroll, & Sauvé, 2004; Yonelinas, 2002). Thus, a different social-influence threshold may exist for recall and recognition of details of a prior event. In several studies, researchers have gathered empirical support for the Theoretical Model of Social Influence in describing human-avatar interaction (see Blascovich, 2002). There is also evidence to support this model in the context of a mock forensic interview (see Chapter 3 and 5).

The Present Experiment

The overarching goal of the present experiment was to answer whether avatars' anthropomorphism and perceived operation influence adults' memory performance and their information disclosure. In addition, as in the previous thesis chapters, I wanted to determine whether participants' level of autistic and personality traits would influence the relation between the type of interviewer and participants' memory performance. There is some evidence to suggest that individuals on the autism spectrum may show similar responses to an avatar that resembles human- or non-human features (see Atherton & Cross, 2018, for a review). Additionally, researchers have also shown that personality traits, such as extraversion, have no impact on participants' recall of semantic memory when they acquired information from avatar interviewers with different levels of anthropomorphism (Hongpaisanwiwat & Lewis, 2003).

In the present experiment, participants watched a 5-min video. They were subsequently interviewed about the details of the video either by a faceless (speech-wave) avatar interviewer or a digital-human avatar interviewer presented on a 2D computer screen. In each interviewer condition, participants were either told that the interviewer was computer-operated or human-operated. I hypothesised that, overall, participants would show better memory performance during free recall, but not directed recall, with the less anthropomorphic (speech-wave) interviewer compared to the more anthropomorphic (digital-human) interviewer. This hypothesis is consistent with the Theoretical Model of Social Influence. Participants who interact with a less realistic, speech-wave interviewer during free recall would fall below the social-influence threshold; participants who interact with that same avatar during directed recall would reach the social-influence threshold. Furthermore, I hypothesised an interaction effect between *anthropomorphism* and *agency*. Specifically, for the speech-wave interviewer, the information that participants received on the avatar's operation would not influence participants' memory performance because participants may fall short of the social-influence threshold. On the other hand, only participants who were told that the digital-human interviewer is human-operated would surpass the social-influence threshold. This hypothesis is consistent with the findings in Chapter 3 in that participants who perceived the same digital-human avatar as in the present experiment reached the social-influenced threshold only when participants perceived that avatar as human-operated. As a result, participants in Chapter 3 reported less accurate details about the target video than did the participants who believed that the avatar was computer-operated.

Finally, recall that several possible explanations were put forward in Chapter 5 in an attempt to explain the contradictory findings between previous studies and Chapter 5; specifically, the avatar's realism; the information provided to the participants on the avatar's operation; and the method of measuring disclosure. First, I examined whether participants preferred talking to a less realistic, speech-wave avatar over a relatively more realistic, digital-human avatar on the same list of 41 topics as I presented to participants in Chapter 5. In previous studies, researchers have outlined the effects of avatars' realism on adults' reports of personal information (see Bailenson et al., 2006; Lind et al., 2013).

Second, I investigated the effects of the information provided to participants on the avatar's method of operation. By being explicitly told of the avatar's operation, participants may have a stronger belief of that avatar's method of operation. Researchers have shown that participants' self-disclosure changes when they are informed explicitly of the avatar's operation (Lucas et al., 2014).

Third, I examined whether the type of avatar interviewer had an impact on participants' memory reports of an embarrassing personal event. Although asking participants which avatar they would prefer to talk to about a range of topics, as I did in Chapter 5, provides useful information about the kinds of things that people would or would not talk about with an avatar, it does not capture whether there are differences in the quality of information that people would report to an avatar. In the present experiment, I examined the quantity of information reported as well as the narrative coherence of participants' reports about a personal event. Both factors play a role in the quality of people's narrative accounts of prior events; accounts rich in detail could be fragmented, or, conversely, a coherent account could be sparse in detail (Reese et al., 2011).

Method

Participants

The final sample consisted of 111 adults (85 females; M_{age} = 22.40 years; *SD* = 5.83; range 18–60) recruited through a university participant database. We based our sample size on other published literature in the field (Sutherland & Hayne, 2001). All participants provided written informed consent and were reimbursed $20 for their participation. The research was reviewed and approved by the University of Otago's Human Ethics Committee, which is accredited by the New Zealand Health Research Council and whose guidelines are consistent with those of the American Psychological Association.

Video Stimulus

I used the same target video as I used in Chapters 3 and 5.

Avatar Realism Conditions

The digital-human interviewer. In the present experiment, the digital-human avatar interviewer was presented on a 21.5" computer monitor and could display the same nonverbal gestures as the avatar in Chapter 3 (see Figure 6.3). The digital-human avatar was controlled using the "Wizard-of-Oz" technique (Kelley, 1983).

The speech-wave interviewer. The speech-wave avatar interviewer was also presented on the same 21.5" computer monitor and its appearance resembled that of Apple's Siri (see Figure 6.3, right). The speech-wave was also controlled using the "Wizard-of-Oz" technique by a concealed human interviewer (Kelley, 1983). When the concealed human interviewer spoke, the speech wave moved up and down in synchrony with the human's voice.

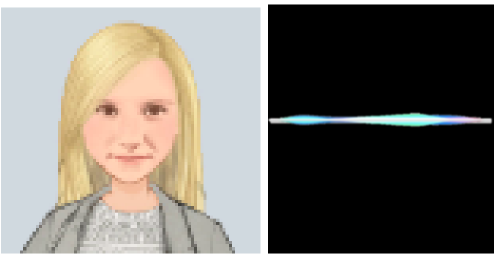

Figure 6.3. The digital-human interviewer (left); the speech-wave interviewer (right).

Trait Measures

As in Chapters 3 and 5, I used the Autism-Quotient (AQ) questionnaire (Baron-Cohen et al., 2001) to measure traits resembling ASD and the NEO-Five-Factor Inventory-3 (NEO-FFI-3; Costa & McCrae, 1992) to measure the five general domains of personality: *neuroticism, extraversion, openness, agreeableness,* and *conscientiousness.* Internal consistency (Cronbach's α[5]) of the AQ in the current experiment was .78. Internal consistency (Cronbach's α) of the NEO-FFI-3 in the current experiment was .84 for Neuroticism; .85 for Extraversion; .77 for Openness; .81 for Agreeableness; and .85 for Conscientiousness.

Procedure

Memory Interview

Session 1. At the beginning of the first session, participants were informed that the purpose of the experiment was to evaluate the suitability of a video for children. Each participant watched the video on their own. Immediately after watching the video, participants completed an online questionnaire to collect demographic information (gender, ethnicity, age, level of education), personality traits using the NEO-FFI-3, and the level of traits resembling ASD using the AQ.

After participants completed the questionnaires, they were asked to return to the

[5] The conventional benchmark for adequate reliability is .70

laboratory six weeks later.

Session 2. Six weeks after watching the video, participants returned to the laboratory and were told that the real purpose of the experiment was to assess their memory for the video. Participants were seated in front of a 21.5” computer monitor that displayed the avatar interviewer. Participants were randomly assigned to one of two Realism conditions: the Digital-human condition (n = 55) or the Speech-wave condition (n = 54). Half of the participants in each Realism condition were randomly assigned to the Human-operation condition and the remaining half to the Computer-operation condition. For participants in the Human-operation condition, the experimenter introduced the interviewer by saying, “*This is Ana, a computer animation that works like a puppet. It allows a person in another room to have a conversation with you. My colleague will be sitting in the other room and will be able to see and hear you on this screen. She has access to a set of pre-recorded questions and responses that will be used to have a conversation with you about the video. You can start the conversation by saying, Hello*” (adapted from Lucas et al., 2014). For participants in the Computer-operation condition, the experimenter introduced the interviewer by saying, “*This is Ana, a computer animation that uses artificial intelligence to have a conversation with you about the video. The system gets audio and visual input from you. It uses a speech recognition tool to understand what you’re saying, then uses a complex series of equations to choose the best way to respond. You can start the conversation by saying, Hello* ” (adapted from Lucas et al., 2014). The experimenter then left the interview room.

The memory interview was conducted in two phases. During the free-recall phase, the interviewer asked the participant to report everything that he or she could remember from the video by saying, “*Tell me everything that you can remember about what happened in the video, from the beginning to the end*.” The interviewers were restricted to verbal feedback only. The only additional prompt given during the free-recall phase was, “*Is there anything* *else you can remember that you haven't already told me?"*

Once the participant indicated that he or she had no more information to report, the interviewer began the directed-recall phase of the interview. The interviewer asked participants six directed questions regarding specific aspects of the video (e.g., What colour was Sally's monkey?).

Interview about an Embarrassing Personal Event

Immediately following the memory interview, the interviewer asked the participant to report about a time when he or she felt embarrassed, The interviewer said,, "*Now I want you to think about something that has happened to you that you feel embarrassed about. Tell me everything that you can remember about what happened at that time, from the beginning to the end. Include details like what happened, where and when, who was involved, and what you felt and thought at that time.*" The only additional prompt given during the interview was, "*Is there anything else you can remember that you haven't already told me?"*

Post-Interview Questionnaires

Immediately after the interview, participants in both Interviewer conditions completed an 11-item feedback questionnaire that was similar to the feedback questionnaire used in Chapter 3. The questionnaire was designed to evaluate their thoughts on the interviewer (e.g., How distracting was the interviewer?; How engaged were you when talking to the interviewer?). Participants responded to each item on a 7-point rating scale (1 = the most negative experience; e.g., *very distracting*; *not-at-all engaging* and 7 = the most positive experience; e.g., *not-at-all distracting, very engaging*).

Participants were then presented with the same 41 topics displayed on a computer screen that were used in Chapter 4 and 5. The basic procedure for the present chapter was the same as that of Chapter 4. Participants were then thanked and debriefed.

Coding and Reliability

The interviews were all audio-recorded and transcribed verbatim.

Free-recall phase. I used the same coding method as I used in Chapter 3 and 5 to code participants' free-recall accounts of the video (see Appendix B). As before, the number of words that participants said during free recall, regardless of the content, were recorded as total word count and was used as a measure of verbal interaction. To code the amount of correct information reported, participants received one point for each item of information correctly reported. The same procedures were used to code errors. One observer coded all of the free-recall accounts, and a second observer coded 25% of them. Neither observer was aware of participants' group assignment. A Pearson's product-moment correlation yielded an inter-observer reliability coefficient of $r = .98$, $p < .001$ for the total amount of information reported. Any discrepancies between the two observers were subsequently discussed and resolved.

Directed-recall phase. One observer coded all of the participants' responses during the directed-recall phase, and a second observer coded 25% of them. There was no discrepancy in the coding of the answers to the six directed questions. Participants received one point for each correct response to the six specific questions regarding specific aspects of the video.

Embarrassing personal event. I coded participants' reports of their embarrassing personal event according to the quantity of information reported (overall number of words) and the report's narrative coherence, To code coherence, I used the Narrative Coherence Coding Scheme (NaCCs; Baker-Ward et al., 2007; Reese et al., 2011). The coding scheme is outlined in more detail below.

One observer coded the narrative coherence for all of the embarrassing events and a second observer coded 25% of them. Neither observer was aware of the participants' group assignments. The reliability of the coding across the two coders for each narrative coherence dimension was assessed using separate intraclass correlation coefficients[6] (ICC) with absolute agreement. Any discrepancies between the two observers were subsequently discussed and resolved.

The NaCCs is a multidimensional model of personal narrative coherence based on three theoretically-independent dimensions of coherence: Context, Chronology, and Theme (Baker-Ward et al., 2007; Reese et al., 2011). Each dimension is given a rating on a 4-point scale (from level 0 to level 3):Context refers to the contextual details in the narrative with respect to the location and the autobiographical time of the event (0 = *the narrative includes no details of either time or place*; 1 = the *narrative includes details of either time or place*; 2 = the *narrative includes details of both time and place, but only one of these dimensions includes specific details*; 3 = the *narrative includes specific details of both time and place*). Reliability (ICC) for Contextual details of participants' reports was .83

Chronology refers to the degree to which a naïve listener is able to place the narrative on a timeline (0 = *the narrative includes no details that can be placed on a timeline*; 1 = the *narrative includes less than 50% of details that can be placed on a timeline*; 2 = the *narrative includes 50–75% of details that can be placed on a timeline*; 3 = the *narrative includes greater than 75% of details that can be placed on a timeline*. Reliability (ICC) for the Chronology of participants' reports was .92.

Theme refers to the extent to which the narrative is on topic and develops into a specific storyline (0 = *the narrative lacks the focus of a specific topic*; 1 = *the narrative includes a topic but the overall theme is unclear*; 2 = *the narrative includes a topic and the overall theme is clear*; 3 = *the narrative includes a topic and the overall theme is clear, with a resolution to bring meaning to the narrative.* Reliability (ICC) for the Theme of

[6] The conventional benchmark for adequate ICC is .75

participants' reports was .82.

Analytic Strategy and Data Analysis

I used the same data analytical approach as I used in Chapters 3 and 5 by conducting moderation analyses and an ANCOVA to examine the influence of individual differences in personality and ASD traits on the effect of interviewer type on participants' verbal interaction and memory performance.

Results

Preliminary Analysis

In the first part of the analysis, I established whether there were any differences in participants' scores on the Autism Quotient (AQ) or on the NEO-Five-Factor Inventory-3 (NEO-FFI-3) personality measure as a function of experimental conditions (see Table 6.1). Participants' AQ scores and NEO-FFI-3 scores were submitted to a separate 2 (Realism: Digital-human, Speech-wave) x 2 (Operation: Computer, Human) ANOVAs. As shown in Table 6.1, there were no significant differences between participants' AQ scores or NEO-FFI-3 scores as a function of Realism or Operation condition, and no interactions.

Table 6.1

Scores on the Autism and Personality Measures (Means and Standard Deviations) as a Function of PEI the avatar Interviewer's Visual Realism and Operation

	Digital-Human Avatar		Speech-Wave Avatar	
	Computer-Operated	Human-Operated	Computer-Operated	Human-Operated
AQ	17.37 (7.50)	16.07 (4.81)	16.00 (6.01)	17.78 (7.02)
NEO-FFI-3				
Neuroticism	3.52 (.75)	3.57 (.92)	3.74 (1.02)	3.15 (1.13)
Extraversion	2.22 (1.12)	2.61 (1.13)	3.22 (1.05)	3.33 (.92)
Openness	3.63 (.97)	3.64 (1.09)	3.67 (1.00)	3.56 (.89)
Agreeableness	3.96 (1.16)	3.39 (1.03)	3.52 (.98)	3.37 (.93)
Conscientiousness	2.56 (.89)	3.11 (.88)	2.82 (1.04)	3.00 (1.18)

I also carried out an exploratory analysis of the dependent variables (amount of correct information, word count, accuracy) to identify any outlier data points. The analysis showed outlier data points (i.e., 1.5 times the interquartile range from the upper or lower quartile) and extreme outliers (i.e., three times the interquartile range from the upper or lower quartile interquartile range) for word count and accuracy. These extreme outlier data were excluded in subsequent analyses of word count and accuracy; the other outliers were included in the analysis because a careful inspection of the 5% Trimmed Mean showed that these scores did not have a strong influence on the mean.

Memory Interview

Free-recall phase. First, I examined group differences in verbal interaction and memory performance during the free-recall of the interview were examined as a function of Realism condition (digital-human, speech-wave) and Operation condition (human-operated, computer-operated).

Verbal interaction. Figure 6.4 shows the level of verbal interaction during free recall was measured using participants' overall word count. The data in Figure 6.4 were submitted to a 2 (Realism) X 2 (Operation) ANOVA. As shown in Figure 6.4, there was a main effect of the avatar interviewer's visual realism; participants who were interviewed by the speech-wave avatar exhibited a higher word count (*M* = 241.57 words, *SD* = 89.16) than did participants who were interviewed by the digital-human avatar (*M* = 201.59 words, *SD* = 75.25), *F*(1, 101) = 6.35, *p* = .01, η_p^2 = .06. There was no difference in word count as a function of Operation condition, *F*(1, 101) = 1.23, *p* = .27, η_p^2 = .01, and no interaction, *F*(1, 101) = .46, *p* = .50, η_p^2 = .005.

