



**MACQUARIE**  
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# **A VIRTUAL EMOTIONAL FREEDOM PRACTITIONER TO DELIVER PHYSICAL AND EMOTIONAL THERAPY**

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A THESIS SUBMITTED TO MACQUARIE UNIVERSITY

FOR THE DEGREE OF MASTER OF RESEARCH

DEPARTMENT OF COMPUTING

MAY 03, 2016



To my mum,

my dad,

my only brother &

my only sister,

for their non-stop support, care & love.

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

A handwritten signature in black ink, appearing to read 'Hedieh Ranjbartabar' in a cursive script.

**Hedieh Ranjbartabar**

## **Acknowledgement**

There are a number of people without whom the completion of my MRes would have not been possible.

First and foremost I would like to express my sincere appreciation to my supervisor, Prof. Deborah Richards, for all her support, patience, friendly manner, motivation and immense knowledge. She has been always there to listen and give advice. I could not have imagined having a better supervisor for my study.

I am also extremely grateful to my associate supervisor, Dr Cat Kutay, for all her prompt support, inspiration, encouragement and suggestions.

Beside my supervisors, I would like to thank the people who have helped me through my research study and I have learned a lot from them, particularly Ayse Bilgin, Meredith Taylor, Mark Dras, Hossein Miri and Nader Hanna.

Finally, I would like to acknowledge with thanks the useful comments provided by the examiners of this thesis.

## **Abstract**

The role of virtual humans in a range of health scenarios, including therapy and counselling, is being explored as a substitute for human therapists and counsellors. This research study investigates the potential benefits of a virtual practitioner to deliver the Emotional Freedom Technique (EFT). EFT is a kind of psychological acupuncture technique to optimize emotional and physical health. Importantly, our study compares two different types of virtual therapists; one that exhibits empathic behaviour and another that delivers the therapy in a neutral manner. Our experimental design, consisting of one within-subjects factor (empathic/neutral therapist) and one between-subjects factor (order), measured the differences in emotional outcomes and sense of rapport. Our evaluation with 63 participants showed benefits for both virtual therapists. While both therapists achieved the same level of rapport, when order was taken into account, the empathic agent received higher ratings for sense of rapport in the second interaction. We conclude that with increased tailoring, the empathic agent would create a stronger sense of rapport than the neutral agent. It remains an open question whether increased tailoring and more empathic behaviours, would result in significant improvements in the emotional benefits delivered by an empathic agent over a neutral and less tailored agent.

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## List of Abbreviations and Acronyms

ASR	Automatic Speech Recognition
BML	Behaviour Mark-up Language
ECA	Embodied Conversational Agent
EEG	Electroencephalography
EFT	Emotional Freedom Technique
GSR	Galvanic Skin Response
IVA	Intelligent Virtual Agent
NLP	Neuro-Linguistic Programming
NLU	Natural Language Understanding
NVBG	NonVerbal Behaviour Generator
PTSD	Post Trauma Stress Disorder
TFT	Thought Field Therapy
VH	Virtual Human
VP	Virtual Patient
VRET	Virtual Reality Exposure Therapy
VT	Virtual Therapist

# Chapter 1: Introduction

Recent research in intelligent virtual agents is showing many potential benefits of this technology in a range of domains, including health and wellbeing (e.g. (DeVault et al., 2014, Bickmore et al., 2015, Lisetti et al., 2013)). This line of research offers practical and interactive computer-based rehabilitation tasks that can be delivered any time at a low cost (e.g. (Lisetti, 2008, Bickmore et al., 2010a)). However, moving this research from the laboratory into the real-world common use requires more efforts to understand the impacts of using animated life-like characters on human users in a wide range of applications. This thesis explores a novel application that includes the creation of a virtual therapist to provide emotional support and potential physical benefits to a human user. The virtual therapist employs a healing tool called Emotional Freedom Technique (EFT) (Craig, 2011). EFT is a kind of Meridian Tapping that combines ancient Chinese acupressure and modern psychology with remarkable results. Tapping utilizes the body's energy meridian points by stimulating them with fingertips. It could be applied to wide range of emotional and physical issues. More details on EFT can be found in the next chapter under literature review.

In our study, we measured the impact of the virtual agent's empathic cues on sense of rapport perceived by the users. Furthermore, we measured whether greater therapeutic benefit was delivered by an empathic virtual character compared to a neutral one.

The rest of this chapter provides an introduction to the research work presented in this thesis. It describes the research background in section 1.1 and explains the motivation for pursuing this work in section 1.2. In addition, in section 1.3 it provides the aims and objectives of the research. Finally, it introduces the structure of the thesis in section 1.4.

## 1.1 Background

The holy grail of Intelligent Virtual Agents (IVA) research has been the achievement of believability, accomplished if the human is willing to suspend disbelief and interact with the Virtual Human (VH) as if it were a human. However, the extent to which VHS need to be believable or regarded in the same way as humans has been questioned (e.g. (de Melo and Gratch, 2015)), particularly when researchers are identifying that VHS might be preferable over real humans, such as in anonymous or non-judgmental contexts (Gratch et al., 2014), and provide numerous benefits over their human counterparts due to being more available, patient and less variable – while also able to tailor their responses according to the situation (Lisetti, 2012). These VHS require social ability, communication skills and appropriate verbal and non-verbal behaviours. Researchers have already included some social skills, such as active listening, mimicry and emotional gestures into

VHs (e.g. (Bevacqua et al., 2008, Bickmore et al., 2005, Gratch et al., 2013)). Interest is particularly growing in examining the viability and benefits of building long-term relationships with VHs (Leite et al., 2009). Rapport has been found to play an important role in establishing and maintaining human relationships (Tickle-Degnen and Rosenthal, 1990). Many approaches have incorporated rapport building as a human-agent communication strategy (e.g. (DeVault et al., 2014, Gratch et al., 2014, Bickmore et al., 2010a, Huang et al., 2011, Hasler et al., 2014)).

An area of vital importance in healthcare scenarios is disclosing sensitive information. Previous studies have shown that VHs can increase willingness to disclose such information as evidenced by users' reporting lower fear of self-disclosure and displaying emotions more intensely in a safe environment and free of judgment (Gratch et al., 2014). These results indicate that VHs can help to overcome a significant limitation to obtaining truthful patient information.

Previous studies have also shown that empathy is needed as part of effective treatment, and that physicians' empathy is an important factor associated with clinical competence and patient outcomes (Larson and Yao, 2005, Hojat et al., 2011). In human interactions with Embodied Conversational Agents (ECAs), the results are often inconclusive and contradictory in learning, game and health domains. In the study presented by Maldonado et al. (2005), an emotional co-learning ECA had a positive impact on study performance, while other studies in the pedagogical domain generally found that use of emotion had little positive impact on the interaction. In a gaming environment, Prendinger et al. (2003) found that empathy had little influence on the perception of an agent, although it was found that empathy had an impact on reducing feelings of frustration and improving an interaction. Similarly in the health domain, while studies showed the potential effects of emotion on interaction, Berry et al. (2005) found that neutral agents might be more applicable in some scenarios. It is noteworthy that empathy perception is influenced by numerous factors. As Hastie et al. (2016) indicate that adding memory to a virtual character, does not necessarily increase the level of likeability and empathy. However, Hall and Woods (2005) present that the greater empathic relationship between a character and a user will occur, if the character is perceived similar to the user in appearance and behaviour.

## **1.2 Motivation**

The existing literature reports a number of potential benefits that can be delivered by intelligent VHs, particularly in the domain of healthcare. In this study, we sought to include a number of these features. Through use of a virtual therapist, we wanted to create an environment that provides a sense of security in terms of privacy and a place where users can feel less inhibited to express how

they feel. Furthermore, an online study was designed and implemented to allow convenient and easy access to therapy.

Review of existing literature also demonstrates that VHS can play an important role in supporting long-term relationships with humans. If VHS are going to move from the research laboratory into our daily life, more research is needed to explore where they can be useful and what features are most important, particularly when the outcome is associated with human health. While the literature reports a comparison between neutral manner and empathic behaviour towards the user in learning and game environments (Leite et al., 2010, Leite, 2011, Lin et al., 2013), to our knowledge there is no such comparison in the health or therapy domain.

The work in this thesis seeks to draw on the potential benefits of VHS in a novel context and explore the role that empathy plays in that context. By using EFT, we take advantage of the physical benefits of acupuncture as well as the cognitive benefits of conventional therapy. This could result in a faster and more effective treatment of emotional and physical issues. EFT tapping is a powerful, and easy to learn and apply technique (Ortner, 2013). It contains physical elements (tapping) that patients apply to themselves. Therefore, it serves as a testbed where it is feasible to provide a physical therapy via a virtual therapist. There is no previous research on virtual therapists using EFT, although there have been two online studies using videos of a real EFT practitioner (Ortner, 2015).

In addition to exploring a novel application domain, this research work investigates whether in the EFT context, empathic dialogue tailored to the user's responses and reported emotional state is more beneficial than a neutral dialogue that is not tailored. Empathic behaviours are being used increasingly to build a socio-emotional bond between the human and agent (Ochs et al., 2008). Indeed, VHS with such skills could heighten feelings of connection and rapport ((Huang et al., 2011). However, providing empathic responses requires sophisticated agent architectures, specialised software and sometimes hardware that may make the technology less accessible. By investigating the value-added by empathic dialogue, we seek to evaluate the benefits of the additional complexity and effort required to add tailored responses.

### **1.3 Research Aims and Questions**

Two initial research questions were investigated:

- *Does a Virtual EFT Therapist deliver emotional benefit?*

- *Does an empathic Virtual Therapist, that takes into account the emotional state of the user and responds in a caring manner, deliver greater emotional benefit using the Emotional Freedom Technique (EFT) than a neutral Virtual Therapist?*

In this study, we explore the relative benefits of a virtual therapist that uses empathic behaviours, primarily exhibited via verbal communication and nonverbal backchannel, over the same therapist who uses neutral behaviours. The therapy involves the use of the Emotional Freedom Technique (EFT), a tapping method described in more detail in Chapter 2. We chose to use EFT because, while it is often guided by an emotional freedom practitioner, the method primarily involves individuals performing the therapy on themselves, as in the case of meditation, but additionally has a physical element also performed by the patient on themselves. This application was deemed an ideal situation for a virtual human and also a testbed for exploring whether the addition of empathy was beneficial.

The significance of the research question is whether tailoring to the context and individual's situation improves or inhibits the results. If there is no difference or a negative impact, then the added intelligent processing and behaviour is not warranted. While the value of empathy and rapport for therapy is, in general, widely accepted as beneficial, EFT follows a standard and repetitive pattern involving physical tapping and repeating of set words, though there is a lack of reported findings on whether tailoring or development of a relationship with a human (or virtual) practitioner, produces greater physical and/or emotional benefit. Additionally, this study seeks to answer whether a VH can provide convenient delivery of the potential therapeutic benefits of EFT.

## **1.4 Outline**

The remainder of this thesis is organised as follows: Chapter 2 reviews the relevant literature concerning empathic IVAs and their social and therapeutic uses, as well as introduces EFT therapy.

Chapter 3 presents the methodology employed for addressing the research questions. Results of the study are detailed in Chapter 4. Discussion can be found in Chapter 5, followed by thesis conclusions and future work in Chapter 6.

Appendices contain the dialogues between the empathic/neutral virtual therapist and the user (Appendix A), the 40 rapport questions descriptive analysis and independent sample test for the two studies (Appendix B), the ethics approval letter (Appendix C), the Qualtrics survey (Appendix D) and the poster advertisement (Appendix E).

## **Chapter 2: Literature Review**

There has been a growing interest in building highly competent virtual characters for serious purposes. Intelligent Virtual Agent (IVA) technology encompasses a wide range of research goals and capabilities. The term used by researchers will often reflect their focus: Embodied Conversational Agents (ECAs) often explore language generation and understanding; relational agents tend to involve the development of long-term relationships such as companions. The term used in the work reported will be the term used in the review. While IVAs can represent any intelligent life, the majority of work considers virtual humans (VHs). This thesis and literature review is restricted to consideration of human intelligence and behaviours and human-agent interaction, rather than agent-agent interaction. In line with the research question, this literature review will narrow its view to IVAs who are VHs known as empathic agents.

The interest in empathic agents has grown from an earlier interest in affective agents. The importance of affect, in both the human's and agent's responses is becoming a focus in work on listening and empathic agents. This work requires the VH to detect how the human is feeling, based on cues such as facial expression, body gestures and verbal responses, and use emotional appraisal to provide an appropriate response. This literature review first provides an overview of research involving empathic virtual humans in section 2.1, followed by therapeutic uses of empathic agents in section 2.2. Creating rapport with agents will be highlighted in section 2.3. The chapter concludes with an introduction to Emotional Freedom Technique (EFT) and the benefits of EFT in section 2.4

### **2.1 Empathic Virtual Humans**

In this section, we start with an overview of empathy definitions, followed by a discussion about using empathy in IVAs. The section concludes with describing empathic agent studies.

#### **2.1.1 Understanding Empathy**

There are almost as many definitions of empathy as there are researchers that have studied this topic. The majority of definitions of empathy encompass a wide range of emotional states including caring for other people, being willing to help them and experiencing the same emotional feeling as other people sense, understanding of nonverbal cues and sensitivity to the other's emotional state (Hodges and Klein, 2001, Goldstein and Michaels, 1985). Previous studies has shown that empathic agents are perceived as more caring, likeable and trustworthy than agents without empathic capabilities (Brave, 2003, Paiva et al., 2004, Klein et al., 2002).

According to Paiva (2011) five constructs need to be considered in any empathic process. I have summarized the process in Figure 1. It includes an *observer*, a *subject*, the *emotion*, the *event* or *event cue* and the *situation* or *context*. The observer shows *empathy* as a reaction to the *emotion* of the *subject*. The *situation* characterizes the occurrence of an *event* leading to the emotion. It includes aspects such as the relationship between the observer and the subject, the presence or not of other agents, the past situation, etc. The event happens and is witnessed by the observer (Paiva, 2011). Paiva (2011) calls these factors *modulating factors* of the empathic process.

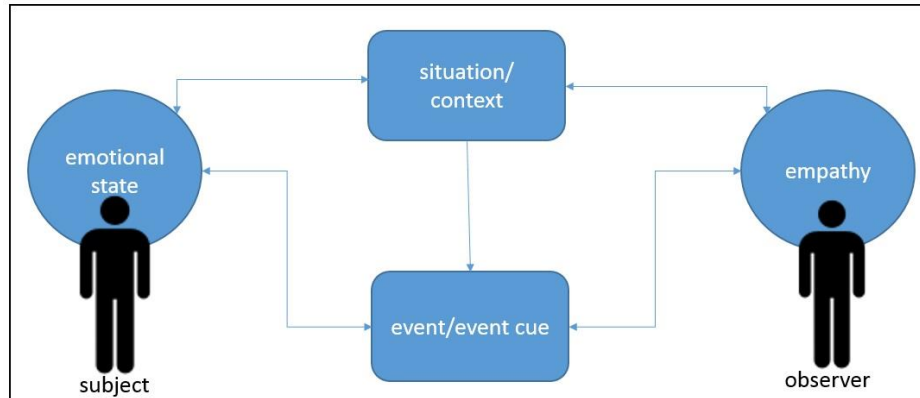


Figure 1: Construction of Empathic Process

### 2.1.2 Empathy and Agents

As per Paiva et al. (2004), there are two ways to associate agents in any empathic process. In the first way the observer or empathizer is the agent showing empathy for the other agent or for the user who is the subject (e.g. (Leite et al., 2009)), the second way is when the agent is the subject who triggers the empathic process in the user such as in FearNot (Paiva et al., 2005) which involves the user as the empathizer showing empathy to a victim of bullying.

Although most of the studies on empathy in social agents involved the user as the empathizer or the subject with emotional state, in order to create scenarios demonstrating empathy between artificial agents, where the user is not involved directly, it is also necessary to build a concrete model for an empathic agent (Paiva, 2011).

Paiva (2011) defines empathic agents as follows: “*Empathic agents are agents that respond emotionally to situations that are more congruent with the user's or another agent's situation, or as agents, that by their design, lead users to emotionally respond to the situation that is more congruent with the agent's situation than the user's one.*” (p. 2).

According to Rodrigues et al. (2009) there are two stages to be considered for the process of empathy, first is the empathic appraisal and second is the empathic response. The first phase involves the appraising of events which happened to observer and the subject has a sensible



emotional state. The second stage considers the reactions and responses to the appraised situation. Figure 2 shows the empathy model diagram, proposed, implemented and integrated into an affective agent architecture (See Figure 3) (Rodrigues et al., 2009). There are a few modulating factors that affect the empathic emotion such as the relation between the subject and the empathizer and the mood and personality of the empathizer (Paiva, 2011).

