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INTELLIGENT VIRTUAL AGENTS TO PROVIDE SUPPORT TO YOUNG PEOPLE AND YOUNG ADULTS

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To My Mum,

To The Soul of My Dad,

To my Only Brother,

To my Only Sister,

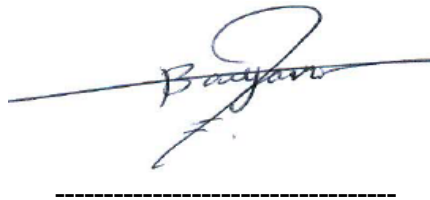
To My Lovely Children,
Handsome “Wesam” and Beautiful “Talleen”

& To My Lovely Husband

The work in this thesis has not been submitted for a higher degree to any other university or institution.

Ethics project entitled: "Virtual Humans to Provide Support to Young People and Young Adults"

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A handwritten signature in black ink, appearing to read 'Bayan', is written over a horizontal dashed line.

Bayan M Alsharbi

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Abstract

An intelligent virtual agent to provide support to young people and young adults with chronic conditions to improve their adherence to treatment advice is an important matter and complex due the psychosocial barriers involved. Empathic agent technology involves the use of animated computerized characters designed to build long-term trust-based socio-emotional relationships with users. Therefore, to establish a strong long-term trust friendship, we wanted to investigate whether users have different preferences on the appearance of the virtual character. In this thesis, we used Mixamo and Unity3D to design twelve models then we distributed among participants to interact with all of them to investigate their preference about the avatar they like to receive help from to serve our common goal of adherence. As a result, a wide investigation about what sort of character is needed based on participant demographic, personality, depression, anxiety, and stress level. We found that female character is the most preferable gender to most participants while the character age needs to be similar to the participant in range. Of course, personality, depression, stress, and anxiety affects and influence the selection of an avatar and some results confirm the need of a virtual character to provide support to young people and young adults.

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1 Chapter 1: Introduction

Research has found that learner relationships (teacher and peer) involving computer-based learning are similar to the equivalent human-human learning relationships in the classroom (Gulz, 2004). Pedagogical agents, a subclass of Intelligent Virtual Agents (IVAs), have been found to be able to provide a mentoring role to aid student learning (Johnson et al., 2000).

More recently, there is an interest in affective agents who are able to express emotions. The work on empathetic or empathic agents goes even further as the IVA seeks to demonstrate understanding of the emotional state of the human and respond in a way that is supportive. The main focus behind this study is to design a suitable character/avatar that adolescents (or young people aged 13-17) and young adults (aged 18-30) would want to interact with, with the future goal of deploying an empathic IVA that acts as a peer, confidante and mentor to provide education, motivation and support to these age groups.

This study is particularly motivated to design a suitable character that could be used in such roles in the health domain. Healthcare technology is growing at a rapid speed and in most hospitals; technology is being used in many departments. According to Acton (2012), these technologies are geared towards ensuring that the patients are served in a good manner. There are some ways in which technology is changing the healthcare sector, game technology is a good example of innovative technology that is showing promising result, particularly with adolescents (Berkowitz and McCarthy, 2012). Due to the appeal of game technology, we propose that intelligent virtual agents could play an important role in addressing issues related to adherence to medical treatment advice, particularly among adolescents with chronic conditions.

The high prevalence of the non-adherence to medication among adolescents is worrying. Studies that were conducted by (Bosworth, 2012) indicate that the lack of adherence to medication is the main cause of treatment failure in long-term paediatric conditions and low adherence to the prescribed medication leads to morbidity and medical complications. According to Desai and

Oppenheimer (2011), adherence can be defined as the extent to which people follow the agreed prescriptions. For acute conditions, adherence to medication ensures that the disease clears in a fast way, complications are eliminated; the diseases are effectively managed among other benefits. For chronic conditions, adherence to medication ensures that the condition is managed and comorbidities are minimised. When adolescents lack adherence to medication, it could be as a result of various factors. Some of the factors include emotional issues, family dysfunction, and hopelessness among other factors (Desai and Oppenheimer, 2011).

Accordingly, intelligent virtual agents to provide support to adolescents with chronic conditions to improve their adherence to treatment advice is an important matter and complex due the psychosocial barriers involved. These barriers, which make them poorly adhere to a chronic disease, include lack of support, stigma and discrimination (Madru, 2003), health provider-patient relationship (O'Donohue and Levensky, 2006), and religion and cultural beliefs (Payne et al., 2013).

Our long-term future goal is to design an empathic virtual friend using agent technology to motivate and help them increase adherence to the recommended treatments of a chronic disease. Empathic agent technology involves the use of animated computerized characters designed to build long-term trust-based socio-emotional relationships with users. They have been used with positive outcomes for weight loss (Watson et al., 2012) , quit smoking, coaching and even medication adherence (Bickmore et al., 2010) purposes; but their use to provide social support and with adolescents is largely unexplored.

To be successful and serve the long-term goal, the agent needs to build and maintain a long-term relationship (Leite et al., 2009). Establishing rapport will play an important role in achieving this. This short-term study seeks to look at the type of character that is appropriate for this role. This role could be in the education or health context. In order to maintain a long-term relationship to achieve the major goal, finding the preferences of the character's age, gender, ethnicity, and

environment, for a young person is the major scop of this study as well as investigating the relationship between the target group's personalities and their preferences.

1.1 Project Goals

This section provides the long-term bigger project aims and the current goal of this short-term project, which is the scope of this study.

❖ This long-term bigger project has the following goals and aims:

- 1) To investigate the impact of an empathic virtual agent that acts as a peer, confidante and mentor to provide education, motivation and support to adolescents with chronic health conditions
- 2) To increase understanding of the potential role of empathic agents to provide support to chronically ill adolescents and overcome the socio-psychological barriers to their adherence behaviours
- 3) To discover adolescents' attitude toward virtual systems not within the usual entertainment context. By using a face-to-face conversational style of communicating with an empathic agent, the project seeks to overcome health literacy barriers, while offering the benefits of accessibility while maintaining privacy and anonymity.

❖ The current goal of this short-term project has the following goals and aims:

- 1) The short-term project aims to investigate: the characteristics of character/avatar/model (which will be used interchangeably) needed for interaction by either a young person (13-17 years old) or young adult (18-30 years old).
- 2) Investigate the preference of the target group in terms of age, gender, and ethnicity and find out which of these has the most impact on the selection.
- 3) Discover the relationship between a target group personality and their preferences as well as their depression, anxiety, and stress level verses their preferences.

As part of this investigation a number of factors are considered such that on the character side we have taken into account three factors for a character, namely, age, gender, and ethnicity. While in the participant side, we investigate their personality according to TIPI Personality Test (Gosling et al., 2003) and other symptoms like depression, stress and anxiety which can be investigated through DASS21 Test (Lovibond and Lovibond, 1995). We also measure some dependant variables such as preferences, rapport, and outcome of the experience.

1.2 Research Questions

In line with the aims of this project, the specific research questions investigated in this study are:

- I. What sort of character would a young person (13-17) or young adult (18-30) want to interact with in a helping role?
- II. What sort of matches between the person and the character in terms of age, gender, and ethnicity are preferred?
- III. What is the relationship between a target group personality and their avatar preferences?
- IV. What is the relationship between a target group's levels of Depression, Anxiety and Stress and their avatar preferences?

1.3 Innovation/Contribution/Outcomes

A small number of studies have considered using technology-based methods, such as reminders and SMS (Haynes et al., 2008), in urging the patient to adhere to their treatment. Although these technologies may help in overcoming the cognitive reasons (memory), they do not provide an interactive and social approach to address the behavioural and the psychological reasons. Moreover, none of the current technology-based methods consider the needs of adolescents while having medical treatment. Navally, the long-term project aims to discover the influence of different emotions integrated in an empathic agent on treatment adherence considering different stages of treatment (early or late), treatment strategies (complex, multiple-times, change lifestyle), poor

adherence reasons (cognitive, psychological, behavioural and social) and treatment symptoms (physiological, psychological,...etc.).

This short term project contributes to this larger goal by clarifying what features might be appropriate for a character with whom the young adult or young person is willing to interact in a helping role. A study was conducted that explores three factors, namely preference for character gender, age and ethnics appearance. The preferences are correlated with these features in the participant as well as their personality and depression, anxiety and stress levels to understand what differences exist for different types of users.

1.4 Thesis Outline

Chapter 2 of this thesis presents the literature review and relevant works.

Chapter 3 of this thesis presents the methodology used to answer the research question and experimental procedure used to achieve the research goals and answer the research questions. Different parts of the online study will also be provided.

Chapter 4 of this thesis presents the results of the data collected, how it has been analysed and the outcome of the data analysis.

Chapter 5 of this thesis presents the conclusion and final remarks.

2 Chapter 2: Literature Review

In this chapter we introduce the literature, which covers both the long-term goal and the short-term goals. In section 2.1 we discuss the non-adherence to treatment while section 2.2 investigates the main factors that affect adolescents in a treatment. Section 2.3 introduces the empathic virtual agent followed by Section 2.4 that describes the use of IVA in healthcare in general. Section 2.5 discusses adolescents and IVA technologies while section 2.6 shows some of the current systems. Finally, 2.7 covers the literature on characters and the findings concerning what gender, age or ethnicity has been found to be most appropriate.

2.1 Non-adherence to treatment advice

The high prevalence of non-adherence to medication among adolescents is worrying. Studies that were conducted by (Bosworth, 2014) indicate that the lack of adherence to medication is the main cause of treatment failure in long-term paediatric conditions. The study by Dayer et al. (2013) found that low adherence to the prescribed medication leads to morbidity and medical complications.

According to Desai and Oppenheimer (2011), adherence can be defined as the extent to which people's behaviour matches with the agreed prescriptions. When the adolescents lack adherence to medication, it could be as a result of various factors. Some of the factors include emotional issues, family dysfunction, and hopelessness among other factors.

Lack of adherence to medical treatment advice is a pervasive and potentially life-threatening problem. (Fenerty et al., 2012) reported that up to 30%-50% of patients are expected to adhere poorly to treatment protocol. A statistical analysis was performed to compare between adherence in groups who received reminder interventions and control groups who did not receive reminders. The meta-analysis showed significant increases in adherence for the groups which received reminders such that 66.61% compared to 54.71% to the controlled group with no reminders system. Consequently, Reminders-Based Intervention has the ability to improve adherence to everyday medication. However, some interventions used in the literature are shown to be impractical such as phone call reminders, text messages, pagers, voice response systems, video-telephone calls, and audio-visual reminder devices (Fenerty et al., 2012).

2.2 Analysis of Several Factors Affecting Adolescents in Treatment

This section is divided into three subsections. The first subsection will evaluate the psychosocial barriers to the medication adherences and the approaches that can be used to reduce them. In the second subsection, the main reasons for non-adherence will be discussed. Finally, in subsection three, approaches to reduce psychosocial factors in drug non-adherence will be detailed.

2.2.1 Psychosocial Barriers to Adherence

A concern faced by paediatricians, nurses and other medical professionals is lack of medical compliance among the adolescents. “(Falvo, 2013) study defines the barriers as something that impedes or separates”. In this case, the psychosocial barriers can be defined as psychological and interpersonal factors that impede the compliance to medication and other recommended treatments such as fitness or diet programs. Non-compliance with treatment advice can be as a result of many factors that include lack of support, stress and depression, cultural and religious factors. In this thesis, we are designing virtual avatar based on participants needs in order to support them to use it to avoid psychosocial barriers and accordingly improve adherence. Thus, investigating these barriers is essential.

Some factors that affect patients' adherence to medical regimes are also identified. In fact, more than 40% of patients sustain significant risk by misunderstanding, ignoring, or forgetting some advices from health-care providers (Martin et al., 2005). Also, they classified the factors, which may affect adherence to cognitive factors, interpersonal factors, patient involvement, patients' attitudes, cultural variations and depression (Martin et al., 2005).

Considering the fact that children's adherence is further complicated by the difficulties that can be associated with administering a certain treatment due to child resistance and power struggles in combination with family relationships (Santer et al., 2014).

A wide agreement on set of key factors to improve adherence are stated such as, realistic assessment of patient's knowledge and deep understanding of the regime, affective communication between the provider and the patients, nurturance of trust in the therapeutic. When it comes to adolescents, additional socio-emotional factors exist, as reported in a recent meta-analysis of the literature (Hanghøj and Boisen, 2014). Relation to peers, parents, and health profession were introduced as socio-emotional barriers. Other factors also detailed are adolescents' development and how they feel themselves between the freedoms and being under ill's control? One of the major factors in the study is physical and mental illness along with the side effect of an illness on one

hand, and mental well-being from the other hand cause stress for adolescents because living with chronic disease is stressful to some patients in general. Finally, other factors to be considered are forgetfulness, financial cost, and complexity of the medicine.

A recent study reviewed interventions for enhancing medication adherence. A great summary of interventions has been provided such as: telephone consulting for HIV patients, checklist diary for type 2 diabetes, and pharmacist care intervention for type 2 diabetes as well (Nieuwlaat et al., 2014).

Aboriginal communities and diabetes was a problem introduced (Battersby et al., 2008) to be solved using a pilot program, which intend to use Flinders model of self-management (Battersby et al., 2008). In the study, social problems, lack of preventative health service, and time pressure on staff, are barriers faced aboriginal to adhere properly.

2.2.2 The Main Reasons for Non-Adherence

2.2.2.1 *Stigma and Discrimination*

Stigma and discrimination have been faced by many of the adolescents in adherence. Stigma can be defined as the reputation that is discrediting in various ways. Stigma according to Hanghøj and Boisen (2014) definition makes an individual undesirable in the eyes of others.

According to Kinsey-Steele (2012), many adolescents who suffer from chronic illness have stopped taking their medication. (Madru, 2003) notes that stigma has led many of the adolescents who were taking Anti-retroviral (ARV) drugs to stop. Some of the adolescents taking medication for HIV/Aids, asthma among other chronic illnesses have faced violence, rejection, and isolation (Danielle Taddeo et al., 2008). In most cases, these adolescents do not receive social support from their friends and peers that cause psychological issues. The fear of discrimination and stigma has led many to stop their medication. (Madru, 2003) adds that some of the adolescents do not completely stop the medication, but they skip some doses when they are with friends. Skipping is largely contributed by fear, stigma, discrimination or ridicule.

2.2.2.2 *Lack of Support*

When adolescents have been diagnosed with some chronic illnesses, they may either get support or lack it. In some cases, adolescents that have been diagnosed with some infectious illnesses have lack of support from parents or friends (Madru, 2003). In such situations, these adolescents may stop the medication because of psychological issues. They may get depressed and forget to take the medication. The adolescent with chronic illnesses requires social support,

encouragement, and monitoring of adherence from the family or friends. (O'Donohue and Levensky, 2006) study associates low adherence with adolescents that live in isolation and lack social support.