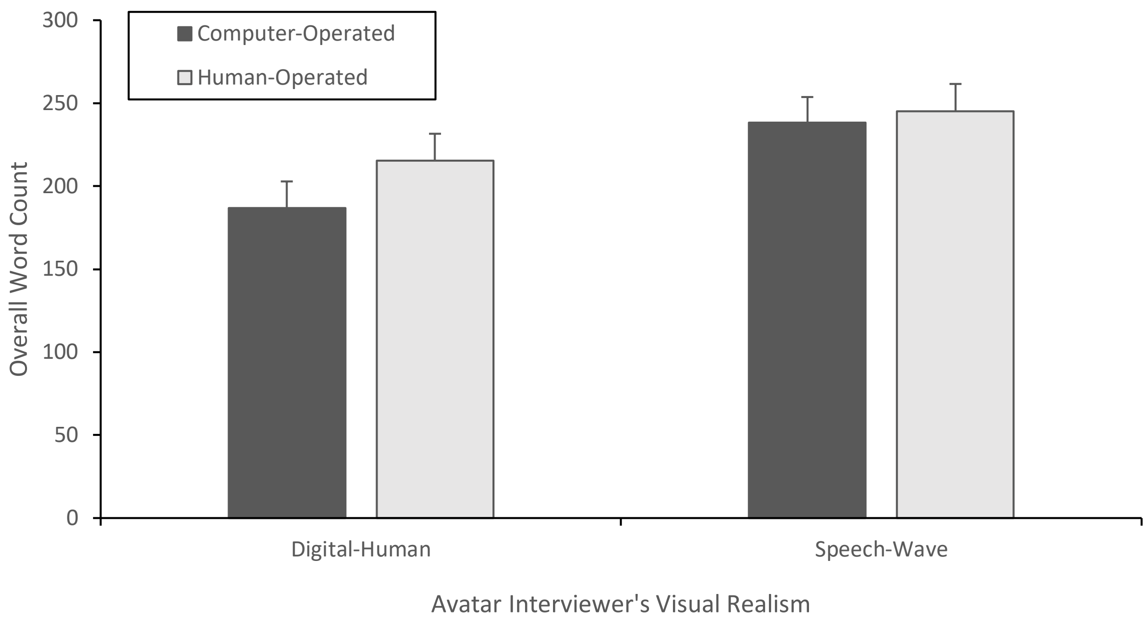

Figure 6.4. Participants' overall word count (+1SE) during free recall as a function of the Avatar interviewer's Realism and Operation conditions.

Memory performance. I measured memory performance during free recall was measured using the amount of correct information (see Figure 6.5) and the overall accuracy (see Figure 6.6). The data in Figure 6.5 were submitted to a 2 (Realism) X 2 (Operation) ANOVA. As shown in Figure 6.5, there was a main effect of the avatar interviewer's visual realism; participants who were interviewed by the speech-wave avatar reported more correct details during free recall (*M* =26.16, *SD* = 10.68) than did participants who were interviewed by the Digital-human (*M* = 22.50, *SD* = 8.16), *F*(1, 107) = 4.09, *p* = .046, η_p^2 = .04. There was no difference in the amount of correct information as a function of Operation condition, *F*(1, 107) = .24, *p* = .63, η_p^2 = .002, and no interaction, *F*(1, 107) = .09, *p* = .77, η_p^2 = .001.

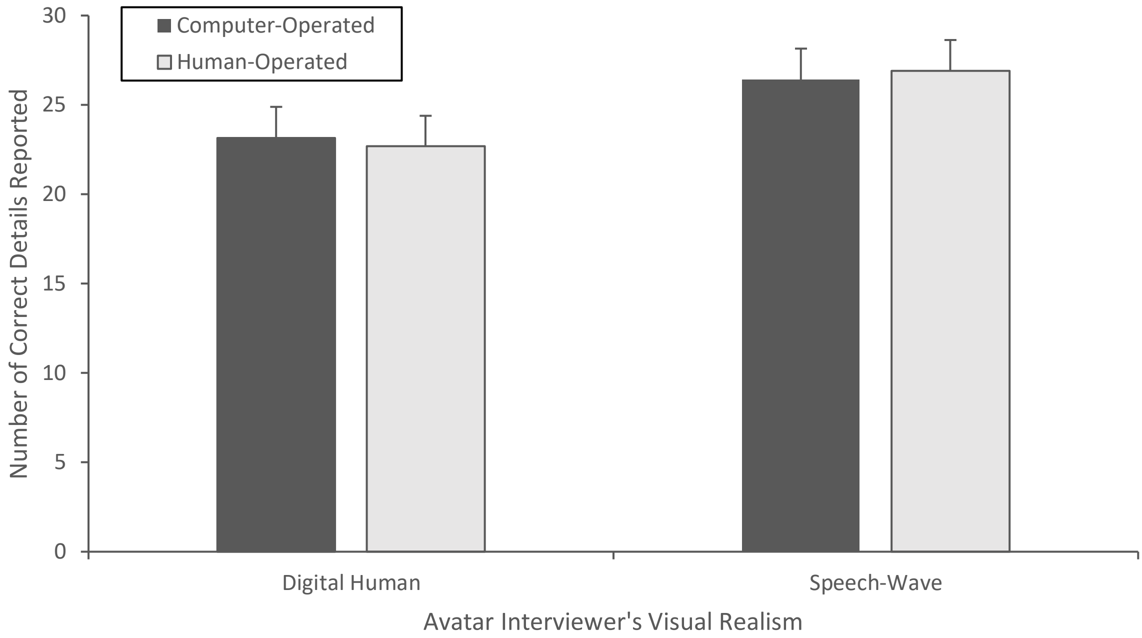

Figure 6.5. The amount of correct information (+1SE) reported by participants during free recall as a function of the Avatar interviewer's Realism and Operation conditions.

To obtain an accuracy score for each participant, the total amount of correct information reported during free recall was divided by the total amount of information reported (i.e., correct information + incorrect information). The data shown in Figure 6.6 were submitted to a 2 (Realism) X 2 (Operation) ANOVA. As shown in Figure 6.6, a there was no difference in accuracy as a function of Realism condition, $F(1, 105) = .09$, $p = .76$, $\eta_p^2 = .001$, or Operation condition, $F(1, 105) = .16$, $p = .69$, $\eta_p^2 = .002$, and no interaction, $F(1, 105) = 1.46$, $p = .23$, $\eta_p^2 = .01$.

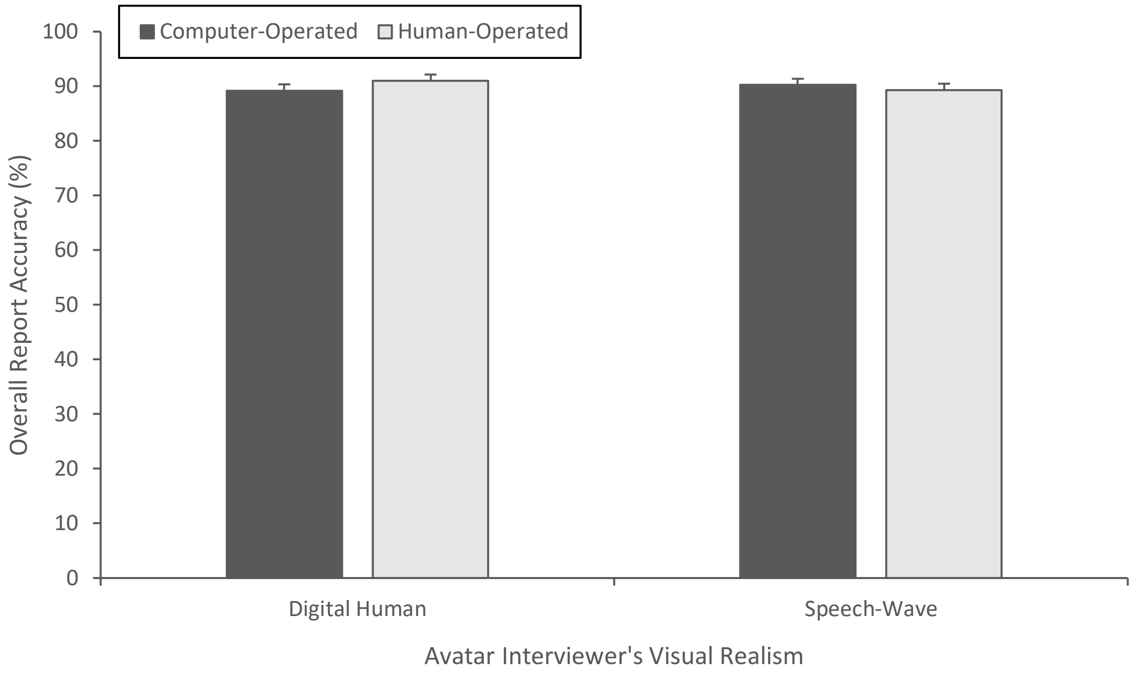

Figure 6.6. The overall accuracy (%) of information (+1SE) reported by participants during free recall as a function of the Avatar interviewer's Realism and Operation conditions.

Directed-Recall Phase. Next, I examined participants' memory performance during directed recall. Figure 6.7 shows the average number of correct responses to the six directed questions as a function of the Avatar interviewer's Realism and Operation conditions. The data in Figure 6.7 were submitted to a 2 (Realism) X 2 (Operation) ANOVA. As shown in Figure 6.7, there was no difference in the number of correct responses to the six directed questions as a function of Realism condition, $F(1, 107) = .24$, $p = .62$, $\eta_p^2 = .002$, or Operation condition, $F(1, 107) = 1.10$, $p = .30$, $\eta_p^2 = .01$, and no interaction, $F(1, 107) = .12$, $p = .74$, $\eta_p^2 = .001$.

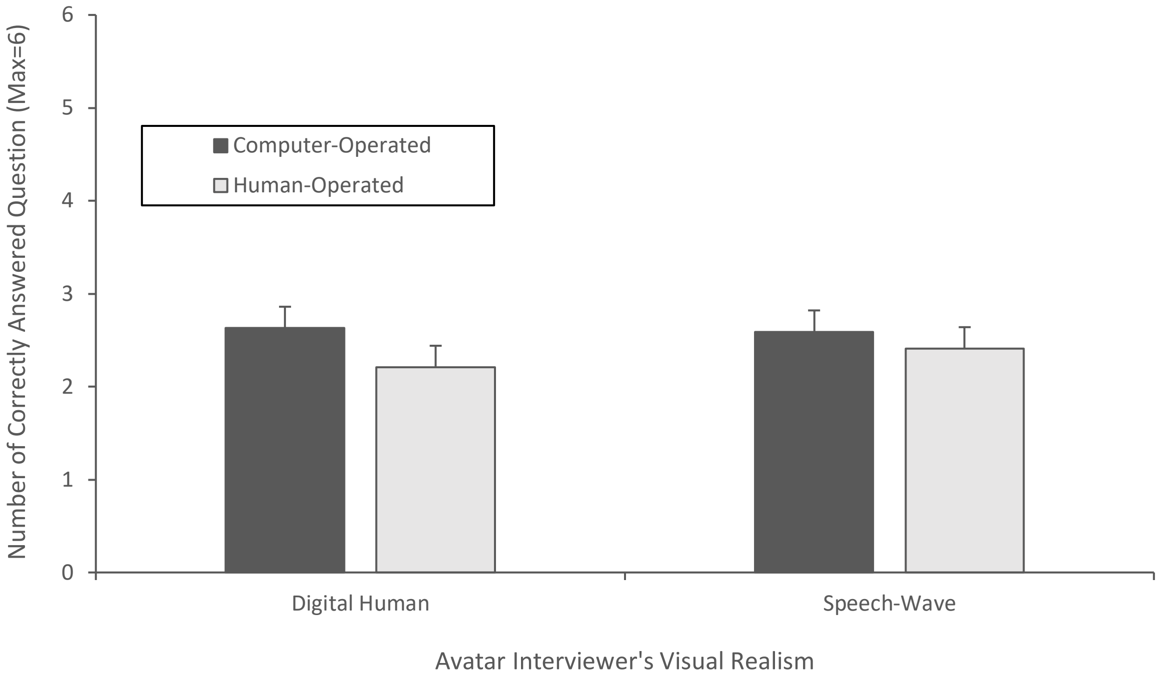

Figure 6.7. The number of questions (+1SE) answered correctly by participants during directed-recall as a function of the Avatar interviewer's Realism and Operation conditions.

In sum, relative to participants who were interviewed by a digital-human, participants who were interviewed by the speech-wave avatar were more talkative and provided more correct details of the target event during free recall without compromising accuracy. There were no differences in participants' memory performance across the two avatar interviewers in response to directed questions.

Individual Differences in Eyewitness Accounts

Autism traits. To examine whether participants' ASD traits (moderator variable) changed the effect of interviewer type on participants' memory performance, I first assigned participants to one of two groups based on their AQ scores. Specifically, I grouped participants to the High AQ group (n = 9) if they scored higher than the cut-off score of 26 on the AQ and to the Low AQ group (n = 102) if they scored 26 or less on the AQ (Woodbury-Smith et al., 2005).

I then conducted a series of moderation analyses using the PROCESS macro for SPSS (Hayes, 2013), with Interviewer type (categorical variable: *digital-human avatar* vs *speech-wave avatar*) as the independent variable; participants' memory performance (*word count, amount of correct information reported, accuracy, number of correct responses to directed questions*) as the dependent variable; participants' level of ASD traits (*low AQ, high AQ*) as the moderator variable[7]. The moderation analyses revealed that ASD traits did not influence the effect of the type of interviewer on participants' memory performance (word count: R^2= .07, $F(1, 107) = .21$, $p = .65$; amount of correct information reported: R^2= .04, $F(1, 107) = .03$, $p = .87$; accuracy: R^2= .01, $F(1, 107) = .06$, $p = .80$; number of correct responses to directed questions: R^2= .01, $F(1, 107) = .29$, $p = .59$). A 2 (Realism) x 2 (Operation) ANCOVA controlling for ASD traits also produced no significant effects.

Personality traits. To examine whether participants' personality traits (moderator variable) changed the effect of interviewer type on participants' memory performance, again, I assigned participants to one of three groups based on their ranking on each of the NEO-FFI-3 personality traits. Specifically, I assigned participants to the *Low* group (*neuroticism:* n = 17, *extraversion*: n = 25, *openness*: n = 15, *agreeableness*: n = 21, and *conscientiousness*: n = 46) if their ranking on the NEO measure was "Extremely Low" or "Low;" to the *Average* group (*neuroticism:* n = 36, *extraversion*: n = 38, *openness*: n = 33, *agreeableness*: n = 44, and *conscientiousness*: n = 30) if their ranking on the NEO measure was "Average;" and to the *High* group (*neuroticism:* n = 58, *extraversion*: n = 48, *openness*: n = 63, *agreeableness*: n = 46, and *conscientiousness*: n = 35) if their ranking on the NEO measure was "High" or "Extremely High."

[7] The unequal number of participants in each AQ group may reduce the power to detect ASD traits as a moderator (see Aguinis, 1995, for a review).

Again, by using the PROCESS macro for SPSS (Hayes, 2013), I conducted a series of moderation analyses for each of the five personality traits (*neuroticism, extraversion, openness, agreeableness,* and *conscientiousness*) as the moderator variable, with Interviewer type as the independent variable; participants' memory performance as the dependent variable. The moderation analyses revealed that the five personality traits did not change the effect of Avatar interviewer's realism on participants' memory performance.

Post-Interview Questionnaires

Feedback on the interviewer. Table 6.2 shows participants' ratings on each of the 11 feedback questions. The data shown in Table 6.2 were submitted to separate Independent-samples t-tests as a function of Realism condition. As shown in Table 6.2, participants who were interviewed by the speech-wave avatar indicated that they were more willing to share secrets and felt that more nature with a speech-wave avatar than did participants who were interviewed by the digital-human avatar. On all other measures, there was no difference in participants' feedback as a function of Realism condition.