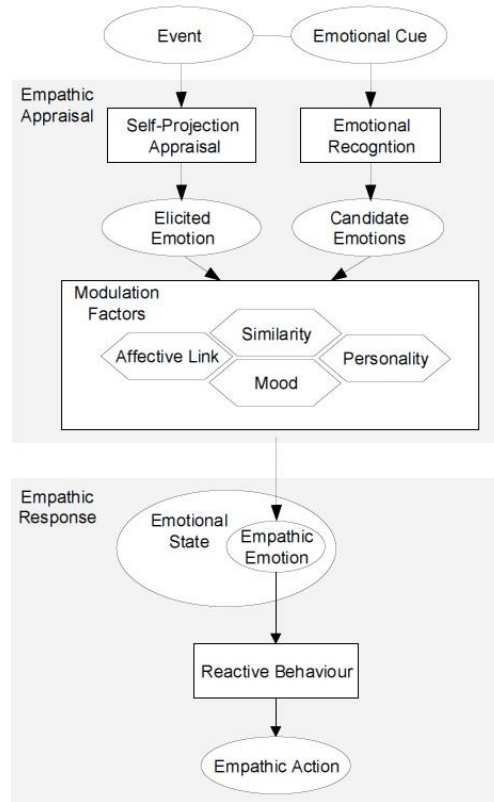


Figure 2: Empathy Model Diagram (Paiva, 2011, Rodrigues et al., 2009)

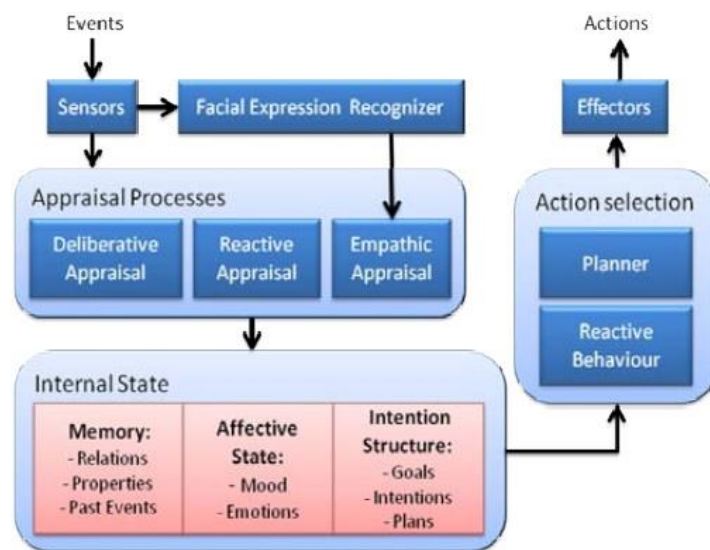


Figure 3: Empathic Agent Architecture (Rodrigues et al., 2009)

Dias and Paiva (2013) aimed at creating agents with managing social reactions dynamically. To this end, three of the emotional intelligence skills identified by (Mayer et al., 1999) were used in the model; the abilities to generate and express emotions, reason about emotions and regulate emotions in others. The model also presents Gross's model (Gross, 2002) of emotion regulation families. Figure 4 illustrates the proposed model.

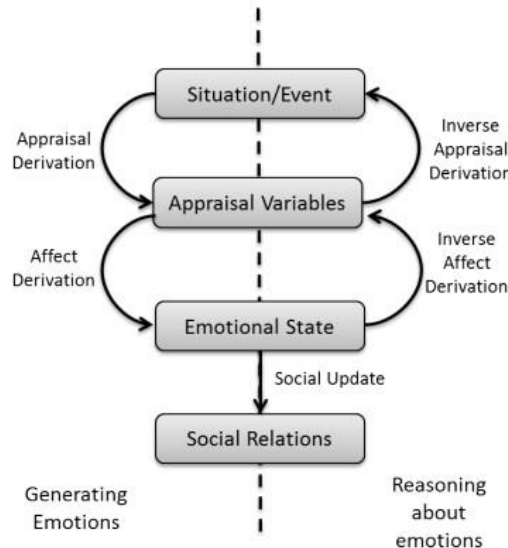


Figure 4: Emotionally Intelligent Agents Model (Dias and Paiva, 2013)

Dias and Paiva's emotionally intelligent agent model (Dias and Paiva, 2013) shows how autonomous virtual agents are able to socialize intentionally. The aim is to let the agent reason about other's emotions and establish interpersonal emotion regulation to dynamically create the relations with others.

### 2.1.3 Empathic Agent Studies

The empathic agent architecture by Rodrigues et al. (2009) was tested in a scenario with four agents: Ollie, John, Paul and Luke. Luck and John dislike each other. Ollie likes John and Paul likes Luke. These interrelations are important to create appropriate empathic behaviour. Two different control conditions regarding the empathic traits were implemented, one with the empathy model and the other one without that. Two videos were recorded. In a study with 44 participants, this architecture was evaluated to determine the effectiveness of the empathy model. The results showed that the agents with empathy model were observed as more caring and likeable than in the scenario without the empathy model (Rodrigues et al., 2009).

An experiment was conducted by Dias and Paiva (2013) investigating the efficiency of interpersonal emotion regulation strategies in the agent in their emotionally Intelligent Agent Model. The model presented above (see Figure 4) was integrated with the game Never Winter Nights 2. Within this game environment the user has the chance of interacting socially with other

characters while pursuing a given task. 17 male and 5 female, between the age 20 and 35 years old, took part in the experiment. Before the experiment participants were told they would be asked about the game experience at the end of the game. There were two versions of the game. In one version the agents employed IER strategies and one version was without IER strategies. Participants were randomly assigned to one of the two versions. At the end of the game, participants answered McGill Friendship Questionnaire (Mendelson and Aboud, 1999) which measures friendship quality about the relationship with the game character Varsuvius. The result showed that when one of the agents employed emotional regulation strategies it was perceived as more friendly according to four out of the six dimensions of friendship (Dias and Paiva, 2013).

In the iCat scenario (Leite et al., 2009), the chess player is a robot who is able to play chess with the user, typically a child. The robot performs an affective reaction to the user's play by showing signs of being happy or upset. For instance, iCat becomes upset if the opponent (the child) makes a good move.

In the more recent version of iCat (Leite et al., 2011), two types of the robot, empathic and neutral, play with the children. In the neutral condition, iCat only displays feedback through facial expression and does not provide any empathic behaviour to the user, whereas in the empathic condition, the robot chooses an empathic strategy such as an encouraging comment by saying "don't be sad, I believe you can still recover your disadvantage". From the result of 40 participants, the empathic robot was significantly found to be more helpful and engaging than the neutral robot.

Another scenario is where the iCat is a game companion and rather than playing a game, it watches the two players playing chess and behaves in an empathic manner towards one of the players and in a neutral way towards the other player. The empathy is reflected via the verbal comments the agent makes such as saying "That was a good move." to the player who makes a good move. Results of the study with 40 participants shows that empathic iCat achieved higher ratings in terms of companionship (Leite et al., 2010).

van der Zwaan and Dignum (2013) proposed an empathic virtual buddy for victims of cyberbullying called Robin to investigate how ECAs can provide social support. Robin has capability of expressing social cues, such as sympathy for the user, encouraging the user, giving compliments and mirroring the user's emotional state. Moreover, he could give advice when the user requests. The evaluation of its prototype by six pedagogical experts indicates that Robin can communicate socially and in a supportive way. Hence, he is successful in what he is delivering.

The empathic and neutral versions of an ECA were created in the study by Bickmore and Picard (2004). Laura, is a virtual exercise advisor, designed to help people to increase their physical

activity level. Subjects interacted with Laura 10 minutes daily at home for a month. Laura helped them by providing feedback and educational content related to exercise. Empathic version of Laura was endowed with caring behaviour (empathic feedback, facial expression, eye gaze behaviour, head nods, etc) while the neutral version of Laura delivered the health content without any empathic cues. With 33 participants in empathic group and 27 in neutral group, empathic Laura was rated significantly greater in caring towards the subjects, concerning about subjects' health, liking them and feeling trust than neutral Laura (Bickmore and Picard, 2004).

## **2.2 Therapeutic uses of Empathic Agents**

There is a growing body of work around therapeutic uses of agents, notably the work of Bickmore and colleagues on relational agents (e.g. (Bickmore et al., 2010b)) and the work using SimSensei (DeVault et al., 2014). For example, Bickmore et al. (2010b) proposed a home-based relational agent system to provide medication adherence for patients with Schizophrenia. This agent has been designed with particular social behaviour to deliver therapeutic alliance and social support for this type of patients. This agent displays empathy, caring and trust which are expected from any human health professionals to foster a “therapeutic alliance” with patients. The interface design is easy to use for patients with a wide range of computer, reading and health literacy skills. The input method is multiple choice which in comparison to unrestricted speech or text input was found to be more accurate. This input method is also more acceptable and usable by patients with different voice quality or computer literacy level. The overall acceptance and use of the system was relatively high in this study (Bickmore et al., 2010b).

SimSensei Kiosk is an implemented virtual human interviewer designed for face-to-face interaction with the user about sharing information related to psychological distress. The agent is sensitive to the user's nonverbal behaviour and recognizes automatically the nonverbal behaviours such as smiling that help to indicate the psychological conditions like Post Trauma Stress Disorder (PTSD). Its core functionalities are dialogue processing, multimodal perception and nonverbal behaviour generation (DeVault et al., 2014).

Simsensei Kiosk is based on the Virtual Human Toolkit (VHToolkit) architecture (Hartholt et al., 2013) as illustrated in Figure 5. It has two main functions, a virtual human called Ellie, who communicates with a user in a spoken, semi-structured interview, and a multimodal perception system which analyses the user's behaviour in real time to identify indicators of psychological distress. It uses the MultiSense framework, which is a flexible perception system for multimodal real-time sensing. Multisense employs continuous automatic speech recognition and voice activity detection. It automatically tracks and analyses real-time facial expressions, body posture, acoustic

features, linguistic patterns and higher-level behaviour descriptors (e.g. attention and fidgeting). Multisense concludes from these signals and behaviours, indicators of psychological distress that directly inform SimSensei, the virtual human (DeVault et al., 2014).

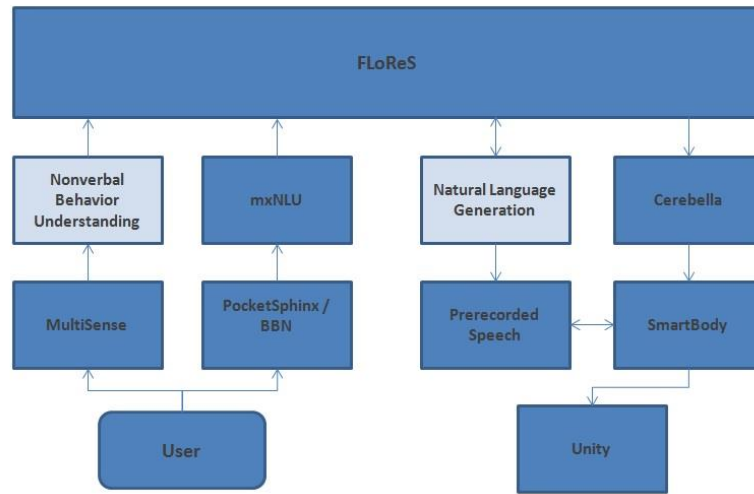


Figure 5: SimSensei Architecture (ICT, 2015)

SimSensei’s design has two universal goals: First, the agent should make the user feel comfortable talking and openly sharing information, and at the same time the agent should create interactional situations that support the automatic assessment of verbal and nonverbal behaviours correlated with psychological distress. Dialogue processing is supported by separate modules for speech recognition, language understanding and dialogue management. Because of the open-ended user responses Automatic Speech Recognition (ASR) and Natural Language Understanding (NLU) tasks are challenging. SimSensei Kiosk uses continuous ASR which is a nonstop operating recogniser and listener to ensure that the user feel comfortable without any interruption. Voice activity detection and speech recognition are performed using PocketSphinx (Huggins-Daines et al., 2006). Furthermore, it currently uses 4 statistically trained speech classifiers to record different aspects of user dialogue meaning (DeVault et al., 2014).

Another study by Gratch et al. (2014) shows that people tend to disclose more personal information when they interact with a virtual medical human. In this research SimSensei has been used as a supportive and safe interaction virtual medical interviewer. The experiment consists of a semi-structured screening interview with the user. The interview organized into three phases: “rapport-building phase”, “clinical phase”, and “ending phase”. In the rapport building phase, the agent asks general questions (e.g. “Where do you come from?”) while in the clinical phase, she asks about the symptom of the illness. In the ending phase she concludes the conversation with asking more positive questions to return the patient’s mood into a positive mood (Gratch et al., 2014).

ODVIC is a personalized On-Demand VIRTUAL Counselor whose aim is to deliver Brief Motivational Interventions (BMIs) for behaviour change by IVA (Lisetti et al., 2013). The goal of this study is to develop a novel modality to convey *empathic* adaptive *ECA* to deliver evidence-based behaviour change intervention in real time on excessive alcohol consumption as a target behaviour. In this study Lisetti et al. (2013) try to achieve assessment of user's behavioural problem (if any) on excessive intake of alcohol. The architecture shown in Figure 6 represents the system architecture of ODVIC. During any interaction with the user, the user's utterances are processed by the Dialog Module. This module decides what type of utterance is to be generated based on the previous interaction. So the generated dialogue is adaptive to the previous conversation. This module also detects discrepancies between the user's answers to the same area questions and adapts itself by changing the dialog style (Lisetti et al., 2013).

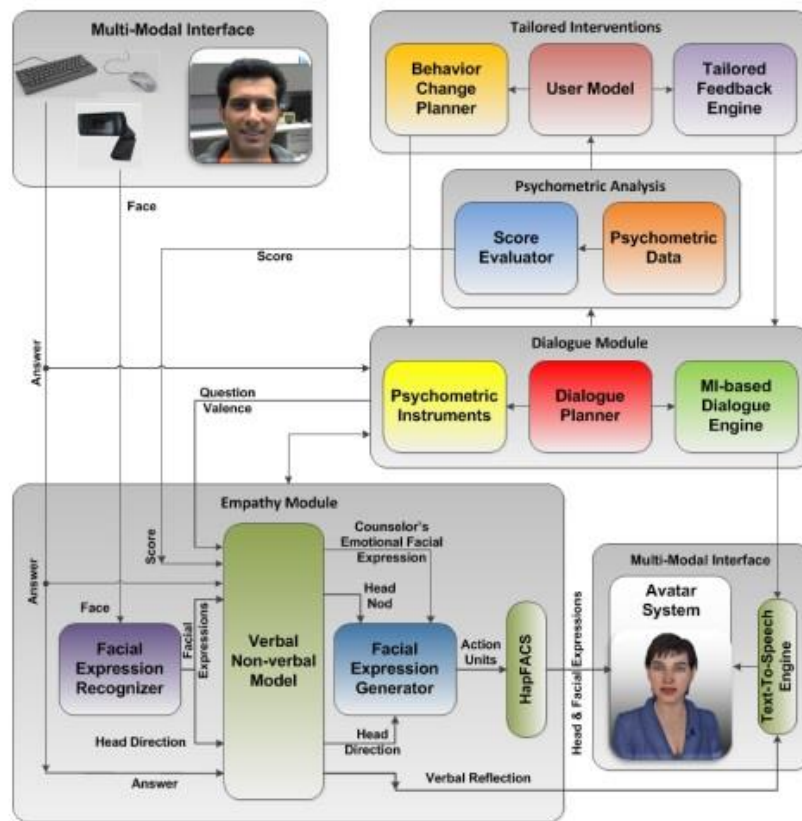


Figure 6: ODVIC: On-Demand VIRTUAL Counselor architecture (Lisetti et al., 2013)

The two aspects of empathy, cognitive and affective attributes, were considered in this design. Cognitive attributes of empathy involves understanding the other person's feeling and communicate appropriately, whereas affective attributes of empathy implies impulsive emotional responses to the other person's display of emotion (Hojat, 2007). Examples of these attributes in ODVIC are when the agent displays facial expression based on the user's perceived expression (affective attribute) and when the counsellor rephrases the user's answers (cognitive attribute).

The counsellor's empathic behaviours are derived from the empathy module and are based on a set of the user's inputs such as facial expressions. The Multimodal Interface uses a 3D animated virtual character and verbal and non-verbal behaviour to convey a sense of empathy based on the data received from the Empathy Module. The result of the study with 85 participants indicates the impact of the empathic counsellor in the user's motivation to continue using that over the long term.

Other work involving a virtual therapist (VT), was presented by van Vuuren and Cherney (2014) investigating the benefits of speech and language therapy delivered by the VT to help persons with aphasia disorder. This VT uses script treatment and is able to model practical and clinical usage such as visible speech, directing speech and language therapy. They recently developed a new system called AphasiaRx™ which is portable and compatible across devices with built-in monitoring. The treatment contains repetitive activities which are sequenced by level. VT would give interactive feedback and guidance through each activity. EFT also involves the use of repetitive activities and moving through multiple sequences.