2.2.2.3 Healthcare Provider-Patient Relationship

Another psychosocial barrier towards drug adherence among the adolescent is the relationship with the healthcare providers (O'Donohue and Levensky, 2006). In most cases, a bad relationship between the two leads to non-adherence. Since the adolescents have not matured completely, they require support from the healthcare providers. Poor practices from the healthcare providers that include condemnatory behaviour, stereotyping patients, homophobia among other wrong practices may lead to non-adherence (Rapoff, 2009).

2.2.2.4 Religious and Cultural Beliefs

In some cultures, various factors influence the treatment choices. According to Payne et al. (2013), the cultural and the religious practices may also lead to non-adherence. (Rapoff, 2009) study indicates that health-care providers are facing a threat from the religious and traditional healers. Since adolescents may not voice their fears, they may choose what their parents propose. In this case, many adolescents do not comply with the medication.

2.2.3 Approaches to Reduce Psychosocial Factors in Drug Non-adherence

2.2.3.1 Psychoeducation

Psycho-education is one of the interventions that can work in this case. Wikipedia's defined psychoeducation as "the education offered to individuals with health condition and their families to help empower them and deal with their condition in an optimal way". The adolescents with chronic illnesses should be educated on the illness, the coping skills, the importance of adherence and identifying social groups for support (Geist et al, 2000). Other sources of education support include printed dosage information among other instructions.

2.2.3.2 Providing Support

Another strategy is social support from family and friends. A suffering adolescent should get all the support from the parents and family. In many cases, these adolescents may be faced with isolation and loneliness that may lead to non-adherence (Salema, 2011) proposes that the churches, NGOs, social groups and employers can support the patients that may lead to good adherence.

2.2.3.3 *Good Health-care Provider-patient Relationship*

Another strategy recommended by (Santer et al., 2014) is that the health-care providers should establish a good relationship with the patients. In order to improve child adherence, health care providers should be able to establish a connection and relationship for long term trust. The health-care providers should work with patients as partners in health-care.

2.2.3.4 *Psychotherapy*

Therapy is another approach that can be used. In some cases, the adolescents are faced with psychological issues and may negate to take the medication. In this case, looking for a therapist for them may be a good decision. The therapists take the adolescents through the medication process providing all the support they require (Nock and Ferriter, 2005).

2.2.3.5 *Motivational Interviewing*

The therapist or the health-care provider may provide motivational interviewing. The main goal of this exercise is to enhance the probability of change. This motivation should highlight the advantages of adherence; develop techniques to counteract drawbacks, increase participation among others (Shaw, 2001).

2.2.4 *Summary*

There are numerous reasons why the adolescents don't adhere to treatments. According to a study that was conducted by (Shaw and DeMaso, 2010), the adherence to treatment is crucial and the health-care providers should ensure that patients fully adhere. Some of the key reasons adolescents do not behave in treatment include:

- ❖ Forgetfulness and distractions
- ❖ Stigma and discrimination
- ❖ Poor planning
- ❖ Wrong beliefs
- ❖ Complexity of some regimens
- ❖ Lack of support

2.3 Desiderata for Empathic Agent

Lack of adherence to medication has adverse effects on the disease management. In various cases, the diseases have worsened, relapse cases and even deaths. The adolescents with chronic illness have a higher chance of non-adherence compared to the other populations (Taddeo et al., 2008).

The reason for the high chances of non-adherence is because of peer-pressure, lack of knowledge, ignorance, and psychosocial barriers among others. If the adolescents are taken through psychoeducation, encouraged and receive social support they may fully adhere to medications. We propose that technology such as IVA, and particularly empathic agents, can provide support to these adolescents. Through the IVA, the adolescent rates of adherence may increase. With a good adherence to medication among the adolescents, issues of complications, relapse among other issues will be minimal.

Empathic agent technology involves the use of animated computerized characters designed to build long-term trust-based socio-emotional relationships with users. We intend to use empathic agent to improve adherence to overcome the adolescent's chronic disease.

The obtained agent model in (Memon and Treur, 2012) describes how the empathic agent deals with another agent's cognitive states and the associated feelings, thus not only understanding the other agent's cognitive state but at the same time feeling the accompanying emotion of the other agent. Table 1 shows different agents, behaviour and usage.

Agent	Behaviour	Usage	Users
Virtual Nurse IVA (Acton, 2012)	Used verbal and non-verbal communication	Diagnosis, treatment and giving instructions	Especially to adolescents and elderly patients
Compound Gesture Generation IVA (Brinkman et al., 2015)	Use gestures to strengthen clinician-patient relationship	Show impact of non-adherence	Especially to patients with dementia
Question answering IVA (Brinkman et al., 2015)	Answers patient's questions	Clarification	For improving patient's knowledge

Table 1: Agent Behaviours, Usage, and Users

These artificially intelligent (AI) agents are systems that act in a certain environment according to their agent architecture. The agent architecture will allow the agent to perceive its environment, reason about the state of the world, make a decision about how to act at the same time updating its internal state. According to Budakova et al.(2015), the foundation of AI can be traced in philosophy, mathematics, neuro-science, forensics and psychology among other fields. Various

AI agents have assisted in the health-care domain especially in diagnosis and medicine adherence. Table 2 presents a number of types of AI agents. The rational agents are known to consider the past and future rules while the reflex agent considers the present. The emotional agents have facial and tones that are empathic that alters people's state. On the other hand, the goal-based agents have certain goals to achieve while the utility-based agents maximize their utility function. In general, the learning agents improve performance after learning. Initially, we clarify that this short-term project was not dealing with architectures or an actual application so, the applicability of the approaches have not been analysed at this stage.

<i>Agent</i>	<i>Agent behaviors</i>	<i>Where it has been used</i>	<i>Effectiveness</i>
Rational agent	These agents build systems and carry out actions to achieve the best outcome. Considers present and future behavior	Used in economics, firms to make goal-directed behaviors.	Effective in making goal-directed behaviors
Empathetic agent	They have emotional facial and tones with voice expressions. Empathetic agents have a goal of altering people's emotional state.	Used in education, hospital among other places.	Effective in giving feedback about people's fear, sadness and happy emotions.
Reflex agent	Respond to the percepts immediately. These agents do not have the information about the past and hence respond to the current situation	Used by environmentalists for example in thermostat machine	Respond to the precepts accurately and fast.
Goal-based agent	Take future into consideration to achieve certain goals. Takes some actions into consideration that helps it attain a computed goal.	Used in healthcare for diagnosis	Effective in health informatics among other fields.
Utility based agent	These agents maximize their utility function. These agents base their decisions on classic axiomatic utility theory to act rationally.	Used in healthcare and psychology	Effective in choosing the most probable occasion
Learning agent	The agents improve their performance after learning	Used in various places for example in architecture, psychology through trial and error method	Effective and easier to learn and perform

Table 2: Types of AI Agents

2.4 Intelligent Virtual Agents

According to the latest Cochrane report reviewing interventions to enhance medication adherence (Haynes et al., 2008), very little research has been conducted with adolescents and only two used technology (SMS or video-game) in their intervention, with positive outcomes. However, these approaches do not address the socio-emotional barriers.

2.4.1 Intelligent Virtual Agents in Healthcare

Health-care technology is growing at a rapid speed and in most hospitals; technology is being used in many departments. There are some ways in which technology is changing the health-care sector, and the virtual agent is a good example of a most effective technology. The sections above have discussed the key reasons adolescents do not adhere to medications. Intelligent virtual agents have been used by the health-care providers to ensure that the adolescents adhere to medications (Berkowitz and McCarthy, 2012). Adherence to medication ensures that the disease clears in a fast way, complications are eliminated; the diseases are effectively managed among other benefits.

Evidence suggests that treatment adherence can be improved with face-to-face communication between a patient and health professional (O'Malley et al., 2002). However, the health care resources to support face-to-face communication are extremely limited and increases waiting times for specialist appointments. In the case of adolescents, having them engage with health professionals is in itself a challenge. Complementary, approaches using the technology they love, i.e. computer-based games and mobile phones are suggested as a way to reach this cohort and bring about behaviour change.

This part will discuss the problems and the solutions that the virtual agents can provide in enhancing drug adherence. The IVAs presented include conversational virtual nurse (Acton, 2012), iRetainRX (Budakova et al. 2015), peer-to-peer pill reminders (Ciampa and Revels, 2012) and Compound Gesture Generation (Bickmore et al., 2014).

➤ Conversational Virtual Nurse

This technology is used for adolescents that have issues with medical adherence. In most cases, this tool is used to the bedridden patients where the nurse conducts the dialogue with the patient to provide advises and medication instructions. According to Acton(2012), this nurse points the medication to the patient and describes it. The patient is responsible for clicking on the right box upon understanding.

The Virtual Nurse helps the patients with instructions regarding drugs, side effects, and non-adherence. According to Brinkman et al. (2015), these virtual nurses improve the patients with social emotional relationships, coaching, and therapy and answer the patient's health-care questions. One of the places that it has been used is Boston Medical Centre. This App educates the patients using the bedside dialogue regarding self-care, re-hospitalization, and follow-up among others. The Virtual Nurse comes in a mobile app design and aims to reduce the drug non-adherence issues (Brinkman et al., 2015).

➤ iRetainRX

It is a phone application. It assists the patients in communicating with the caregivers and health-care providers. For adolescents that are orphans or with absent parents, this application can be used to communicate with healthcare providers. This application uses the mobile app and proposes a cloud-based system. Since some adolescent's lack adherence because of the complexity of the drug regimens, this app may assist them to get instructions from pharmacists, caregivers or the healthcare providers. This application ensures that the adolescent understands the drug instructing in the case of complexity (Budakova et al. 2015).

➤ Peer-to-peer Pill Reminders

The support from parents and friends plays an important role in medical adherence. This inspiration was behind the invention of Medisafe that provides patients with adherence programs. The app usage is very simple since it alerts the family and friends when the adolescent has not taken the medication. This application ensures that the patient takes the medication and on time (Ciampa and Revels, 2012).

➤ Compound Gesture Generation

According to the innovators, the technology uses gestures from the clinicians to communicate some knowledge (Bickmore et al., 2014). The adolescents can use this app to understand the impacts of non-adherence. This design has been used to strengthen the clinician-patient relationship (Brinkman et al., 2015). As aforementioned, the clinician-patient relationship can enhance drug adherence.

2.5 Adolescents and IVA Technologies

FearNot, which is a school based virtual learning environment, is widely used to teach children about bullying and to learn strategies for coping. The results showed that an affective interaction resulting in the expression of empathy was more likely whenever children have high belief and interest in the character conversation (Hall et al., 2005).

According to Lisetti (2012), empathic agents were found to increase patient disclosure of sensitive information that they are less inclined to share with a human therapist. By sharing that information, the patient can receive some therapeutic benefit. Expressing empathy is hard and crucial; while tailoring information leads to improve the patient's outcome because of the better communication, which intends to meet a person's needs. (Hieftje et al., 2013) provides a study of media-based health interventions with the main focus on behaviour changes in adolescents. Some of the methods can be used to change the adolescent's behaviour such as computer games (computer-controlled game), video clips, Internet, video games (games run by a console or arcade machine), Internet games, simulations, and simulators. However, high quality interventions are required to notice a significant change in behaviour (Hieftje et al., 2013).

An IVA has the ability to significantly change the behaviour of someone. The study shows two groups of people, one group knows that virtual human is fully automated and the other group did not. The result shows that an IVA is able to reduce fear if we increase the level of believability for the user (Gratch et al., 2014).

(Ackerman and Hilsenroth, 2003) provide a review of therapist characteristics and techniques positively impacting the therapeutic alliance. They stated that the therapist's personal attributes are an important matter in building a strong relationship between the patients and the therapists. Attributes such as flexibility, honesty, respectfulness, trustworthiness, confident, warmth, interested, and openness are important factors to positively contribute with a patient to the alliance. The techniques of the therapist are also an important matter, techniques such as exploration, reflection, noting past therapy success, and finally attending and taking into account the patient's past experience. Those techniques also contributed positively to the alliance as well. Generally, the virtual agent should be able to provide those attributes and techniques in order to improve adherence.

An evaluation to an Internet world chat room for adolescent's smoking cessation has been studied. In particular, a smoking cessation counsellor has been created. The chat room is an Internet-based, virtual reality world combined with interviewing conducted by an IVA in real-time. The results suggest that the innovation used was effective in providing some help for adolescents to reduce their daily consumption, at least for a short time, or stay off cigarettes (Woodruff et al., 2007).

The impact of human agent interaction in clinical interviews has been taken into account. The study argues that virtual human agents have a better chance to reduce psychological barriers such as fear of self-disclosure and impression management to honestly respond which in reality may

lead profession to an inaccurate picture of the patient’s medical history. Consequently, virtual human will reduce the fear of self-disclosure and impression management, which was proven by this study. A virtual agent was used in the Simsensei study (Gratch et al., 2014).

"I can help you change! An empathic virtual agent delivers behaviour change health interventions" has been conducted by (Lisetti et al., 2013). The main focus behind this study was to control alcohol consumption as well as the approach can be adopted for other behaviours such as lack of exercise, overeating, and drug use. Their design of the 3D On-demand Virtual Counsellor sought to simulate both aspects of empathic communication to be affective and cognitive. This involved the agent's dynamic display of facial expression and a verbal reflective listening scheme with sentence paraphrase and summarisation of the user's answers.

2.6 Current Tools for Designing a Character

Based on our findings, Table 3 below shows some of the current tools that can be used to create IVAs. The five tools have been compared by asking 5 questions. The results are based on the descriptions provided at the website of the tool, and so there may be some features that remain unknown until the system is actually downloaded and tested. The five points considered are:

[1] Availability of selecting different avatars?

[2] Are they customizable?

[3] Can the user create a free avatar?

[4] Is it possible to create something that allows them to create their own avatar?

[5] Do we provide 5-10 different options to allow participant to choose from?

The System	[1]	[2]	[3]	[4]	[5]
Virtual Human Toolkit	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Visual Scene Maker	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Rapid Avatar Generator	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
SimSensei	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FearNot	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Table 3: Comparison of Current Systems.

Legend: [1] Availability of selecting different avatars; [2] Are they customizable? [3] Can the user create a free avatar? [4] Is it possible to create something that allows them to create their own avatar? [5] Do we provide 5-10 different options to choose from?

Virtual Human Toolkit is a system allows us to select from the menu different available avatars, but I do not think we can customize them.

Rapid Avatar Generator the avatar of a real person was created using a camera, which I think answer the fourth question as well. In this generator, we can create a real avatar that looks like the patient himself/herself.