Table 6.2

Participants' Ratings (Mean and Standard Deviations) on the Feedback Questions (Max Score = 7) as a Function of Realism Condition

	Digital-Human	Speech-Wave	*t*-value
Comfortableness of interaction	4.30 (1.59)	4.49 (1.49)	.64
Distraction of interviewer	5.14 (1.57)	5.40 (1.70)	.83
Ease of interaction	4.77 (1.73)	4.78 (1.73)	.04
Engagement with interviewer	4.32 (1.54)	4.67 (1.50)	1.22
Willingness to share the deepest secrets	**2.52 (1.43)**	**3.15 (1.67)**	**2.13***
Stress of interaction	4.63 (1.57)	4.46 (1.64)	.56
Understandability of interviewer	5.59 (1.30)	5.64 (1.20)	.61
Frustration towards the interviewer	3.84 (1.46)	3.84 (1.67)	.16
Perceived pressure of interaction	3.44 (1.93)	4.13 (1.82)	.01
Desire to please the interviewer	3.77 (1.50)	3.89 (1.34)	.46
Level of naturalness of the interaction	**1.84 (.68)**	**2.18 (.77)**	**2.48***

Note. Significant differences are shown in bold; *$p < .05$.

Avatar and Information Disclosure

Disclosure of personal event. The disclosure of an embarrassing personal event was measured using participants' overall word count during the disclosure phase of the interview (see Figure 6.8), and the narrative coherence of their narrative of the embarrassing event (see Figure 6.9). To examine the overall word count, the data in Figure 6.8 were submitted to a 2 (Realism) X 2 (Operation) ANOVA. As shown in Figure 6.8, there was a main effect of the avatar interviewer's visual realism; participants who were interviewed by the Speech-wave exhibited a higher word count (*M* = 110.04 words, *SD* = 77.61) than did participants who were interviewed by the Digital-human (*M* = 81.70 words, *SD* = 49.65), $F(1, 107) = 5.20$, *p*

= .03, η_p^2 = .05. There was no difference in word count as a function of Operation condition, *F*(1, 107) = .26, *p* = .61, η_p^2 = .002, and no interaction, *F*(1, 107) = .44, *p* = .51, η_p^2 = .004.

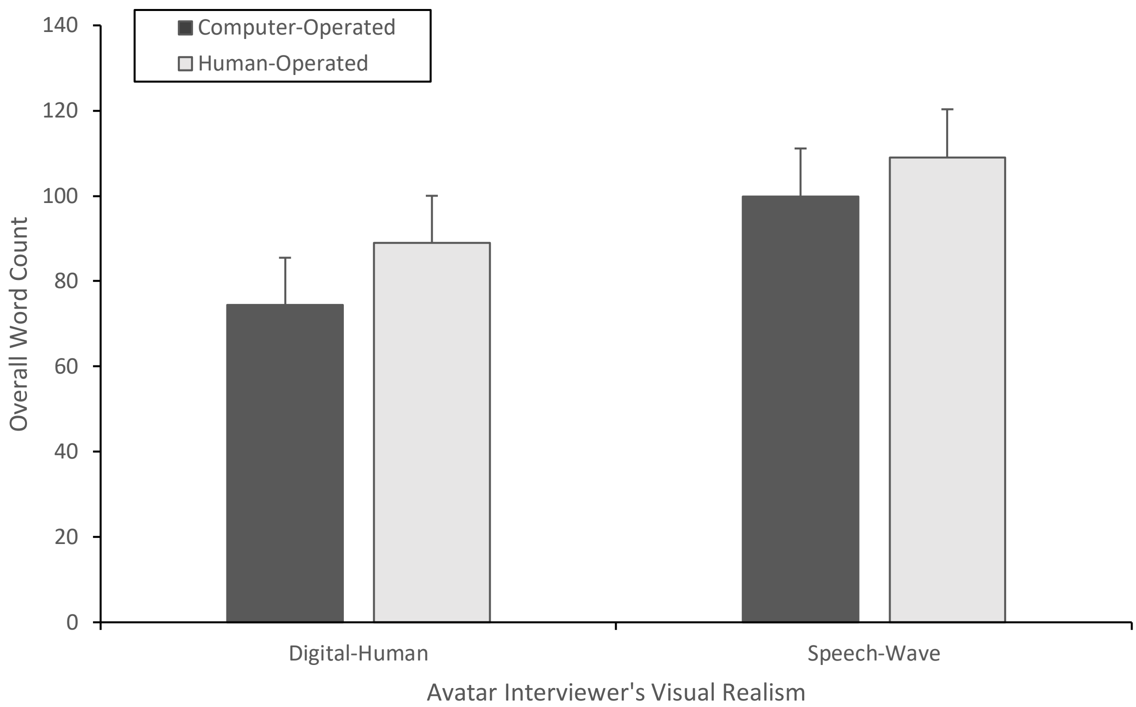

Figure 6.8. Participants' overall word count (+1SE) during disclosure of an embarrassing personal event as a function of the Avatar interviewer's Realism and Operation conditions.

To examine the narrative coherence of the personal embarrassing event, the data in Figure 6.9 were submitted to a series of 2 (Realism) X 2 (Operation) ANOVAs. As shown in Figure 6.9, there was a main effect of the avatar interviewer's visual realism for the Context dimension; participants who were interviewed by the Speech-wave showed higher ratings with respect to time and place (*M* = 1.36, *SD* = .95) than did participants who were interviewed by the Digital-human (*M* = 1.04, *SD* = .76), *F*(1, 107) = 4.12, *p* = .04, η_p^2 = .04. There was no difference in the ratings of context as a function of Operation condition, *F*(1, 107) = 2.53, *p* = .11, η_p^2 = .02, and no interaction, *F*(1, 107) = .08, *p* = .78, η_p^2 = .04. The other coherence dimensions did not differ as a function of Realism or Operation conditions, and there were no interaction effects.

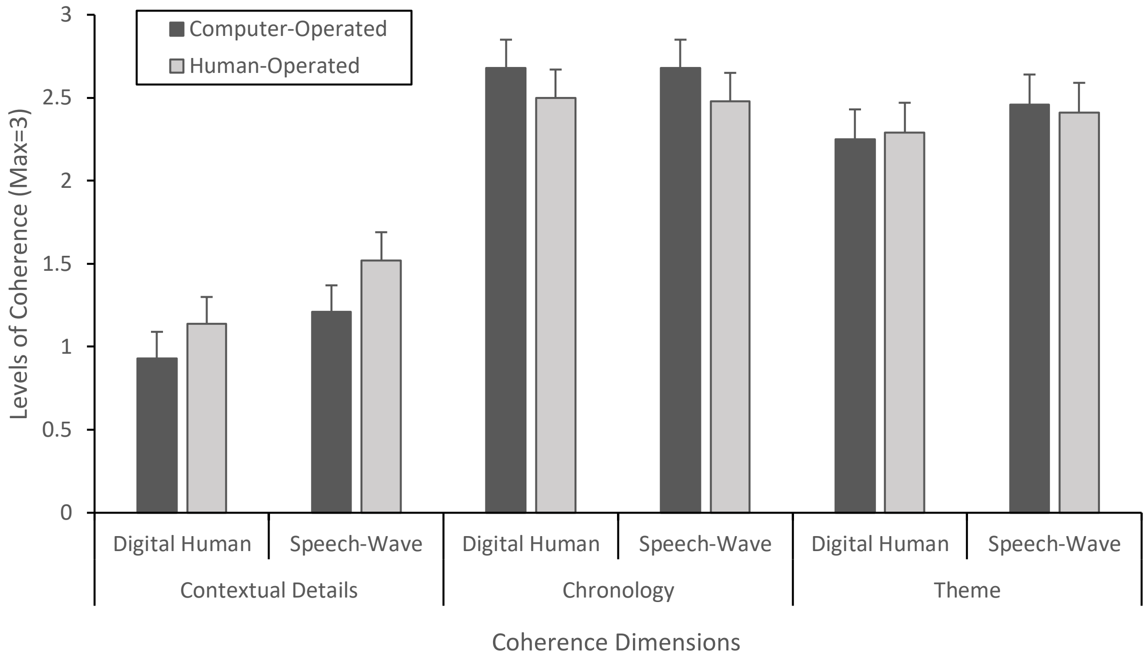

Figure 6.9. Participants' level of narrative coherence (+1SE) during disclosure of embarrassing personal event as a function of the Avatar interviewer's Realism and Operation conditions.

Interviewer preference for disclosure. Recall that immediately after the feedback questionnaire, participants were presented with the same list of 41 embarrassing topics that I used in previous chapters to measure participants' preference for disclosing these topics to an avatar interviewer.

Topic sensitivity. Figure 6.10 shows the percentage of participants who indicated whether each topic was *embarrassing* or *not embarrassing*. The number of participants who selected a topic as *embarrassing* was divided by the total number of participants (N = 111) to obtain the percentage of participants who selected a topic as *embarrassing*. As shown in Figure 6.10, no participants considered 'Physical pain' (0% of total participants) and very few participants considered 'Flu' (3% of total participants) to be embarrassing topics, while the majority of participants considered 'Smelly private parts' to be an embarrassing topic.

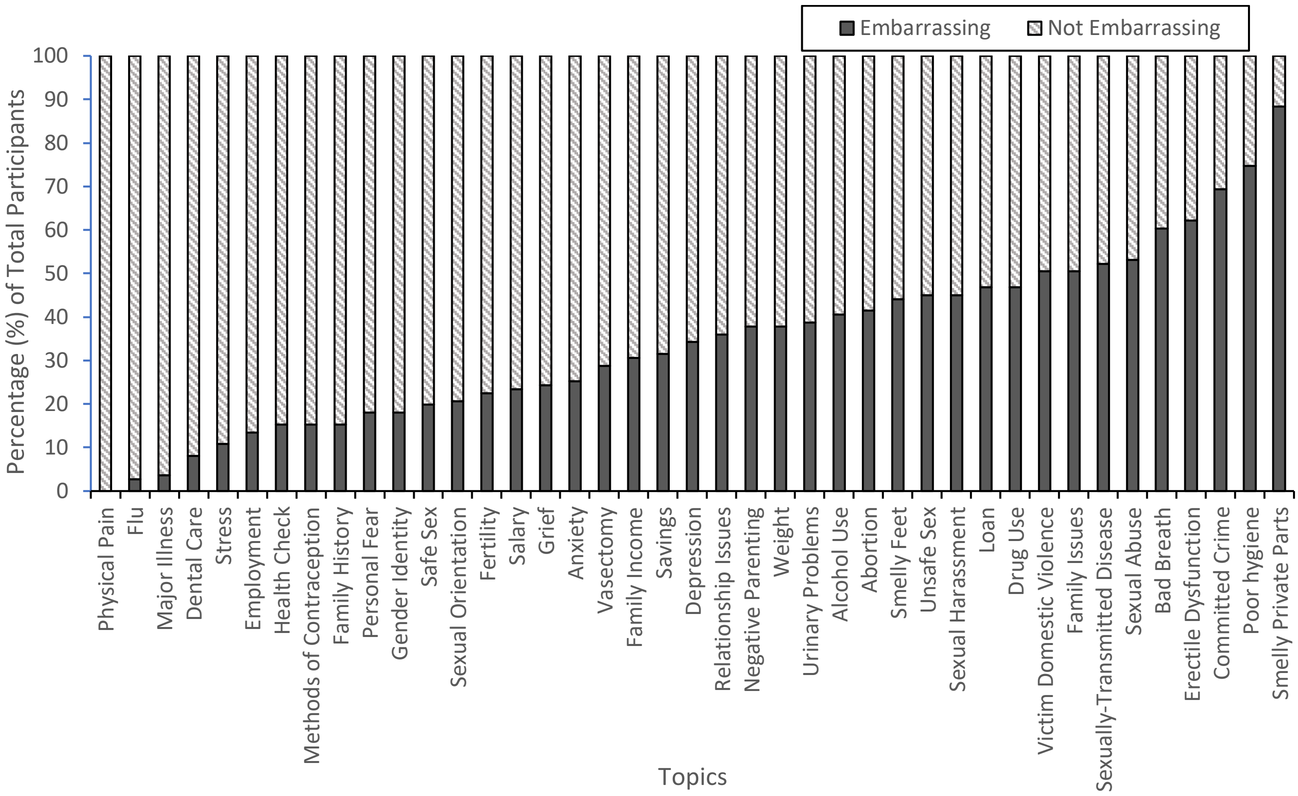

Figure 6.10. The topics are shown in order of percentage of participants who found the topic embarrassing (lowest to highest).

Interviewer preference. Next, I examined participants' preferences for discussing the topics with either the digital-human avatar or speech-wave avatar interviewer. A Chi-square goodness-of-fit test showed that irrespective of the topic, participants chose the speech-wave avatar (54%) over the digital-human avatar (46%) for discussing these topics χ^2 (1) = 26.76, p < .001.

Interviewer preference for each topic. To examine participants' preferences more closely, I conducted a series of Chi-square goodness-of-fit tests on participants' interviewer preference for each of the 41 topics. The results of these analyses are shown in Table 6.3, ranked in order of topic embarrassment. As shown in Table 6.3, a speech-wave avatar was preferred for 17 of the 41 topics, while a digital-human avatar was preferred for only 7 of the 41 topics. There was no preference for one interviewer over the other for the remaining 17 topics. Participants indicated that they would prefer to discuss 4 of the 5 least embarrassing topics with a digital-human avatar and would prefer to discuss all of the 5 most embarrassing topics with a speech-wave avatar.

Consistent with these patterns, a Pearson's product-moment correlation revealed a significant positive correlation between the percentage of participants who selected an avatar and the percentage of participants who considered each topic embarrassing, $r = .69$, N = 40, $p < .001$. That is, the percentage of participants who selected the avatar increased with topics that were considered more embarrassing to talk about.

***Interviewer preference for sex-related topics*.** Finally, recall that in Chapter 5, participants were more willing to discuss the details of sex-related topics with an avatar than with a therapist face-to-face, but that they exhibited the opposite pattern when discussing mental health-related topics (see Yokotani et al., 2018). In the present experiment, I wanted to explore participants' views of different types of avatar interviewers for discussing embarrassing topics. To examine potential differences in participants' preferences here, again, I assigned 5 of the 41 topics to the sex-related category (i.e., safe sex, contraception, unsafe sex, sexually transmitted diseases, erectile dysfunction) and 5 topics to the mental-health category (i.e., stress, anxiety, depression, grief, personal fear; see also Yokotani et al., 2018). Chi-square goodness-of-fit tests revealed that for the sex-related topics, participants indicated a significant preference for the speech-wave avatar professional (63%) over digital-human professional (37%), χ^2 (1) = 36.85, $p < .001$. In contrast, for the mental health-related topics, the digital-human was preferred (61%) compared to the speech-wave avatar (39%), χ^2 (1) = 25.52, $p < .001$.

Interviewer preference and avatar's operation. I conducted two separate Chi-square goodness-of-fit tests to explore the relation between the information received on the avatar's operation and participants' preference for the type of avatar for discussing the topics. To do this, I summed the number of topics that participants preferred to talk to with the speech-wave avatar or with the digital-human as a function of avatar operation. Participants who were told that the avatar was computer-operated (n = 56) preferred to discuss embarrassing topics with the speech-wave avatar (56%) compared to the digital-human avatar (44%), χ^2 (1) = 33.66, $p < .001$; similarly, participants who were told that the avatar was human-operated (n = 55) also preferred to discuss embarrassing topics with the speech-wave avatar (62%) compared to the digital-human avatar (38%), χ^2 (1) = 122.23, $p < .001$.