Shamekhi and Bickmore (2015) developed a virtual meditation coach to help users relax. To monitor the user's breathing a respiration sensor was used. The agent used this data to guide the novice through an interactive meditation session. Similar to EFT, the meditation session requires the user to be mindful of their cognitive and affective mental state. A pilot study comparing the virtual meditation coach with a video guide found that the virtual coach was better able to alleviate anxiety (Shamekhi and Bickmore, 2015).

In a similar study, Hartanto et al. (2015) developed a home-based Virtual Reality Exposure Therapy (VRET) system, called MEMPHIS, that uses a virtual health agent to allow patients to undergo therapy in their homes. The system exposes the patient to up to 19 different scenarios. Sensors are used to ensure that the patient does not become too distressed. The agent teaches the patient how to use the equipment, guide them through the therapy, provides motivation at certain points and educates them about social anxiety disorder (Hartanto et al., 2015). The system has been developed to meet ISO security standards, however further research is needed to determine whether sufferers find the system usable and effective.

An IVA as a virtual discharge nurse was developed by Bickmore et al. (2009) for educating hospital patients with inadequate health literacy. Patients interacted with two different types of nurses, one with relational behaviours (having social chat, appropriate humour, empathic feedback, reminding information from past, etc) while the other one did not include relational behaviours. Evaluation of the system shows that patients find the system easy to use with high rate of satisfaction. Moreover,

74% of them preferred receiving information from the agent than a doctor. The relational virtual nurse seemed more caring than the non-relational agent (Bickmore et al., 2009).

### **2.3 Creating Rapport with VHs**

A lot of effort is put in research to make ECAs more lifelike, effective and efficient. In order to do so, creating a sense of rapport between the ECA and the user is vital. According to Cassell et al. (2007) rapport is deepening interdependence overtime as a consequence of the fact of instant responsiveness. In any reciprocal conversation, the feeling of mutual understanding and warmth in the interaction is called rapport (WEI-ERN, 2012).

Most research on rapport is focused on achieving immediate or instant rapport (Gratch et al., 2006, Maatman et al., 2005) or creating a long term relationship (Bickmore and Picard, 2005, Cassell and Bickmore, 2003, Stronks et al., 2002, Lisetti et al., 2013, Bickmore and Picard, 2004). Establishing instant rapport is essential for systems that provide only short-term relationships with the user which are attractive from the beginning. Whereas, for the long term relationship systems, intimacy and friendship are achieved through verbal and nonverbal behaviours over a longer period of time (Cassell et al., 2007).

Tickle-Degnen and Rosenthal (1990) specifies the three essential components of rapport as mutual attentiveness, positivity and coordination. That means it is necessary for a participant of an interaction to focus on the other participant and experience a sense of mutual friendliness and responsiveness for high achievement of sense of rapport.

The purpose of small talk is establishing rapport and trust between interlocutors (Bickmore and Cassell, 2005). In the study by Bickmore and Cassell (2001), two versions of an ECA were created in the real estate domain; one with small talk before the main conversation, and the other one who started the main business talk immediately. The experimental results showed that small talk had impact on the level of trust in people and this level is significantly higher in extroverts than introverts (Bickmore and Cassell, 2001).

Although initial talk can break the ice, most rapport-building happens without conversation and through non-verbal behaviours which is important for conveying communicative and social cues. People develop and maintain rapport unconsciously through synchronising non-verbal signals, including body posture and movements, eye contact, facial expressions and tone of voice with the other party (Cassell et al., 2007). We mirror each other's body postures and interpose nonverbal feedback like head nod or smile. Given that, participants feel a greater sense of rapport (Gratch et al., 2006).

Special considerations exist in developing relational agents for psychiatric patients. In the study by Bickmore and Pfeifer (2008), to promote medication adherence, adults with Schizophrenia received



10 minutes conversation with a relational agent over one month period. The relational agent sought to develop rapport by showing empathic behaviour (verbal and nonverbal), providing positive feedback, demonstrating caring and interest in the patient. The result of an experiment with 20 participants showed over 95% satisfaction with using the relational agent and user adherence to medication was 89% (Bickmore and Pfeifer, 2008).

Gratch et al. (2006) proposed a rapport agent (evolution of the listening agent (Maatman et al., 2005)) that aims at creating a sense of rapport in human speaker. The empirical evidence showed that establishing a sense of rapport from the virtual agent increases speaker fluency and engagement. This goal was achieved by showing nonverbal listening feedback and behavioural mimicry on real-time based on the user's input. This includes positive impression, quality of speech, motivation and trust between conversational partners (Gratch et al., 2006). The design of this rapport agent was improved by Huang et al. (2011) where the three-factor theory of rapport proposed by Tickle-Degnen and Rosenthal (1990) was considered. In comparison with the first version, this virtual rapport agent performs more natural behaviours and therefore, establishes a stronger feeling of rapport.

## **2.4 Emotional Freedom Technique (EFT) Therapy**

About 5,000 years ago, the Chinese discovered a complex system of energy circuits that run throughout the body. These energy circuits (meridians) form the basis for acupuncture, acupressure and a wide variety of other healing techniques (Craig, 2011).

Current evidence shows that stimulation of acupuncture points (acupoint) for treating psychological disorders, has been examined in a variety of studies that met accepted scientific standards. Energy therapy researchers claim that acupoint tapping creates unexpectedly strong and rapid clinical outcomes (Feinstein, 2012). According to Feinstein's study with evaluating and assessing current and previous studies and practices, if favourable research outcomes on energy psychology continues to expand, acupoint stimulation will offer clinicians a technique that can be used with assurance for rapid change in neural pathways that underlie psychological problems (Feinstein, 2012).

Callahan (1995) developed a method of tapping on acupressure points for treating mental problems called Thought Field Therapy (TFT) in the 1980s. Gary Craig developed EFT in the mid-1990s as a consequence of his study of TFT. Craig modified and improved Callahan's methodology to a simplified version. EFT is easy to learn and effective (Mitchell, 2009).

EFT, also known as Tapping Method, is based on various theories of alternative medicine like acupuncture, Neuro-Linguistic Programming (NLP), energy medicine, and TFT. EFT is a kind of counselling intervention. It is effective for anyone with emotional issues or physical ailments and

the reason behind that is the cause of all negative emotions is a disruption in the body's energy system which EFT can identify the causes of energy disruptions, often resulting in permanent solutions with a gentle tapping procedure without medication (Craig, 1995).

EFT has some unique features that distinguish it from other kinds of healing methods. It utilizes a simple tapping pattern which is helpful for physical and emotional issues. Moreover, when energy meridians become balanced the belief will gradually change and becomes healthier. There is an example by Hegarty (2004) about the abuse victim. The belief might shift from "My father hates me" to the healthier, "Dad doesn't know how to love. He needs help." Along with this peaceful attitude, physical symptoms are often relieved. EFT's effects are often long term and if the process is done properly it most often does not need to be repeated (Hegarty, 2004).

The EFT process involves first identifying a specific problem to focus on during the process, e.g. fear of flashbacks following a recent trauma. Next, is to score the level of emotional feeling towards the trouble on a scale of 0-10. After that, saying out loud three times the "set-up" or "affirmation statement" which indicates the problem, e.g. 'Even though I have this fear of the flashbacks, I deeply and completely accept myself.' The affirmation statement is repeated three times at the beginning of each process, while tapping on the Karate Chop Point.

It is followed by two sequence states. Each sequence state involves tapping gently on the end points of the major energy meridians in the body. The meridian points are: 1-inner eye brow 2- side of eyes 3-under eye 4-under nose 5-chin 6-collar bone 7-under arm. In this two sequence states reminder phrases such as "This fear in my body" are repeated. All EFT statements are detailed in Appendix A. Figure 7 shows the tapping meridians points.

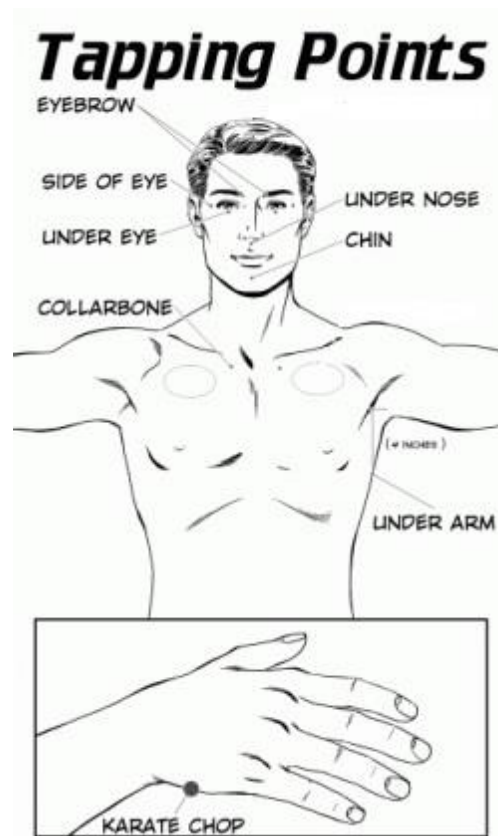


Figure 7: EFT Energy Meridians Points (<http://www.acuityhypnotherapy.com/about-eft/>)

Finally, reassessing the level of disturbance and if necessary repeating the whole process till the score towards the problem becomes zero (Scott, 2008). Sometimes the problem will simply vanish after just one round while, at other times, one round provides only partial relief and more additional rounds are required to obtain fully relief.

## 2.5 Chapter summary

This chapter mostly considered a range of literature on empathic VHs and the therapeutic usage of them. The importance of demonstrating emotions and empathy in IVAs, particularly in health domain, is enhancing the believability and realism of them. Therefore, engaging with the IVAs would be more realistic. However, there are fewer studies comparing the impacts of empathic and neutral behaviours of IVAs in the health domains. Most of the previous research on empathic and neutral behaviour focused on game and social environments.

## Chapter 3: Methodology

This chapter presents the methodology used in this research work, starting with experimental design, explaining the online semi-interactive design and the onsite interactive design (section 3.1). Section 3.2 describes the recruitment method in detail. 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 Design

To address the research questions of this research work, we designed an experiment consisting of one within-subjects factor (empathic/neutral virtual therapist) and one between-subjects factor (order of experimental sequence). The research study has been approved by the Macquarie University's Human Research Ethics Committee (See Appendix C for the ethics approval letter).

A within-subjects design for agent-type was chosen to expose participants to both types of agents which would allow them to observe any differences and allow us to gather more data, including their preferences, with fewer participants.

The therapy was therefore considered to be completed after two therapy cycles. Two different agents were designed and implemented in this study. One who exhibited empathic behaviour and another that delivered the therapy in a more neutral manner. Participants experienced interacting with both agents in different orders and evaluated the extent of their problem three times (before and after each interaction with the virtual therapist) at Time 1 before the first interaction, Time 2 after the first interaction and Time 3 after the second interaction with the virtual therapist. The score is based on a scale of 0 to 10 where 10 represents maximum intensity and 0 represents no intensity at all. The evaluation at Time 1 provided a benchmark against which to measure their progress. For example, participants might start at 6, then go to 3 and finally to 1. This score measured the intensity as it exists at the time of therapy as the user thinks about their problem.

A different experiment order was used between two groups to counterbalance and measure potential order effects. Group 1 interacted with the empathic ECA followed by interaction with the neutral ECA. Group 2 interacted with the neutral ECA followed by interaction with the empathic ECA. The independent variables (time and agent) were manipulated to measure the effect on the dependent variables: emotional score and sense of rapport. While any number of therapy cycles was possible with our implemented system, in order to increase experimental control, our design included only

two sequences of therapy, rather than continuing through cycles until the participant's matter was resolved. Figure 8 shows a schematic of the experimental design. EFT sessions started with demographic questionnaire followed by giving an introduction about EFT to the user. The procedure and instruments are presented next.

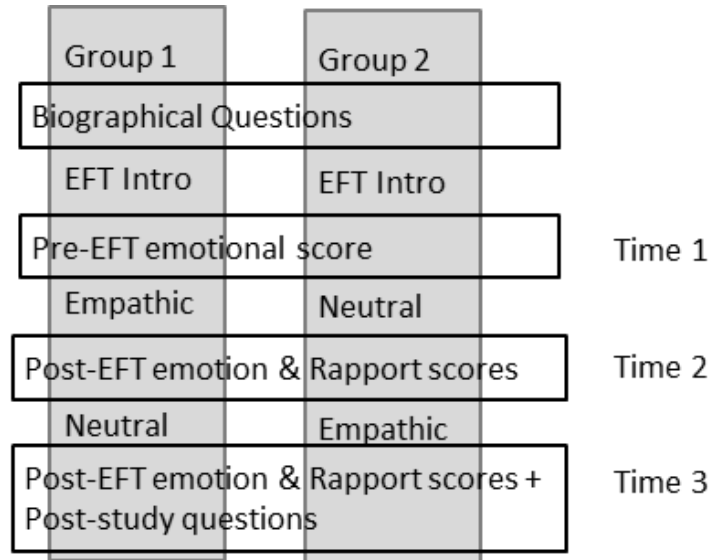


Figure 8: Experimental design

A previous agent-based training study focused on possible interaction methods with a virtual patient (VP) for training novice healthcare student (Carnell et al., 2015). In the chat-based interaction method, the VP responds to a range of free-text questions asked by the user. The alternative was a selection-based interaction method where the available answerable questions are visible for the user. This latter design was found to be easier to use by novice students by restricting the questions and answers to topics they want to consider. The study also outlined a method for implementing a selection-based VP (Carnell et al., 2015). We used a selection-based user interface in our design, as in addition to keeping it simple and not doing any language processing, it makes it easier for the user to not have to decide what to write.

In order to maximise access to participants and aid data collection, two versions of study were created and deployed: 1: online video-based semi-interactive and 2: onsite interactive application. The semi-interactive method was designed to support online video interaction. The interactive method was designed to enable real-time direct interaction with the agent. In both methods participants were randomly assigned to one of two groups (Group 1 and 2) that received the two types of agent (empathic/neutral) in different orders (empathic/neutral or neutral/empathic), as shown in Table 1. The duration of the both studies was 15 to 20 minutes. The following two sections provide details of each study.

Table 1: Experimental Orders

Group/Therapist	First	Second
Group 1	Empathic	Neutral
Group 2	Neutral	Empathic

### 3.1.1. Online Semi-Interactive Study Design

To run the application developed with the Virtual Human Toolkit (VHToolkit: <https://vhtoolkit.ict.usc.edu/>) (see section 3.4) three 3<sup>rd</sup> party software tools are required: .NET Framework (<https://www.microsoft.com/net/>), DirectX Redistributable (<http://directx-redistributable.en.softonic.com/>) and ActiveMQ (<http://activemq.apache.org/>). These tools need to be installed on the users' machines and would require downloading of a 400+MB zip file, which unzipped to over 600MB. These plugins will not run from Unity3D (<http://unity3d.com/unity>) on a web-based application and made the computer-based application too large.

We did not believe that it was ethical or practical to ask participants to download and install the application in their own time and on their personal machine, although the system could be trimmed down for future deployment. Therefore, we decided to record videos of the simulations of our character with the two scenarios, empathic virtual therapist and neutral virtual therapist. The process of recording videos required taking options in the interaction that we believed would be generally appropriate. For example, depending on the day of the week (determined by querying the computer's clock), the empathic therapist asked either how the participant's weekend was (if Monday), how their day was going (if Tuesday to Thursday) or what plans they had made for this weekend (if Friday). However, for the video, regardless of the day of the week, the therapist asked "how is your day?" Moreover, depending on the emotional feeling (i.e. score) the user reports after the first round of therapy, Group 2 users received one of four different versions of empathic conversation videos. For example, if the user did not receive any emotional benefit towards the problem (i.e. the score was worse or not better) the therapist said, "I am so sorry that it doesn't seem to be helpful at this stage. Let's try again." but if the user received benefit though it was non-significant, the virtual therapist said "Let's try again to get a better score. I think we can do better and I'd really like to see some more improvement in you." More discussion of the dialogues is presented under the heading Intervention Materials in section 3.4. We did not have different videos for Group 1 because they received the neutral therapist in the second interaction and in this condition the dialogue was not tailored to their emotional responses/score.

### **3.1.2. Onsite Interactive Study Design**

As described in the previous section, this interactive design was implemented first, but due to the constraints mentioned in section 3.1.1, we could not run the experiment online. After conducting and evaluating the semi-interactive design, we decided to set up the onsite interactive experiment, where participants were able to engage with the character with real-time interaction by providing answers through the user interface using mouse and keyboard.

Furthermore the nature of the system made it unsuitable for a public lab test. In this design (i.e. onsite), we set up a computer in a room in the Computing Department where the participants had a private session with the virtual therapist at a time slot allocated to them. This additional effort allowed us to evaluate the virtual therapist as intended in an interactive mode and explore the differences between semi-interactive and interactive communication with the virtual therapist.