In the "SimSensei" project, the main goal was to identify and recognize psychological distress from multi-modal signals by monitoring the patient and recording his/her body's activities, attentions, movements, voice, and other factors. SimSensei is very powerful to analyse and record the patient surroundings. Even though it looks like there is one avatar only, however, the main focus was on the patient him/herself.

Visual Scene Maker is one of the powerful frameworks based on the current projects available such as Dynalearn and TARDIS. Since the framework is based on modelling, we can create free avatars.

Maya and Blender are modelling software, which may be considered in case of creating free avatars that can be imported to a system and use it in the designing phase.

2.7 Character/Avatar Most Appropriate Elements

In order to achieve the short-term goal, this research considers previous findings in the literature concerning preferences of an avatar in a helping role. Hall et al. (2006) discuss the importance of involving children in the design of the virtual agent. Their approach focused on gaining some input from children using different techniques and approaches such as learner-centred approach to support and strengthen the development phase. In fact, involving the child in the design improved the context of use. The study emphasis was on having the child involve in selecting the character in terms of looking, age, and clothes, the more the child like to interact with. Some children are in favour in selecting a character like them in age or particular style (Hall et al., 2006).

Health-related behaviours and psychosocial characteristics of 18-year-old Australians study have been conducted in 1997. The test has been conducted on 18-year-old Australians to examine some psychosocial variables such as, diet, physical activity, alcohol consumption and smoking. The tested group had 301 men and 282 women. These variables included depression, self-efficacy for engaging in health behaviour, and finally perceived barriers to preform those behaviours. Diet and alcohol consumption was greater in females in terms of self-efficacy while physical activity was greater in males. Lack of willpower was another factor to be considered in dietary, smoking and physical activities. Other barriers have been identified such that in diet-related suitable food and expenses, physical activity such that planning time, tiredness, and lack of social support, and finally barriers for alcohol consumption and quit smoking are lack of family support, stress, and weight gain (Milligan et al., 1997).

A wide variety of studies analysing children, teachers, and experts for the problem of physical bullying behaviour have been conducted. In particular, the problem was focusing on investigating differences in views, opinions, and attitudes between children and adults. Furthermore, they considered if differences existed, what design implications for embodied agents need to be address. Children were more favourable towards the character movement and voice as well as more believable towards the storyline as they think that it is true to life. All groups found the character's conversation more believable. However, the child's gender was playing a major role in their responses towards different characters. Significantly, children express more empathy towards different characters in the scene. This indicates the importance of the design of an empathic agent to change certain behaviour. Significant analysis has been performed here showing that different personality levels and experience with particular gender, age, and storyline, has an impact on the children and their feelings (Hall et al., 2004).

According to Mei et al. (2015), customizable self-avatars have an interesting impact including psychological effects and training benefits (Quarles, 2015). The main question behind this research was how does the customizable appearance of a virtual human affect 3D interaction and task performance for users with autism spectrum disorder (ASD)A hand-eye coordination training game, which represents imagination soccer, has been developed to investigate the effect of a customizable virtual human (CVH). The customizable variables allowed the user to customize the hairstyle, fat level, skin colour, age, gender, and T-shirt patterns. The study found that “users with ASD, CVHs could effectively motivate them to play the game more, and offer a better user experience. Surprisingly, results also showed that the CVHs improved performance in the hand-eye-coordination task-users had higher success rate and blocked more soccer balls with the CVH than with a non-customizable virtual human”.

(Fabri et al., 2007) proposed emotionally expressive avatars for chatting, learning and therapeutic intervention. Avatars or animated characters have the ability to easily express emotions via facial expressions. In general, they stated that those avatars can be widely used in various applications, where several people meet in a virtual environment/space. The study resulted in a suggestion that social interaction behaviour can be transferred into virtual world. They propose an avatar for chatting in a virtual messaging room, where a choice of six avatar's heads was available to the user with different facial expressions such that happiness, anger, sadness, disgust, surprise, and finally fear. However, all avatars have an identical animation sequence to ensure consistency and validity. As a result of the experiment, which was conducted in the age group of 21 to 63 years old; it was shown that the use of avatar faces was effective and efficient. In our case, using different

facial expressions may be important to convey appropriate empathetic responses and to ensure that the facial expression is congruent with what the avatar expresses verbally.

2.8 Chapter Summary

In this chapter, we have discussed the literature review for both the long-term project and the short-term project. The literature revealed that different people respond differently to different situations, based on their past experiences, and there was not a clear indication of what avatar is most appropriate that could be used to support adherence to treatment advice. Thus, as a first step it is necessary to investigate more about what sort of characters are needed that could act as peers for the long-term project., which required us first to investigate more about what sort of characters are needed that could act as peers for the long-term project.

3 Chapter 3: Methodology

This chapter presents the methodology used in this research work. The first step was an analysis phase. A literature review was conducted to understand the nature of the lack of adherence problem in adolescents. As presented in the previous chapter, from the literature review it became apparent that many of the issues were psycho-social. Thus a proposed solution was creation of an Intelligent and Empathic Virtual Agent that could act as a friend in whom the young person could confide and work through issues with. As a starting point, we sought to investigate what sort of character might be most appropriate and preferred. This investigation would involve manipulation of different character features.

The second step was a design phase. In the long term our aim is to build a 3D virtual system that includes an agent that can be tuned to the cognitive, emotional and personality factors to match different users' preferences. It was not feasible or appropriate to have an unlimited number of character features and preferences. In the design, phase we chose to manipulate three characteristics of the character: age, gender and ethnicity. Other factors which were not manipulated included what the character was wearing, what it would say, its voice and the background environment. These were controlled in our experimental design to avoid interference with the variables of interest.

Thus, we chose to design 12 characters (two genders, two age groups, three ethnicities). Participants would meet briefly with each character, so that the character exhibited some basic behaviour and was not simply 2D screen shot but had some “life”. This involved the 3D character walking up to the screen, waving and saying “Hi, How are you?”

The third step was to implement our design and conduct an experiment. The rest of this chapter focuses on presenting the experiment. Section 3.1 provides an overview of the experimental phase. Section 3.2 describes the recruitment method. The procedure and data collection are subsequently discussed in section 3.3. The intervention materials for both studies are focused on in section 3.4. Section 3.5 presents the instrument and measures of the study (demographic questionnaire and rapport questionnaire). Finally, the chapter concludes with a summary in section 3.6.

3.1 Experimental Phase

A study was conducted to target two age groups: young adults (aged 18-30) and young people (aged 13-17). While the second group is the target of the larger project, the first group was more accessible and comprised undergraduate university students from the psychology pool ((i.e. first year Psychology students who must participated in research studies)) and students from computing and other departments within our university. This empirical study involved sample populations being exposed to alternative avatars and interacting with an avatar. Data was collection via questionnaires to obtain participant demographic, preferences and opinions. Since the research is being conducted at a tertiary educational institution, we had less access to young people”. Furthermore, to access children you need to get permission from their parents. As per our ethics approval, we sought the involvement of the Robotics Club and also MacICT. However, only a few parents were interested and consented to pass the details of the study to their children. As a result we were only able to conduct a small study with young people... The aim was to determine if there were differences between these two cohorts or if no significant differences, the results from the larger cohort could be used to answer our research question.

3.2 Participant Recruitment

Our first method of recruitment was targeted at undergraduate university students to provide our cohort of young adults (aged 18-30). Specifically, we targeted Psychology students in their first year but we also sought to recruit Computing students and any other students in this age group.

We accessed Psychology students via the Psychology Pool, an online recruitment software program. Psychology students received course credit for their participation in the study. To recruit other participants, a Poster advertisement has been distributed in the university campus that included a link to the survey with some relevant information. Moreover, invitation emails have been sent by unit convenors and other tutors to encourage people to participate.

We also sent an invitation email to school teachers asking them to distribute the study to parents who could choose to provide the link to their children. The target group of the school children was within the age of 13-18.

Importantly, all participants in this study were volunteers and all non-Psychology participants did not receive incentives or rewards.

3.3 Procedure and Data Collection

The experimental procedure consists of 10 sections, starting with the Participant Information and Consent Form (PICF), demographic questionnaire, preference questionnaire concerning using

an avatar to provide support, watching 12 videos that introduce each of the characters (in random order), ranking of the characters, interaction with a character, rapport questionnaire, post interaction questionnaire, TIPI Personality test (is an extremely brief measure of the Big-Five personality dimensions (Gosling et al., 2003)) and DASS21(Depression Anxiety Stress Scales consists of 21 self-report questionnaire items (Lovibond and Lovibond, 1995)) psychometric survey to measure depression, anxiety and stress levels in participants. Details will be given about each section in the survey. We used Qualtrics to create the survey and collect the data. The survey can be found in Appendix E. The study was fully conducted online. No researcher was present.

The whole procedure is as follows: the participant starts the survey by reading the PICF and giving consent and agreement to continue. Then, they start answering the demographic questionnaire, which consists of 6 questions. Followed by 6 questions are about the participant preference for virtual characters that would help to support. Then the participant is asked to watch 12 short videos (approximately 9 seconds each) where the 12 models introduce themselves, while in the next section participants are required to rank the 12 avatars based on what they like. In the next step, the participant is asked to download a file with their highest ranked character and interact with them. After interacting with the character, they then answer the rapport questionnaire of 21 questions, post intervention questionnaire of 5 questions, TIPI personality measure test with 10 questions and DASS21 with 21 questions. The TIPI and DASS21 questions are features of the participant and may have logically been asked following the demographic questionnaire. However, since we were concerned about participants not completing the survey due to fatigue, we left those questions until last as we preferred to find out their preferences. Each questionnaire is described below.

3.3.1 Demographic Questionnaire

The demographic questionnaire sought to identify the characteristics of our participants and in particular, allow us to determine whether participants preferred a character that looked like them. The questionnaire asked about the participant's age, gender, ethnicity, course enrolled, and if they played computer games or not indicating the number of hours. In multicultural Australia it can be difficult for individuals to specify their cultural or ethnic background. Rather than provide a list of the countries of the world and then categorise them, our question on ethnicity was more about the participant's sense of identity with an ethnic/cultural group. As Australians are asked to complete the Australian Bureau of Statistics (ABS) census survey every five years, we chose to use the ABS categories to identify the participants' ethnic backgrounds. The full set of questions can be found in Appendix E, Section A.

3.3.2 Preference Questionnaire (Before Interaction)

Before the participant met any of our characters we wanted to find out the participant's preferences with respect to the age, gender or ethnicity of a character. We asked this before seeing any characters as we did not want to influence their preference or limit them to the context of the models we were able to create. It was difficult to clearly represent a particular age or ethnicity and different individuals would perceive our models in different ways. This section was followed by 6 questions about preference of an avatar such that we seek to find the most important factor that an adolescent might want in choosing an Intelligent Virtual Agent (IVA) to interact with. Factors that have been investigated include gender, appearance, age, level of authority, and environmental theme (e.g. home, mall, school, hospital, and park).

3.3.3 Rapport Questionnaire (Post Interaction)

After interacting with the character, we wanted to investigate if the character has built a trust-based relationship with the participant. The perceived rapport questionnaire is a 5-point Likert-type scale from "strongly disagree" to "strongly agree" (corresponding to 1-5) measuring the character interpersonal attraction, task attraction, social attraction, credibility and believability derived from five studies (Tickle-Degnen and Rosenthal, 1990) (Astrid et al., 2010) (DeVault et al., 2014) (McCroskey et al., 1974) (McCroskey and McCain, 1974). The rapport questions can be found in section D of Appendix E. This instrument provides a single score that seeks to measure the extent to which rapport exists. The score is calculated by summing all Likert scale values after reverse scoring all negatively worded questions so that low values indicate a low rapport response and high values represent a high rapport response. Numerous agent researchers have used this instrument to measure rapport

3.3.4 Usefulness Questionnaire (Post Interaction)

We asked a number of questions that sought to measure whether the participant would seek support from this avatar. Six questions have been asked to investigate whether the participant would like to receive help from such a virtual character. The questions can be found in section E of Appendix E. We have designed those questions specifically for our study. We are not aware of others looking at preferred avatar according to similarities in age, gender or ethnicity.

3.3.5 TIPI and DASS21 (Post Interaction)

We wanted to measure the personality of the young adults in case it influences avatar preferences. Ten Item Personality Instrument (TIPI) is an extremely brief measure of the Big-Five personality dimensions. This short 10 items questionnaire was developed mainly to ease the process of personal selection (Gosling et al., 2003). The Big Five personality dimensions include 1)

Extraversion where the participant is extraverted, enthusiastic, reserved, and quiet, 2) Agreeable where the participant is sympathetic and warm or critical, and quarrelsome, 3) Conscientious where the participant is dependable and self-disciplined or disorganized and careless, 4) Emotionally Stable where the participant is calm and emotionally stable or anxious and easily upset, and finally 5) Open to Experiences where the participant is open to new experience and complex or conventional and uncreative. The TIPI questions can be found in section F of Appendix E.

We wanted to measure whether depression, stress or anxiety levels influences avatar preferences, as the aim is to provide a tailored avatar to support the individual. Depression Anxiety Stress Scales (DASS21) consists of 21 self-report questionnaire items. It is intended to measure the severity of a range of symptoms, which are common in depression and anxiety (Lovibond and Lovibond, 1995). Reluctance to seek and listen to support is a particular behaviour exhibited by adolescents (Ettridge, 2010), hence the desire to use an avatar. As our future goal is to provide support with treatment adherence, depression and anxiety can be high in this future target population. The DASS21 questions can be found in section G of Appendix E.

3.4 Experimental Materials

Our Virtual models are 12 characters/avatars. They have been designed using Mixamo 3D Animated Characters. After all models were designed, they were uploaded into Unity 3D to set up environment and animate characters. They have utilized in Unity and 24 scenes have been created. 12 animation scenes, one per characters, are introducing themselves in verbal and written dialog while the other 12 animation scenes are set for longer verbal and written interaction which required the user to interact with. All models were distributed to the research team (to about 5 people) to gain opinions regarding the age and ethnicity of the character. Suggestions were applied and models updated and re-evaluated. It was a lengthy and iterative process.

We considered three main elements in the design, which are age, gender, and ethnicity. For the young adult group, we created 12 characters/avatars as shown in Table 4. Six avatars were male and six were female. Six avatars were made to appear older than the other 6. Three different ethnicities were also taken into consideration, namely, Asian, White, and Mediterranean. These three were chosen as they most commonly used by the general population in Australia to describe ethnic appearance. Asian may include all Asian and subcontinental (e.g. India and Pakistan) countries. White may include those with descendants from Northern and Eastern European countries. Mediterranean may cover Southern European and Arab-speaking countries.