Table 6.3

Participants' Preference for a Digital-Human Avatar Versus a Speech-Wave Avatar by Topic

Topics	Prefer Digital-Human	Prefer Speech-Wave	χ^2	*p*
Physical Pain	**70**	**30**	**18.24**	**< .01**
Flu	**67**	**33**	**12.33**	**< .01**
Major Illness	**75**	**25**	**27.25**	**< .01**
Dental Care	44	56	1.52	.25
Stress	**67**	**33**	**12.33**	**< .01**
Employment	**67**	**33**	**12.33**	**< .01**
Health Check	**35**	**65**	**9.81**	**< .01**
Methods of Contraception	47	53	0.44	.57
Family History	47	53	0.44	.57
Personal Fear	**65**	**35**	**9.81**	**< .01**
Gender Identity	55	45	1.09	.34
Safe Sex	41	59	3.25	.09
Sexual Orientation	57	43	2.03	.18
Fertility	52	48	0.23	.71
Salary	**38**	**62**	**6.57**	**.01**
Grief	56	44	1.52	.25
Anxiety	**61**	**39**	**5.63**	**.02**
Vasectomy	**38**	**62**	**6.57**	**.01**
Family Income	56	44	1.52	.25
Savings	**40**	**60**	**4.77**	**.04**
Depression	55	45	1.09	.34
Relationship Issues	52	48	0.23	.71
Negative Parenting	57	43	2.03	.18
Weight	**38**	**62**	**6.57**	**.01**
Urinary Problems	**33**	**67**	**12.33**	**< .01**
Alcohol Use	**31**	**69**	**16.66**	**< .01**
Abortion	46	54	0.73	.45
Smelly Feet	**22**	**78**	**35.76**	**< .01**
Unsafe Sex	**34**	**66**	**11.04**	**< .01**
Sexual Harassment	**40**	**60**	**4.77**	**.04**
Loan	44	56	1.52	.25
Drug Use	**37**	**63**	**7.58**	**< .01**
Victim Domestic Violence	54	46	0.73	.45
Family Issues	55	45	1.09	.34
Sexually-Transmitted	**38**	**62**	**6.57**	**.01**
Sexual Abuse	46	54	0.73	.45
Bad Breath	**30**	**70**	**18.24**	**< .01**
Erectile Dysfunction	**25**	**75**	**27.25**	**< .01**
Committed Crime	**34**	**66**	**11.04**	**< .01**
Poor Hygiene	**29**	**71**	**19.90**	**< .01**
Smelly Private Parts	**17**	**83**	**48.01**	**< .01**

Note. Significant differences between interviewer preference are shown in bold; the shaded lines indicate the topics for which a digital-human was preferred over a speech-wave avatar interviewer.

Discussion

In the present experiment, I examined the impact of an avatar's anthropomorphism and the information on the avatar's operation on participants' verbal interaction and memory performance in response to the avatar interviewer. Overall, participants' memory performance was enhanced when a less anthropomorphic (speech-wave) avatar interviewed them. These same participants also showed a higher rate of disclosing embarrassing personal events and preferred a speech-wave avatar for discussing information about the majority of embarrassing topics, in particular sex-related topics.

Relative to the digital-human avatar, participants who were interviewed by a speech-wave avatar interviewer were more talkative and reported more correct details during the free-recall phase of the memory interview without a compromise in accuracy. There was no difference in memory performance during the directed-recall phase as a function of the Interviewer Realism condition. These findings are consistent with the fact that the social-influence threshold is not fixed; it changes depending on the situation or task, and the individuals' awareness or involvement during that task with an avatar (Blascovich, 2002). For instance, relative to directed recall, a higher social-influence threshold may exist for free recall because free recall is largely associated with conscious neural process (see Quamme et al., 2004; Yonelinas, 2002). Overall, participants in the present experiment potentially reached the social-influence threshold during free recall when interviewed by a more anthropomorphic interviewer (digital-human), but not with a less anthropomorphic, speech-wave avatar. The findings in Chapter 3 provide some evidence to support this explanation where I found that participants' memory performance and verbal interaction were comparable when they were interviewed by either the same digital-human avatar as the one that was used in the present experiment or the human interviewer.

A similar explanation can also be used to account for the findings on participants' memory performance in directed recall. More specifically, relative to free recall, a lower social-influence threshold may exist for directed recall because during directed recall, participants' responses to specific questions are associated with automatic neural process, which is more akin to the process for recognition (see Quamme et al., 2004; Yonelinas, 2002). Overall, participants in the present experiment potentially reached the social-influence threshold in directed recall and responded similarly to either type of interviewer (digital-human, speech-wave).

Although the same digital-human avatar interviewer was used in the present experiment and in Chapter 3, the findings across these two experiments were inconsistent in terms of avatars' agency. More specifically, in Chapter 3, participants who perceived the avatar interviewer as computer-operated provided memory accounts with greater accuracy than did the participants who perceived the avatar interviewer as operated by a concealed human. In contrast, in the present experiment, the information that participants received about the avatar's operation did not affect their memory performance. One possible explanation for the inconsistent pattern of findings could be the method of measuring participants' views about the avatar's operation. Participants in Chapter 3 were grouped according to their perception of the avatar interviewer; that is, their assumption about the avatar's operation was not directly manipulated. In the present experiment, half of the participants were explicitly told that the avatar was computer-operated and the other half of the participants were told that the avatar was human-operated. Because their perception of the Avatar was not measured in Chapter 3, it is also possible that participants in the present experiment perceived the digital-human avatar as human-operated, despite being told that the avatar interviewers were computer-operated.

Consistent with this explanation is the differences in the avatar's voice across those two studies. The concealed human interviewer in the present experiment was a trainee clinical psychologist, who may, given her training conveyed more human-like qualities, such as empathy, through her tone of voice. Researchers have demonstrated that human qualities, such as empathy and affect, can be expressed through an individual's vocal tones (Riess & Kraft-Todd, 2014). By comparison, the concealed human interviewer in Chapter 3 was not trained in clinical interviewing. Therefore, due to the avatar's voice, participants in the present experiment may have perceived the digital-human avatar as human-operated, regardless of the information they had received about the avatar's operation.

This explanation, however, is inconsistent with our speculation in Chapter 5. Recall that in Chapter 5, despite the fact that the human interviewer provided the voice for the avatar, participants who were interviewed by an avatar provided free-recall accounts that were qualitatively and quantitatively different compared to the participants who were interviewed by a human interviewer. One explanation put forward in Chapter 5 was that during an interaction with an avatar interviewer, participants may distribute more attention to what they see (visual) rather than what they hear (audio). Hence, either the findings in Chapter 5 potentially ruled out this explanation of the effects of an avatar's voice on participants' perception of the avatar's operation, or that there is a more complex relation between an avatar interviewer's voice and appearance. A future avenue of research would be to examine the effects of an avatar's voice and appearance on people's memory performance in evidential interviewing. Hongpaisanwiwat and Lewis (2003) have conducted a similar experiment investigating the effects of an avatar's voice and appearance on participants' knowledge acquisition. In that study, the researchers found that participants who were taught by an anthropomorphic avatar with a computer voice showed better recall of previously learned materials than did the participants who were taught by an anthropomorphic avatar with a human voice.

Individual Differences in Eyewitness Accounts with Avatars

In the present experiment, individual differences in traits resembling ASD did not influence participants' memory performance with either interviewers. This finding is consistent with Atherton and Cross' (2018) review on links between anthropomorphic stimuli and individuals with ASD. In that review, the authors showed that individuals with ASD tend to anthropomorphise non-human entities and show similar responses with human-like and non-human-like avatars. Individuals in the present experiment who scored higher on the ASD measure potentially anthropomorphised and responded similarly to both types of interviewers. Furthermore, Feng et al. (2018) found that the 'uncanny valley effect' did not influence children with ASD; children with ASD interacted with avatars in a similar manner regardless of the avatar's visual realism.

Similar to ASD traits, in the present experiment, participants' personality traits also did not influence their memory performance as a function of the avatar's anthropomorphism. This finding is consistent with Hongpaisanwiwat and Lewis (2003). In that study, extraversion did not influence the effects of an avatar's anthropomorphism on adults' semantic memory performance. Still, given the explanation in Chapters 3 and 5 on the engaging effect of an avatar on adults with low conscientiousness, it was hypothesised that conscientiousness might also moderate the association between an avatar's realism and participants' memory performance. It is possible, however, that an avatar's visual realism per se does not affect adults' level of engagement (e.g., Choi & Clark, 2006), but rather, other factors like an avatar's facial expressions have a greater impact (Baylor & Kim, 2009). The two avatar interviewers in the present experiment did not exhibit any facial expressions.

Disclosure of Embarrassing Information

The data in the present experiment on participants' preference to discuss each of the 41 topics revealed several findings. First, participants preferred a speech-wave avatar over a digital-human avatar in discussing many of the 41 topics, especially for topics that were considered more embarrassing. Second, participants preferred to discuss sex-related topics (e.g., unsafe sex) with a speech-wave avatar and mental health topics (e.g., depression, anxiety) with a digital-human avatar. Finally, participants' knowledge of the avatar's operation did not impact their choice of the type of avatar in discussing potentially embarrassing information; that is, participants overwhelmingly preferred the speech-wave avatar regardless of the information they received on the avatar's operation.

Recall that several possible explanations were put forward in Chapter 5 in an attempt to explain the contradictory findings between previous studies and Chapter 5; specifically, the information on the avatar's operation; the method of measuring disclosure; and the avatar's realism. With respect to participants' knowledge of the avatar's operation, participants in the present experiment were told that the avatar was either computer-operated or human-operated; in Chapter 5, on the other hand, participants did not receive information on the avatar's operation. Again, similar to Chapter 5, the information provided to the participants on the avatar's operation did not impact their choice of the avatar for discussing embarrassing topics.

In terms of the method of measuring disclosure, in the present experiment, I examined the quantity of information reported as well as the narrative coherence of participants' reports about a personal event; in Chapter 5, I asked participants which avatar they would prefer to talk to about a range of topics. Despite some previous studies reporting inconsistent results between different methods of measuring disclosure (e.g., Bowling, 2005; Pickard & Roster, 2020), the findings from the present experiment could not detect a difference across the two methods, and potentially rule out the explanations put forward in Chapter 5 in an attempt to explain the contradictory findings between Chapter 5 and previous studies (e.g., Bailenson et al., 2006; Lucas et al., 2014).

Regarding the avatar's realism, I found that participants in the present experiment indicated that they prefer to disclose information to a speech-wave avatar than to a digital-human avatar. In fact, they provided more coherent narrative accounts that were also rich in detail to a speech-wave avatar compared to a digital-human avatar. On the basis of these findings, it is impossible to completely rule out the impact of other factors like the avatar's operation or the method of measuring disclosure to explain the inconsistent findings between Chapter 5 and previous studies because different avatars were used in the present experiment, in Chapter 5, and in previous studies (e.g., Lucas et al. 2014). It could be that an avatar's operation may not be important for participants' interaction with less anthropomorphic avatars, as in the present experiment, but may influence participants' responses to a more realistic avatar, like that in Lucas et al. (2014).

The data from previous studies, such as Lucas et al. (2014), and in Chapter 5 and the present experiment suggest that individuals' social experience with an avatar for disclosing embarrassing information may follow the non-linear path, as suggested by the 'uncanny valley effect.' To summarise, Lucas et al. (2014) used an avatar with the highest visual realism, followed by a relatively less realistic avatar presented in Chapter 5, followed by the least realistic, speech-wave avatar used in the present experiment. Still, in terms of information disclosure, the avatar in Lucas et al. outperformed a human interviewer face-to-face; the less realistic, digital-human avatar in Chapter 5 was inferior to a human face-to-face; but the least realistic avatar in the present experiment was superior to the digital-human avatar. The digital-human avatar in Chapter 5 may appear eerie to its participants due to its photorealistic eyes and lips, but cartoonish appearance, which may hinder disclosure.

Participants' rating of the avatar interviewers in the present experiment may support this claim; that is, they rated the speech-wave avatar higher in *naturalness* but rated the same digital-human avatar as in Chapter 5 lower in *naturalness* during their feedback of the interviewers.

In addition to asking participants for their interviewer preference in discussing each of the 41 potentially-embarrassing topics, participants were also asked to describe an actual embarrassing experience. Overall, participants were more talkative and provided more contextual details when interviewed by a speech-wave avatar compared to by a digital-human avatar when they were asked to describe an embarrassing personal story.

When asked to recall an embarrassing experience, participants described a wide range of events. For example, some participants described experiences that included an audience such as public speaking, accidentally tripping over, ripped pants, or walking into a pole. Some these audiences included family or friends (e.g., wetting accident, did something silly). For example, one female participant told the speech-wave avatar:

> "*when I was younger I remember I had like a shower and I didn't have my towel with me, so I went out to grab a towel and I had to like go through the hallway….My brother and his friend were in the hallway….My brother's friend might have seen me naked…. I was just like ruminating….*"

In another example, a female participant told the digital-human avatar:

> "*….we were with our family friends….I just need to go to the bathroom sorry, and then I went to the bathroom and I saw these urinals and there was a guy going to the toilet….he was like you are in the wrong toilet….I ran out and cried, I was like seven.*"

Another female participant reported to the speech-wave avatar:

"*….I think just yesterday,….I was in the lab….my friend and lab mate Jacob came by and showed me a picture of his new born cousin….he was like babies are looking rough….I said they are ugly mother fxxx….my supervisor walks past and says Who's the mother fxxxx….then I just hid in my bench….I was just really embarrassed, my cheeks were burning."*

Another example provided by a male participant to the digital-human avatar:

"*….I was at an athletics training….we were doing long jump and a boy grabbed my pants from the back and pulled them down as a joke….I remember not taking it as a joke and crying and not being very happy at all….that was pretty embarrassing as a kid….:*

Several valuable observations can be made on the basis of these stories. First, many of the participants' reports were about incidents that occurred during childhood. More specifically, of the stories that included time details, 70% were events that occurred in childhood (i.e., < age 14 years); only 30% were about events that occurred within the last 2 years. For example:

"*I was about 11….," "In Year 8 we had to….," "When I was younger….," "When I was like Year 4 or 5….," I was maybe 11/12….," "I was I the 6th grade….," "When I as a young child….," "When I was a kid….," "I was about 12 years old and…."*

One possible explanation for participants' favouring describing childhood events over more recent events might be that those events are the most memorable due to the emotional valence of the content. Embarrassment is a negative emotional state (Tangney, Stuewig, & Mashek, 2007), and children process negative emotions differently. Specifically, children tend to form memories of expressions of emotional responses rather than to form particular details of an emotionally-laden event (see LeDoux, 1993).

Another possible explanation for reporting childhood, rather than more recent, embarrassing events may be that these incidents were embarrassing at the time that they occurred, but they are no longer embarrassing. This kind of "emotional distance" from the original event may have made participants more comfortable discussing them. Details of reported events included participants' emotional or physical reactions at the time that these events occurred, rather than their responses during the interview. The following example is from a female participant who was interviewed by the digital-human interviewer:

> "*I was on a bus with a whole lot of children, we were going to a food technology day….I pushed the emergency button and it was very loud and the bus driver stopped….he yelled out who did that….I stood up and felt very flustered and embarrassed."*

In another example, a male participants reported to the speech-wave avatar:

> "*when I was a kid….I went into the wrong bathroom and went to the woman's bathroom and the cubicle couldn't lock properly and a woman saw me in the cubicle….that was embarrassing. That's all I can remember really."*

Another female participant articulated to the speech-wave avatar that her embarrassing stories are no longer embarrassing, without actually going into details of any specific event:

> "*embarrassing stuff happens to me all the time….I've definitely got embarrassing stories, but they just seem so normal now."*

One female participant reported to the digital-human avatar:

> "*….we were walking back to the party and it was dark….I slopped over and got mud all over me….all my friends found it funny….it was quite funny….my shoes got covered in mud too and I still haven't cleaned them.*"

Still, the fact that there was a difference in the quantity and quality of reports about the embarrassing event across the Interviewer condition suggests that participants may still have felt embarrassed when talking about the incidents during the interview. Future studies could compare the effects of interviewer type on participants' reports of childhood embarrassing and non-embarrassing personal events.