## **3.2 Subject Recruitment**

Due to ease of accessibility, our main method of recruitment was targeted at university students. We utilised the online recruitment program of the Psychology Department for this purpose. First year Psychology students are aware of the availability of the Psychology research participation facility through their course materials. Once they log in the system, they can select which study they wish to participate in. We also utilised poster advertisements distributed on campus, as well as invitation emails sent out by unit convenors and tutors. Additional participants were sought via distribution of a link to the online study to other researchers and invitations to the Department of Computing staff and PhD students. Advertisements included a URL to the online study in the semi-interactive design. In the interactive design, participants were invited to come to the Department of Computing, Faculty of Science and Engineering, building E6A at the booked time slot.

All participants were volunteers. Only Psychology students received half an hour course credit for their participation. Other participants received no incentives or rewards.

## **3.3 Procedure and Data Collection**

The Qualtrics research software (Qualtrics.com) was used to administer the surveys in the study and provide online access to all questionnaires and intervention materials.

As described in section 3.1, two versions of the experiment were designed for this study to allow online and onsite access to the virtual therapist. In both studies after reading and accepting the information and consent form, the demographics questionnaire asked participants for their age, gender, degree being studied, years living in an English-speaking country, whether they played computer games, and if they had used EFT or acupuncture in the past. Next, in the semi-interactive

method participants were randomly allocated to two groups using the Qualtrics “Randomizer” feature. The videos of the virtual therapist using the semi-interactive design were embedded in the Qualtrics website as links to YouTube. However, in the interactive method the participant was alternatively assigned to either Group 1 or Group 2 by the researcher by running the different applications in different order. Since the order in which participants chose to come onsite was unpredictable and the features of the participant were unknown to the researcher, this method was effectively a random allocation to each group.

As described in the experimental design, each group underwent two rounds of therapy. The procedures for each group are outlined in Figures 9 and 10. As seen in Appendix A (Effie’s dialogue with the user), there are two rounds of tapping in the procedure. Each round consists of one *setup* part and two repeated EFT *sequence* parts. The *setup* is tapping on the karate chop point while repeating the affirmation statements. The *sequence* involves tapping on the end points of the major energy meridians in the body which makes the energy system to be balanced out. This *sequence* was repeated twice in each round.

The empathic dialogues shown in Figures 9 and 10 uses the empathic cues identified from the literature in (Bickmore et al., 2005); the letters in the figures identify the specific type of cues. The intervention materials and dialogue are discussed further in section 3.4.

As shown in Figures 9 and 10, the data collected during the study included: a pre-intervention demographic questionnaire, a score of emotional feeling before and after each interaction with the character, a post interaction rapport questionnaire and a post study questionnaire. These instruments are described in section 3.5.



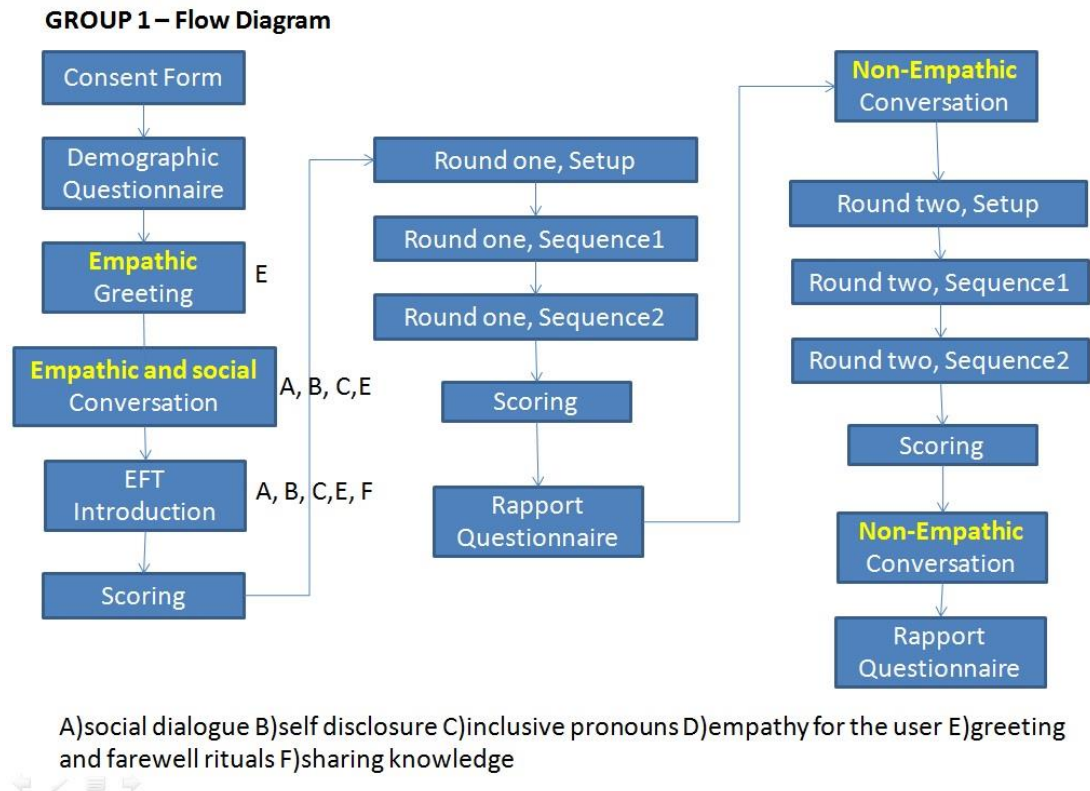


Figure 9: Group 1 procedure

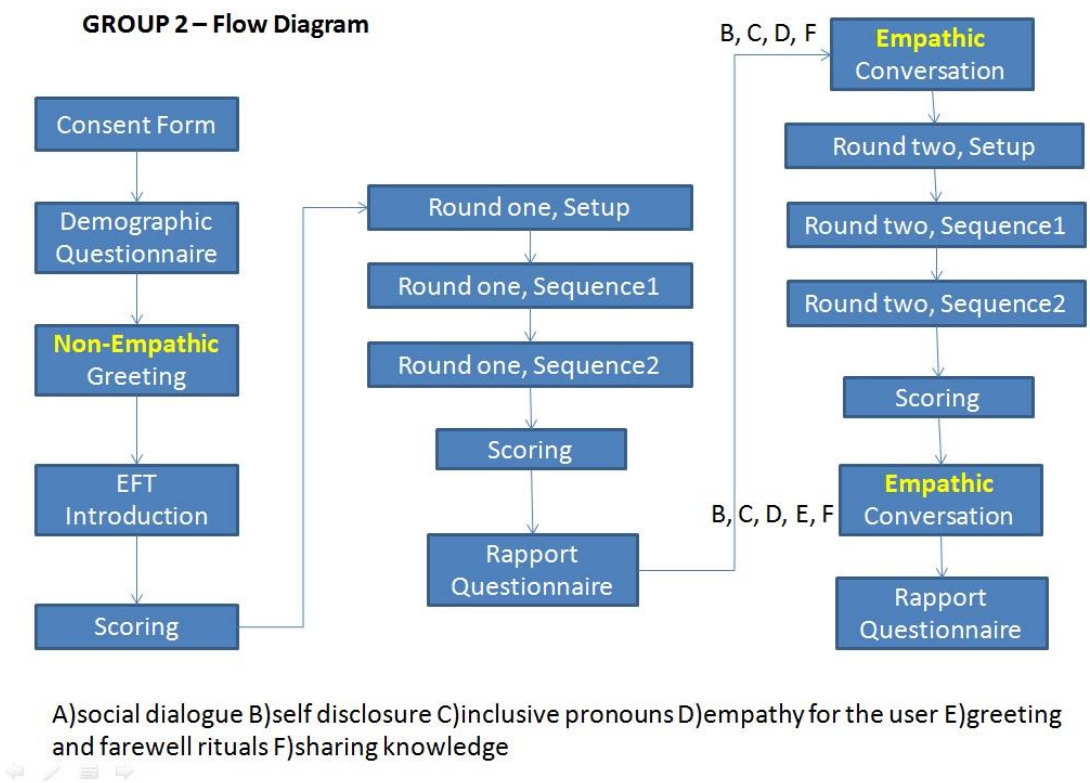


Figure 10: Group 2 procedure

### 3.4 Intervention Materials

Our virtual EFT practitioner, known as EFFIE the Emotional Freedom FriEnd, has been created using components from the VHToolkit. As seen in Figure 11, for the system to deliver credible and effective communication in real time, we developed a dialogue engine written in the C# programming language. Communication between components is done by message passing, which is implemented in ActiveMQ (Snyder et al., 2011). The dialogue engine sends BML (Behaviour Mark-up Language) messages to the NVBG (NonVerbal-Behaviour-Generator) module containing the line the character will say and which nonverbal behaviour needs to be generated. BML (Kopp et al., 2006) is an XML description language used for controlling the verbal and nonverbal behaviours of embodied conversational agents. The output of NVBG is also of the BML format which is transformed into synchronized sequences of animations by Smartbody character animation system. Smartbody is a BML realization engine that transforms BML behaviour descriptions into real-time animations (Thiebaux et al., 2008).

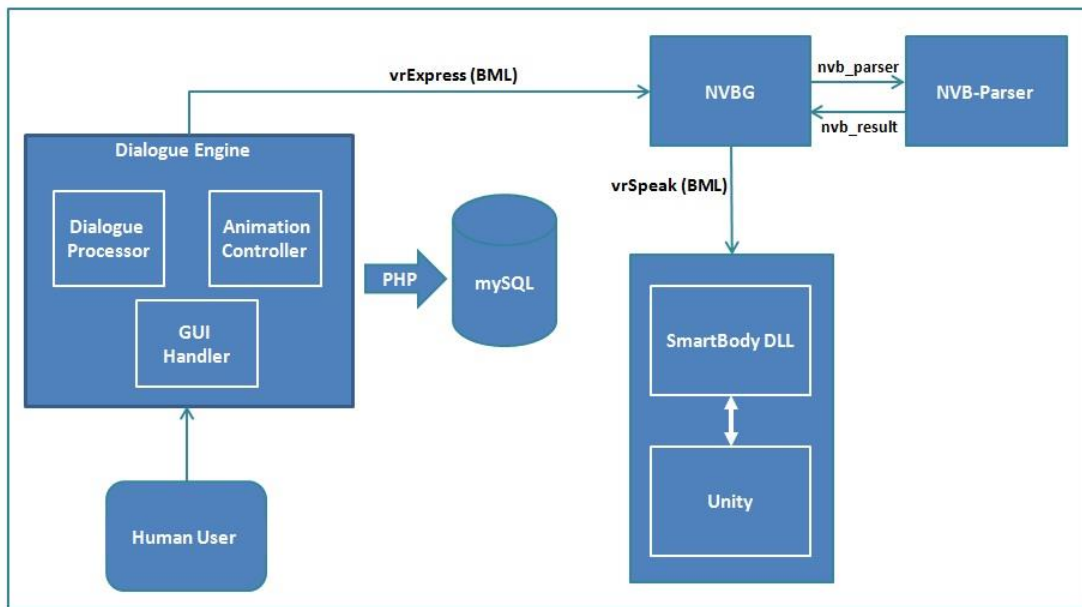


Figure 11: Architecture for virtual EFT practitioner: EFFIE

We used pre-recorded voice for Effie's dialogues. We chose not to use speech synthesis in order to minimize the possible negative influence of automated voices, as well as the fact that in our semi-controlled study, it was feasible to record the dialogue snippets. For each continuous speech, there exist 4 files: a wav file for the audio, an XML file for nonverbal behaviour generation (such as smiling or nodding), a BML file for lip synchronising and a text file containing the utterance(s). To create the BML files, we used the CSLUPhonemeScheduler tool from the CSLU Toolkit (<http://www.cslu.ogi.edu/toolkit/>). The toolkit provides a comprehensive environment for speech synthesis and facial animation. The BML files generated by this tool have Viseme schedule with

detailed timing information for lip-synching and word boundary timing information for synchronization of nonverbal behaviour as specified through BML.

The dialogue engine consists of three main parts: a dialogue processor, an animation controller and a GUI handler. These three parts run simultaneously to achieve synchronizing between dialogues, user interaction and animations.

The dialogue processor sends BML messages to NVBG and is responsible for turn taking. The user interacts with the system through the GUI handler.

For each tapping animation, there is an animation clip and an animation state. All tapping animation clips are maintained by an animator controller. The controller manages the animation states. Figure 12 shows Mecanim's Animation State Machine created for Effie. Animation Controller uses the state machine parameters to trigger desired animation and simulate the dynamic reasoning process of a real EFT therapist. The information provided by the user during the EFT session is sent to the mySQL database via a PHP command.

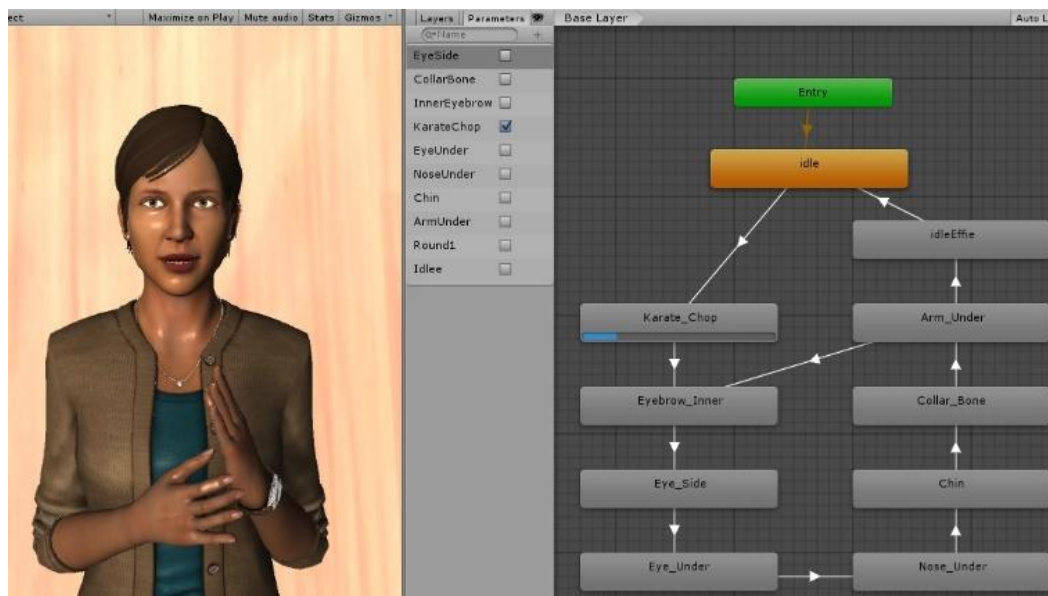


Figure 12: Mecanim's Animation State Machine created for Effie

Appendix A includes the dialogue as presented in the studies. It shows part of the process of participants being asked to choose a problem area in their life that they are stressed about to focus on, while they proceed through the tapping and speaking of affirmations. All of the EFT affirmation statements Effie utters are derived from this source: <http://eft.mercola.com/>.

To develop our virtual therapist, we have taken inspiration from a body of work around therapeutic uses of virtual agents, particularly the work of Bickmore and colleagues on relational agents (Bickmore et al., 2010a, Bickmore et al., 2010b) as well as SimSensei (DeVault et al., 2014).

Effie's verbal and nonverbal behaviours seek to establish and maintain a working alliance with the user. It selects effective facial displays, such as smiling, in the role of empathic therapist while uttering empathic dialogue. The empathic cues used in Effie's dialogue were derived from the literature in (Bickmore et al., 2005) such as A) social dialogue, B) self disclosure, C) inclusive pronouns, D) empathy for the user, E) greeting and farewell rituals and F) sharing knowledge.

Empathic Effie's dialogue would start with an empathic cue (greeting/farewell rituals): "Hello, I am your Emotional Freedom Friend or EFF for short. You can call me Effie. I'm very happy to meet you and hope you'll find our session together worthwhile. Please make yourself comfortable." While neutral Effie's conversation would start with a simple greeting by saying "Hello, I am Effie a virtual human." Next, empathic Effie would continue with an empathic and social conversation, where she would use the other empathic cues such as social dialogue, self disclosure and inclusive pronouns. Depending on the day of the week, she would ask, "How is your day going?", "How was your weekend?", "How was your day?" or "I hope you have something nice planned for your weekend." Then empathic Effie said "Now I'm going to be your therapist in order to help you work through a problem you are facing. How are you feeling about coming to see me?" Depending on the user's response to "do you know anything about EFT?" Effie replied back "Okay great! I'll give you a brief explanation of the way I think of it in case it's different to what you've come across." Or "Okay no problem! It's not that complicated, I'll give you a brief explanation before we get started." However, neutral Effie does not have such a communication, and after greeting, she would start talking about the EFT method.