The set of characters shown to the young adults are found in Figure 2. For the young people group, the 6 young characters/avatars made even younger (to represent peers). The set of characters

shown to the young people are found in Figure 3. Users interacted with the avatar by selecting text based dialogue options shown in speech bubbles.

Number	Name	Age	Gender	Ethnicity
1	Bill	Old	Male	White
2	Celia	Old	Female	Asian
3	Jasmine	Young	Female	Mediterranean
4	Joe	Young	Male	Mediterranean
5	Josh	Young	Male	Asian
6	Mary	Old	Female	Mediterranean
7	Sally	Young	Female	White
8	Sarah	Old	Female	White
9	Trina	Young	Female	Asian
10	Will	Young	Male	White
11	John	Old	Male	Asian
12	George	Old	Male	Mediterranean

Table 4: The Designed 12 Models

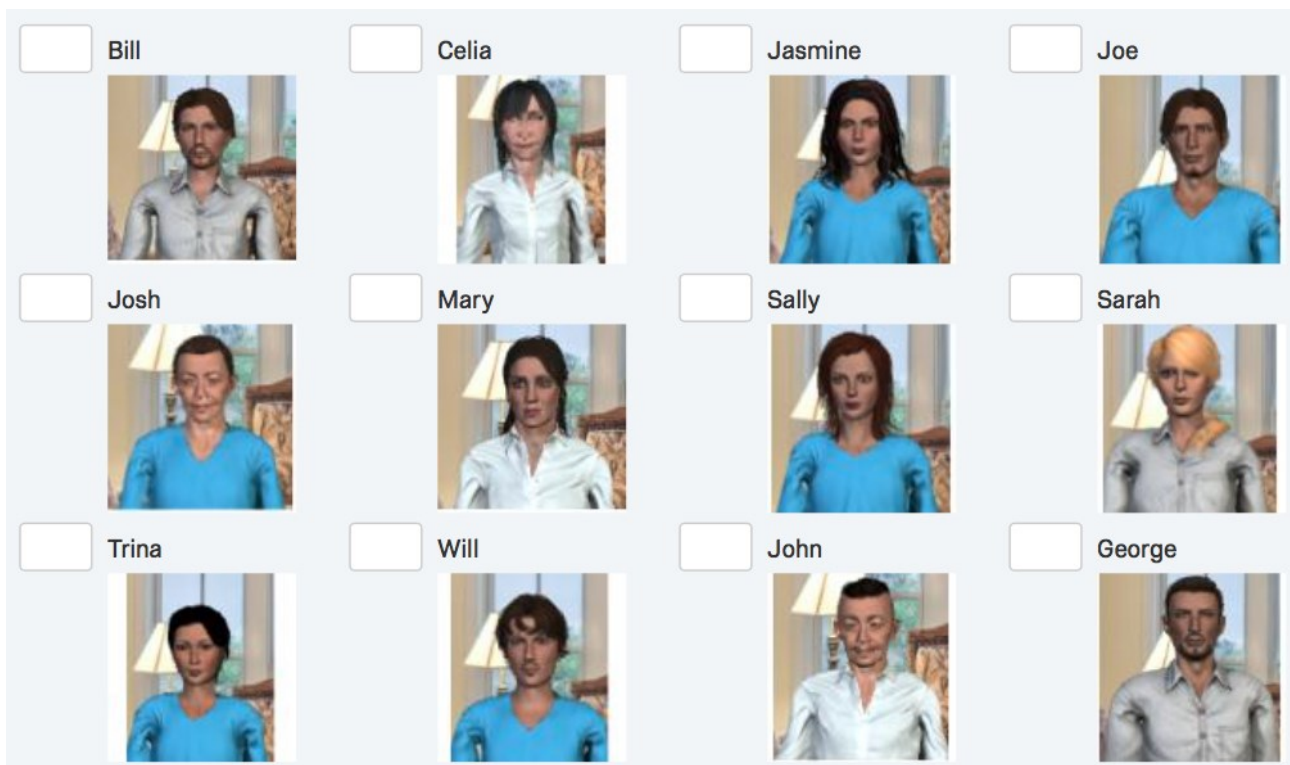


Figure 1: The Set of Characters shown to Young Adults

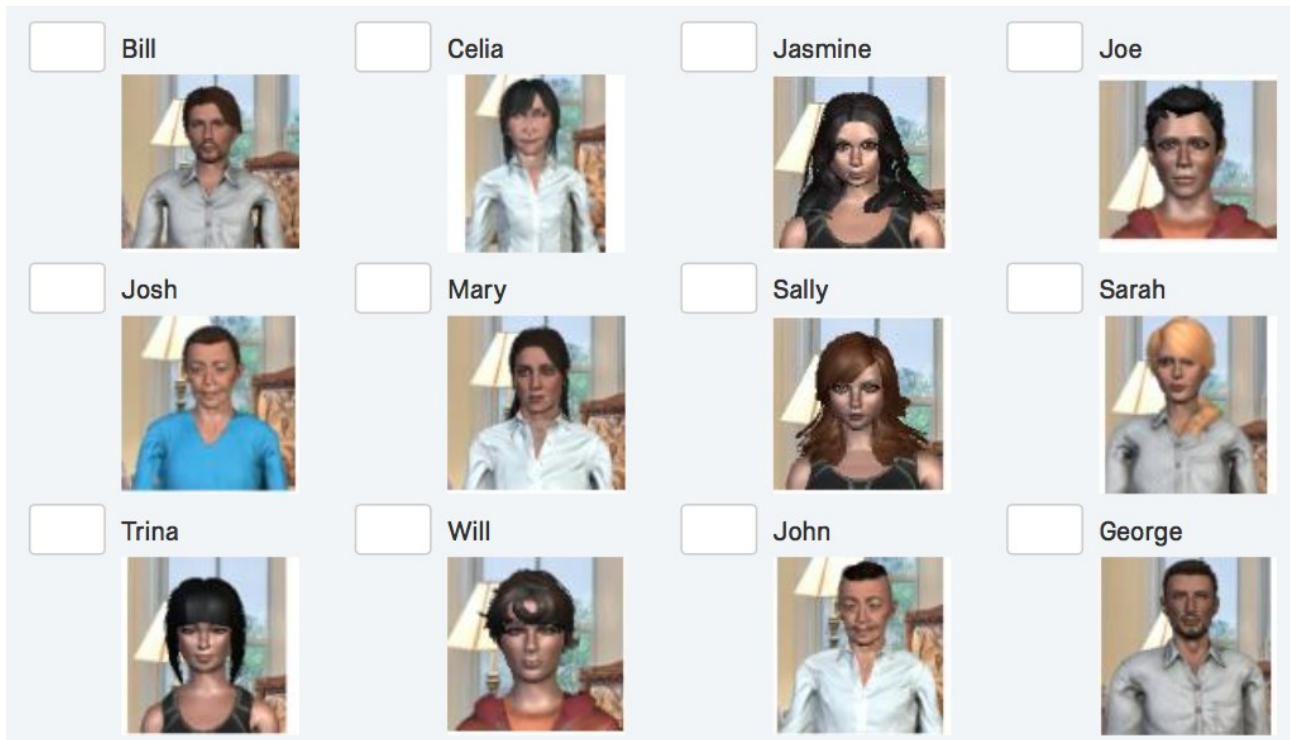


Figure 2: The Set of Characters shown to Young People

All of the “older” avatars wore a white shirt. The “same age” avatars for the “young adults” wore tee-shirts. Josh for the young people should have had clothing like Joe and Will, but had a t-shirt as we did not have time to make this change and for such a small study it was not deemed so important. After creating the avatars, names and recorded dialog were created and added to the avatar models to create two versions of character animations. In the first version, avatars come towards the camera, wave and introduce themselves. Since there was no input from the user required and to avoid requiring participants to download, install and run the Unity3D software, we created 12 videos, one for each character. The second version of the animations was longer and required the participant to interact with the chosen avatar.

To achieve this, a dialogue engine has been developed using the C# programming language. The Mixamo character is imported into Unity3D. The Unity3D environment is a room. The interaction starts with the character greeting the participant by waving his/her hand and starting to talk according to the dialog in Appendix A. Whenever a response was required from the user, it appears as a set of different choices to select an answer from the GUI of the scene and move on.

In principle, all models, written dialog and recorded voices are stored in the Unity 'Assets'. In Unity, 'Assets' is the representation of any item used in the project. The old voices were recorded by a male and female in their 40s and 50s, respectively. The young voice was recorded by a male and female in their 20s. After importing the required files, we put together the scene together in the 'Scene View', which is the interactive view into the scene we are making. In the 'scene view', we select and handle things like positions of the characters, camera, lights, and any related objects. Afterwards, the 'Inspector' is used to allow changing and editing the properties and settings of the scene view. The next figure shows The 'Assets', 'Scene View', and 'Inspector'.

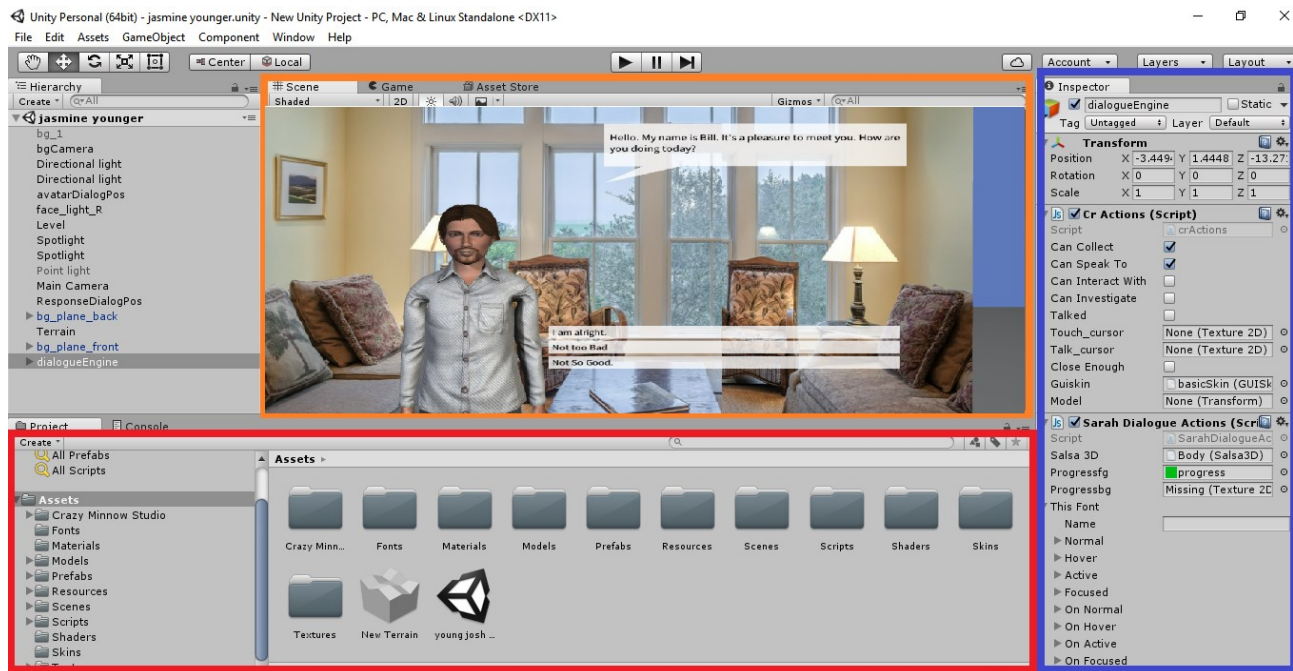


Figure 3: The Blue Square is Inspector, Red is Assets, and Orange is Scene View

We pre-recorded the voice used in the 12 scenes such that 2 males (one a young adult and the other a mature adult) and 2 females (one a young adult and the other a mature adult) recorded the voices. The four voices were used to represent the voice of all the young males and mature male and similarly for females. We did this to control for differences in preferences for the sound of the voice and to avoid issues around making the voice congruent with a particular ethnicity. Thus, we sought to represent age and gender via voice, but not ethnicity. All four speakers had Australian accents. In every scene, we have some mp3 files for each scene and an XML file for the nonverbal dialog. We chose to pre-record speech which was feasible rather than use text-to-speech synthesis. Our main reason for avoiding TTS is the possible unfavourable reactions of some participants to such voices. The dialogue engine included lip synching with the spoken dialogue. Facial expression was restricted to representing a pleasant/happy character.

3.5 Chapter Summary

In this chapter, we have presented our methodology, which consisted of different phases, analysis, design, and experiment, the latter phase having been the main focus of the chapter. We have also shown 12 models, which have been designed for the online experiments. We also, have explained how we are going to evaluate the participants' personality and depression, anxiety, and stress level.

4 Chapter 4: Results

In this chapter we show the data analysis and results of the experiments. In 4.1, we discuss about the participants demographic, manipulation check, and avatar preference questionnaire while in 4.2 we show some qualitative analysis. Section 4.3 shows some discussion in young adult's results while 4.4 shows pilot study with young people. This chapter concludes with a summary in section 4.5.

4.1 Participants

As shown in Table.5, the total number of participants is 199 participants. Only 139 of them completed the entire survey. The remaining 60 completed the study up to the point where they were required to download a character. The mean age group is 21.7 and the standard deviation is 6.3, median age is 19. Furthermore, 159 of the participants are between the age group of 17 to 25 years old while 16 participants are between the age of 26 and 30, 7 participants from 31 to 35 years old and 9 participants older than 35 years old. It is important to mention that the data of all 16 participants over 30 years old have been excluded since they are outside the target age group and one participant did not enter his/her age. This leaves 174 participants in our main data analysis.

The survey participants represented 43 males (22.51%), 146 females (76.44%), and 2 (1.05%) did not identify with either gender. The gender imbalance will be discussed later.

A variety of cultural groups have been involved in the study such that: Oceania= 63, Northern-Western European= 22, Southern-Eastern European= 12, North African and Middle Eastern= 23, South-East Asia= 27, North-East Asian= 9, Southern and Central Asia= 10, People of the Americas=1, Sub-Saharan African= 0, and Don't Identify= 28. The largest group comprising 32.31% identified most with Oceania, which includes Australia, New Zealand and the pacific islands. The next largest group is South-East Asia (13.8%). By combining the three Asian regions, the percentage grows to (23.59%). Most of the participants are enrolled in Psychology by 55.50% and nearly half of the participants were interested in playing computer games (45 %).