Many of the participants' narratives of embarrassing personal events contained details of emotional or physical reactions at the time that these events occurred. For example, one male participants told the digital-human avatar:

> "*A school speech…. we had to go up in front of the whole class and I can remember I was really nervous…. My hands were like shaking…. We were supposed to look up and make eye contact with everyone but I was just like stuck to my cards."*

In another example, a female participants reported to the digital-human avatar:

> "*I was about 11…. I was waiting to do my beam routine and I started to really need to go to the toilet but I was next up…. I ended up letting it all go on the bean…. It was very, very embarrassing…. I was like crying."*

Another female participant reported to the speech-wave avatar:

> "*….I was in high school and was wearing a pair of jeans….they like ripped and so for the rest of the day, I was wearing a long cardigan, it was just like above the knees….I was being real careful about how I was walking….it was just awful and I just*

remember being really self-conscious the whole day….just how self-conscious and paranoid I was feeling"

The fact that participants provided vivid emotionally-laden details of events that occurred a long time ago suggest the personal significance of those events. These narratives are of particular relevance because emotional events of personal importance are often the subject of evidential or clinical interviews. For example, a witness may be asked to report what they saw during the Christchurch Earthquake; a patient may report details of a violent home in his or her childhood.

In contrast to the emotionally-laden experiences, some stories appeared to be relatively benign, yet they still left their mark on the participant's memory. For example, a female participant reported to the digital-human avatar:

> "*When I was younger and at kindergarten, there was like a Christmas event…. I was going on stage to give Santa a hug and I tripped in front of everyone…. I think that scarred my memory of like Santa Claus…. And now every time I drive past I think of that memory."*

Another female participant told the speech-wave avatar:

> "*I was walking across a crossing in the centre of town….and I kicked my own ankle, sort of and I stumbled quite noticeably and it was a busy crossing….I was red in the face….I managed to carry on walking and I was red for the rest of the walk home."*

These narratives, like many others produced by participants in the present experiment suggest that even benign events can be distressing and emotionally-charged. Often in a clinical setting, patients' accounts may appear benign because of a lack of insight into the significance of the original experience.

Taken together, the majority of participants' reports of embarrassing personal events in the present experiment involved incidents that were emotionally-charged and had occurred in their childhood. Many of the stories that participants told included a fear of being negatively evaluated by either strangers, family, or friends. These stories are clinically- or forensically-relevant. Issues that are discussed in a clinical or forensic setting, such as child sexual abuse, are often not reported until many years later. Furthermore, these issues are emotionally-laden and often embarrassing to talk about with an interviewer. The findings from the present experiment provide an empirical basis for the use of a less anthropomorphic avatar, such as the speech-wave avatar interviewer, in clinical and evidential interviewing.

Recall that each of the embarrassing stories was coded based on contextual detail, chronology, and theme. This Narrative Coherence Coding Scheme (Baker-Ward et al., 2007; Reese et al., 2011) captured many of the differences in the quality of participants' reports of embarrassing personal events. For example, the following example illustrates a story with low contextual details provided by a male participant interviewed by a digital-human avatar:

> "*In Year 8 we had to do speeches…. Right at the beginning of the slide show, I had a massive voice crack in front of the entire class…. And everyone laughed…. And sat down with a bright red face.*"

In this example, the participant reported a specific autobiographical time (i.e., "in Year 8"), but did not provide a location in which the embarrassing event occurred.

In contrast, the following example illustrates a report with greater contextual details provided by a female participant to the speech-wave avatar:

> "*When I was about 7, I remember being at my nana's house and she had made these little jelly square things…. I was very nervous around people…. I finally about half an hour plucked up the courage to go and get one…. My nana told me I was being a*

selfish little girl and that I had to wait…. I was so embarrassed because I finally plucked up all the courage I had to go and get one.”

In this example, the participant reported both a specific autobiographical time (i.e., “*When I was about 7*"), and a particular location in which the embarrassing event occurred (i.e., "*at my nana's house*”).

The following example illustrates a report with low levels of both chronology and theme from a male participant who was interviewed by the digital-human avatar:

“*Me giving a public speaking and then I stumbled and fumbled on the speech.”*

In this example, less than 50% of details in the participant's narrative could be placed on a timeline (i.e., *“…. public speaking and then I….*"). Although the narrative is on topic with an embarrassing experience (i.e., *“…. I stumbled and fumbled….*”), the participant's narrative failed to provide an overall embarrassment theme. In contrast, the following example illustrates a report with high levels of both chronology and theme from a female participant who told her story to the digital-human avatar:

“*When I was in primary school….we were just in the classroom and we had to raise our hands to provide an answer to the question and when I thought of my answer, instead of saying Mr so and so, I said dad and the whole class laughed and I turned red and I sat back down and was so embarrassed.”*

In this example, more than 75% of details in the participant's narrative could be placed on a timeline (i.e., “*…. We had to raise our hands….I thought of my answer…. I said dad and the whole class laughed….*”). In addition, the narrative contained a well-developed embarrassment theme that included causal linkages and interpretation and elaborations of the event (i.e., “*…. instead of saying Mr so and so, I said dad and the whole class laughed and I turned red…. “).*

Furthermore, the participant reported closure to the experience (i.e., "…. *I turned red and I sat back down and was so embarrassed.*").

Taken together, when interviewed about an embarrassing personal story, participants, in general, provided a clear storyline about a personally-experienced event. Participants who were interviewed by a speech-wave avatar interviewer provided more details in their narrative accounts of an embarrassing personal story than did participants who were interviewed by a digital-human avatar interviewer.

Conclusion

On the basis of the findings of the current chapter, it appears that it may not be necessary to design an avatar with highly realistic, anthropomorphic features, for interviewing an eyewitness or for interviews about potentially emotional events. In fact, it may be more efficient and more economical for a person to talk with an avatar with less anthropomorphic features. An avatar with these types of features has the potential to enhance the recall of a prior event and to elicit higher quality reports of embarrassing personal experiences. These findings are not to say that an avatar with less visual realism is superior to an avatar with higher visual realism, but rather, the impact of an avatar's design is task-dependent. For example, building rapport with a patient with mental health issues may require a more visually realistic avatar clinician. Empirical evidence, together with a theoretical model, may be used to predict individuals' responses with different avatars in different situations. In the context of a forensic interview, an avatar with human features may not always yield the best results.

Chapter 7

Concluding Comments: The Final Frontier for Avatars?

Technology is evolving exponentially. According to Moore's Law, the overall processing power of digital technology will double every two years (Moore, 1965). Since humans first discovered a method for starting a fire, we have continued to transform rudimentary tools into more advanced machines. Modern technology has allowed us to do *more with less.* For example, we can now take notes verbatim on a laptop; we can broadcast information that can reach millions of people within seconds with a click of a button. Modern technology has allowed us to travel to farther galaxies than we could have ever imagined. As technology evolves, humans have evolved with it. We think, act, and interact with other people differently as a byproduct of modern technology. As we continue to move forward, modern technology will continue to be integrated into our lives. Avatar technology may ease this integration by putting a 'face on a machine.' Through technological advancements, avatars are now more realistic—conveying empathy, emotions, and facial expressions that were once thought impossible for cold, unemphatic machines. Because of these technological advancements, avatars may be a useful tool in a wide range of areas, including education, advertising, communication, health, digital assistants, and legal settings, just to name a few.

In the present thesis, my overarching goal was to explore the use of avatars in the context of evidential and clinical interviewing, in the hope that this novel technology could facilitate adults' memory performance and enhance their disclosure of sensitive information. More specifically, the overarching aims of the current research were two-fold. First, I aimed to compare the effectiveness of an avatar and a human interviewer on adults' accounts of a prior witnessed event. In this context, participants were interviewed using both free- and directed-recall questions. Some participants also received post-event misinformation that was presented by either an avatar or a human. In addition to comparing the effectiveness of the avatar and human interviewer, I also investigated the relation between participants' personality traits, traits resembling autism, and their perception of the avatar's operation on their memory performance. I also explored participants' memory performance when two avatars with varying degrees of anthropomorphism served as the interviewer.

The second aim of the present research was to compare the effectiveness of an avatar interviewer and a human interviewer in eliciting disclosure of embarrassing information. In addition, I examined participants' accounts of an embarrassing personal event when two avatars of varying degrees of anthropomorphism interviewed them.

Two types of avatar interviewers were used in the present research: a more anthropomorphic, 2D cartoon-rendered digital-human avatar, and a less anthropomorphic, speech-wave avatar (see Figure 7.1).

Figure 7.1. The avatar interviewers used in the present research.

The digital-human avatar resembled the human interviewers used in the present research in facial features, and hair colour and style. Furthermore, to increase the predictability of the avatar's movement and reduce non-verbal gestures during interviews, the avatar was limited to eye blinks and head tilt to one side. The appearance of the speech-wave avatar interviewer resembled that of Apple's Siri. A concealed human interviewer provided the voice of the avatar and operated the avatar from another room via the internet. The digital-human avatar's lips moved in synchrony with the human's speech; the speech-wave avatar moved up and down—also in synchrony with the human's speech. The avatar was displayed on a 21.5" computer monitor that was placed on a table. The human interviews were conducted face-to-face.

In general, when participants were interviewed only once, the digital-human avatar interviewer did not elicit more information, but it also did not elicit less information than did a human interviewer about a prior event in response to either free-recall or directed-recall questions. Furthermore, participants who were interviewed only once were also equally talkative when interviewed by the digital-human avatar or by the human interviewer. In contrast, participants' reports were quantitively different when they were interviewed twice across two interview sessions. More specifically, participants who were interviewed by the same human interviewer on both occasions were more talkative and provided more correct details than did participants who were interviewed on both occasions by the digital-human avatar. However, the same participants who were interviewed by the same human interviewer on both occasions produced reports that were less accurate. When post-event misinformation was presented, participants were generally less accurate in response to questions containing false information irrespective of whether the avatar or the human interviewer provided that information or conducted the final interview. In short, the digital-human avatar was generally as effective as the human interviewer, and similar to the human interviewer, the avatar interviewer did not protect the participants from the negative effects of misleading information.

When the comparison shifted from '*digital-human avatar vs human'* to '*digital-human avatar vs speech-wave avatar*,' under some circumstances, participants interviewed by the speech-wave avatar were more talkative and provided more correct details with similar accuracy during free recall compared to those interviewed by the digital-human avatar.

Figures 7.2 and 7.3 show the data for *word count* and the *amount of correct information*, respectively for Chapters 3 and 6. Relative to the speech-wave avatar, participants who were interviewed face-to-face by a human interviewer were more talkative and reported more correct details about the event (bars on the left-hand sides of Figures 7.2 and 7.4). I observed similar results when I compared participants' performance when interviewed by the digital-human avatars in Chapters 3 and 6; participants in Chapter 3 were more talkative and showed better memory performance compared to the participants in Chapter 6 (bars on the right-hand sides of Figures 7.2 and 7.3). These findings suggest that an adult's interaction with an avatar is not only affected by the avatar's appearance, but also by the avatar's voice. Recall that in Chapter 6, the concealed human interviewer who voiced the digital-human avatar was a trainee clinical psychologist; in Chapter 3, the concealed human interviewer who voiced the digital-human avatar (identical in appearance to that used in Chapter 6) was not trained in clinical interviewing. Trained interviewers may convey more human-like qualities, such as empathy, through their tone of voice (Riess & Kraft-Todd, 2014). Consequently, participants in Chapter 6 may have perceived the digital-human avatar as 'more human' than did participants in Chapter 3. Somewhat counterintuitively, in Chapter 3, participants who perceived the avatar interviewer as computer-operated outperformed the participants who perceived the avatar interviewer as human-operated. On this basis, I conclude that avatar interviewers that are perceived as 'more human' may actually hinder adults' performance when an avatar interviews them. In Chapter 6, the speech-wave avatar was voiced by a trained interviewer. Whether or not, a speech-wave avatar voiced by an untrained interviewer would facilitate memory performance to the level of the face-to-face human interviewer remains a question for future research.

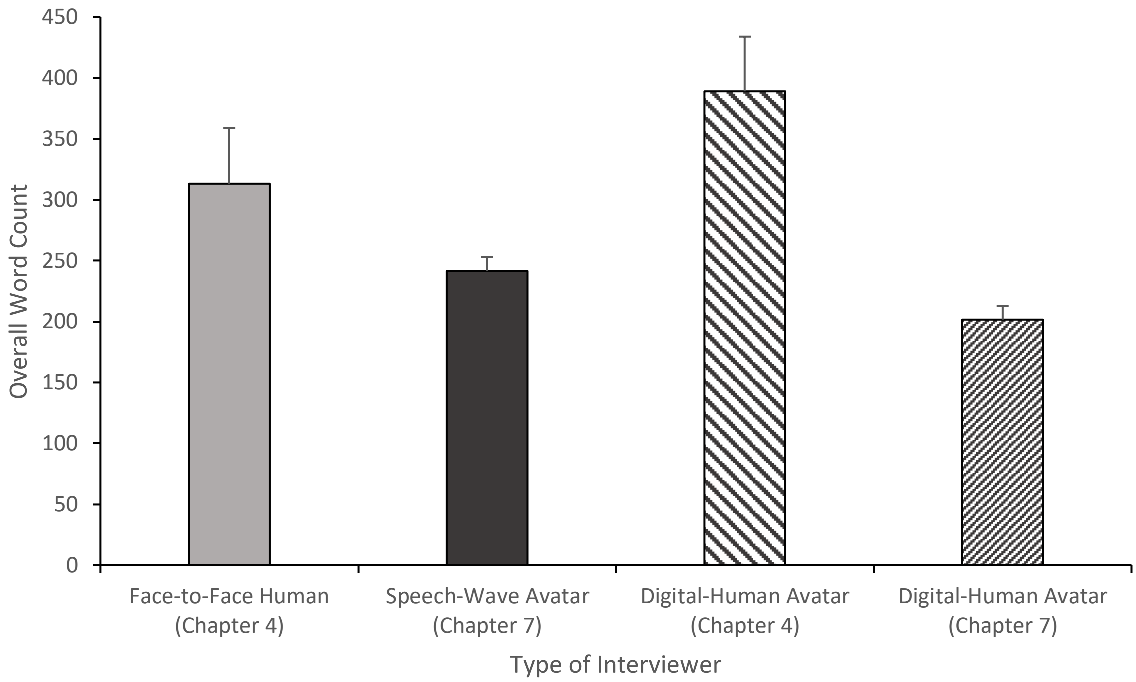

Figure 7.2. A comparison of the overall word count (+1SE) during free recall as a function of the Interviewer condition in Chapters 3 and 6.