Empathic Effie would also use empathic cues, such as self-disclosure, inclusive pronouns, empathy for the user and sharing knowledge in empathic dialogue after her first and second interactions with the user. Depending on the score the user achieves towards the problem s/he is facing, empathic Effie would feel empathy for the user by saying "I am sorry that it doesn't seem to be of much help. I don't want to waste your time but I'd really like us to try again." or "Oh it's really great to see that this could help you feel better about your emotional issue."

### **3.4.1 Intervention Materials Study 1: Semi-Interactive**

In the semi-interactive design, we used videos of the virtual therapist embedded in Qualtrics. There were some issues associated with this design. A few user-therapist interactions had been eliminated due to lack of interactivity. The following questions were not answered by the user via the application in this design (i.e. when Effie asked the questions in the video, she paused for a few seconds to provide opportunity for the user to speak out loud or think of the answer if they chose and then continued with the session.): How is your day going? How are you feeling about coming

to see me? How does that sound? Did you find that interesting? Do you know anything about EFT? In this design, we moved two crucial questions that had been designed to be collected during the user interaction with the participant to the Qualtrics survey to ensure we were still able to collect this data from the user; e.g. Please select the area of your life which you want to resolve during this session from the options provided. Score your emotional feeling towards your problem on a scale of 0 to 10.

### **3.4.2 Intervention Materials Study 2: Interactive**

It had been our original intention for the study to be interaction, but as explained previously, for practical purposes the first study ran in a semi-interactive mode (i.e. involving a set of alternative videos played according to experimental condition and user responses). However, after analysis of the results from Study 1, that were inconclusive regarding the value of the empathic therapist compared to the neutral therapist, we decided that we would conduct a second study that was fully interactive. We wanted to evaluate whether the interactivity in our original interactive study design makes any difference, and whether the additional effort to make the session more adaptive and believable, delivers greater therapeutic benefit. To achieve this, we needed to run the study onsite, instead of online. Participants were invited to a private office in the Computing Department to have a real-time interaction with Effie. All participants used the same environment as well as the Qualtrics for completing the survey and the application for interacting with Effie. All the users' interactive data were input into our database through a mouse and keyboard.

Furthermore, before running the second study we wanted to fix any small aspects that might have hindered the interaction. In the first study, due to time constraints and resource accessibility, Effie was endowed with a young female voice. Due to the non-significant difference between neutral and empathic, we wanted to ensure that issues such as incongruent voice were not a factor, even though no one had complained about it. Therefore, Effie's voice was changed from that of a young female to a mature one in the second study. This suited Effie's appearance more appropriately. Also, the nonverbal behaviour 'smile' was added to empathic Effie. The final version of study 2 was fully interactive.

## **3.5 Instrument and Measures**

The survey consists of five sections, including the participants' information and consent form, a demographic questionnaire and two rapport questionnaires after each interaction with the virtual therapist and ending with a post-experiment questionnaire. Qualtrics was used to create the survey and capture the data. The complete survey can be found in Appendix D. The post-experiment questionnaire consists of three questions that were asked after the second rapport questionnaire.

These questions are: whether participants spoke with the character, physically tapped on their body and also if they had any comments or suggestion about their experiment. The demographic and rapport questionnaire are detailed in subsections 3.5.1 and 3.5.2, respectively.

### **3.5.1. Demographic Questionnaire**

The demographic questionnaire consists of ten general questions about the participants. Demographics are characteristics of our population and help us determine how close the sample population represents the target population. Characteristics such as gender, age, education, level of English understanding, how many hours per week participants play computer games (if at all) and if they had experienced EFT or acupuncture in the past, were asked in the demographic questionnaire.

### **3.5.2 Rapport Questionnaire**

In providing counselling or support to a client, the application needs to gain trust and respect from the participant, both to ensure that the therapy is adhered to but also that a positive approach is taken to the likely outcome of the therapy. One of the important factors in a good conversational partner is capability to build rapport with another person (WEI-ERN, 2012). In a face-to-face interaction, participants respond to each other, and present unconscious nonverbal and verbal mimicry behaviour and feedback. Such behaviours establish a sense of rapport which result in an effectual conversation, more liking and trust between interlocutors (Gratch et al., 2006). Therefore, rapport is a key factor in designing conversational agents.

The study with Effie also sought to measure the sense of rapport experienced by the participants. Our rapport questionnaire was developed, along the lines of instruments used in other IVA studies interested in measuring rapport (e.g. (Gratch et al., 2006)). The perceived rapport questionnaire is a 5-point Likert-type scale from “strongly agree” (1) to “strongly disagree” (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) and (McCroskey and McCain, 1974). The questions were presented in a random order using the Qualtrics randomizer function.

## **3.6 Chapter Summary**

Two types of experiment were designed. One was online semi-interactive design, using videos of the virtual therapist embedded in Qualtrics, and the other one was onsite interactive design where participants had real-time interaction with the system.

The experiments were based on a cross over repeated measures design with one between-subjects factor (empathic/neutral virtual therapist) and one within-subjects factor (order of experimental

sequence). Each participant was randomly assigned to two different groups. In the first group participants interacted with an empathic virtual therapist followed by a neutral virtual therapist while in the second group participants engaged with the neutral virtual therapist followed by the empathic one. We created the survey and collected data in Qualtrics. Qualtrics randomiser was used to assign different groups to different participants in the semi-interactive study. Moreover, the order of rapport questionnaire was randomised with Qualtrics too.

## Chapter 4: Results

This chapter presents the results of our two studies. After presenting the demographic details of the participants in section 4.1, our preliminary analysis in section 4.2, comparing the results of both the semi-interactive and interactive study, shows that the two cohorts were not significantly different. Thus, to increase statistical power and simplify presentation of the results, the results of the combined studies are presented in section 4.3. Finally, the qualitative analysis including participants' comments are provided in section 4.4.

### 4.1 Participants

A total number of 63 participants (39 females, 24 males; mean age=27, SD=10.6) took part in our studies. Table 2 provides a summary. Study 1 was the online semi-interactive design with 37 participants (22 females, 15 males, mean age=23, SD=4.9) and Study 2 was the onsite interactive design with 26 participants (17 females, 9 males, mean age=30, SD=5.6). Group 1 (empathic-neutral) had 30 participants (17 from Study 1 and 13 from Study 2) and Group 2 (neutral-empathic) had 33 participants (20 from Study 1 and 13 from Study 2). The number of participants in each group (empathic or non empathic) were not significantly different from each other ( $\chi^2=0.101$ ,  $df=1$ ,  $p=0.75$ ).

In Study 1, a total of 23 started the study but did not complete both rounds of EFT; 21 never progressed past the biographical section to meet Effie, 2 only participated in one session and the data of 8 was lost due to a technical problem. No data for completed studies was found to be invalid (e.g. all responses the same) and thus no data was excluded as a result. In Study 2 all 26 participants completed the study.

To ensure that the outcome of the experiment was not influenced by participants' previous experience with EFT, we analysed participants' prior experience with EFT. Only five participants had used EFT and their responses were within the range of the other participants' responses.

Since the participants were generally students, the mean age was 27 years (range 18-53). 52% of participants were born in an English-speaking country. Due to our use of the Psychology Pool for recruitment, the field of study of almost half of the participants was Psychology (47%). Nearly half of the participants played computer games. Most of the participants had never experienced EFT (92%) and a few of them had experienced acupuncture (20%).



Table 2: Participants Demographics

Demographics		Study 1		Study 2		Total	
		Count	%	Count	%	Count	%
Gender	Female	22	59.5%	17	65.4%	39	61.9%
	Male	15	40.5%	9	34.6%	24	38.1%
years living in an English speaking	all life	19	51.4%	14	53.8%	33	52.4%
	<1 years	3	8.1%	0	0.0%	3	4.8%
	1-5 years	5	13.5%	3	11.5%	8	12.7%
	>5 years	10	27.0%	9	34.6%	19	30.2%
Age	<20	13	35.1%	0	0.0%	13	20.6%
	20-30	17	45.9%	16	61.5%	33	52.4%
	>30	7	18.9%	10	38.5%	17	27.0%
Current Study Degree	Undergrad	32	86.5%	15	57.7%	47	74.6%
	C/work	0	0.0%	1	3.8%	1	1.6%
	Research	3	8.1%	3	11.5%	6	9.5%
	Not Studying	2	5.4%	7	26.9%	9	14.3%
Field of Study	Psychology	16	43.2%	14	53.8%	30	47.6%
	Games	3	8.1%	1	3.8%	4	6.3%
	Computing	14	37.8%	3	11.5%	17	27.0%
	Multi Media	0	0.0%	1	3.8%	1	1.6%
	Other	4	10.8%	7	26.9%	11	17.5%
Play Computer Game?	Yes	22	59.5%	9	34.6%	31	49.2%
	No	15	40.5%	17	65.4%	32	50.8%
Experienced EFT?	Yes	1	2.7%	4	15.4%	5	7.9%
	No	36	97.3%	22	84.6%	58	92.1%
Experienced Acupuncture?	Yes	5	13.5%	8	30.8%	13	20.6%
	No	32	86.5%	18	69.2%	50	79.4%

The gender distribution between the studies (semi-interactive vs. interactive) was not significantly different from each other ( $\chi^2=0.227$ ,  $df=1$ ,  $p=0.63$ ). The gender distribution between the groups (i.e. Group 1 & 2) was not significantly different from each other either ( $\chi^2=0.666$ ,  $df=1$ ,  $p=0.41$ ).

As shown in Table 3, the average age of the participants in the onsite interactive group (mean= 30.4, std=11.1 years) was significantly higher than the average age of the participants in the semi-interactive group (mean= 23.5, std=7.38 years) ( $p=0.01$ ). The average age of the participants was not significantly different between Group 1 (mean= 25.5, std=9.07 years) and Group 2 (mean= 27.1, std=10.24 years) ( $p=0.52$ ).

Table 3: Age Group Statistics

Study	N	Mean	Std. Deviation	Std. Error Mean
How old are you? Video	37	23.54	7.385	1.214
Real Interaction	25	30.44	11.184	2.237

## 4.2 Preliminary Analysis

In this section, we present two initial statistical tests. First, in section 4.2.1 we examine if our datasets come from a normally distributed population. Lastly, in section 4.2.2 we present the reasons for combining the two sets of data.

### 4.2.1 Test of Normality

We performed tests of normality to determine if the two datasets were modelled well by a normal distribution. According to the p values for score 0 (baseline), score 1 and score 2 in Shapiro-Wilk test in Table 4, it is concluded that the scores data come from a normal distribution.

Table 4: Test of Normality

Group (EmpathicFirst=1; NeutralFirst=2)		Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Score.0	1	.117	30	.200*	.967	30	.467
	2	.130	33	.174	.958	33	.222
Score.1	1	.198	30	.004	.956	30	.248
	2	.136	33	.130	.974	33	.589
Score.2	1	.145	30	.110	.954	30	.210
	2	.159	33	.034	.936	33	.052

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figures 13, 14 and 15 illustrate the data distribution charts for scores 0 (baseline), 1 (after first session) and 2 (after second session), respectively. The histograms with the normal curve superimposed show the normal distribution of the three time scores among the populations.



Figure 13: Baseline Scores in the Two Groups

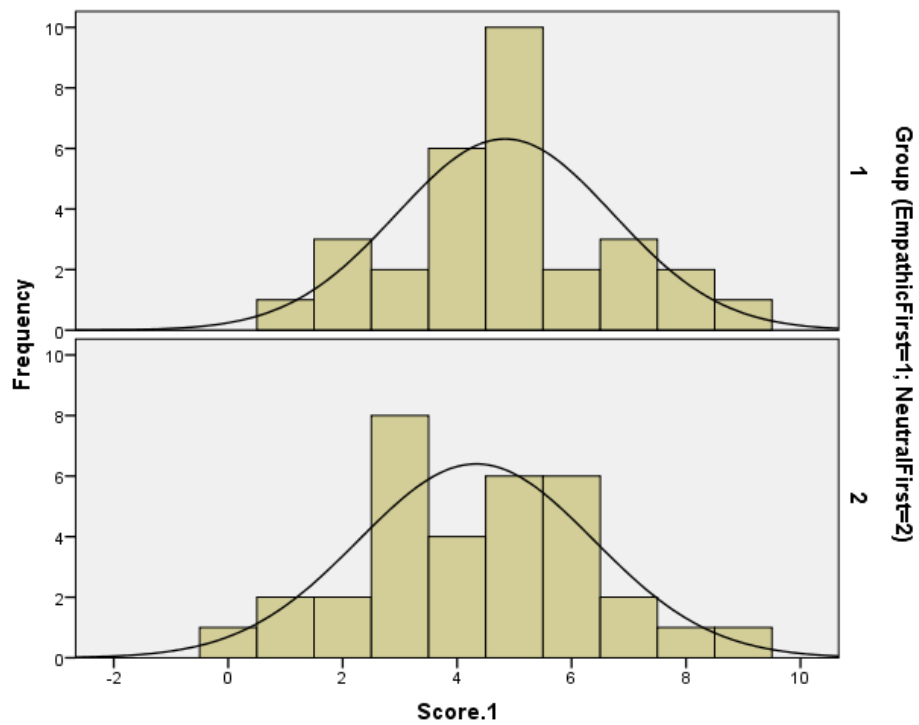


Figure 14: Score after First Interaction in the Two Groups

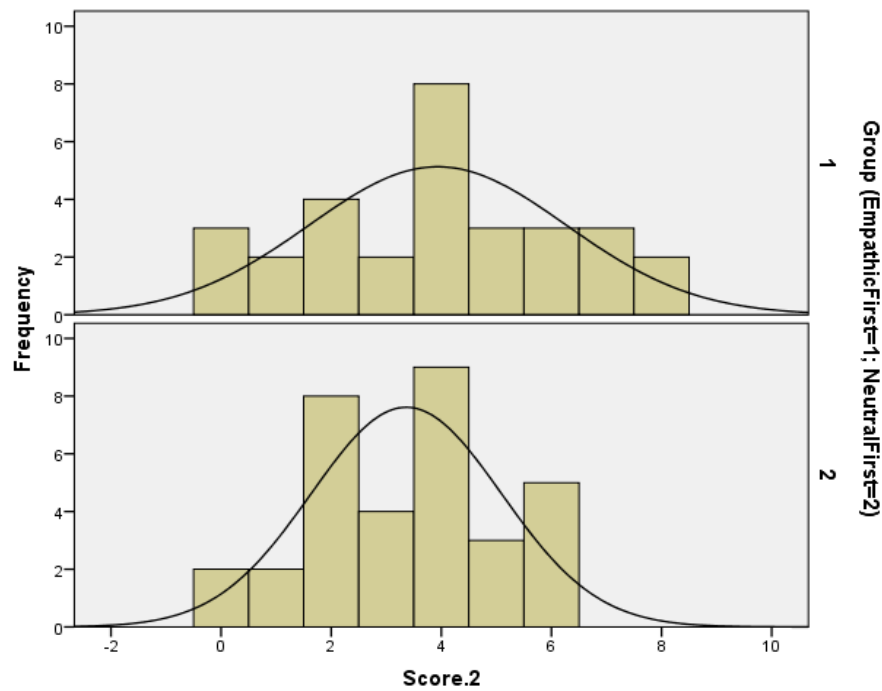


Figure 15: Score after Second Interaction in the Two Groups

#### 4.2.2 Merging the Data of the Two Studies

In this section, we present the results of our investigations to determine if it is appropriate to merge the data of the two studies (semi-interactive and interactive). The main parameters we focused on in our analysis were the emotional scores and the rapport questionnaire responses.

From the score perspective, as seen in Table 5, there was a significant difference between the means of scores 0, 1 and 2, showing a considerable order effect. However, when we added the study as a variable, the within subject test showed that the scores were not majorly different between the two studies. This means that it was statistically valid to combine the score data from both studies.

Table 5: Tests of Within-Subject Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Score	Sphericity Assumed	152.073	2	76.037	51.887	.000
	Greenhouse-Geisser	152.073	1.938	78.461	51.887	.000
	Huynh-Feldt	152.073	2.000	76.037	51.887	.000
	Lower-bound	152.073	1.000	152.073	51.887	.000
Score * Study	Sphericity Assumed	1.618	2	.809	.552	.577
	Greenhouse-Geisser	1.618	1.938	.835	.552	.572
	Huynh-Feldt	1.618	2.000	.809	.552	.577
	Lower-bound	1.618	1.000	1.618	.552	.460
Error(Score)	Sphericity Assumed	178.784	122	1.465		
	Greenhouse-Geisser	178.784	118.230	1.512		
	Huynh-Feldt	178.784	122.000	1.465		
	Lower-bound	178.784	61.000	2.931		

Independent sample t-tests were conducted on the rapport questionnaire responses to determine variances between the two studies. We could have chosen to run a test on the overall rapport scores from each study which would have reduced the likelihood of significant differences. However, to add rigour to allow us to identify and interpret differences, we chose to do the test on the individual questions. To reduce space requirements, the results are reported in Appendix B. The highlighted sentences in Appendix B Table B-1 are the rapport questions which were negatively worded and the 5-point likert scales have not been reverse-coded for those questions, thus careful interpretation is required. For positively worded questions, the lower number (from strongly agree to strongly disagree), shows a better result, but in negatively worded questions, the larger the number shows the better the result.