Demographic		Count	%	Participants Completed The Survey	Unanswered
Gender	Male	43	22.51%	32	9
	Female	146	76.44%	107	
	Don't Identify	2	1.05%	0	
Culture Group	Oceania	63	32.31%	44	5
	Northern-Western European	22	11.28%	17	
	Southern-Eastern European	12	6.15%	9	
	North African and Middle Eastern	23	11.79%	13	
	South-East Asian	27	13.85%	18	
	North-East Asian	9	4.62%	7	
	Southern and Central Asian	10	5.13%	10	
	People of the Americas	1	0.51%	1	
	Sub-Saharan African	0	0.00%	0	
	Don't Identify	28	14.36%	20	
Age	17-25	159	83.25%	121	9
	26-30	16	8.38%	10	
	31-35	7	3.66%	4	
	36-40	4	2.09%	2	
	> 40	5	2.62%	2	
Course Enrolled	Psychology	106	55.50%	89	9
	Computer games	10	5.24%	6	
	Other Computing	20	10.47%	10	
	Multi media	1	0.52%	0	
	Others	54	28.27%	34	
Computer Games	Yes	86	45.03%	60	9
	No	105	54.97%	79	

Table 5: Participants Demographics

Expressing information about participants, TIPI personality test and DASS21 was also taken into account. The number of participants who completed the DASS21 test was 141, of which 135 were 30 years and younger, where the average of the result was 27.00 and the average standard deviation is 18.45 as shown in Table 6. This test measures the level of depression, anxiety, and stress for each participant. It is worthwhile to mention that 62 people were extremely depressed, 93 extremely anxious, and 13 are extremely stressed.

	Depression	Anxiety	Stress	Mean	SD
Normal	3	3	39	15.00	20.78
Mild	0	0	27	9.00	15.59
Moderate	37	16	28	27.00	10.54
Severe	33	23	28	28.00	5.00
Extremely Severe	62	93	13	56.00	40.34

Table 6: DASS21 Results showing numbers of participants in each of the depression, anxiety and stress categories

The results of TIPI are presented in Table.7 below. TIPI personality test provides 5 scales for each participant, namely, extraversion, agreeableness, conscientiousness, emotional stability and openness to experience. Unlike DASS21, TIPI gives just a number for each scale, the mean, standard deviation, and variance is presented in the table below. Referring to the TIPI questions in section F of Appendix E, each of the five scales were calculated as follows. For each participant, we sum and average items such that Extraversion is the sum and average of item 1 and reverse of the score for item 6, Agreeableness is the sum and average of item 7 and reverse score of item 2, Conscientiousness is the sum and average of item 3 and reverse score of item 8, Emotional Stability is the sum of item 9 and reverse score of item 4, and finally Openness to Experience is the sum and average of item 5 and reverse score of item 10. To reverse a score means to transpose scores 1,2,3,4,5,6,7, to 7,6,5,4,3,2,1. After we do this for each record we found the mean, standard deviation, and the variance for all the participants.

Scale	Mean	St.Dev	Variance
Extraversion	3.86	1.73	2.99
Agreeableness	4.65	1.48	2.18
Conscientiousness	4.81	1.59	2.51
Emotional Stability	4.08	1.61	2.60
Openness to Experiences	4.89	1.51	2.29

Table 7: TIPI Personality Results

4.1.1 Manipulation Check

The post interaction questionnaire included a question “The character I chose was”

- Similar age to me (1)
- Younger than me (2)
- Older than me (3)

The purpose of this question was to determine if the participant perceived the character’s age to be what we had intended. In total, six people perceived the character to be younger than them. However, we had no characters that were meant to be younger than the participant. Four of these participants were older than 30, so their data has been excluded from the data analysis. Two males (aged 22 and 23 who chose Sarah and Trina, respectively) also said their model was younger than them. Looking at Figure 4a and 4b, Sarah was an “older” model, while Trina was designed to be “same age/peer” model, and Trina are clearly not younger than 20.



Figure 4: a) Sarah and b) Trina

69 participants found the model they chose to be similar age to them, while 56 found the model to be older than them. When we compared their perceptions with the actual model they downloaded we found that 60 out of the 69 who said the model was same age and choose a same age model while 27 out of the 56 who said it was older choose an older model.

We did not ask a similar question to confirm the perceived gender of the avatar downloaded as we did not believe the genders were ambiguous. We did not ask about ethnicity. In hindsight we probably should have included this question. However, given that the three ethnic groups represented were generalisations of many possible ethnic groups, we suspect that many participants would not have answered that they considered themselves to look like the same ethnicity as the character. For example, participants from Egypt, Saudi Arabia, Greece, Italy or Iran may not have felt that they looked like Jasmine (particularly if they were male) and participants from China, Korea, Malaysia, India, Nepal, Indonesia and Vietnam may not have considered themselves to look like Trina.

These results confirm that the younger models we created represented the age group that we intended. The results however indicate that the older models did not necessarily represent an older age group. Overall, it means that 89 (i.e. $60 + (56-27)$) out of the 140 participants, who did the rapport questionnaire, were commenting on what they believed to be a same age character, while 36 ($((69-60) + 27)$) were commenting on what they believed to be an older character. This, however, is not true of the avatar preference questionnaire because that survey was done before any characters had been shown to participants. We present the results of the preference and rapport questionnaires in the following two subsections.

4.1.2 Avatar Preference Questionnaire

Avatar preference questionnaire was mainly given to the participant to investigate their preferences before introducing our characters. Table 8 shows the participant's preferences for the 174 participants that are 30 years old or younger. The table shows participants preferences based on their age, gender, and ethnicity and also we find out whether their preference match their most liked character. Furthermore, it is important to mention that about 55% of the participants like to have a character of similar age, while ethnicity and gender was mostly doesn't matter. 54% of the participants prefer the avatar to be their friend in the level of authority while nearly half of them have no preference on the character environment.

Avatar Preference		Count	TOTAL	%
Would you prefer a virtual character that would help you to be?	Younger than you	5	174	2.87%
	Older than You	75		43.10%
	Same Age as you	94		54.02%
Would you prefer a virtual character that would help you to be?	Male	23	174	13.22%
	Female	71		40.80%
	Doesn't matter	80		45.98%
Would you prefer a virtual character that would help you to be?	Same ethnicity	43	174	24.71%
	Different ethnicity	9		5.17%
	Doesn't matter	122		70.11%
Do you prefer the character that would help you to look like you?	Yes	37	174	21.26%
	No	54		31.03%
	Doesn't matter	83		47.70%
What environmental theme would you prefer the helping character to be in:	School	21	174	12.07%
	Clinic	13		7.47%
	Mall	6		3.45%
	Hospital	9		5.17%
	Park	28		16.09%
	Home	25		14.37%
	None of the above	11		6.32%
	No preference	61		35.06%
Level of authority/role you would prefer a character that would help you to be/play:	Teacher	21	174	12.07%
	Doctor	24		13.79%
	Parent	5		2.87%
	Friend	96		55.17%
	Peer	28		16.09%

Table 8: Responses to Part B of the Preference Questionnaire for a Helping Virtual Character

To determine the relationship between different responses and participants' characteristics, a number of cross tables were created (see Figures 5) and chi-test statistics run (see Tables 9&10).

Chi-square tests revealed a number of significant relationships between participant demographics and their preferences. We report significant relationships where $p \leq 0.05$ and highlight them in red in most tables. We also draw attention to relationships where $p \leq 0.10$ and highlight these in blue. While these do not show significance, with larger sample sizes these relationships could become significant or confirmed not to be significant. For example, found between the participant gender and the character's age preference $X^2(N=174) = 10.26, p=0.04$, but also a

significant relation found between the participant gender and character gender $X^2 (N=174) = 12.93$, $p=0.01$. The associated cross table with numbers and percentages can be found in Figure 5 while the Chi-Square test provided in Table 10.

The cross table comparing demographic features and the character downloaded are provided in Figure 6. Participant demographic has a significant impact on their preference and accordingly in the character downloaded. A Chi-square test was performed and a significant relationship has been found between the preference of avatar's gender and the character downloaded $X^2 (N=174) = 34.98$, $p= 0.04$. We notice that the target group agree on having a female character to help as they would love to have a virtual character regardless of their ethnicity as long as it is in similar/peer age range.

		Would you prefer a virtual character that would help you to be (Age)?	Would you prefer a virtual character that would help you to be (Gender)?
The character I downloaded was	Chi Square	28.24	34.98
	Degrees of Freedom	22	22
	p-value	0.17	0.04

Table 9: Character Downloaded Vs. Preferences

		What age would you prefer a virtual character that would help you to be?	What age would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	Do you prefer the character that would help you to look like you?	Level of authority/role you would prefer a character that would help you to be/play:	What environmental theme would you prefer the helping character to be in:
What is your gender?	Chi Square	10.26	12.93	1.46	5.14	10.51	5.98
	Degrees of Freedom	4	4	4	4	8	14
	p-value	0.04	0.01	0.83	0.27	0.23	0.97

Table 10: Participant Gender vs Preferences

		Would you prefer a virtual character that would help you to be?				Would you prefer a virtual character that would help you to be?				Would you prefer a virtual character that would help you to be?				Do you prefer the character that would help you to look like you?			
		Younger than you	Older than you	Same age as you	Total	Male	Female	Doesn't matter	Total	Same ethnicity	Different ethnicity	Doesn't matter	Total	Yes	No	Doesn't matter	Total
What is your gender?	Female	4 2.74% 44.44%	62 42.47% 80.52%	80 54.79% 76.19%	146 100.00% 76.44%	12 8.22% 48.00%	68 46.58% 86.08%	66 45.21% 75.86%	146 100.00% 76.44%	42 28.77% 84.00%	7 4.79% 70.00%	97 66.44% 74.05%	146 100.00% 76.44%	36 24.66% 85.71%	36 24.66% 66.67%	74 50.68% 77.89%	146 100.00% 76.44%
	Male	5 11.63% 55.56%	15 34.88% 19.48%	23 53.49% 21.90%	43 100.00% 22.51%	43 30.23% 52.00%	11 25.58% 13.92%	19 44.19% 21.84%	43 100.00% 22.51%	8 18.60% 16.00%	3 6.98% 30.00%	32 74.42% 24.43%	43 100.00% 22.51%	6 13.95% 14.29%	18 41.86% 33.33%	19 44.19% 20.00%	43 100.00% 22.51%
	Don't identify with either	0 0.00% 0.00%	0 0.00% 0.00%	0 100.00% 1.90%	2 100.00% 1.05%	2 0.00% 0.00%	0 0.00% 0.00%	2 100.00% 2.30%	2 100.00% 1.05%	0 0.00% 0.00%	0 0.00% 0.00%	2 100.00% 1.53%	2 100.00% 1.05%	0 0.00% 0.00%	0 0.00% 0.00%	2 100.00% 2.11%	2 100.00% 1.05%
	Total	9 4.71% 100.00%	77 40.31% 100.00%	105 54.97% 100.00%	191 100.00% 100.00%	25 13.09% 100.00%	79 41.36% 100.00%	87 45.55% 100.00%	191 100.00% 100.00%	50 26.18% 100.00%	10 5.24% 100.00%	131 68.59% 100.00%	191 100.00% 100.00%	42 21.99% 100.00%	54 28.27% 100.00%	95 49.74% 100.00%	191 100.00% 100.00%
What cultural group does your family most strongly identify with? &																	

		Level of authority/role you would prefer a character that would help you to be/play:					What environmental theme would you prefer the helping character to be in:									
		Teacher	Doctor	Parent	Friend	Peer	Total	School	Clinic	Mall	Hospital	Park	Home	none of the above	no preference	Total
What is your gender?	Female	19 13.01% 76.00%	22 15.07% 91.67%	5 3.42% 71.43%	81 55.48% 78.64%	19 13.01% 59.38%	146 100.00% 76.44%	18 12.33% 78.26%	13 8.90% 92.86%	5 3.42% 83.33%	10 6.85% 90.91%	21 14.38% 70.00%	25 17.12% 78.13%	8 5.48% 72.73%	46 31.51% 71.88%	146 100.00% 76.44%
	Male	6 13.95% 24.00%	2 4.65% 8.33%	2 4.65% 28.57%	21 48.84% 20.39%	12 27.91% 37.50%	43 100.00% 22.51%	5 11.63% 21.74%	1 2.33% 7.14%	1 2.33% 16.67%	1 2.33% 9.09%	9 20.93% 30.00%	6 13.95% 18.75%	3 6.98% 27.27%	17 39.53% 26.56%	43 100.00% 22.51%
	Don't identify with either	0 0.00% 0.00%	0 0.00% 0.00%	0 0.00% 0.00%	1 50.00% 0.97%	1 50.00% 3.13%	2 100.00% 1.05%	0 0.00% 0.00%	0 0.00% 0.00%	0 0.00% 0.00%	0 0.00% 0.00%	0 0.00% 0.00%	1 50.00% 3.13%	0 0.00% 0.00%	1 50.00% 1.56%	2 100.00% 1.05%
	Total	25 13.09% 100.00%	24 12.57% 100.00%	7 3.66% 100.00%	103 53.93% 100.00%	32 16.75% 100.00%	191 100.00% 100.00%	23 12.04% 100.00%	14 7.33% 100.00%	6 3.14% 100.00%	11 5.76% 100.00%	30 15.71% 100.00%	32 16.75% 100.00%	11 5.76% 100.00%	64 33.51% 100.00%	191 100.00% 100.00%
What cultural group does your family most strongly identify with? 																

		The character I chose was			Total
		Similar age to me	Younger than me	Older than me	
What age would you prefer a virtual character that would help you to be?	Younger than you	2 50.00% 2.94%	1 25.00% 50.00%	1 25.00% 1.79%	4 100.00% 3.17%
	Older than you	30 50.00% 44.12%	0 0.00% 0.00%	30 50.00% 53.57%	60 100.00% 47.62%
	Same age as you	36 58.06% 52.94%	1 1.61% 50.00%	25 40.32% 44.64%	62 100.00% 49.21%
	Total	68 53.97% 100.00%	2 1.59% 100.00%	56 44.44% 100.00%	126 100.00% 100.00%
What age would you prefer a virtual character that would help you to be?	Male	11 55.00% 16.18%	0 0.00% 0.00%	9 45.00% 16.07%	20 100.00% 15.87%
	Female	24 50.00% 35.29%	1 2.08% 50.00%	23 47.92% 41.07%	48 100.00% 38.10%
	Doesn't matter	33 56.90% 48.53%	1 1.72% 50.00%	24 41.38% 42.86%	58 100.00% 46.03%
	Total	68 53.97% 100.00%	2 1.59% 100.00%	56 44.44% 100.00%	126 100.00% 100.00%
What ethnicity would you prefer a virtual character that would help you to be?	Same ethnicity	22 61.11% 32.35%	0 0.00% 0.00%	14 38.89% 25.00%	36 100.00% 28.57%
	Different ethnicity	6 75.00% 8.82%	0 0.00% 0.00%	2 25.00% 3.57%	8 100.00% 6.35%
	Doesn't matter	40 48.78% 58.82%	2 2.44% 100.00%	40 48.78% 71.43%	82 100.00% 65.08%
	Total	68 53.97% 100.00%	2 1.59% 100.00%	56 44.44% 100.00%	126 100.00% 100.00%
Do you prefer the character that would help you to look like you?	Yes	9 42.86% 13.24%	0 0.00% 0.00%	12 57.14% 21.43%	21 100.00% 16.67%
	No	28 63.64% 41.18%	1 2.27% 50.00%	15 34.09% 26.79%	44 100.00% 34.92%
	Doesn't matter	31 50.82% 45.59%	1 1.64% 50.00%	29 47.54% 51.79%	61 100.00% 48.41%
	Total	68 53.97% 100.00%	2 1.59% 100.00%	56 44.44% 100.00%	126 100.00% 100.00%

Figure 6: The Relationship between the Character Downloaded and the Participants Preference

Also, DASS21 investigates the depression, anxiety, and stress level of participants was combined with avatar preferences and some significant relationship was found. A Chi-square test was performed as shown in Table 11 between the depression level and the avatar age preference and a significant result was found $X^2 (N=132) = 20.66, p= 0.01$. On the other hand, a possible relationship was found between the participant anxiety level and the character ethnicity preference $X^2 (N=132) = 13.96, p= 0.08$. Finally, nothing interesting is to be reported about the stress level for participants.