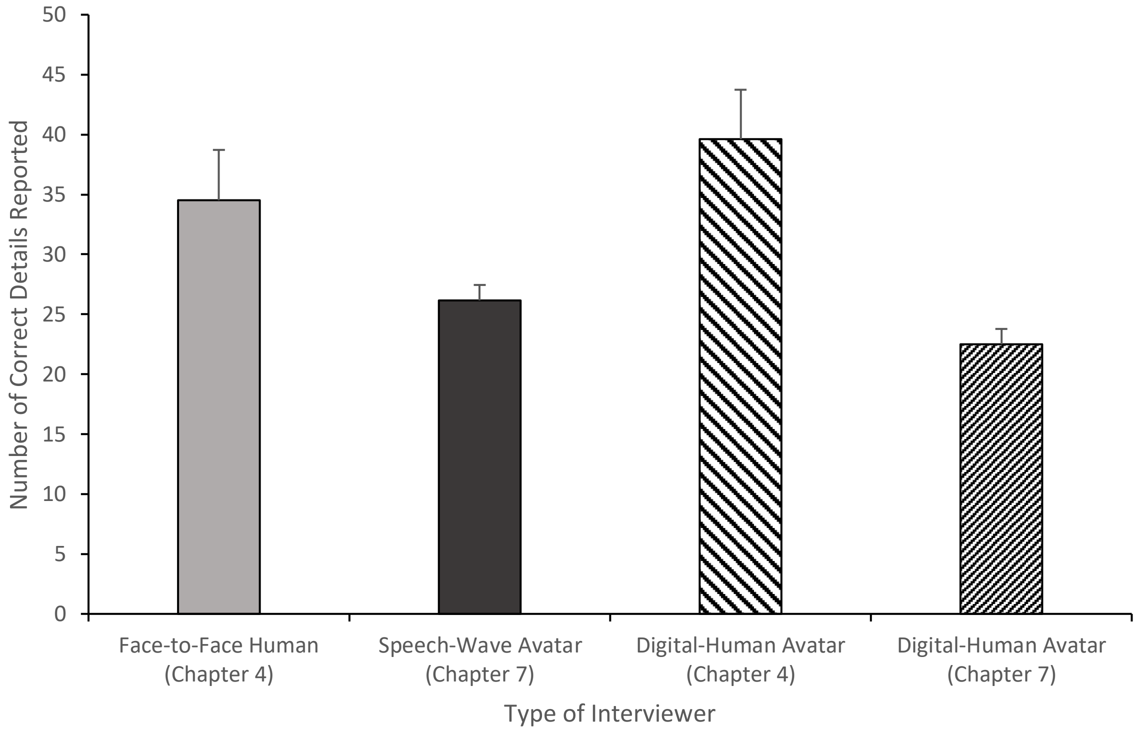

Figure 7.3. A comparison of the amount of correct information (+1SE) reported during free recall as a function of the Interviewer condition in Chapters 3 and 6.

Figure 7.4 shows the accuracy data from Chapters 3 and 6 as a function of Interviewer condition. As shown in Figure 7.4, the *accuracy* of participants interviewed by either the digital-human avatar in Chapter 3 or the same digital-human avatar in Chapter 6 was very similar.[8] The accuracy of the reports elicited by the speech-wave avatar in Chapter 6, on the other hand, was significantly higher than the accuracy of the reports elicited by the human interviewer in Chapter 3, albeit the difference was small.[9]

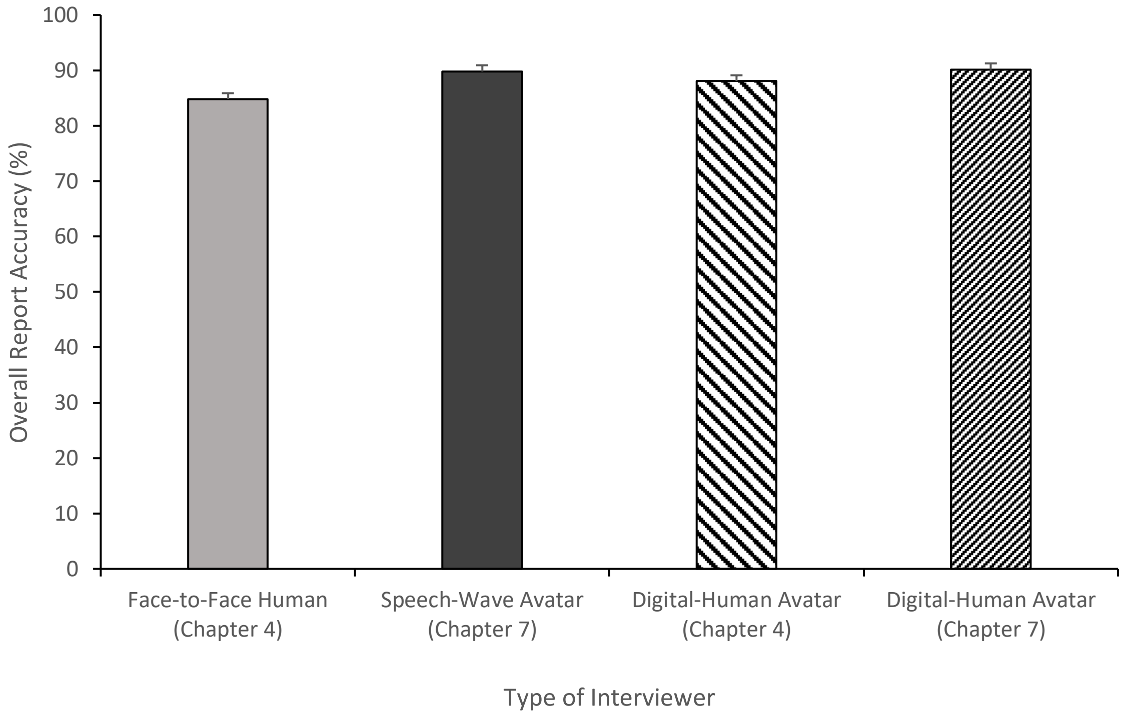

Figure 7.4. A comparison of the overall % accuracy (+1SE) of participants' free recall reports as a function of the Interviewer condition in Chapters 3 and 6.

In terms of disclosure, participants overwhelmingly preferred to discuss information with a human professional face-to-face compared to a digital-human avatar in Chapters 4 and

[8] The *accuracy* data were comparable for participants interviewed by the same digital-human avatar in Chapter 3 (*M* = 88.09%, *SD* = 7.56) and Chapter 6 (*M* = 90.14%, *SD* = 6.45), *t*(79) = 1.26, *p* = .05, *d* = .29.
[9] The speech-wave avatar may elicit more accurate reports (*M* = 89.80%, *SD* = 5.18) compared to that of the human interviewer (*M* = 84.84%, *SD* = 5.50), *t*(77) = 3.88, *p* < .001, *d* = .93.

5 but preferred to disclose more embarrassing information to the speech-wave avatar than to the digital-human avatar in Chapter 6. To compare participants' preference for discussing embarrassing information between the speech-wave avatar and a human interviewer face-to-face, the *disclosure* data as a function of Interviewer conditions from Chapters 4, 5, and 6 are combined in Figure 7.5. Adult participants have a slight preference for disclosing embarrassing information to a face-to-face human professional over a speech-wave avatar.[10]

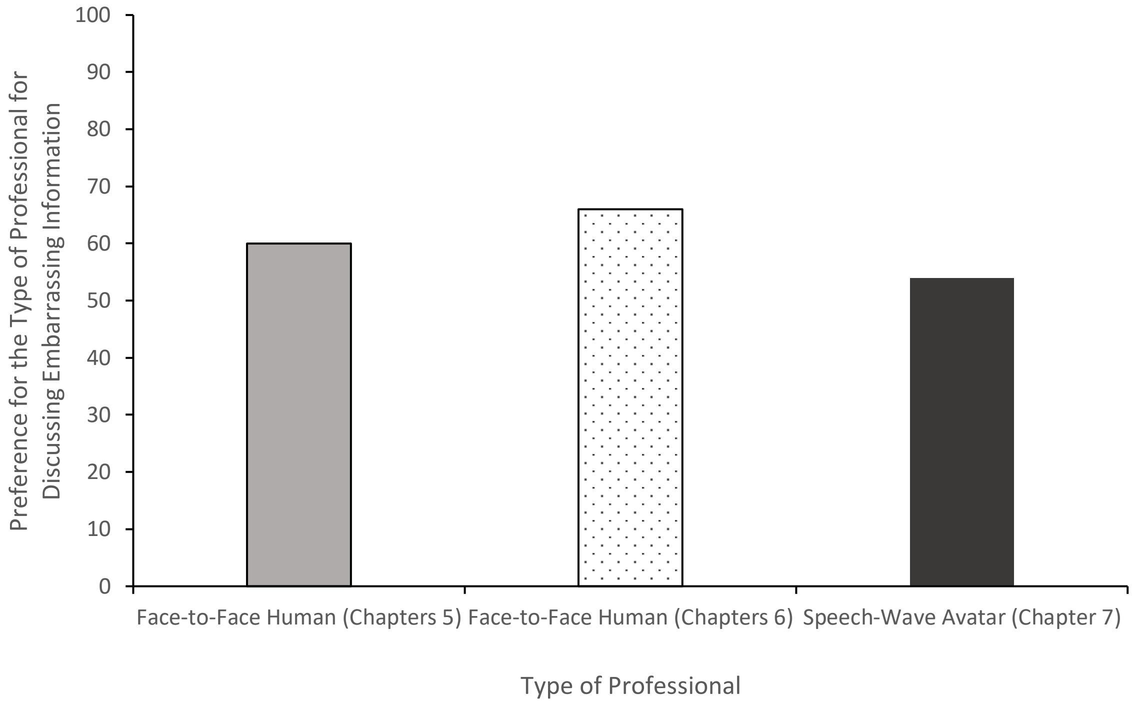

Figure 7.5. A comparison of the percentage of participants who indicated a preference for talking to each type of professional about embarrassing events in Chapters 4, 5, and 6, to talk about embarrassing topics.

When participants were asked to report an embarrassing personal event, they reported more information about that personal event when interviewed by the speech-wave avatar

[10] Participants' preferences for disclosing embarrassing information to a speech-wave avatar (*M* = 54%), and a face-to-face human professional (Chapter 4: *M* = 60%; Chapter 5: *M* = 66%).

compared to participants who were interviewed by the digital-human avatar. Participants also indicated that they would be more comfortable disclosing embarrassing information to an avatar appearing as a female around 45- to 54-years.

Taken together, the present research demonstrated that several factors need to be considered when designing studies that involve avatar evidential interviewers: 1) individual differences in participants' memory performance and responses when an avatar interviewed them, 2) the number of interview sessions, 3) the inclusion of post-event misinformation, 4) the effects of varying topics on information disclosure, and 5) the avatar interviewer's realism and perceived operation.

The findings from the present thesis also provide a glimpse into the potential value of using avatars in evidential and clinical interviewing. First, an avatar's appearance could be tailored to meet an individual's needs during an interview. In the present thesis, adult participants indicated that their preference for disclosing embarrassing information would be to an avatar that appeared as a middle-aged female, and they provided more detailed accounts of an embarrassing personal event to a speech-wave avatar. Additionally, compared to other topics, participants indicated that they would prefer to discuss sex-related topics with a speech-wave avatar rather than with a digital-human avatar.

Second, avatar interviewers may elicit more accurate reports when adult witnesses are repeatedly interviewed. In the present thesis, participants who were interviewed twice by an avatar interviewer provided more accurate reports than did participants who were interviewed twice by a human interviewer. Whether or not you would get the same effect in a forensic or a clinical setting where witnesses and patients are often interviewed multiple times across a number of weeks remains a question for future research. Third, avatar interviewers may be more beneficial for specific populations. In the present thesis, participants with low conscientiousness provided more accurate reports and were less susceptible to post-event misinformation when a digital-human avatar interviewed them.

Finally, a fully-automated avatar system could address staff shortage issues. As shown in the present thesis, I could not detect differences in adults' memory performance when interviewed by either the avatar or the human interviewer. On this basis, automated avatar interviewers could be deployed in regions that lack forensic interviewers as an alternative to using human interviewers via teleconferencing. Although I did not examine the effects of a fully-automated avatar, Lucas et al. (2014) has argued that it is the perceived operation of the avatar, rather than the actual operation, that impacts adults' responses to an avatar. In future studies, researchers could test this argument by directly comparing the effect of a fully-automated avatar versus a human-operated avatar in the context of evidential or clinical interviews. Furthermore, a 'new normal' may have been established with people's social experience with machines in Generation Z (people born after 1996), Millennials (people born between 1981 and 1996), and possibly some older generations. That is, in this day and age, humans may have adapted to technology as an integral part of our society, treating non-human interviewers in much the same way as they treat human interviewers—as technology has evolved, humans have evolved with it. In the present thesis, my samples consisted almost exclusively of young adults aged between 18 and 30. In future studies, however, it will be important to examine the effects of avatar interviewers across the lifespan.

Limitations

As with any research, the current research has limitations. First, all of the avatars that I tested in the present thesis were voiced by a human. Given this, it is possible that participants may have considered that the avatar was a human and as such, responded differently than if they had thought that the avatar was a computer. Second, in the introduction of my research, I placed considerable emphasis on two aspects of interviewing;

high pressured environments and the characteristics of the interviewer. However, in the present thesis, I did not directly induce stress/pressure during the interviews because as a starting point to the research, I wanted to examine the effects of avatar interviewers in more controlled environments. Introducing pressure during interviews to more closely resemble real-life interviewing conditions will be an important avenue for future research in this area. Third, I also did not manipulate the avatar interviewer's characteristics and appearance for the same reason described above—I initially wanted to explore the effects of one type of avatar interviewer as a preliminary step to future research. Finally, the sample sizes that I used in my experiments meant that my studies may have been underpowered. Post hoc analyses revealed the power for each of the experiment was between .70–.79 for detecting a medium effect size (f^2 = .25). This is less than the conventionally accepted power of > .80 and may not be sufficient to detect differences between avatar and human interviewers. However, in the current research, our goal was to assess the utility of avatar interviewers for use in a range of contexts so we were really most interested in detecting large effects. Inputting a large effect size (f^2 = .40) into the post hoc power analysis revealed that the power achieved for each of the experiment was > .90.

The Theoretical Model of Social Influence

By and large, the Theoretical Model of Social Influence can account for many of the findings from the present research. Recall that individuals' social experience with an avatar is primarily dependent on two variables: the avatar's *realism* and *agency* (Blascovich, 2002). To summarise, *realism* refers to the degree to which an avatar appears and behaves in a way that is similar to the object it represents and *agency* refers to people's perception of the avatar's control—that is, whether an avatar is controlled by a computer system or a concealed human. Simply put, according to the model, individuals should respond to a human-operated, realistic-looking avatar in the same way that they would to another person (see Figure 7.6).

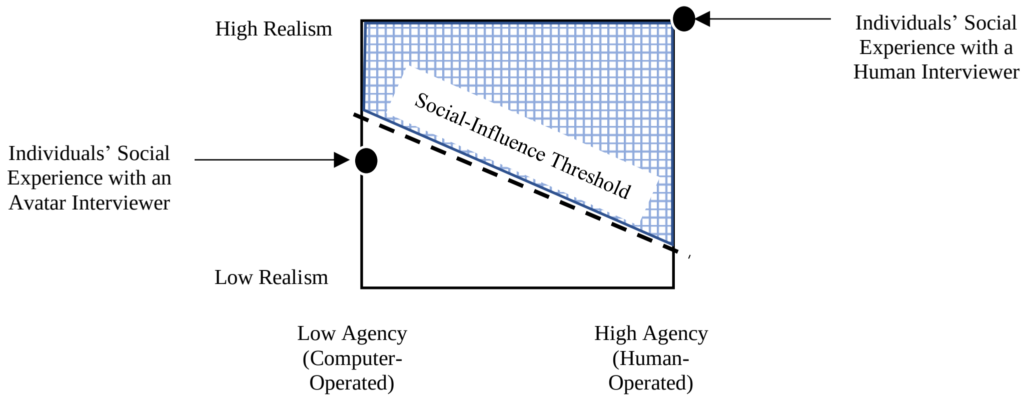

Figure 7.6. A conceptual illustration of the Theoretical Model of Social Influence (adapted from Blascovich, 2002).

For the sake of simplicity, in the present thesis, a linear relation between an avatar's *realism* and *agency* denoted people's social experience with an avatar, and only one aspect of realism was examined (i.e., anthropomorphism). People's social experience, however, is more likely nonlinear, and an avatar's *realism* and *agency* is dependent on several factors. For example, realism includes both visual realism and behavioural realism (see pp.156–158, for a discussion on an avatar's realism). Furthermore, visual realism involves a handful of dimensions that could impact a human-avatar interaction, for instance, attractiveness (e.g., Callcott & Phillips, 1996), anthropomorphism (e.g., Ahmadi et al., 2017), facial expressions (e.g., Van Der Heide et al., 2012), or fidelity (Kang & Watt, 2013). Behavioural realism, on the other hand, also includes many variables that could affect human-avatar interaction, such as an avatar's movement and social appropriateness during an interaction. To complicate things even more, individuals' experience with an avatar also depends on the interaction between an avatar's visual and behavioural realism (e.g., Bailenson et al., 2006), and when an avatar's realism appears 'almost human,' individuals respond repulsively to that avatar. This phenomenon is known as the 'uncanny valley effect' (Mori et al., 2012; see pp. 21, for a discussion of this effect). Furthermore, recall from previous chapters that a threshold—known as the social-influence threshold—exists for people's social experience with an avatar communication partner (see Figure 7.6). Once the social influence threshold is reached for a particular situation or task, individuals may respond similarly to another conversational partner that also reached this threshold (Blascovich, 2002). The social influence threshold is not fixed; it changes depending on the situation or task, and the individuals' awareness or involvement during that task with an avatar. Additionally, different thresholds may exist simultaneously during a single interaction with an avatar (Blascovich, 2002). To summarise the different social-influence thresholds in the present thesis, Figure 7.7 shows the different social-influence thresholds for participants' verbal interaction, disclosure, and responses to free- and directed-recall questions when an avatar interviewed them.