There were 40 rapport questions in total, 20 repeated after each interaction. There were no significant differences in the first set of 20 rapport questions (after the first interaction) between the two studies regardless of the group (as seen in Appendix B). In the second 20 set of questions, there were some differences between the two studies for 5 of the 20 repeated questions. In the discussion chapter, we consider explanations for these differences. The questions that showed significant differences include:

Q27- I felt uncomfortable during the session.

Q28- I felt embarrassed during the session.

Q30- I don't like the way she looks.

Q39- Seeing Effie helped me to focus on EFT.

Q40- Following Effie's actions helped me to focus on EFT.

Thus, we conclude that we can merge the rapport questionnaire results of the two studies (semi-interactive and interactive) statistically. The actual reason for that is, at the two time points (after each interaction with the virtual therapist), the responses to the individual questions of the rapport questionnaire regardless of the group, in most cases (45/50 questions) were not significantly different from each other between the two studies (see Table B-2 in Appendix B).

### **4.3 Quantitative Results**

Having determined that it was appropriate to combine the data from both studies and thereby increases our overall sample size, in this section, we present the results based on the combined Study 1 and 2 datasets. Section 4.3.1 describes the manipulation check. Section 4.3.2 looks at the

effect of interacting with the empathic or neutral virtual therapist on the emotional score reported by participants and section 4.3.3 presents the rapport questionnaire results.

#### 4.3.1 Manipulation Check

In order to determine if participants had perceived the two versions of the virtual therapist as intended in our design, we conducted a manipulation check. In the rapport questionnaire, there are two questions which show whether participants find the character empathic (Question 14) and find her warm and caring (Question 15). Question 14 was negatively worded (Effie was not empathic towards me) and the 5-point likert scales from strongly agree to strongly disagree was reverse-coded for this question. However, question 15 was positively worded (Effie was warm and caring). The results of the paired T-Test on Q14 and Q15 (see Table 6) show that there is no significant difference in the case of Q14 after empathic and after neutral interaction, though there is significant difference for Q15. In other words, in Q14 there is no perceived difference in terms of showing empathy between empathic and neutral Effie and in Q15 empathic Effie seemed more caring.

Table 6: Paired T-Test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
					Mean	Std. Deviation			
Pair 1	Q15E - Q15N	-.254	.621	.078	-.410	-.097	-3.244	62	.002
Pair 2	Q14E - Q14N	-.016	1.008	.127	-.270	.238	-.125	62	.901

#### 4.3.2 Score Result

The result reported in this section, is based on the three scores: score 1 = baseline, score 2 = score after empathic interaction (regardless of the order) and score 3 = score after neutral interaction (regardless of the order).

The between groups test (Table 7) indicates that the variable group is an important factor, consequently in Figure 16 we see that the scores for the two groups are rather far apart. The within subject test indicates that each exposure to the therapist has a significant effect on the score,  $F(2, 122) = 64.46$ ,  $p < 0.001$ , partial  $\eta^2 = 0.514$ ; in other words, the scores do change over time. Moreover, the interaction of score and group is statistically significant  $F(2, 122) = 11.01$ ,  $p < 0.001$ , partial  $\eta^2 = 0.153$  which means that the scores are changing over time (depending on the experimental conditions) but in different ways.

Table 7: Test of Between-Subject Effects (Score & Group)

Measure: MEASURE\_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Score	Sphericity Assumed	161.493	2	80.746	64.464	.000	.514
	Greenhouse-Geisser	161.493	1.788	90.299	64.464	.000	.514
	Huynh-Feldt	161.493	1.869	86.402	64.464	.000	.514
	Lower-bound	161.493	1.000	161.493	64.464	.000	.514
Score * Group	Sphericity Assumed	27.588	2	13.794	11.013	.000	.153
	Greenhouse-Geisser	27.588	1.788	15.426	11.013	.000	.153
	Huynh-Feldt	27.588	1.869	14.760	11.013	.000	.153
	Lower-bound	27.588	1.000	27.588	11.013	.002	.153
Error(Score)	Sphericity Assumed	152.814	122	1.253			
	Greenhouse-Geisser	152.814	109.094	1.401			
	Huynh-Feldt	152.814	114.014	1.340			
	Lower-bound	152.814	61.000	2.505			

a. Computed using alpha = .05

Figure 16 illustrates that in both groups, the score went down after each interaction, with the most significant reduction after the first interaction, regardless of the group. The blue dots show the baseline score, the red dots are the scores after empathic interaction and the green dots are the scores after neutral interaction. The scores are significantly different between the groups.

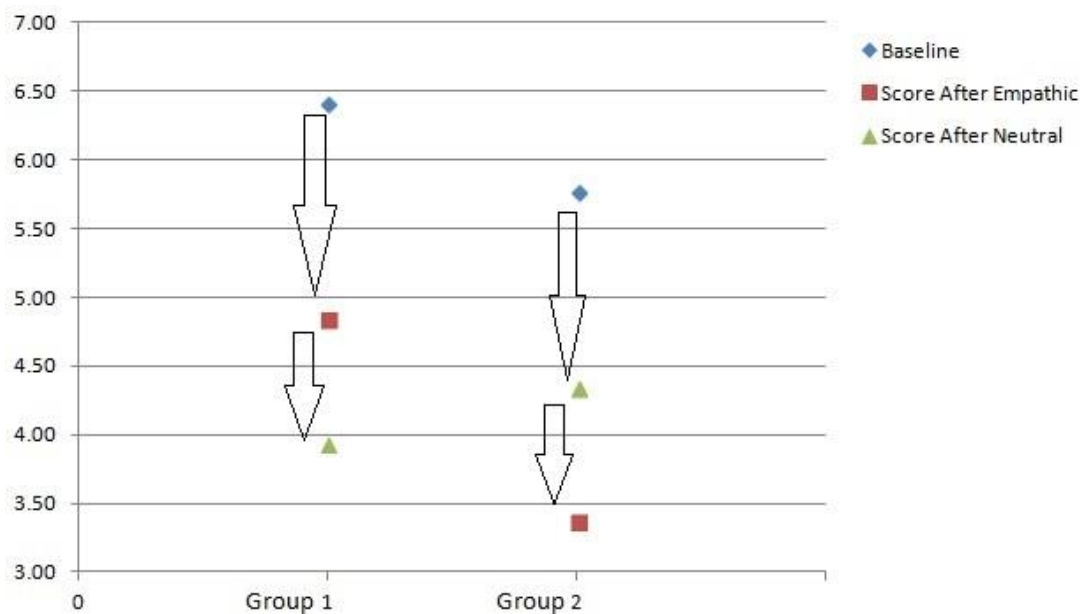


Figure 16: Score results in two groups

One way within subjects ANOVA was performed to test whether there was a difference of scores between baseline, empathic and non-empathic Effie conditions. The results showed that the scores

were significantly different between the different experimental conditions  $F(2, 124) = 55.54$ ,  $p < 0.001$ , effect size  $\omega^2 = 0.07$ , partial  $\eta^2 = 0.473$  (Table 8).

Table 8: Test of Within-Subject Effects (Score)

Measure: MEASURE_1		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Score	Sphericity Assumed	161.598	2	80.799	55.537	.000	.473
	Greenhouse-Geisser	161.598	1.942	83.212	55.537	.000	.473
	Huynh-Feldt	161.598	2.000	80.799	55.537	.000	.473
	Lower-bound	161.598	1.000	161.598	55.537	.000	.473
Error(Score)	Sphericity Assumed	180.402	124	1.455			
	Greenhouse-Geisser	180.402	120.404	1.498			
	Huynh-Feldt	180.402	124.000	1.455			
	Lower-bound	180.402	62.000	2.910			

a. Computed using alpha = .05

As shown in Table 9 and consequently in Figure 17, there is not a significant difference between the score after empathic (Level 2) and the score after neutral interaction (Level 3) regardless of the order.

Table 9: Tests of Within-Subject Contrasts

Measure: MEASURE_1		Type III Sum of Squares	df	Mean Square	F	Sig.
Score	Level 1 vs. Level 2	252.000	1	252.000	90.837	.000
	Level 2 vs. Level 3	.397	1	.397	.155	.695
Error(score)	Level 1 vs. Level 2	172.000	62	2.774		
	Level 2 vs. Level 3	158.603	62	2.558		

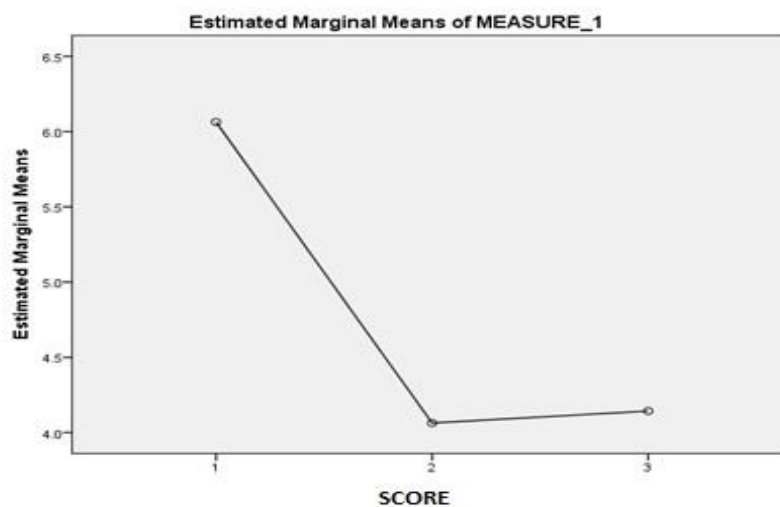


Figure 17: Scores (1=Baseline, 2=Empathic, 3=Neutral)



Figure 18 illustrates that from the baseline score, whether in Group 1 or Group 2, the score improves (i.e. it goes down) over time.

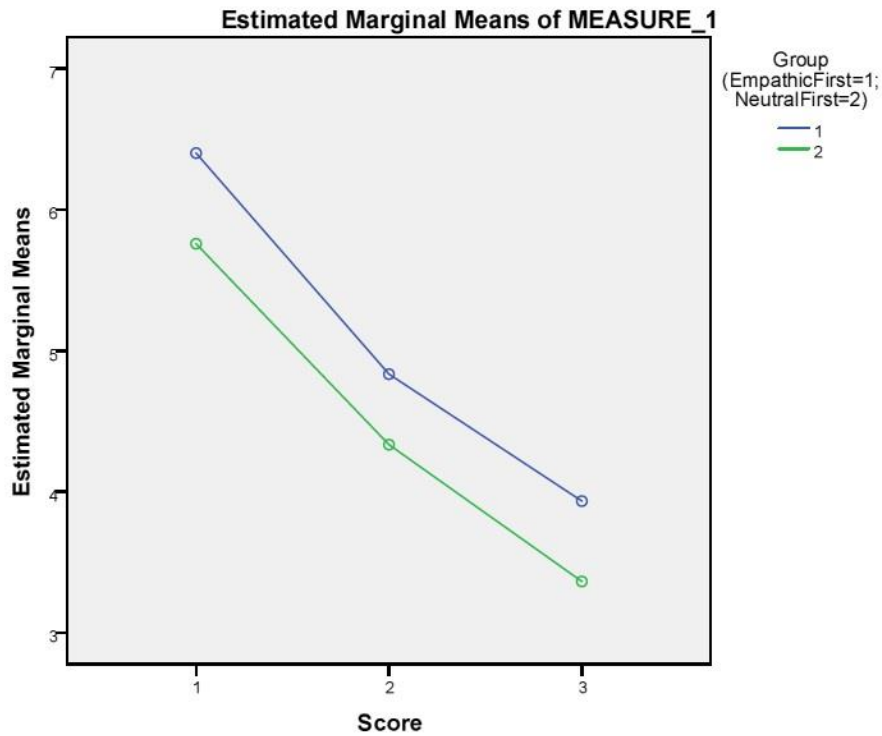


Figure 18: Changes in Scores over time

#### 4.3.3 Rapport Result

A one way within subjects ANOVA (Table 10) was performed to test whether there was a difference in participants' feeling of rapport with the virtual therapist between empathic and non-empathic Effie conditions. The observed F value was not statistically significant,  $F(1, 62) = 2.76$ ,  $p = 0.10$ , effect size  $\omega^2 = 0.001$ , partial  $\eta^2 = 0.043$ , which indicated no difference of rapport between empathic and non-empathic Effie conditions.

Table 10: Tests of Within-Subjects Effects (Rapport)

Measure: MEASURE_1		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Rapport	Sphericity Assumed	34.57	1	34.571	2.757	.102	0.043
	Greenhouse-Geisser	34.57	1.0	34.571	2.757	.102	0.043
	Huynh-Feldt	34.57	1.0	34.571	2.757	.102	0.043
	Lower-bound	34.57	1.0	34.571	2.757	.102	0.043
Error(Rapport)	Sphericity Assumed	777.43	62	12.539			
	Greenhouse-Geisser	777.43	62.0	12.539			
	Huynh-Feldt	777.43	62.0	12.539			
	Lower-bound	777.43	62.0	12.539			

a. Computed using alpha = .05

Table 11 (the between groups test) indicates that the variable group is an important factor, consequently Figure 19 demonstrates that the changes in rapport over time are different for the two groups. The within subject test showed that there was not a statistically significant difference of rapport between empathic and non-empathic Effie conditions ( $F(1,61) = 2.75$ ,  $p=0.10$ ); in other words, the rapport did not change significantly over time. However, there was a statistically significant interaction of rapport and group which means that the level of rapport is significantly changing over time (depending on the experimental conditions) but in different ways ( $F(1,61) = 162.34$ ,  $p<0.001$ , partial  $\eta^2=0.209$ ).

Table 11: Tests of Between-Subjects Effects (Rapport & Group)

Measure: MEASURE_1		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Rapport	Sphericity Assumed	27.734	1	27.734	2.750	.102	0.043
	Greenhouse-Geisser	27.734	1.0	27.734	2.750	.102	0.043
	Huynh-Feldt	27.734	1.0	27.734	2.750	.102	0.043
	Lower-bound	27.734	1.0	27.734	2.750	.102	0.043
Rapport * Group	Sphericity Assumed	162.338	1	162.338	16.099	.000	0.209
	Greenhouse-Geisser	162.338	1.0	162.338	16.099	.000	0.209
	Huynh-Feldt	162.338	1.0	162.338	16.099	.000	0.209
	Lower-bound	162.338	1.0	162.338	16.099	.000	0.209
Error(Effie)	Sphericity Assumed	615.091	61	10.083			
	Greenhouse-Geisser	615.091	61.0	10.083			
	Huynh-Feldt	615.091	61.0	10.083			
	Lower-bound	615.091	61.0	10.083			

a. Computed using alpha = .05

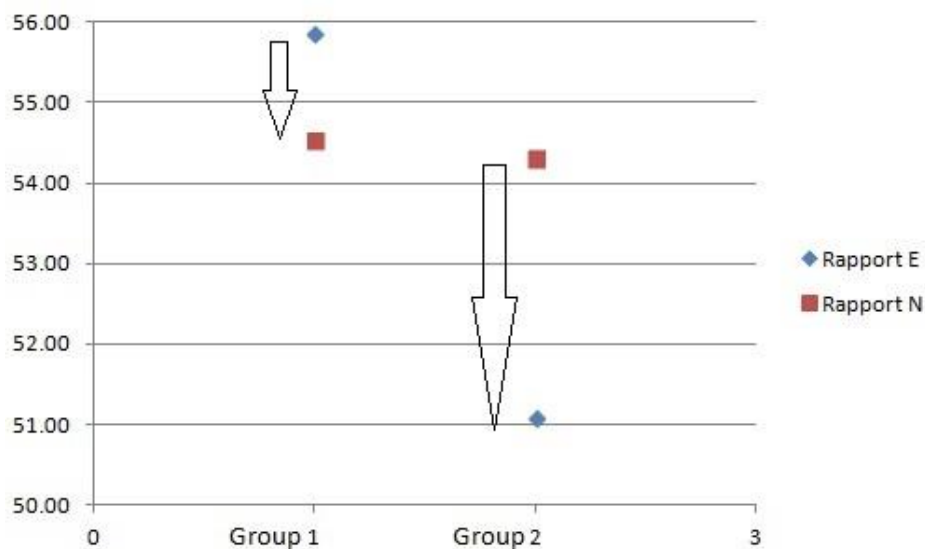


Figure 19: Rapport results in two groups

## 4.4 Qualitative Analysis

At the end of the survey, there was a question asking participants for comments and suggestions about the experiments. For Study 1 and Study 2, we received 17 and 18 comments, respectively. Eight (8) comments were affirmative in Study 1, such as “I really loved it and it did help me distress with exams and all that.” and “Very impressive technology! I can tell it is in very early stages still but this can go far in the future.” There were 11 positive comments for Study 2, including “All together a good experience and I feel more relaxed as the result. This has potential to help people.” and “I actually felt better after the experiment, great work. Excellent voice modulation with an easy understandable pace and the general concept is promising.” and “The result was interestingly positive for me and the level of my anxiety decreased significantly”.