		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.
Depression	Chi Square	20.66*	2.52*	3.06*	2.27*	40.33*	15.32*	9.80*	52.05*	7.72*
	Degrees of Freedom	8	8	8	8	36	32	8	44	16
	p-value	0.01	0.96	0.93	0.97	0.28	0.99	0.28	0.19	0.96
		What age would you prefer a virtual character that would help you to be?								
		Young than			Older than			Same as		
Depression	Normal	0			23			31		
	Mild	3			15			14		
	Moderate	1			21			14		
	Severe	0			3			5		
	Extremely Severe	1			0			1		
		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.
Anxiety	Chi Square	11.03*	4.73*	13.96*	0.22*	20.55*	17.63*	4.48*	46.25*	17.72*
	Degrees of Freedom	8	8	8	8	36	32	8	44	16
	p-value	0.2	0.79	0.08	1	0.98	0.98	0.81	0.38	0.34
		What ethnicity would you prefer a virtual character that would help you to be?								
		Similar Ethnicity			Different Ethnicity			Doesn't Matter		
Anxiety	Normal	11			1			18		
	Mild	10			1			9		
	Moderate	8			4			38		
	Severe	3			2			14		
	Extremely Severe	6			0			7		

Table 11: Depression and Anxiety Relationship and Set of Attributes for Significant Relationships

A Chi-square test found a possible relationship between the participant's agreeableness level (see Table 12) and the character downloaded $X^2 (N=131) = 45.43, p=0.07$.

		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.			
Agreeableness	Chi Square	5.38*	7.58*	8.45*	3.17*	26.25*	13.33*	5.66*	45.43*	10.18*			
	Degrees of Freedom	6	6	6	6	27	24	6	33	12			
	p-value	0.50	0.27	0.21	0.79	0.50	0.96	0.46	0.07	0.60			
		The character I downloaded was											
		Bill	Celia	Jasmine	Joe	Josh	Mary	Sally	Sarah	Trina	Will	John	George
Agreeableness	Low	0	1	11	1	0	3	2	4	3	3	1	5
	Medium Low	0	2	6	1	0	0	9	2	10	3	0	2
	Medium High	2	1	11	1	1	0	3	4	0	0	1	1
	High	1	0	5	1	0	0	0	1	3	1	0	1

Table 12: Chi-Square Test for Agreeableness and Set of Attributes for Significant Relationships

A Chi-square test was performed between the participant's openness to experience (see Table 13) first item of the rapport questionnaire "I like the character", and a significant relation found between them $X^2 (N=131) = 20.94, p=0.05$. Also, A Chi-square test found a relation between the participant's openness to experience and the character ethnicity preference $X^2 (N=131) = 13.89, p=0.03$ while another possible relation was found between the participant's openness to experience and the character appearance preference $X^2 (N=131) = 11.73, p=0.07$.

		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.		
Openness to experience	Chi Square	1.24*	2.29*	13.89*	2.70*	19.43*	6.53*	11.73*	24.40*	20.94*		
	Degrees of Freedom	6	6	6	6	27	24	6	33	12		
	p-value	0.97	0.89	0.03	0.85	0.85	1.00	0.07	0.86	0.05		
		What ethnicity would you prefer a virtual character that would help you to be?			Do you prefer the character that would help you to look like you?			I liked the character.				
		Same	Different	Doesn't Matter	Yes	No	Doesn't Matter	S.Disagree	Disagree	N	Agree	S.Agree
Openness to experience	Low	7	0	23	1	12	17	0	4	12	14	0
	Medium Low	0	0	3	0	0	3	0	0	2	1	0
	Medium High	0	1	2	1	1	1	0	0	1	2	0
	High	0	0	2	1	1	0	1	0	1	0	0

Table 13: Chi-Square test for Openness to Experience and Set of Attributes for Significant Relationships

4.1.3 Rapport Questionnaire

The average and standard deviation for each of the questions in the Rapport Questionnaire are presented in Table 16. We see that in general 48 participants found the character they downloaded to be believable while 63 participants would be able to engage with the character. 78 participants like the character and 69 participants would like to receive help from a character. Rapport relation has been investigated and significant results show that 63 participant would be able to engage with the designed characters while 79 people thought that the character was interesting to interact with.

Following the method presented in the methodology chapter, a rapport score was calculated for each individual such that we gather up all the positive questions, reverse the negative questions, and then sum up the positive and the reverse negative ones. An individual result varied from 36 to 83, average is 45.37, standard deviation 2.12. We categorised each of those individual values in order to determine if there was relationship between the level of rapport and their demographic features. Given that a five-point Likert scale was used and there were 19 questions, we created five categories with the following cut-off points at very low rapport (between 1×19 and 2×19), low rapport (equal to/greater than 2×19 and less than 3×19), medium rapport (equal to/greater than 3×19 and 4×19), good rapport (equal to/greater than 4×19 and 5×19) and high rapport (equal to/greater than 5×19). The number of participants (x-axis) in each category is shown in Figure 7. We can see

that no participants felt a strong sense of rapport, 40 established good rapports and the majority did not feel a sense of rapport with the character. A Chi-Square test has been performed to investigate relationships for Rapport Questionnaire, no results to be report.

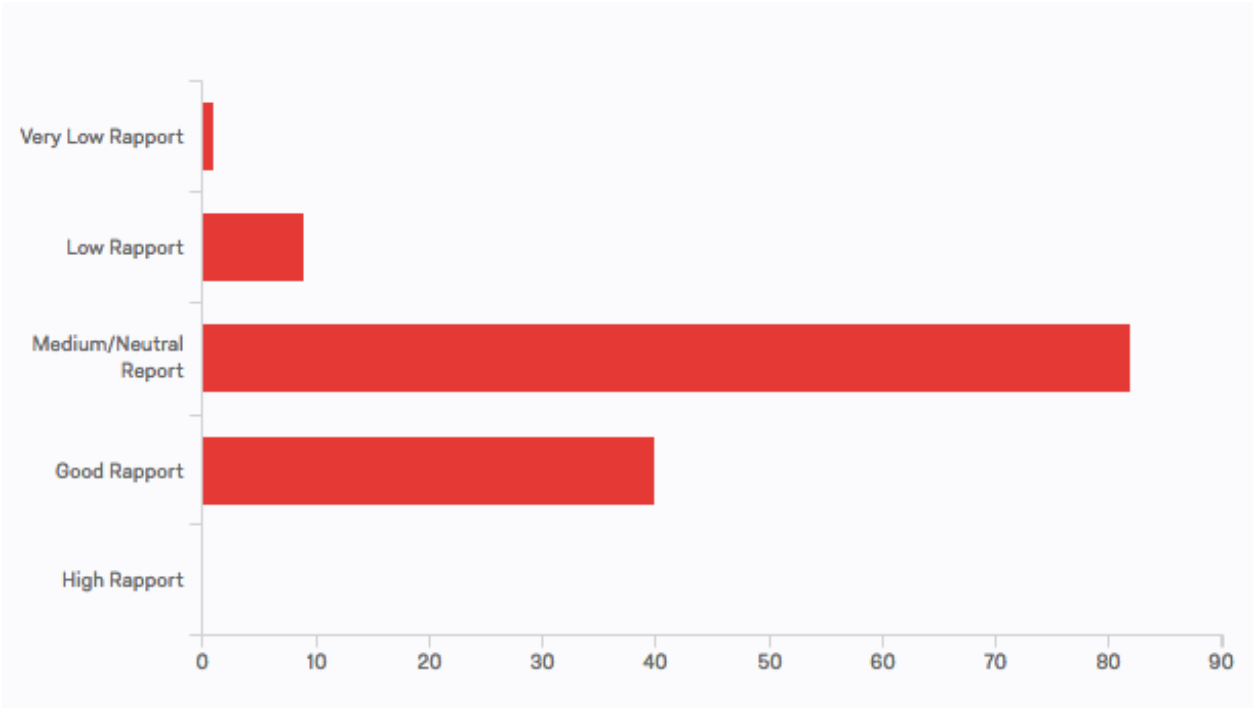


Figure 7: Categorized Rapport Score Results. (Rapport category shown on y-axis, number of participants in each category shown on x-axis)

		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.
Rapport Score	Chi Square	2.86*	4.27*	4.06*	4.04*	16.54*	29.02*	6.42*	16.50*	93.86*
	Degrees of Freedom	8	8	8	8	36	32	8	44	16
	p-value	0.94	0.83	0.85	0.85	1.00	0.62	0.60	1.00	0.00
		I liked the character.								
		S.Disagree	Disagree	N	Agree	S.Agree				
Rapport Score	Very Low Rapport	0	0	0	0	0				
	Low Rapport	2	4	2	1	0				
	Medium/Natural	0	3	42	37	0				
	Good Rapport	0	0	2	33	5				
	High Rapport	0	0	0	0	0				

Table 14: Chi-Square Test for Rapport Questionnaire and Set of Attributes for Significant Relationships

Emotional Stability level (see Table 15) of participants (found by TIPI) was an interesting pattern as it shows significant relationship with character gender preference $X^2 (N= 131) = 35.08, p=0.00$. It also shows a significant relation with the participant gender $X^2 (N=131) = 17.81, p=0.01$. It is worthwhile to mention that 34 females were in low in emotionally stable, 42 females in medium high level of their emotion, while 18 males were also in medium high level of emotionally stable. Not only this, also the participant course enrolled was significant with the emotion stability $X^2 (N=183) = 50.77, p=0.00$.

		What age would you prefer a virtual character that would help you to be?	What gender would you prefer a virtual character that would help you to be?	What ethnicity would you prefer a virtual character that would help you to be?	What is your gender?	What cultural group does your family most strongly identify with?	What course you are currently enrolled?	Do you prefer the character that would help you to look like you?	The character I downloaded was	I liked the character.		
Emotional Stability	Chi Square	35.08*	9.64*	6.63*	17.81*	18.75*	50.77*	2.49*	35.56*	12.46*		
	Degrees of Freedom	6	6	6	6	27	24	6	33	12		
	p-value	0.00	0.14	0.36	0.01	0.88	0.00	0.87	0.35	0.41		
		What age would you prefer a virtual character that would help you to be?			What is your gender?			What course you are currently enrolled?				
		Young than	Older than	Same as	F	M	N/A	Psycho	Comp Games	Computing	M.Media	Other
Emotional Stability	Low	0	18	19	34	3	0	28	0	2	0	7
	Medium Low	1	17	8	21	5	0	20	0	0	3	6
	Medium High	1	22	37	42	18	0	35	3	6	3	12
	High	3	4	1	2	6	0	2	4	1	0	1

Table 15: Emotional Stability Vs Rapport and Set of Attributes for Significant Relationships

Rapport	S. Disagree	Disagree	Neutral	Agree	S. Agree	Total	Mean	SD Dev	Variance
I liked the character.	2	8	47	78	5	140	3.55	0.72	0.52
The character was weird	6	48	45	30	11	140	2.95	1.04	1.07
I think the character and I established rapport.	7	34	63	36	0	140	2.91	0.83	0.69
I felt I had a connection with the character.	10	39	59	28	4	140	2.83	0.93	0.86
I think the character and I understood each other.	8	25	63	41	3	140	3.04	1.71	2.92
I would like to have someone like the character help me	4	24	40	69	3	140	3.32	0.87	0.76
I would recommend the character to a friend	6	36	56	40	2	140	2.98	0.88	0.77
I felt uncomfortable during the session.	12	68	35	23	2	140	2.54	0.92	0.84
I felt embarrassed during the session.	20	63	39	13	5	140	2.44	0.96	0.92
I had difficulty understanding the character.	31	73	31	5	0	140	2.07	0.76	0.58
I don't like the way the character looks.	10	57	36	25	12	140	2.81	1.09	1.18
It would be difficult to virtually meet and talk with the character.	6	26	49	53	6	140	3.19	0.94	0.88
Communicating with the character felt natural	11	35	49	43	2	140	2.92	0.96	0.92
This character was warm and caring.	3	9	63	61	4	140	3.39	0.74	0.55
Interacting with the character was believable.	13	37	40	48	2	140	2.91	1.01	1.03
The character was not empathic towards me.	6	58	53	21	2	140	2.68	0.83	0.69
I felt that the character was interested in what s/he was doing.	0	20	37	79	4	140	3.47	0.77	0.59
The character would be a poor problem solver.	4	49	63	21	3	140	2.78	0.81	0.66
I couldn't get anything accomplished with the character.	2	61	45	30	2	140	2.78	0.85	0.72
I would be able to engage with the character.	4	24	48	63	1	140	3.24	0.84	0.71

Table 16: The average and standard deviation for each of the questions in the Rapport Questionnaire

4.1.4 Usefulness Questionnaire

According to Table 17, the results show some interesting results to the long-term goal (Avg Mean= 3.014, Avg Standard Deviation= 1.07, and Avg Variance= 1.144) such that 54 participants would like to talk to a virtual human if they need help while 55 participants like to virtually chat (typing) with a virtual human. 61 participants agree to listen and take advice from virtual human 59 participants would be comfortable to talk to a virtual human. A Chi-square test has been performed against the usefulness questionnaire and participants demographic and no significant relation to be reported. However, significant relationship has been found between each question in the usefulness questionnaire and ethnicity preference as shows in Table 18.