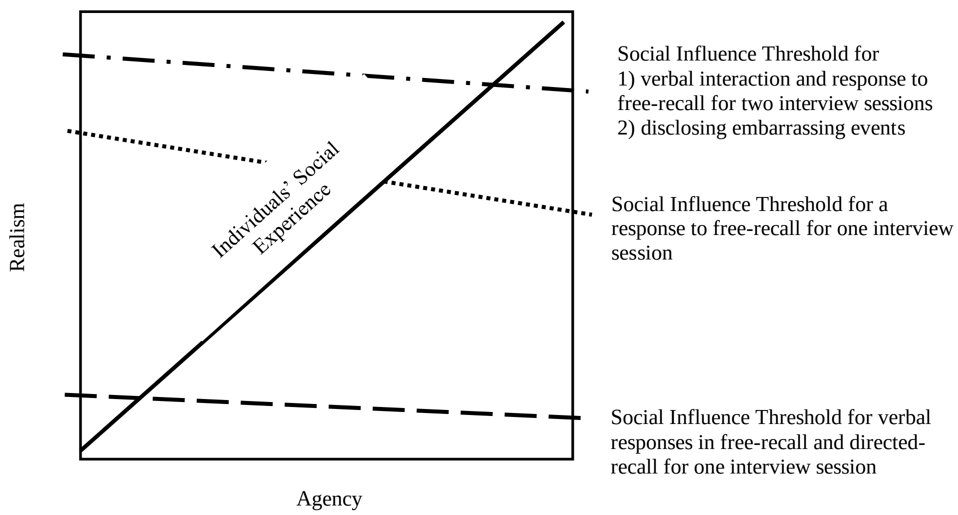

Figure 7.7. A conceptual illustration of the Theoretical Model of Social Influence with different social-influence thresholds.

More specifically, the *long-dash line* shown in Figure 7.7 represents the social-influence threshold for participants' verbal interaction with an avatar during free recall and their responses to directed-recall questions when they were interviewed once by an avatar interviewer. The social-influence threshold is low for verbal interaction and directed recall because these tasks are associated with automatic cognitive responses (see Quamme et al., 2004). Participants' interaction with an avatar with low realism could reach this low-social influence threshold. When the social-influence threshold is reached, participants' interaction with that avatar would be comparable to that of another avatar that also reached this threshold or a human face-to-face. In this case, I would predict that participants would be as talkative and respond to directed-recall questions in a similar manner when an avatar with low or high realism, or a human interviewer interviewed them.

Second, the *dotted line* shown in Figure 7.7 shows the social-influence threshold for participants' responses with an avatar during free-recall when an avatar interviewer interviewed them twice. The social-influence threshold falls somewhere above the midpoint of participants' social experience with an avatar because free recall is associated with more conscious responses (see Quamme et al., 2004). In this context, participants are likely to fall short of the social influence threshold during free-recall when they interact with an avatar that is perceived as computer-operated. That is, participants would respond differently to an avatar and a live human interviewer when they perceive the avatar as computer-operated. On the other hand, participants reached the social-influence threshold during free recall when an avatar that is perceived as human-operated interviewed them; specifically, participants would respond to an avatar that is perceived as human-operated and a live human interviewer in a similar manner. In the former situation, participants would provide higher quality free-recall accounts to an avatar interviewer compared with a human interviewer; in the latter situation, participants would provide free-recall accounts of similar quality compared to a human interviewer.

Finally, the *dot-dash line* shown in Figure 7.7 illustrates the social-influence threshold for participants' verbal responses during free recall when they were interviewed twice.

Additionally, the line also represents the social-influence threshold for participants' response to an avatar professional during their disclosure of embarrassing personal events. The social-influence threshold is high for participants' verbal responses with an interviewer that they have met twice because their interaction potentially became more meaningful over multiple meetings (see Feyereisen, 1994). In this context, the social-influence threshold for responding to an avatar across two interview sessions may be elevated to the point that even with a highly realistic avatar, participants' responses during free recall may never reach the level of that with a human face-to-face. Furthermore, the social-influence threshold is also high for participants' social experience with an avatar during disclosure of embarrassing information because disclosing embarrassing information is also associated with more conscious responses (see Beer & Keltner, 2004). Participants' interaction with avatars would only reach the social-influence threshold when the avatar is somewhat more realistic. Once the social-influence threshold is reached, the quality and quantity of participants' disclosure with that avatar would be comparable to that of a human face-to-face. By comparison, for interactions that fail to reach the social-influence threshold, for example, in the case of a less-realistic avatar, the quality and quantity of participants' disclosure with that avatar would be different to that of a human face-to-face (i.e., participants may disclose more or less information depending on the avatar's realism with respect to the effects of the *uncanny valley effect*).

In general, the Theoretical Model of Social Influence can explain many of the patterns of findings in the present thesis on adult participants' responses to an avatar interviewer. The key points of this model are 1) individuals' social experience with an avatar is complex and nonlinear, 2) individuals' social experience with an avatar is dependent on the avatar's realism, operation, and the digital environment in which the avatar is displayed, and 3) different social-influence thresholds can exist simultaneously for different tasks or situations.

Generalisability of the Theoretical Model of Social Influence. The Theoretical Model of Social Influence explained many of the patterns found in the present research on adult participants' responses to an avatar interviewer. Findings from other studies that have compared the effects of avatars of varying degrees of realism on participants' social responses may address the question: Does the Theoretical Model of Social Influence also account for other findings in the current literature on human-avatar interaction? For instance, in one study, Kwon, Chalmers, Czanner, Czanner, and Powell (2009) examined the effects of avatars' realism in eliciting social anxiety in 60 university students who were between 21- and 34-years of age. In that study, participants were randomly assigned to one of three avatar conditions that differed in the avatar's realism: 3D realistic digital-human avatar, 3D cartoon-rendered digital-human avatar, and photorealistic human avatar. The avatar interviewers were displayed in an immersive virtual environment. Participants were interviewed by the avatar in their respective interview conditions using nine directed questions. Participants' social anxiety levels were measured using eye gaze and two standardised social anxiety measures.

How well did the Theoretical Model of Social Influence predict the relation between an avatar's realism and participants' social anxiety levels? Given that the feeling of social anxiety is associated with self-conscious emotions, such as embarrassment (e.g., Bas-Hoogendam, van Steenbergen, van der Wee, & Westenberg, 2018; Moscovitch, Rodebaugh, & Hesch, 2012), the social-influence threshold for this particular response is likely to fall somewhere near the midpoint of participants' social experience with an avatar (see Figure 7.7, for social-influence threshold of disclosing embarrassing events). Consequently, participants' responses to all three avatars in Kwon et al. (2009) would be predicted to surpass the social-influence threshold because even the avatar with the lowest realism still showed a certain degree of realism (i.e., a 3D cartoon-rendered avatar). In this situation, participants' social anxiety levels were likely to be comparable across the three avatars.

Consistent with the Model, Kwon et al. showed that, overall, the avatar's realism did not predict participants' social anxiety levels. It is expected, then, that participants might experience lower levels of social anxiety when an avatar with lower realism interviews them because these participants may not yet reach the social-influence threshold. When considered against the backdrop of the present research, I predict that a speech-wave avatar might elicit lower levels of social anxiety. Investigating this prediction further would be a valuable direction for future research.

Exploring the effects of a computer-operated avatar examiner in intelligence tests is another area for future research that may further establish the predictive value of the Theoretical Model of Social Influence (Vrana & Vrana, 2017). The strength of this avenue of research is that different subtests in standard intelligence tests, such as the Weschler's Adult Intelligent Scale 4^{th} edition (WAIS-IV), tap into different cognitive domains. In essence, some cognitive domains are associated with automatic neural processing (e.g., working memory; Soto, Hodsoll, Rotshtein, & Humphreys, 2008) and some cognitive domains are associated with conscious neural processing (e.g., verbal recall; Quamme et al., 2004). The Theoretical Model of Social Influence predicts that a more realistic avatar examiner would match the results obtained from human administration on verbal recall tests because tasks that require conscious processing may have a high social-influence threshold. In contrast, a less realistic avatar examiner would match the results obtained from human administration on working memory tests because tasks that use automatic processing may have a low social-influence threshold.

In sum, the Theoretical Model of Social Influence provides a framework for predicting many of the patterns that were found in the present research and also in the literature on human-avatar interaction. Future research on avatars could benefit from using the Theoretical Model of Social Influence to inform the design of an avatar for specific tasks.

Avatars as a paradigm for studying human behaviour. Avatar systems may also serve as a novel paradigm for studying human behaviour. For example, by comparing people's responses and behaviours with an avatar of different degrees of realism and mode of operation and a human face-to-face, it is possible to determine the degree of automatic (or conscious) responses associated with specific tasks. Recall that a low social-influence threshold exists for tasks or behaviours that are associated with more automatic cognitive processing (Blascovich, 2002). When people's reactions and behaviours are comparable during their interaction with an unrealistic computer-operated avatar and a human face-to-face, then most likely, individuals' experience with that avatar will have reached the social-influence threshold for that particular task or behaviour. Reaching the social-influence threshold with an unrealistic avatar for a specific task response suggests that the response is associated with a more automatic response (e.g., responding in fear or sadness).

This idea has been explored, to some extent, in the present thesis. Specifically, memory associated with directed recall might be related to higher levels of automatic cognitive processing because participants' responses to a less realistic, speech-wave avatar during directed recall were comparable to that of a digital-human avatar. In this case, participants' social experience with both types of avatars reached the social-influence threshold, and their responses during directed-recall were comparable to that of a human face-to-face. If the case had been, that participants' responses during directed recall were different between a speech-wave avatar and a digital-human avatar, then participants' social experience with the digital-human, but not the speech-wave avatar, reached the social-influence threshold. That is, participants' responses during directed recall with a digital-human, but not a speech-wave avatar, would be comparable to that of a human face-to-face. In this case, directed recall might be associated with higher levels of conscious processing (i.e., a higher social-influence threshold that a less realistic, speech-wave avatar would be unable to reach), which was not the case in the present thesis.

Studies from the current literature might also provide corroborative evidence for the claim that an avatar paradigm is a valuable way to study human behaviour. For example, Gallup, Vasilyev, Anderson, and Kingstone (2019) examined contagious yawning in adults who were immersed in a virtual environment with an avatar watching them. In Experiment 4 of that study, 10 participants (Mean age = 20.59 years) watched a series of video clips of people yawning in an immersive virtual reality environment. While participants watched the video clips, an avatar stood to one side of the virtual room facing the participants. This avatar was designed to increase participants' feelings of social pressure from being watched. The social presence of another person is linked to inhibited contagious yawning (e.g., Bartz, Zaki, Bolger, & Ochsner, 2011; Gallup, Church, Miller, Risko, & Kingstone, 2016). Subsequently, the same avatar turned its back on the participants during the video clips (i.e., a condition designed to decrease participants' feelings of social pressure from the avatar's presence). A 3D avatar with high visual realism was used in that study. Overall, participants were affected by contagious yawning regardless of the level of social pressure exerted by the avatar. Similarly, in Experiment 5 of that study, participants were affected by contagious yawning irrespective of the level of social pressure exerted by the avatar, even when the avatar displayed high behavioural realism (i.e., realistic movements).

The Theoretical Model of Social Influence could be used to conclude whether contagious yawning is associated with conscious or automatic neural processes. Given that participants' contagious yawning was not influenced by being watched by a highly realistic avatar, it is likely that the social-influence threshold is exceptionally high. In this case, it is possible to infer from Gallup et al.'s (2019) findings that social pressure concerning contagious yawning is associated with more conscious neural processing (see Su, van Boxtel,

& Lu, 2016, on social pressure of contagious yawning and conscious responses). To test this prediction, however, other avatar characteristics need to be incorporated into the procedure. For instance, participants would need to be informed of the avatar's operation; this could be an avenue for future research. In addition, it would also be interesting to examine whether people still exhibit contagious yawning when an avatar yawns rather than when a human yawns. If participants display similar rates of contagious yawning with a less realistic avatar, then contagious yawning is more likely associated with automatic neural processing (see Provine, 2005, on contagious yawning and automatic responses).

Taken together, avatar systems may serve as a novel paradigm to study human behaviour, specifically automatic and conscious neural processing. Traditionally, brain imaging and standardised cognitive tasks, such as the Stroop Test, have been used to study cognitive processes of specific tasks. There are several advantages of using avatar systems to study human behaviour, including experimental control, replicability, and ecological validity (see Pan & Hamilton, 2018, for a review). A caveat, however, of using avatar paradigms to study human behaviour is the generalisability of the results; that is, it is still uncertain whether results from avatar studies on human behaviour can be generalised to human-to-human interaction. More specific details of current psychological theories are needed to guide the design of an avatar system. For example, merely knowing that being observed by other people impedes the rate of contagious yawning is not enough. We need to answer more detailed questions—'what observer characteristics have the most impact?' 'How far away does the observer need to stand to be effective?' 'What actions must the observer perform to influence contagious yawning?' These more specific questions representing a broad range of human behaviours need to be addressed before we employ avatar systems as a robust paradigm for studying human behaviour.

Theory Explaining Theory

The Theoretical Model of Social Influence provides a clear explanation of *when* an individual's social experience with an avatar may be different from that of face-to-face human interaction. Yet, this model does not explain *why* these differences occur. Social psychology and communication theories that explain human-to-human social exchanges may provide a basis for understanding human-avatar interactions. Specifically, Uncertainty Reduction Theory, Social Cognition Theory, and Expectancy Violations Theory in isolation or in concert may provide some explanations for the differences between an individual's interaction with an avatar and a human face-to-face.

Uncertainty Reduction Theory. Uncertainty significantly diminishes our ability to predict and bring order to possible future events, which can lead to anxiety (see Grupe & Nitschke, 2014, for review). In the context of social communication, uncertainty exists in an initial interaction. Uncertainty Reduction Theory posits that when meeting someone for the first time, people have no prior understanding of how that person thinks or behaves (Berger & Calabrese, 1975). This situation creates uncertainty, and one of the goals of this initial interaction is for people to reduce this uncertainty to understand better and predict another's behaviour (e.g., Berger & Calabrese, 1975; Clatterbuck, 1979). There are a handful of approaches in which people can reduce uncertainty about another person during an initial meeting, one of which is to observe nonverbal communication cues. Nonverbal cues—gestures, facial expressions, appearance, and movements—are the most salient features available during the initial interaction. Nonverbal cues provide valuable information about a person (see Foley & Gentile, 2010, for using nonverbal cues in psychotherapy). When we adapt Uncertain Reduction Theory to an initial interaction with an avatar, people may also seek nonverbal cues exhibited by an avatar in an attempt to reduce uncertainty and better understand and predict the avatar's behaviour (Nowak & Rauh, 2006). Avatars that appear or behave more human-like may reduce this uncertainty because people may be able to apply prior experiences from interacting with another person to their interaction with an avatar (see Social Cognition Theory below).

In the present research, when adult participants were interviewed once by either an avatar or a human interviewer, participants showed similar responses to both types of interviewers. The level of participants' uncertainty towards both interviewers may have been initially equal because the digital-human avatar in the present research had human-like features. Participants may have applied prior experiences from interacting with another person to their interaction with the digital-human avatar (see Social Cognition Theory below). Thus, participants' social experience when the digital-human avatar interviewed them reached the social-influence threshold.