There were 9 comments in Study 1 about the animation glitches, while there were only three in Study 2. We believe this was due to having more participants who had already experienced with either EFT or acupuncture in the second study in comparison with the first study (9 vs. 4). Furthermore, the real-time interaction in Study 2, potentially made it more believable than watching the videos in Study 1. Participants generally commented on the break/flickering in the flow of the tapping animation and the distraction they experienced during the EFT session such as “There are glitches on Effie during the tapping, improving the animation will make the experience more believable”.

We received comments for unusual eye and blank staring in both studies; e.g. “First thing I noticed was Effie's eyes that looked a bit unnatural and little off putting”.

There were some overall comments about Effie’s statements used during the therapy session. Three participants could not relate to those statements (“It doesn't feel safe” or “It still feels out of control.”) and suggested that having the option where the user is able to select the statements would be helpful. Alternatively, there were some suggestions to provide customised statements dependent on the user’s problem to increase the degree of emotional improvement. Another recommendation was to ask the subject about the type of emotional problem they were experiencing, so that Effie could use the appropriate statements based on that problem. Another comment mentioned that asking more questions about the issue would allow them to feel and focus more on their issue. It was also noted that more than two rounds would be needed for some problems.

One user commented that they found Effie’s talking and movement to be very fast to follow. Two participants were unsure about the exact nature of tapping; i.e. where exactly to tap, and hence suggested to show a diagram of the meridians points would help.

Three Participants also recommended the system for people who are not able to go to a therapy session, as an alternative to save time and money. In the second study there were two suggestions to include a background relaxation music (both comments from male, aged 28 and 30), one comment about improving the quality of the speaker (female, aged 19) and two comments about using earphones (both from male, aged 20 and 30) so the effect of the interaction would be better.

## **4.5 Chapter Summary**

The results were not significantly different between the two studies. Therefore, we combined the obtained result. Both neutral and empathic virtual EFT practitioners were able to deliver emotional benefits. The benefit was greater after the first interaction for both groups. Although there was no perceived difference in terms of being empathic between empathic and neutral Effie, empathic Effie seemed more caring. Participants felt more sense of rapport with the empathic Effie in the second round where Effie had the ability to tailor responses based on the user's score.

## Chapter 5: Discussion

As detailed in Chapter 3, two different studies were designed and implemented for this research work. Study 1 was online semi-interactive using videos, while Study 2 was onsite fully interactive. Although Study 2 received the benefits of having real-time interaction with the user, as well as some additional enhancements (e.g. voice and nonverbal behaviour improvement) and ensuring differences between the two studies, the results of the two studies were not significantly different from each other. In this chapter, we discuss the different aspects of the results. We start with the consideration of study and domain features in section 5.1, and then in section 5.2 we look at the empathic dialogues, their therapeutic benefits and their impact on the results. The implementation of the virtual therapist will be discussed in section 5.3 followed by the rapport effect in section 5.4. The chapter concludes with a summary in section 5.5.

### 5.1 Study and Domain Features

Our second study (onsite interactive) was conducted during the holiday season. Therefore, together with the need to constrain participants to attend a fixed location at a fixed time, recruiting participants for this study was challenging. In comparison with the first study (semi-interactive), which had been done during the semester and on the user's own convenient time and place, fewer participants volunteered and fewer had serious emotional feeling towards a problem. Moreover, as mentioned in the Results chapter, in our second study the average age of participants was higher than the first study. However, this did not affect the results.

After we had started the video study, to try to understand whether participants were interacting with the video in a similar way to using the system interactively, we added some questions to ascertain if participants were replying to Effie, speaking the affirmations out loud and doing the actions (In our recording Effie asked for responses, paused for replies and waited for the participant to complete the tapping and affirmation so it still supported interactive behaviour). From the 19 participants who answered these questions, all except one were doing the actions and 11 were speaking out loud and replying to Effie. In the second study with 26 participants, all participants were doing the tapping action and 18 of them spoke with Effie.

According to Church (2013), the three essential ingredients of Clinical EFT are exposure, cognitive shift and acupressure. Church (2013) states that "*thousands of videos made by hundreds of different individuals appear on YouTube, social networking sites, and individual websites, attesting to the popularity of EFT method as well as practitioners' conviction of its efficacy.*"(p.1). Despite the use of online methods to access information about EFT, church's research review article about EFT

(Church, 2013) only identified two studies in which EFT has been delivered using online technology. In the first study, Church and Wilde (2013) used EFT to aid weight loss and deliver improvements in depression and anxiety. The study by Brattberg (2008) focused on self-administered EFT via the Internet for individuals with fibromyalgia. An eight-week EFT self-administered treatment program was established online. The specific technology used is not clarified in the study. The results indicated improvements in the participants' health and also showed that EFT had the advantage of being extremely easy for patients to self-administer via instructions over the Internet (Brattberg, 2008). More research is needed to specify how EFT can be delivered via available technologies. Regardless of using a virtual agent or real human, many studies emphasize that the treatment involves more than one session, day or even week. Our study has the potential to be run in a clinic or hospital along with an ongoing treatment.

## **5.2 Achieving Empathic Dialogue and Its Therapeutic Benefit**

Early work in the field of affective IVA-human interactions indicated that IVAs are able to reduce negative emotions in users (Hone, 2006). In our research study, participants reported a reduction in their negative emotional feelings after following the virtual therapist. However from the result section, there is no perceived difference in terms of reported benefits or perception of Effie showing empathy between empathic and neutral Effie. In the case of the first study, we believed this was due to having to use a video which meant we were unable to tailor empathic Effie's responses to the individual. The video did not allow participants to experience some aspects of our empathic dialogue, in particular the "empathy for the user" cues where Effie would respond to the questions about how the participant's day was going or whether their scores were improving or getting worse. In response to these results, we felt it necessary to run an onsite study to allow participants to experience interaction with Effie as we had originally intended when creating Effie. However, the results of the second study were consistent with the first study and no significant difference was found between empathic and neutral Effie, though both delivered benefits.

In both studies, it appears that the empathic dialogue we have created for Effie in the role of empathic character, has not been perceived as showing empathy for the users. Empathic Effie in greeting used social dialogue such as "How is your day going?" The available responses the user could select were limited to "It's great", "It's going well" and "Not so good". The design of Effie's dialogue had sought to draw on the empathic cues identified by Bickmore et al. (2005). However, more cues may be needed and some wording could be improved. For example, there exists a lack of self-disclosure after the user's response. For instance, Effie did not ask any additional questions (personal) when the user selected "Not so good". Effie would start the therapy straight afterward by only saying "I am sorry; I hope I can help you feel better".

Empathy is the capacity to understand or feel what another person is experiencing; i.e., the capacity to place oneself in another's position (Bellet and Maloney, 1991). Although saying "I am sorry..." conveys empathy, it can be interpreted as carrying a hidden message laying some blame on the recipient. A similar, but less controversial, way of expressing empathy by Effie could be "I can understand how you are feeling; I hope I can help you feel better."

Another two parts of Effie's dialogue that contain empathic conversation are when the user returns back from the survey after the two interactions with the therapist. Empathic Effie compares the user's scores to determine the degree of improvement. In the case where the score gets worse, Effie says "I am sorry that it doesn't seem to be of much help." which contains negative sentiments. After discussing empathic Effie's dialogue with a real therapist, we were advised by an EFT practitioner to use an alternative response (i.e. feedback) which is more affective and positive. For instance, in case of the score getting worse, Effie would say: "It is great to see you are in touch with your emotions on a deeper level. Now we can work on releasing it in a more effective way which will be more long lasting". In learning environments, affective and elaborate feedback has been shown to be an important factor to deliver motivation and performance in students' learning (Lin et al., 2013). Furthermore, in therapeutic usage of IVAs in hospitals (e.g. bedside companionship study provided by Bickmore et al. (2015)), empathic feedback has a key role to comfort patients who live in hospitals while under treatment.

This interpretation of the data is reinforced via responses to Question 14 in the rapport questionnaire where both versions of Effie were found to be similarly moderately empathic even though empathetic cues derived from the literature (Bickmore et al., 2005) were only included in the empathic agent implementation. As described in section 4.3.1, in the absence of a manipulation check in the original design of our study, we sought to use Question 14 of the rapport questionnaire ("Effie was not empathic towards me") as a manipulation check to test if participants perceived the two versions of the character. However, as the question was negatively worded) some participants may have interpreted the question to ask whether they perceived Effie was nasty rather than simply neutral. A manipulation check should be added to future studies.

From the result section users achieved emotional benefits as they used the system, but potentially there is the possibility of a placebo effect, i.e. that scores were improved simply because participants believed the treatment to be effective. Moreover, a related but different issue is a possible role of the so-called "Hawthorne effect". It shows that people's behaviour and self-reporting are influenced by the fact that they are taking part in research (e.g. they might have motivation to please the researchers.). Therefore, the improved emotional scores may be attributable at least partly to either belief in the efficacy of the treatment, or to the effect of taking part in the

research, rather than to interaction with the virtual therapist by itself. We can conclude that initial improvement might disappear after prolonged use of the system or if the system is used at home.

In the design of Effie, we sought to provide a more sophisticated means of communication than the use of conversation trees. Conversation trees have been commonly used to manage the behaviour of agents during human-agent conversation. In this method, the agent is given a choice of what to say and makes subsequent choices until the conversation ends. Although using a conversation tree is easy, it makes the ECA's behaviour predictable. The approach we used is closer to the use of a mental states model (Bosse and Provoost, 2015) where the agents' behaviour is based on its internal mental state resulting from previous observations and interactions (Bosse and Provoost, 2015). Bosse and Provoost (2015) further proposed incorporation of personality into the agent, but we have not explored that in this work.

### **5.3 Implementation of the Virtual Therapist**

In our first experience using the Virtual Human Toolkit with the modular design and abstract components, we found the framework straight forward to use. In our design and development stages, the way to achieve the end result (i.e prototype implementation) was challenging but clear. Good support was provided by the VHToolkit support team from the Institute for Creative Technology at the University of Southern California. The VHToolkit architecture provides individual capabilities, such as speech recognition, perception, animation, text-to-speech systems and natural language generation in one single framework which makes the tool easy to use. This framework reduces the barriers which exist in other virtual human research attempts, such as complex modelling, limitation in natural language processing, limiting to a specific domain, 2D representation, etc. The major limitation related to this study was the incompatibility of the VHToolkit with the Unity web player. Also, due to the need to install 3rd party software on the user's machine in order to run the application and the size of the overall application (600MB), it was not practical to run an online study with this version. These requirements had an impact on recruitment with the pool of participants likely to enrol in our study.

One of the challenges in creating Effie's animations was EFT tapping. There were 9 tapping animation clips and the corresponding animation states created for Effie. All tapping animation clips were linked and managed by a Unity3D animator controller. All animation loop sequences had to start and stop at an idle stand pose with hands at the hips, so the looping fitness was constrained to this point. This reduced continuity in tapping that naturally occurs around the hand staying in position at each of the tapping point, as after each loop the hand returned to the hip.



A more complicated sequence of hand motions followed by looped animations could be used, but this would need the character motion to retain continuity between separate animations, which is hard to achieve without a standard idle pose.

## **5.4 Rapport Effects**

Notwithstanding the limitations of analysing individual questions in the Rapport Questionnaire, as shown in Appendix B, fourteen of the rapport questions received positive responses, four questions received negative responses, and two were neutral overall with mixed scores for empathic and neutral agent for different groups for both studies. An absence of rapport is evident for Q3, Q4, Q12 and for the video interaction in Q13. Participants felt no connection (Q3) or mutual understanding (Q4) with Effie. This may be because the communication did not seem natural (Q12) and interaction was thus not believable (Q13).

Some of the general feedback we received may explain these scores. Twelve participants commented about the limitations of the technology, particularly related to the animations (e.g. “There are glitches on Effie during the tapping”, “improving the animation will make the experience more believable”, “few glitches with hand movement timing/errors”). Due to the physical nature of tapping and imprecision of some of the animations, two participants indicated they did not know how hard or exactly how or where to tap (e.g. “It should be made clearer what type of tapping motion Effie is doing.”, “it was little difficult to determine the speed of the tapping and how many fingers to use”). We believe that the scores for these questions can be improved with improvements to the animation.

The last two responses show that people were more focused on what they were doing in the real interaction with the character than when they were following a video. This indicates that having real interaction with the virtual therapist makes the session more engaging. This is reflected in Q17 where participants felt more engaged with Effie in the second study.

In the second interaction, empathic Effie demonstrated care and tailored responses according to the user’s score. Therefore, according to the Q13 of the rapport questionnaire, interacting with Effie seemed more believable in the second study. From Q10 of rapport questionnaire, people liked the way she looked in real interaction better. This maybe because in response to a few comments from participants in the first study, after 13 participants the background colour of Effie was changed, from a dark colour to a brighter colour. These comments had not arisen in our pilot testing. Moreover, we added ‘smile’ to her when she had a role of empathic character in the middle of the first study (See Figure 20).



Figure 20: Effie's Smile and Background Changes

The remaining Rapport questions were positive. Participants liked Effie and they would like to have someone like her to help them. They found her interested in what she was doing and they believed doing EFT with her is possible, so they would recommend her to others. These results reflect participants' enthusiasm in using a virtual therapist. Moreover, it shows that Effie was successful in what she was delivering. They reported being comfortable and not feeling embarrassed during the session. Understanding Effie was not hard for participants and it would not be difficult to meet and talk with Effie. We attribute this result to the clarity of the pre-recorded voices and the fact that the instructions were well explained. We received some favourable comments regarding the potential of the technology (e.g. "I really loved it and it did help me destress with exams and all that.", "Effie is a good initiative [sic] for people who don't have time or money to visit a real therapist.", "Very impressive technology.", "good approach for people that for some reason can't go to a therapist, make it available at any time when required.", "A real human voice with Effie's image would also be a good compromise.").

## 5.5 Summary

The results of our research study show the benefits of using IVAs in IVA-human interaction, but enhancing interactivity and adaptability of our virtual therapist, did not alter the extent of the effect on the emotional benefits reported. Both versions of Effie (empathic and neutral) were found to be similarly moderately empathic. However, empathic Effie seemed to be more caring.

## Chapter 6: Conclusion

In this research work, we presented a virtual EFT practitioner that delivers physical and emotional therapy. Our aim was to explore the potential benefits of a virtual therapist. Moreover, we compared two different types of virtual therapists: empathic and neutral. Our design consisted of two study groups, and participants were randomly assigned to one group. In the first group, participants interacted with the empathic character, followed by the neutral therapist, while in the second group, users interacted with the neutral therapist, followed by the empathic character.

### 6.1 Summary and Outcomes: Answering the Research Question

The result of our experiments with 63 participants showed that interaction with both virtual therapists achieved emotional benefits from the baseline emotion for both groups. Furthermore, both empathic and neutral therapists received the same rating for sense of rapport regardless of the experimental condition (group) but by taking into account the group, the empathic agent achieved a higher level of rapport with the users in Group 2 though this did not occur in Group 1.

This indicates that participants interacting with the empathic version of the therapist in the second interaction experienced and achieved a greater sense of rapport than the participants interacting with the empathic therapist in the first interaction. We believe this is because in the second interaction empathic Effie's dialogue was tailored to the user's emotional responses/score (More discussion of the dialogues is presented under the heading Intervention Materials in section 3.4).

The results of our study showed no significant differences in therapeutic benefit between empathic and neutral versions of Effie or between the semi-interactive Effie and the fully-interactive and more adaptive Effie. These findings raise the important question, at what point would a significant difference be achieved? In particular, how much interactivity, adaptability, believability or empathy would be needed to improve the benefits to the user? Since significant benefits were achieved by both versions of the therapist, would the additional effort to make a sophisticated interactive empathic virtual therapist result in improved outcomes for the user?