Post Interaction	S. Disagree	Disagree	Neutral	Agree	S. Agree	Mean	SD Dev	Variance
I would like to talk to a virtual human if I needed help.	12	37	28	49	5	2.98	1.08	1.18
I would like to virtually chat (typing) with a virtual human.	15	30	30	50	6	3.02	1.12	1.25
I would listen to a virtual human.	10	26	35	56	4	3.14	1.02	1.03
I would like recommend a virtual human to a friend.	17	46	31	32	5	2.71	1.09	1.18
I would be comfortable to talk to a virtual human.	10	34	27	55	5	3.08	1.06	1.13

Table 17: Usefulness Questionnaire's Results

A Chi-square test has been performed and significant relationship has been found between each of the questions and the ethnicity preference, such that $X^2 (N=131) = 15.66, p= 0.05$, $X^2 (N=131) = 18.44, p= 0.02$, $X^2 (N=131) = 20.31, p= 0.01$, $X^2 (N=131) = 17.46, p= 0.03$, $X^2 (N=131) = 18.05, p= 0.02$, respectively.

		What ethnicity would you prefer a virtual character that would help you to be?
I would like to talk to a virtual human if I needed help.	Chi Square	15.66
	Degrees of Freedom	8
	p-value	0.05
		What ethnicity would you prefer a virtual character that would help you to be?
I would like to virtually chat (typing) with a virtual human.	Chi Square	18.44
	Degrees of Freedom	8
	p-value	0.02

		What ethnicity would you prefer a virtual character that would help you to be?
I would listen to a virtual human.	Chi Square	20.31
	Degrees of Freedom	8
	p-value	0.01
		What ethnicity would you prefer a virtual character that would help you to be?
I would like recommend a virtual human to a friend.	Chi Square	17.46
	Degrees of Freedom	8
	p-value	0.03
		What ethnicity would you prefer a virtual character that would help you to be?
I would be comfortable to talk to a virtual human.	Chi Square	18.05
	Degrees of Freedom	8
	p-value	0.02

Table 18: A Chi-Square Test for Usefulness Questionnaire

4.2 Qualitative Analysis

Once a participant reached the end of the survey, they were allowed to leave comments and further suggestions about the experience and the experiment. We have received 28 comments in total.

There were nine positive comments related to the study. Some were about the experience such as “This was a really fun and interactive study! I enjoyed it!” and “great study, thanks”. Other comments were more about the goals of the study such as “Great innovation which I see as a huge success in the future”, and “Thank you for this great job. We need this kind of Programs” and “Good luck with the rest of your survey”.

There were 13 comments about the voice, animation and reality such that some participant mentioned that the voices were almost the same and some of the animation was clearly not human like. In regard to the voice, as explained, we intentionally had only four different voices (young male, young female, older male, older female) all with Australian accents. We had decided that since the three ethnicities (Northern European descent, Middle Eastern/Mediterranean, Asian) covered many different cultural backgrounds and accents, for control and to avoid preferences for the voice, every character would have an Australian accent. In multi-cultural Australia it is common for individuals whose appearance indicates a certain ethnicity to have an Australian accent

particularly for individuals who are second generation (i.e. individual born in Australia but parents of individual born overseas) or even first generation (individual born overseas) to have an Australian accent. Perhaps we could have recorded a separate voice for all 12 characters, but this would reduce control of that variable and we recording a special voice for each character require more people and more time.

Regarding the animation, some people thought that the characters' animation is not realistic. Interestingly, when we investigated whether the participants who made this comment played computer games, we found that they tended not to play computer games. We conclude that they are less familiar with interacting with characters and found the experience unusual and unrealistic while some participants made such comments, because of heavy game usage they have become accustomed to more sophisticated models than we were able to create for our study. Some participant mentioned that especially "Josh", "Joe" and "Celia" were completely unrealistic. Such comments "Joe has a creepy smile and fake/glassy eyes. With better graphics this initiative could really work! Especially due to the anonymity of it". With better graphics this initiative could really work! Especially due to the anonymity of it" were received from two participants. We agree that these models were unrealistic and poor quality. We found creating Asian models particularly difficult because we had to modify other models to have a more Asian appearance. We were unable to find existing Asian models. We note that finding suitable character models for serious but non-military applications is more difficult than finding fantasy or military models.

Also, there were 2 comments about the interaction with the character such that it was short and selecting responses from the screen interrupt the participant from reality, those comments are "I like the idea of a virtual person; however, selecting a response from a screen takes away from its potential as a human-like experience (more contrived than real). I liked many of the characters provided - upbeat and cheerful in expression, they made me feel quite happy" and "The interaction with the virtual character was quite short and didn't reveal very much in order to answer the following questions however the study looks great and I am interested to see how the study turns out and all the results". The main reason behind the study is to investigate the characteristics of participants and whether those characteristics influence the characteristics of the avatars they would like to have to help them. To provide a combination of different key participant characteristics (gender, age, ethnicity), we have designed 12 avatars. Since we want the participant to select from 12 models we chose to keep the length of each introductory interaction scenario to a minimum, otherwise the time spent on the survey will not be reasonable for all participants. Since it is short and to avoid complications, we decided not to include any interaction in the introduction scenarios so that we could produce short videos that did not require the user to download all 12 models

(which would require 12 downloads each with 3 download versions according to Mac, Windows or OpenGL/web version). In each of the videos, the character says “Hi! How’s it going? I’m Sally/Trina/Josh/etc., if it is a young/peer character or “Hello. My name is Sarah/John etc.; it’s a pleasure to meet you. How are you doing today?” if it is an older character. We could have just shown photos, but then there was no third dimension to the character and no sense that it is a virtual human who will communicate with you. The dialogue of the conversation is provided in Appendix A.

The effort involved in creating 36 downloadable applications to cover the 12 characters and associated dialogues and animations for this short-term project, meant that it was not feasible for us to create a lengthy interaction with the top ranked character. Even if there had been resources, it is not clear what the nature of the interaction could have been at this exploratory stage of choosing a suitable model. For this reason, it was also not expedient to implement open-ended dialogue requiring voice recognition and language technology processing and so we chose to receive responses from participants by selecting an answer from the screen. In the long-term project we are considering to receive responses verbally and monitor participant movement.

The criticism regarding the requirement to select options to interact with the character and that influencing the realism of the interaction, indicates that the participant was not willing to “suspend disbelief” and did not experience the characters as believable. In general, participants were split in their responses to “interacting with the character was believable”, where 13 participants were strongly disagree, 37 disagree, 40 participant felt neutral, 48 agree that it was believable, and 2 participants were strongly agree.

There were 3 comments from participants who had some difficulties dealing with the survey and the downloading phase. Although the entire description of how to download an avatar was provided, some people may still have difficulties because they did not read the description or have an issue in their machine. The need for 36 files to provide a Windows installation, MAC installation, and Web installation for each character in each scenario ranging in size from 20-60MB made it necessary for us to upload the files into “Dropbox”.

4.3 Discussion of Young Adult Results

Our results indicate that most people have no preference for a character that looks like them. In general, participants felt a sense of rapport with the character they chose, which the majority perceived as a similar age to themselves. The usefulness questionnaire indicates most would like to have such a character to help them.

Some differences were found for different genders and different student cohorts. Almost no females wanted a male character to assist them, but males were split in their preferences. No Psychology students wanted a character that was younger than them to help them; however, some Computing students did prefer a younger character.

While numerous significant results were found, these findings are limited because we did not have equal representations of genders and student cohorts. To try to address this imbalance, we conducted a smaller study that only asked the set of questions provided in Appendix F with a cohort of computing students. Computing classes only have about 10% females. We invited a class of 115 third year Computing students to participate and 23 completed our short study, 15 males, 7 females, 1 did not identify with either gender. This gender balance does not represent the class gender balance, but is consistent with the fact that females are more likely to complete a survey or request for participation than males (Curtin et al., 2000; Moore and Tarnai, 2002; Singer et al., 2000). Although these numbers and gender balance did not manage to bring significant balance to the study (i.e. equal gender and Psychology/Computing students) these additional participants reduced the extent of the imbalance and thus we present results for the questions that were asked of the original and additional computing students. They did not complete the whole study.

Figure 8 shows the comparison of demographic versus preference with extra computing students. A Chi-square test has been performed and significant relationship has been found between the participant gender and the character gender preference $\chi^2 (N=199) = 8.55, p=0.07$ while another significant relation found between the participant gender and the character gender preference $\chi^2 (N=199) = 22.51, p=0.00$. Finally, a significant relation found between the participant gender and the character ethnicity preference $\chi^2 (N=199) = 9.55, p=0.05$. Another relationship has been found between the participant cultural group and the character age preference $\chi^2 (N=197) = 28.26, p=0.06$.

On the other hand, two significant relationships were found between the participant course and both character age preference and character appearance to be look like the participant. Such that a Chi-Square test shows the relation between the course enrolled and the character age preference is significant $\chi^2 (N=199) = 18.89, p=0.02$. While the other relationship was found between the course enrolled and the character appearance preference $\chi^2 (N=199) = 14.10, p= 0.08$. A great indication on that a wide agreement on the character age, such that the designed character should be similar age as the participant.

Finally, a Chi-square test was performed and a significant relationship was found between the participant playing computer games and the character age and gender preference, such that the relation with the age preference was $X^2 (N=199) = 8.57, p = 0.01$ and the relation with the gender preference is $X^2 (N=199) = 7.80, p = 0.02$.

		What age would you prefer a virtual character that would help you to be?				What gender would you prefer a virtual character that would help you to be?				What ethnicity would you prefer a virtual character that would help you to be?				Do you prefer the character that would help you to look like you?			
		Younger than you	Older than you	Same age as you	Total	Male	Female	Doesn't matter	Total	Same ethnicity	Different ethnicity	Doesn't matter	Total	Yes	No	Doesn't matter	Total
What is your gender?	Female	2	64	73	139	12	63	64	139	36	8	95	139	33	38	68	139
	Male	4	18	36	58	19	14	25	58	11	2	45	58	7	24	27	58
	Don't identify with either	0	0	2	2	0	0	2	2	0	1	1	2	0	1	1	2
Total		6	82	111	199	31	77	91	199	47	11	141	199	40	63	96	199
What cultural group does your family most strongly identify with?	Oceania	2	36	34	72	14	27	31	72	20	2	50	72	12	22	38	72
	Northern-Western European	0	13	8	21	5	5	11	21	4	1	16	21	4	6	11	21
	Southern-Eastern European	1	6	6	13	1	5	7	13	2	1	10	13	3	3	7	13
	North African and Middle Eastern	0	4	13	17	1	9	7	17	4	1	12	17	2	6	9	17
	South-East Asian	0	12	21	33	4	12	17	33	3	5	25	33	7	11	15	33
	North-East Asian	2	2	5	9	0	3	6	9	2	0	7	9	1	4	4	9
	Southern and Central Asian	0	3	8	11	1	5	5	11	1	0	10	11	2	4	5	11
	People of the Americas	0	0	1	1	1	0	0	1	1	0	0	1	1	0	0	1
	Sub-Saharan African	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I don't identify with any cultural group	1	6	16	23	4	12	7	23	9	1	13	23	7	8	8	23
Total		6	81	110	197	31	75	91	197	46	11	140	197	38	63	96	197
What course you are currently enrolled?	Psychology	2	48	49	99	17	42	40	99	33	5	61	99	25	29	45	99
	Computer games	2	3	4	9	0	4	5	9	1	0	8	9	1	6	2	9
	Other Computing	2	12	27	41	8	9	24	41	6	3	32	41	6	15	20	41
	Multi media	0	0	1	1	0	1	0	1	0	0	1	1	1	0	0	1
	Other	0	19	30	49	6	21	22	49	7	3	39	49	7	13	29	49
Total		6	82	111	199	31	77	91	199	47	11	141	199	40	63	96	199
Do you play computer games?	Yes	6	34	58	98	20	29	49	98	18	5	75	98	16	35	47	98
	No	0	48	53	101	11	48	42	101	29	6	66	101	24	28	49	101
Total		6	82	111	199	31	77	91	199	47	11	141	199	40	63	96	199

Figure 8: Comparison of Demographic versus preference with extra Computing Students

A wide variety of studies analysing children, teachers, and experts for the problem of physical bullying behaviour have been conducted (Hall et al., 2004). In particular, the problem was focusing on investigating differences in views, opinions, and attitudes between children and adults. Furthermore, they considered if differences existed, what design implications for embodied agents need to be addressed. Children were more favourable towards the character movement and voice as well as more believable towards the storyline as they think that it is true to life. We confirm this through our study. However, we investigate the needs of virtual agent to help through the investigation of participant's personality and depression, anxiety, and stress level.

According to Hall et al. (2004), all groups (children, teachers and experts) found the character's conversation more believable. However, the child's gender played a major role in their responses towards different characters. Significantly, children express more empathy towards different characters in the scene. This implies the importance of the design of an empathic agent to change certain behaviour. Significant analysis has been performed here showing that different personality levels and experience with particular gender, age, and storyline, had an impact on the children and their feelings (Hall et al., 2004). We confirm this beside the fact that people may prefer to have a character that is a similar age to them while we cannot ignore the fact that some participants do not play lots of computer games which makes it difficult to provide them with support unless we are able to provide realistic or authentic scenarios to help them.

4.4 Pilot Study with Young People

This is the second target group whose ages varied between 11 years and 15 years old whom we called “young people”. While young people are the target of the larger project; the young adult group was more accessible and comprised undergraduate university students from the psychology pool and students from computing or other departments within our university. As we had less access to young people, a smaller study was conducted with them. The aim was to determine if there were differences between these two cohorts and if no significant differences, the results from the larger cohort could be used to answer our research question. We did not ask the DASS21, personality questions or usefulness of the young people. Our bigger project goal is to work with young adults.

4.4.1 Participants and Avatar Preferences

The number of participants is 11, 9 were female and 2 male. The ages ranged from 11 to 15 (average age 12.6). Furthermore, 9 participants were from the same cultural group, which is Northern-Western European while the other 2 were Oceania. However, all participants with no exception played computer games for more than 3 hours a week.

In terms of the avatars preferences, 7 of them preferred character that would help to be same age as them while 4 preferred older than them. In terms of the gender preference, 6 preferred female, 4 did not care, and only one preferred male while in the ethnicity preference, 8 preferred same ethnicity, 1 different ethnicity and 2 did not care. In general, 7 children did not care about having a character that looked like them while the other four were divided between yes and no. Not surprisingly, 5 children preferred the home to be the character theme, while 4 preferred a mall theme and only 2 preferred the school theme while the majority agreed on having a character to be a friend.

4.4.2 Results and Discussion

The rapport questionnaire was also provided to this age group despite their small number, which consists of 11 participants, did the rapport questionnaire. Table 19 shows the rapport questionnaire and its results.