Uncertain Reduction Theory can also apply to interactions with a speech-wave avatar. That is, participants would not be able to use prior experiences from interacting with another person to their interaction with the speech-wave avatar. As a result, communication with the speech-wave avatar in the present research may have created more uncertainty than an interaction with a digital-human avatar. Thus, participants' social experience when the speech-wave avatar interviewed them may not have reached the social-influence threshold.

On the other hand, when participants were interviewed twice by either an avatar or a human interviewer, the level of participants' uncertainty significantly diminished during their second interview with the human, but not with the avatar interviewer. In this case, participants' responses when they were interviewed twice by the digital-human avatar failed to reach the social-influence threshold. Participants' attributions of human-like predictions to the avatar were unable to create a better understanding of the avatar in their second meeting. Participants, in this situation, may ask themselves: "*I wonder how the avatar would act since it does not act like a human?*" They may try to mitigate their uncertainty of the avatar using other alternative explanations and testing their hypotheses with each successive interaction. Future studies could explore participants' feelings of uncertainty and their responses to an avatar across multiple interactions. Furthermore, exploring uncertainty across multiple human-avatar interactions may also explain the different levels of the social-influence threshold across interview sessions. One possibility is that more interactions with the avatar are needed to reduce uncertainty, and subsequently lower the social-influence threshold.

Social Cognition Theory. Social Cognition Theory was derived from Albert Bandura's Social Learning Theory (Bandura, 1986). The central idea of Social Cognition Theory is that there is a dynamic and reciprocal association between people's cognition, behaviours, interpersonal exchanges, and environment. Social Cognition Theory emphasises the importance of interpersonal relationships and the context in shaping people's behaviours and thoughts. Some behaviours and beliefs are reinforced, while others are hindered (Bandura, 1986). People construct 'schemas'—an organisation of ideas and themes—as a result of prior social experiences and environment to shape their future behaviours and interpersonal relationships. From an evolutionary standpoint, humans use schemas and information from the current environment to predict possible future outcomes. These predictions may help ameliorate future adverse events. In the context of social communication, individuals may construct schemas of social norms and etiquette for interpersonal exchanges by using prior experiences with other people. These social schemas may help people understand and predict the behaviours and thoughts of their communication partners.

When interacting with an avatar, people may activate their schemas of prior social experiences with humans to help understand and predict the behaviours of an avatar. Activation of these schemas is more likely to occur when the avatar appears more human-like (see Epley, Waytz, & Cacioppo, 2007), sounds human (see Atkinson et al., 2005; Mayer, Sobko, & Mautone, 2003), or displays appropriate social cues (see Moreno et al., 2001, for a study on Social Agency Theory). For example, a person might think: "*I have never talked to an avatar before, but the avatar has human-like features. I predict that the avatar would display similar social behaviours as that of another person. Therefore, I will use my existing knowledge of a human-to-human interaction to respond to this avatar.*"

Social Cognition Theory could provide some explanation for the findings in the present research. For example, participants responded differently to a less anthropomorphic, speech-wave avatar than did participants who were interviewed by a more anthropomorphic, digital-human avatar. In the case of the digital-human avatar, participants may draw on schemas of social interactions with humans to help shape their social responses to that avatar. On the other hand, the schemas of social interactions with humans do not apply to an interaction with a speech-wave avatar. Thus, overall, participants' social experience with the speech-wave avatar did not reach the social-influence threshold. That is, participants responded differently to the speech-wave avatar than did participants who were interviewed by the digital-human avatar because of the lack of available schemas on human-avatar interaction.

Expectancy Violations Theory. Imagine a situation where a person from a Western country speaks native Mandarin, or a person from an Eastern country speaks native English. These contexts, for some people, may create a violation of their expectations; that is, some people would 'not expect' a person from a Western country to speak native Mandarin or vice versa. This is an example of a negative violation. Negative violations create feelings of uncertainty, whereas a positive violation creates more pleasant feelings towards the communication partner (e.g., a caress from a well-liked, shy boy; see Burgoon, 2015). Still, regardless of the valence of the violation, any expectancy violation subsequently impacts people's responses to their communication partner during social interaction. In a human-avatar interaction, an expectancy violation could occur when a highly realistic avatar behaves non-human (e.g., an avatar that appears human-like but displays odd movements), or when a less-realistic avatar exhibits human-like traits (e.g., a stickman that talks with a human voice and displays human-like gestures; Saygin, Chaminade, Ishiguro, Driver, & Frith, 2011).

In the present thesis, participants may have expected the digital-human avatar to have a human voice due to the avatar's human-like features. As a result, participants responded similarly to both the digital-human avatar and the human face-to-face. In contrast, expectations were violated when participants interacted with a speech-wave avatar that is voiced by a concealed human interviewer. This expectancy violation resulted in differences in participants' responses to the speech-wave avatar compared to the digital-human avatar. Therefore, participants' social experience with the speech-wave avatar did not reach the social-influence threshold. Participants may have perceived this particular violation as favourable because they may feel less distracted and less pressure to respond to the speech-wave avatar. In future studies, researchers could investigate the effects of using the same speech-wave avatar in a therapeutic setting where the therapeutic alliance is important. An expectancy violation, in the case of therapy, may be perceived as a negative violation because participants may have more desire to connect to a more human-like avatar therapist emotionally.

In a nutshell, psychological theories, in isolation or in concert, can explain the differences and the similarities in adults' responses to an avatar and a live human. Some of these theories can explain *why* adults respond differently to an avatar compared to a human if their social experience with that avatar does not reach the social-influence threshold. Other psychological theories can explain *how* adults respond to an avatar in different situations. For example, despite an expectancy violation with a speech-wave avatar, adults reported more information about an embarrassing personal event. Possibly, a myriad of factors may influence a human-avatar interaction. Still, psychological theories supported by robust empirical evidence may provide us with a better understanding of *when*, *why*, and *how* adults respond to an avatar across different contexts. Although in the present thesis, I did not specifically test these theories, it would be beneficial in future research to examine conditions that directly violate each theory, for instance, by exploring the effects on adults' memory performance when an avatar appearing as a female is voiced by a male.

Areas of Application

The findings from the present research on avatars could apply to other areas, such as education and mental health (see Chapter 1, for different areas of application). As I was writing this final chapter, many parts of the world, including New Zealand, went into lockdown due to the COVID-19 pandemic. Many professionals and students were suddenly forced to stay in isolation. Social interactions, meetings, health consultations, and learning were restricted to online exchanges in the comfort (or discomfort) of people's homes. The findings from the present experiments suggest possible applications of using avatars in distant learning. More specifically, the current research showed that a cartoon-rendered digital-human avatar might be particularly useful in engaging adults with low conscientiousness. Low conscientiousness individuals tend to be less motivated and less efficient in completing a task, and often produce low quality work. In the context of education, students with low conscientiousness may be more motivated to complete school work with higher efficiency and quality with an avatar educator.

The present experiments also showed that the avatar's appearance influenced adult participants' memory performance, and that participants showed selective preferences for an avatar's age, gender, and possibly ethnicity. These findings suggest that an avatar educator with features that resonate with the content of the teaching material may influence participants during knowledge acquisition and testing. For example, an avatar designed to mimic a butterfly may have more impact on students' learning in the Butterfly House at Otago Museum than would a live human instructor; or students may prefer to learn about Egypt from an avatar designed to appear as a mummy than from a live teacher. The effects of these types of avatar educators on learning and memory are an avenue for future research.

Concerning mental health, patients with low conscientiousness may be more willing to report their concerns to an avatar clinician, with higher accuracy. Willingness to report details of an event with personal significance, especially events that are associated with shame and stigma, is particularly important in psychotherapy. For example, topics related to child sexual abuse or related sexual trauma is often the root of many presented difficulties in therapy. The present research showed that adults might provide more details of an embarrassing personal event with higher quantity and quality to a speech-wave avatar.

Next, the findings from the present research on the impact of an avatar's realism may apply to the design of virtual-reality exposure therapy for patients with specific phobias. For example, spider phobia—an intense fear of spiders—is commonly seen in outpatient settings. The gold standard evidence-based treatment for spider phobia is exposure therapy (e.g., Raeder, Merz, Margraf, & Zlomuzica, 2020). In exposure therapy, patients with spider phobia extinguish their fears through exposure to spiders. This exposure is often not practical in therapy sessions. Furthermore, the adherence rate for remaining in exposure therapy is low due to the intense fear that is associated with this type of treatment. Researchers have proposed using 'virtual spiders' as an alternative form of exposure. The results of the present research suggest that higher realism does not always equate to optimal task performance. Specifically, in the present research, a less anthropomorphic, speech-wave avatar elicited more details of an embarrassing personal event that did a more anthropomorphic, digital-human avatar. It is then possible that virtual spiders with higher realism may not be necessary or may even hinder the effects of exposure therapy because a low social-influence threshold exists for using virtual spiders to elicit fear in people with spider phobia because fear is an automatic response (e.g., Öhman & Soares, 1993). On this note, however, the results of exposure to a virtual spider with low realism may not generalise to spiders in the physical world. The impact of virtual spiders' realism on virtual exposure therapy is another interesting direction for future research.

Another area of application worth mentioning is the use of an avatar examiner for administering automated intelligence tests. The data obtained in the present research on avatars' realism and operation, together with the Theoretical Model of Social Influence, can be used to inform the design of an avatar-based automated intelligence testing system. Such a testing system could reduce or even eliminate frequent administration and scoring errors in intelligence testing (see Styck & Walsh, 2016, for a meta-analysis). Furthermore, an avatar-based intelligence test could address the current challenges in the New Zealand context; that is, a shortage of trained professionals (especially Māori professionals), the time required to complete a clinical assessment, and the broad geographical coverage of each District Health Board.

In summary, there are vast areas of application for avatars. The findings from the present research provide empirical evidence for predicting the utility of human-avatar interactions in forensic contexts, as well as in education, mental health, and the list goes on and on. The effects of avatars in other areas of application are empirical questions that await future researchers and professionals to answer.

Ethical Implications of Avatar Interviewers

Despite some promising findings in the present thesis, several ethical implications need to be considered before we would recommend integrating avatar interviewers into widespread use. First, to effectively use avatars in the field, current guidelines in forensic interviewing and telehealth need to incorporate the latest research findings and recommended best-practice for using avatar interviewers. For example, who would benefit from being interviewed by an avatar? Are avatars effective (or a detriment) over multiple interview sessions? What are the procedures for handling technical issues during an interview? In addition, regular training and supervision would be needed to keep the technology up-to-date with the latest research findings.

Second, as with any digital system, information privacy and confidentiality are potential issues for conducting remote interviewing, especially with using avatar interviewers. By way of example, there was a news item about a father who was being interviewed via teleconferencing about a serious subject. During the interview, his two children went into the room (Willingham, 2017). With avatars, respondents are unable to see the actual human interviewer on their screen. This pose as an ethical issue as there could be people watching and listening to the interview that the interviewee is unaware of. Interviews conducted remotely by avatar interviewers are also at risk of eavesdropping or being hijacked because the flow of information through digital networks is often unencrypted. Securing a communication line is the first step to conducting remote interviews using avatars. Even with this admission, however, system administrators and computer engineers have access to data that flows in and out of a network. The ability to maintain adequate security and confidentiality are challenges for future policymakers.

Finally, a critical consideration in health settings in particular is the procedure for reporting any serious or imminent risk to patients or clients. Health professionals have ethical responsibilities to report risk if they are concerned with the patient's safety. Simply identifying potential risks without support for the patient may *open up a can of worms*, leaving the patient in a vulnerable state. Procedures and policies around risk specifically related to avatar interviewers are essential before their addition to the interviewer's toolkit.

Final words

As technology continues to advance at a rapid pace, the application for avatars is only going to continue to grow. For centuries, humans have designed machines with one goal: to be the same or better than us. Even in the 1950s, people developed computers to beat humans in chess. Currently, we are seeing a surge in the invention of avatar systems that can mimic human appearance, behaviours, thoughts, and even emotions (e.g., Soul Machines and Facebook's Codec Avatars). But are avatars that mimic humans better? The patterns found in the present research suggest otherwise, at least for some tasks. These patterns suggest avatars as an alternative rather than a replacement to humans. When we think of avatars as our replacements, our opinions of avatars are negative; when we think of avatars as tools, our views of avatars may become more positive. Maybe as psychology researchers, we should think about optimal approaches to designing machines that can aid humans in performing tasks rather than creating tools that can take our place.

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Appendices

Appendix A

Interview Protocol used for the experiment described in Chapter 3

EXPERIMENTER

You may have already guessed but the real purpose of the study isn't to rate the video that you saw yesterday (last time) but instead to see how much you can remember about it. The reason that we didn't tell you the real purpose first, was because we wanted to see how much you can remember without having rehearsed it.

This is Ana (it's a computer animation) and she's going to talk to you about the video (You can talk to it and it will respond).

ANA

Hi, my name's Ana. As you can see, I have a microphone here. It'll record our conversation so that I can remember everything you tell me. Sometimes I forget things and the recorder allows me to listen to you without having to write everything down.

Start the interview by saying:

Tell me everything that you can remember about what happened in the video from the beginning to the end.
[Use only minimal responses, reflections and paraphrases, or encouragement, to keep the conversation going.]

[The only other thing that you can say is:]
Is there anything else you can remember that you haven't already told me?

I'm going to ask you some questions now. You may have already told me about these, but just tell me again anyway.
[After each question, wait for an answer.]
[If the participant doesn't answer, repeat the question.]
[If the participant says, "I don't know," move to the next question.]

1. **In the video, Maire chases after a dog. What kind of dog was it?**
2. **At the police station, Maire was given a bear. Who gave her the bear?**
3. **The policeman takes Maire back into the foyer. What do they do with the bear when they leave?**
4. **In the video, Karen goes into Know Row and asks a man if he has seen Maire. What does he say?**
5. **In the video, the policeman asks Maire for her address and phone number. What is her phone number?**
6. **Karen meets an old friend. What is her friend's name?**

Appendix B

Interview Coding Scheme used for the experiment described in Chapter 3

Free-recall phase

Tell me everything that you can remember about what happened in the video

- one point for each item of information correctly reported in response to the free-recall question. E.g., the participant would receive four points for the statement, "The child got distracted by the dog and just ran after it"
    - A **new object** (e.g., person/thing) is given one point.
        - E.g. 1: "The child got distracted by the dog and just ran after it." would receive two points for the objects because the two objects were new.
        - E.g. 2: "The child got distracted by the dog. **The child** cried." would receive two point for the objects because the second child in bold is not a new object—this does not receive any points.
    - A **new action-object pair** (e.g., dog running) is given one point.
        - E.g., 1: "The child got distracted by the dog and just ran after it." Would receive two points for the actions because the action-object pair (i.e., child ran after it) is new.
        - E.g., 2: "The child got distracted by the dog and just ran after it. The **child kept on running after the dog**." would receive two points for the actions because the action-object pair (i.e., child and running after the dog) is not new.
        - E.g., 3: "The child got distracted by the dog and just ran after it. The cat ran after the dog" would receive three points for the actions because the action-object pair (i.e., cat ran after) is new.
    - **Repeated action and/or object in a scene switch to help give context** to the narrative is given one point.
        - E.g., 1: "The child got distracted by the dog and just ran after it, and the cat laughed at the child. While the child got distracted by the dog, he realised that the cat was laughing." Would receive two points because these two clauses gave context to the narrative (i.e., because the child was distracted by the dog, s/he noticed the cat was laughing).
        - E.g., 2: "The mum met up with her friend and they talked. The policeman found Sally. While the mum's talking to her friend, she realises that Sally is missing." would receive two points because these two clauses gave context to the narrative (i.e., sally is missing due to the adults talking).
- In instances where participants changed their responses, only their last response is to be coded;

Specific Questions

- Code as correct or incorrect