Rapport	S. Disagree	Disagree	Neutral	Agree	S. Agree	Mean	SD Dev	Variance
I liked the character.	0	0	2	8	1	3.91	0.51	0.26
The character was weird	0	0	6	5	0	3.45	0.50	0.25
I think the character and I established rapport.	0	1	9	1	0	3	0.43	0.18
I felt I had a connection with the character.	1	5	4	1	0	2.45	0.78	0,61
I think the character and I understood each other.	3	4	1	3	0	2.36	1.15	1.32
I would like to have someone like the character help me	2	4	2	2	1	2.64	1.23	1.50
I would recommend the character to a friend	1	0	7	3	0	3.09	0.79	0.63
I felt uncomfortable during the session.	0	4	4	2	1	3.00	0.95	0.91
I felt embarrassed during the session.	1	5	4	0	1	3.45	0.99	0.98
I had difficulty understanding the character.	0	4	6	1	0	3.27	0.62	0.38
I don't like the way the character looks.	2	2	2	4	1	3.00	1.28	1.64
It would be difficult to virtually meet and talk with the character.	0	3	3	2	3	3.45	1.16	1.34
Communicating with the character felt natural	3	1	3	3	1	2.82	1.34	1.79
This character was warm and caring.	1	3	6	1	0	2.64	0.77	0.60
Interacting with the character was believable.	3	2	4	1	1	2.55	1.23	1.52
The character understood and shared my feelings.	0	2	8	1	0	2.91	0.51	0.26
I felt that the character was interested in what s/he was doing.	0	2	5	4	0	3.18	0.72	0.51
The character would be a poor problem solver.	0	2	6	3	0	2.91	0.67	0.45
I couldn't get anything accomplished with the character.	0	3	5	1	2	3.18	1.03	1.06
I would be able to engage with the character.	1	2	5	3	0	2.91	0.90	0.81

Table 19: Results of the Rapport Questionnaire for Young People Group

Rapport scores for the each individual ranged from 38 to 68. When we compare the rapport scores for the young people with the young adults we see that in general the rapport level is lower.

Interestingly, half of the participants ranked “Jasmine” to be in the first place and rank “John” to be least ranked character. Comparing the results with the young adults, “Jasmine” took the first place in ranking by 46 participants by the young adults and 5 participants by the young people, while “John” took the least rank by 45 in young adults and 5 participants in the young people group. We did not calculate Chi- square tests due to the small number of participants.

4.5 Chapter Summary

In this chapter, we have discussed both target groups’ results to investigate what sort of character is needed, and also to find out their personality, depression, anxiety, and stress level in order to investigate whether it influences their decisions. There was wide agreement on the character age, such that the results support that the designed character should be a similar age to the participant. Furthermore, we noticed that the target group agreed on having a female character to help as they would love to have a virtual character regardless of their ethnicity as long as it is in similar/peer age range.

5 Chapter 5: Conclusion

5.1 Summary and Outcomes: Answering the Research Question

In order to achieve the long-term goal of designing empathic agents to support adolescents, it was important to answer the research questions given in chapter 1 and reproduced below. The questions consider what sort of character/avatar is preferred based on the participant's characteristics and the matches between the person and the character's age, gender and ethnicity. Each of the research questions are considered and answered in the following subsections. Unless specified, the conclusions offered cover both the young adult and young people cohorts.

5.1.1 What sort of character would a young person (13-17) or young adult (18-30) want to interact with in a helping role?

Finally, we notice that both target groups agree with each other on having a female character to help as they would love to have a virtual character regardless of their ethnicity as long as it is in similar/peer age range. Both target groups agree on having "Jasmine" in top rank and "John" in least rank.

5.1.2 What sort of matches between the person and the character in terms of age, gender, and ethnicity are preferred?

We conclude that the designed avatar can be made in any ethnicity as long as the gender of the character was satisfied since we observe that female and male mainly prefer female characters. However, a wide agreement on the character age, such that the designed character should be similar age as the participant.

5.1.3 What is the relationship between a target group personality and their avatar preferences?

The relationship between the target group, their personality, and how it influences their decision was an important matter to investigate their preference for a virtual character on one hand, and to compare their selection based on their personality on the other hand.

Participant's openness to new experience has a strong relationship with the character ethnicity preference, such that, people strongly have no issue to have a character to help with any ethnicity. On the other hand, participant agreeableness level was strongly related to the character downloaded, such that "Jasmine" has the top rank among all avatars by 46 participants.

5.1.4 What is the relationship between a target group's levels of Depression, Anxiety and Stress and their avatar preferences?

It is also worth mentioning that a large number of participants suffer from extreme depression and anxiety. Unfortunately, participants reported suffering extremely severely from anxiety (93), depression (62) and stress (13). Due to their depression and anxiety, even though they were largely neutral in their responses in the rapport questionnaire, participants in our target age group liked the character and would like to receive help from such a character. Possibly due to their extreme depression and anxiety, 53 participants agreed “It would be difficult to virtually meet and talk with the character” and 43 participants agreed that “Communicating with the character felt natural”. Due to the significant results found between depression and character’s age preference, and anxiety with character’s ethnicity in Table 11, we believe that depression and anxiety influenced the participant’s decision more than stress.

We mentioned that the age of the character should be the same as the participant’s age based on their preferences, but by looking at the actual selection versus the preference we found that 49% of the participants choose a character in similar age, but 47% choose the one to be older than them. This difference was explained when we found that most participants suffer from extreme depression and anxiety on the one hand, and their openness to new experiences is high on the other hand while 28 participants suffered from stress. This implies that they have a particular preference and they establish a rapport relation with a character they found more comfortable and interesting to deal with.

5.2 Future Work and Limitations

Having sufficient representation of the different users that can make up a target population is a common limitation and one faced by our study. In terms of the online survey, we believe the survey may have been longer than what participants expected or required more time than participants were willing to give without any compensation. This is why Psychology students, who received course credit, completed the study and downloaded a character, while the additional effort was considered too much or too difficult for others who received no compensation.

Another limitation was that some of the designed characters looked weird because of some quality of the scene. This explains why both characters “Celia” and “John” were in the bottom ranking among the rest. Unlike those, “Jasmine” and “Trina” which was clearly and significantly better scene become the top ranking characters respectively. It is important to mention the fact that designing weird character may impact the results which need to be

considered in the future work. Likewise, uncanny valley (Mori, 2012) which is a hypothesis when a human replicas almost like a real human, the issue in our study was not that the characters were too real, but poorly rendered in the case of John, Josh, and Celia.

The classification and rendering of ethnicity was coarse and does not include minority ethnic groups. Most notably it does not cover any black ethnicities, including Indigenous Australians (approximately 2% of the Australian population). Providing 18 models in total (12 for the study with Young Adults and an alternative set of 6 young models for the Young People study) was already challenging. Our aim was to provide models that not only allowed us to match on whether participants wanted someone who looked like them (which obviously was not tested in the case of any black participant) but also to evaluate models that we might use in our IVA applications that have features similar to teachers, health professionals or friends that users are likely to encounter in real life in Australia. Thus, we sought to cover the main groups distinguished by their facial features including eyes, nose, mouth, hair and skin colour.

A further limitation is that the visual representations are superficial markers for cultural background. We use the ABS categories to identify the participants' ethnic backgrounds. These do not directly map to the three ethnic appearances that we model. As future work we suggest that a study be conducted with indigenous Australians, to determine if they have a preference for the ethnic appearance of the characters.

5.3 Final Remarks

The long term aim of this project is to provide an IVA that could act as a mentor or friend to a young person or young adult, particularly for the purpose of adherence to treatment advice. The aim would be to build a working alliance with the character that allows shared goals and plans within an environment of trust. Through chatting with the IVA, the young person would be able to discuss their psycho-social problems and get the support they do not currently feel they receive from parents, peers or medical professionals. This short-term project has sought to contribute to that vision by shedding light on the sort of character that might be most appropriate to use to create such a relationship.

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Appendix A: Dialogues

Welcome dialogues

Older male	1. Hello. How are you doing? I'm George. 2. Hello. How are you doing? I'm Bill. 3. Hello. How are you doing? I'm John.
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Older female	1. Hello. How are you doing? I'm Sarah. 2. Hello. How are you doing? I'm Celia. 3. Hello. How are you doing? I'm Mary.
---------------------	--

Younger male	1. Hi! How's it going? I'm Josh. 2. Hi! How's it going? I'm Will. 3. Hi! How's it going? I'm Joe.
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Younger female	1. Hi! How's it going? I'm Sally. 2. Hi! How's it going? I'm Trina. 3. Hi! How's it going? I'm Jasmine.
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Conversation Dialogues

Older male and female

(Older female intros)

Hello. My name is Sarah. It's a pleasure to meet you. How are you doing today?

Hello. My name is Celia. It's a pleasure to meet you. How are you doing today?

Hello. My name is Mary. It's a pleasure to meet you. How are you doing today?

(Older male intros)

Hello. My name is George. It's a pleasure to meet you. How are you doing today?

Hello. My name is Bill. It's a pleasure to meet you. How are you doing today?

Hello. My name is John. It's a pleasure to meet you. How are you doing today?

Response: I am alright.

Response: Not too bad.

That's good to hear

Response: Not so good.

I'm sorry to hear that.

I'm a lecturer at Macquarie University. What about you? Are you studying here?

Response: yes I am a student

I love working with students. Maybe I can help you out some time. Would you like to chat with me sometime if you have a problem?

Response: No I'm not a student.

Maybe I can help you out some time. Would you like to chat with me sometime if you have a problem?

Response: Maybe.

Response: Yeah, sure.

That's great.

Response: Not really.

That's a shame.

Well, it's nice to meet you. I've got to run to a lecture now. I hope we can talk again soon.

Younger male and female

(Younger female intros)

Hi, I'm Jasmine. How you going?

Hi, I'm Sally. How you going?

Hi, I'm Trina. How you going?

(Younger male intros)

Hi, I'm Josh. How you going?

Hi, I'm Will. How you going?

Hi, I'm Joe. How you going?

Response: Great.

Response: Not so bad.

That's good to hear.

Response: Not so good.

Sorry to hear that.

I'm studying multi-media design. I'm just in my first year. What about you?

Response: Yes, I am studying too.

Response: No, I'm not a student

Do you think sometimes you'd like a bit of help from someone like me?

Response: Yes.

Response: No.

Response: Not Sure

Well, it was nice to meet you. I've got to go. I hope we can talk again soon

Appendix B: Rapport Questions

Rapport	Mean	SD Dev	Variance
I liked the character.	3.55	0.72	0.52
The character was weird	2.95	1.02	1.04
I think the character and I established rapport.	2.91	0.83	0.69
I felt I had a connection with the character.	2.83	0.93	0.86
I think the character and I understood each other.	3.04	1.71	2.92
I would like to have someone like the character help me	3.32	0.87	0.76
I would recommend the character to a friend	2.98	0.88	0.77
I felt uncomfortable during the session.	2.54	0.92	0.84
I felt embarrassed during the session.	2.44	0.96	0.92
I had difficulty understanding the character.	2.07	0.76	0.58
I don't like the way the character looks.	2.81	1.09	1.18
It would be difficult to virtually meet and talk with the character.	3.19	0.94	0.88
Communicating with the character felt natural	2.92	0.96	0.92
This character was warm and caring.	3.39	0.74	0.55
Interacting with the character was believable.	2.91	1.01	1.03
The character was not empathic towards me.	2.68	0.83	0.69
I felt that the character was interested in what s/he was doing.	3.47	0.77	0.59
The character would be a poor problem solver.	2.78	0.81	0.66
I couldn't get anything accomplished with the character.	2.78	0.85	0.72
I would be able to engage with the character.	3.24	0.84	0.71

Appendix C: Post Intervention

Post Interaction
I would like to talk to a virtual human if I needed help.
I would like to virtually chat (typing) with a virtual human.
I would listen to a virtual human.
I would like recommend a virtual human to a friend.
I would be comfortable to talk to a virtual human.

Appendix E: Qualtrics Survey

The Survey with all sections can be found in the following link

<http://tinyurl.com/12Models>

Appendix F: Questions Set for Computing Students

Please answer the following questions. Please do not provide your name or any identifying data.

Q1 what is your gender?

- ☐ Female
- ☐ Male
- ☐ Don't identify with either

Q2 what cultural group does your family most strongly identify with?

- ☐ Oceania
- ☐ Northern-Western European
- ☐ Southern-Eastern European
- ☐ North African and Middle
- ☐ South-East Asian
- ☐ North-East Asian)
- ☐ Southern and Central Asian
- ☐ People of the Americas
- ☐ Sub-Saharan African
- ☐ I don't identify with any cultural

Q3 How old is you?

Q206 How many hours per week on average do you play computer games?

A virtual character is a computer-based humanlike character. The following questions concern your preferences for a virtual character that would help and support you.

Q1 Would you prefer a virtual character that would help you to be?

- ☐ Younger than you
- ☐ Older than you
- ☐ Same age as you

Q2 Would you prefer a virtual character that would help you to be?

- ☐ Male
- ☐ Female
- ☐ Doesn't matter

Q3 Would you prefer a virtual character that would help you to be?

- ☐ Same ethnicity
- ☐ Different ethnicity
- ☐ Doesn't matter

Q4 Do you prefer the character that would help you to look like you?

- ☐ Yes
- ☐ No
- ☐ Doesn't matter

Appendix G: Poster Advertisement



Want To Experience an Interaction with Virtual Human/Intelligent Agent and Young People

You are invited to participate in a study on 'Virtual Humans to Provide Support to Young People and Young Adults'. The purpose of the study is to find a suitable avatar for adolescents to interact with for the purpose of learning. The study is being conducted by **Ms. Bayan Alsharbi**, Department of Computing, Bayan.Alsharbi@students.mq.edu.au, to meet the requirements of Master of Research under the supervision of **Professor Deborah Richards**, 61 (02) 9850 9567, Deborah.richards@mq.edu.au, of the Department of Computing, Faculty of Science and Engineering. Also, other people involved in this project are:

Dr. Lauren McLellan	Lauren.mclellan@mq.edu.au
Associate Professor Michael Hitchens,	Michael.hitchens@mq.edu.au
Dr. Cat Kutay	Cat.kutay@mq.edu.au
Mr Wayne Reg Charters	Wayne@charters.id.au



If you decide to participate, you will first complete a questionnaire about yourself and your avatar preference. You will interact with 2 avatars and provide feedback. The duration of the study is expected to be around 20 minutes. We cannot offer any financial reward for participation. However you may find the outcome of this project useful for some learning purposes.

To participate take the link on the side

For any queries, please contact Bayan Alsharbi:
Bayan.Alsharbi@Students.mq.edu.au

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