While IVAs have been shown to be helpful in therapeutic and behaviour change contexts, how much believability and empathy is needed to produce these results? In the health context, does the patient experience improved health and well-being? In learning contexts, does the learner better achieve the learning outcomes? In coaching and mentoring roles, is the user more adherent in following the advice, or more persistent in their training regime or more abstinent from a habit they are trying to break? As has been found in educational studies involving the use of virtual worlds (Richards, 2006, Richards and Taylor, 2015), users may prefer more interaction and believability,

however, it may not lead to improved learning outcomes. In our study, rapport was improved through more empathic behaviours, but therapeutic benefit was not greater. Researchers such as de Melo and Gratch (2015) are questioning the importance and appropriateness of believability in some contexts. The findings of this study and mixed results in other studies (e.g. by Maldonado et al. (2005), Prendinger et al. (2003), Berry et al. (2005), Hastie et al. (2016), Hall and Woods (2005)) show that empathic behaviours do not always achieve improved outcomes and suggest that empathic behaviours may not always necessary, desirable or justify the additional complexity and effort involved to provide such behaviours.

## **6.2 Future Work and Limitations**

The main limitation of the current study is the lack of multimodal interaction and tailoring. While sophisticated systems such as SimSensei (DeVault et al., 2014) and ODVIC (Lisetti et al., 2012) are showing what the future is holding for VHs, the drawbacks in the field are mainly due to the complexity, effort and cost involved in creating virtual humans, particularly one that exhibits social and empathic behaviours.

The design of the therapy session could be improved. Another limitation of our study is having only two rounds of therapy. If the participant's score gets worse or does not change after two rounds, Effie would end the therapy session, whereas in a therapy session with a human therapist, another round would be added to achieve a better score. In an actual therapy, the therapist would continue until the score is zero. We could have done this without any additional programming. However, in order to run a controlled experiment, it was decided that all participants would experience two rounds and we would then compare that data.

The other improvement we could add to our therapy session is asking users to identify the type of emotion they are experiencing with the issue they wants to resolve. The options would be anger, fear, worry, sadness or general anxiety. Depending on the emotion, there are specific meridian points associated with each emotion (specific sequence) which need to be tapped if the score hasn't changed after two or three rounds. This suggestion was advocated by a real EFT therapist, who clarified that she tailors the location of the tapping according to the expressed emotion.

Another limitation is not having an appropriate manipulation check after the therapy, to determine which virtual therapist was perceived as more empathic. This manipulation check could avoid misinterpreting an individual rapport question regarding empathy.

We further note limitations with the analysis of individual questions in the rapport questionnaire. The rapport questionnaire was intended to determine the overall degree of sense of rapport.

However, interpreting questions individually is subject to biases and inconsistencies because participants' understandings of individual questions may vary. Therefore, we cannot really know whether individual questions measure the construct we are interested in. An approach of asking participants 20 questions arguably related to the same underlying construct and looking at the aggregate score is reasonable, but problems with individual questions are likely to be averaged away.

To leverage off the progress of researchers in the field, we utilised the VHToolkit in our own project. Nevertheless, there was a considerable learning curve in using the toolkit. Also the process of creating animations is time-consuming and laborious, even for experienced modellers. This project was limited to a 9 month time-frame and thus the time that could be devoted to perfecting the models and animations was severely constrained.

While the VHToolkit was a great aid to our project, a major hurdle faced in our study was the incompatibility of the VHToolkit with the Unity web player, requiring us to use a computer based environment; and the need to install 3rd party software on the user's machine in order to run the application. Hence, recruiting participants for the onsite study was challenging.

Effie's non-verbal behaviour was limited to smiling. There was a lack of proper type of backchannel like nodding and gazing exist in her behaviour. Nguyen et al. (2015) proposed a model for non-verbal behaviour generation to reflect warmth and competence in virtual characters. Warmth and competence are the two main human traits that influence social judgements in people interaction (Cuddy et al., 2011). As described in (Nguyen et al., 2015), open gesture is required for a character with high warmth and high competence. This could be achieved with eyes fixated on the audience, happy face, hands held centre, and posture leaning forward and stable.

To improve the dialogue manager in the future work, we will explore the possibility of fusing the NPCEditor (Leuski and Traum, 2010) with a Planning Module to enable the agent to choose an appropriate response(s) based on user's speech input. Moreover, the future work for this project would also include adding multimodal perception modules (e.g. emotion and feeling detection, natural language understanding) and generating appropriate nonverbal behaviours such as nod, smile and mimicry in real-time based on Effie's perceptions and understanding. This requires extending and adopting our agent architecture. In that way, Effie would be capable of establishing more sense of rapport with the user as showed in the rapport agent proposed by Huang et al. (2011). Another future avenue to explore, could be taking inspiration from the three factors of theory of rapport (positivity, mutual attention and coordination) presented by Tickle-Degnen and Rosenthal (1990) to complete the empathy module of the system.

A further implication of being unable to recruit widely was potentially biased populations that results when convenience sampling is used. As we saw in the result section (Table 2), the average age of the participants in the onsite interactive group (mean= 30.4) was higher than the average age of the participants in the semi-interactive group (mean= 23.5). That reflects another limitation of this study that may affect the generality of our findings.

It is hard to know the future of EFT and thus the value of using a virtual EFT therapist is also unknown. According to Church (2013), EFT is rapidly spreading internationally. Proponents of EFT believe that EFT can easily and very soon become a dominant method for the fast resolution of mental, emotional, psychosomatic and physical issues. However, the "problem" of scientific verification and explanation of EFT still remains. Many credible professionals over the world are spending their time to find this evidence, so perhaps it is only a matter of time for EFT to be fully explained and documented.

Irrespective of the future of EFT, this research work has shown that the recital of mantras and inner reflection can be supported by a virtual therapist.

Future studies should investigate whether the same level of benefits can be delivered simply by uttering the statements and performing the tapping without the aid of a virtual therapist. Using an automated system such as this one, allows us to control other variables and examine specific factors that impact in EFT therapy. Moreover, we could test whether simply hearing the affirmations would be sufficient, or if reading them would be adequate to produce some benefit. This would allow us to determine the value of having an embodied virtual character. Ideally, we would have had a control group that did the affirmation but did not see or interact with Effie. Another appropriate control group could have engaged in a neutral task with Effie but would not receive EFT such as reading a book. It is conceivable that if they are asked to rate the intensity of their emotions, repeatedly paying attention to emotional problems and quantifying them, then they may be positively influenced and report emotional benefits over time. However, with limited access to participants, we wanted to focus our data collection on answering whether empathic or neutral dialogue delivered greater benefit.

In the future, we should also ask "Did Effie make you feel better?" as a manipulation check to allow us to compare their responses with the emotional scores. The capture of biometric data such as Galvanic Skin Response (GSR), eye tracking, heart rate, electroencephalography (EEG) to measure emotional response and cross-validate with reported feelings would be ideal enhancements, though currently impractical.

### **6.3 Final Remarks**

IVA-human interaction is a challenging area for IVA researchers that involves taking into consideration numerous factors in order for the interaction to be beneficial. In therapeutic usage of IVAs, in order to achieve useful outcomes, the user needs to establish a sense of rapport with the therapist. EFT has been found to be an effective treatment for a wide variety of health problems, such as phobias, anxiety, trauma, stress and also physical pain. A virtual EFT practitioner was developed in this work, offering the possibility to release emotional feelings of the user. The virtual EFT therapist guides them through the therapy in a supportive and safe interaction. The results of this study were promising. Empathic dialogue with the user and expressing facial expressions achieved a greater sense of rapport between the therapist and the user. With further future enhancements, EFFIE and EFT in general will provide a testbed for measuring a variety of factors that have been found to be important in establishing successful IVA-human interactions. For example, with the addition of listening and more adaptive and empathic behaviours, the EFT therapist will have the potential to exert complex functionalities that support multimodality, dialogue management and responding appropriately according to the emotional state of the user. Towards these longer term goals, the work in this thesis provided a proof of concept that a virtual therapist can deliver EFT and emotional benefit to the user. It also demonstrated the feasibility and limitations of employing an available virtual agent technology, namely VHToolkit that provides a unified framework for dialogue management. Furthermore, the work in this thesis evaluated the design and value of empathic versus neutral dialogue and raised important questions for future research.

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## Appendix A: Group 1 and Group 2 dialogues

Greeting (Neutral)

**Neutral Effie:** Hello, I am Effie a virtual human. How are you?

**User:** I am well thanks / I am not very well.

**Neutral Effie:** Okay then. Let's get started.

Greeting (Empathic)

**Empathic Effie:** Hi, I am your Emotional Freedom Friend, EFF for short. You can call me Effie. I'm very happy to meet you and hope you'll find our session together worthwhile.

Please make yourself comfortable.

**Empathic Effie:** How is your day going?

**User response**

**Empathic Effie:** I hope I can help you feel better.

Now I'm going to be your therapist to help you work through a problem you are facing. How are you feeling about coming to see me?

**User response**

**Empathic Effie:** That's great to hear / Well hopefully I can put your mind at ease.

Introduction about EFT

**Empathic Effie:** Before we get started, do you know anything about EFT?

**User Response**

**Empathic Effie:** Okay good, it's not that complicated, I'll give you a brief explanation before we get started.

**Neutral Effie:** Let's start. First, I am going to give you an introduction about EFT.

**Both Effie:** The Emotional Freedom Technique or EFT (often known as Tapping), is a universal healing tool that can help you to overcome negative beliefs, negative emotions, negative thought patterns and help you to replace them with positive thoughts, positive feelings, help you to feel calm and relaxed.

**Both Effie:** How does that sound?

**User response**

**Both Effie:** Let me explain some more about EFT. Our bodies have a profound electrical nature. Electrical messages are constantly sent throughout your body to keep it informed of what is going on. Negative emotions result in energy disruptions that interfere with the body's ability to fight disease. EFT can identify the causes of energy disruptions, often resulting in permanent solutions without medication. In this method certain meridian points are stimulated by tapping with the fingertips while the client focuses on the issue they wish to resolve. Did you find that interesting?

**User response**

**Both Effie:** This treatment involves the use of fingertips to tap on the end points of energy meridians that are situated just beneath the surface of the skin. I will do tapping on my own body and you need to follow me. While you are tapping on your body you need to "tune in" to a problem you are facing and repeat exactly the phrases I say. It is best to say the words out loud. Are you somewhere where you won't be distracted or feel embarrassed to speak out loud?

**User response – wait**

**User:** I'm ready.

**Both Effie:** Okay, let's start.

**Both Effie:** Please select the area of your life which you want to resolve during this session from the options provided. You don't need to disclose that problem to me but I'd like you to keep that in mind during this session:

Family/ Study/ Relationship/ Physical/ Financial/ Other

**User:** Selecting... **Both Effie:** This session will be completed after two rounds. Before each round you need to score your emotional feeling towards your problem on a scale of 0 to 10. Zero means "extremely good and relaxed" and 10 means "extremely bad and stressed". Please close your eyes, tune in to your body and score your feeling on the sliding scale before starting the first round.

**User:** Scoring... **Both Effie:** Tuning in to a problem can be done by simply thinking about it. In this way an important link is established between your mind and body. Please tune in to your problem and repeat the phrases which I say loudly while you are tapping on your body.

Effie (Start tapping)

(Note: In this study the tapping consists of maximum two rounds. Each round starts with the setup state which is tapping on karate chop point while indicating the problem three times. It is followed by two sequence states. The sequence of tapping in each state is 1-inner eye brow 2- side of eyes 3-under eye 4-under nose 5-chin 6-collar bone 7-under arm. In this two states user would repeat reminder phrases.)

Round 1

### **Set up**

*(Tapping on Karate-Chop point or setup point, saying what the problem is, repeating three times)*

Even though.... [\(Waiting for the user to repeat\)](#).... I am feeling so anxious..... I deeply and completely.... love and accept myself.....

Even though..... I am feeling so anxious..... I deeply and completely.... love and accept myself.....

Even though..... I have all this anxiety..... about various things in my life.... I love and accept.....how I feel about this.....

### **Sequence - First time**

*(Around 7 times tapping on each point, saying reminder phrase)*

*(Effie is tapping on inner eyebrow):*

This anxiety in my body..... [\(waiting for the user to repeat\)](#)

*(Effie is tapping on Side of eyes):*

This anxiety is intense.....

*(Effie is tapping on under eyes):*

I feel all this anxiety in my body....

*(Effie is tapping on under nose):*

It feels overwhelming.....

*(Effie is tapping on chin):*

It feels out of control.....

*(Effie is tapping on collar bone):*

It feels that I don't have control over my body.....

*(Effie is tapping on under arm):*

It doesn't feel safe here....

### **Sequence - Repeat**

*(Effie is tapping on inner eyebrow):*

I am open to releasing this emotion.....

*(Effie is tapping on side of eyes):*

I feel safe to release this emotion.....

*(Effie is tapping on under eyes):*

I know what it feels like.....to feel calm.....

*(Effie is tapping on under nose):*

I am allowing my body to feel calm and relaxed.....

*(Effie is tapping on chin):*

I have control of my body....

*(Effie is tapping on collar bone):*

I am able to own my power.....

*(Effie is tapping on under arm):*

I let it go....

**Effie:** Take a deep breath and close your eyes. I want you to tune in to your body again and score how you are feeling now on the sliding scale of zero to ten. If the score is not zero we will do the second round.

**User:** Scoring....

**Neutral Effie:** Let's try gain.

**Empathic Effie:** "Let's try again to get a better score. I think we can do better and I'd really like to see some more improvement for you. "

Round 2 – same as round 1 but with words like “still”, “remaining” and “yet” added in certain places.

**Empathic Effie:** “I hope I've been able to help you get over your emotional feeling.”

**Empathic Effie:** It was great meeting you. Thanks for participating in this EFT experiment. See you next time. ”

**Neutral Effie:** Thanks for your participation. See you next time.

## Appendix B

**Table B-1: The 40 rapport questions descriptive analysis for the two studies**

The highlighted rows indicate the negative worded questions.

	Study	N	Mean	Std.	Std. Error
I liked Effie.	Video	37	2.70	.878	.144
	Real Interaction	26	2.58	.643	.126
Effie was weird.	Video	37	2.86	1.182	.194
	Real Interaction	26	3.08	1.055	.207
I felt I had a connection with Effie.	Video	37	3.41	.956	.157
	Real Interaction	26	3.19	.801	.157
I think that Effie and I understood each other.	Video	37	3.30	.996	.164
	Real Interaction	26	3.27	.962	.189
I would like to have someone like Effie help me.	Video	37	2.76	.955	.157
	Real Interaction	26	2.69	1.087	.213
I would recommend Effie to a friend.	Video	37	2.92	.983	.162
	Real Interaction	26	2.73	.778	.152
I felt uncomfortable during the session.	Video	37	3.43	1.015	.167
	Real Interaction	26	3.73	.874	.171
I felt embarrassed during the session.	Video	37	3.49	1.121	.184
	Real Interaction	26	3.50	.860	.169
I had difficulty understanding Effie.	Video	37	4.27	.732	.120
	Real Interaction	26	4.27	.778	.152
I don't like the way she looks.	Video	37	3.03	1.118	.184
	Real Interaction	26	3.04	.824	.162
It would be difficult to meet and talk with Effie.	Video	37	3.08	.983	.162
	Real Interaction	26	3.15	1.008	.198
Communicating with Effie felt natural.	Video	37	3.43	.899	.148
	Real Interaction	26	3.31	.838	.164
Interacting with Effie was believable.	Video	37	3.32	.973	.160
	Real Interaction	26	2.96	.871	.171
Effie was not empathic towards me.	Video	37	3.22	.886	.146
	Real Interaction	26	3.31	1.123	.220
Effie was warm and caring.	Video	37	2.68	.784	.129
	Real Interaction	26	2.62	.941	.185
I felt that Effie was interested in what she was doing.	Video	37	2.76	.955	.157
	Real Interaction	26	2.38	.697	.137
I felt I was able to engage with Effie.	Video	37	3.19	.995	.164
	Real Interaction	26	2.85	.967	.190
I think doing EFT with Effie would be impossible.	Video	37	3.57	1.042	.171
	Real Interaction	26	3.65	.797	.156
Seeing Effie helped me to focus on EFT.	Video	37	2.49	.901	.148
	Real Interaction	26	2.15	.732	.143
Following Effie's actions helped me to focus on EFT.	Video	37	2.41	.762	.125
	Real Interaction	26	2.27	.778	.152
I liked Effie.	Video	37	2.49	1.044	.172
	Real Interaction	26	2.50	.860	.169
Effie was weird.	Video	37	3.08	1.187	.195
	Real Interaction	26	3.38	.898	.176
I felt I had a connection with Effie.	Video	37	3.27	.871	.143
	Real Interaction	26	3.08	.935	.183
I think that Effie and I understood each other.	Video	37	3.22	.976	.160
	Real Interaction	26	3.12	.864	.169
I would like to have someone like Effie help me.	Video	37	2.57	.987	.162



	Real Interaction	26	2.96	1.076	.211
I would recommend Effie to a friend.	Video	37	2.78	1.084	.178
	Real Interaction	26	2.81	.895	.176
I felt uncomfortable during the session.	Video	37	3.43	1.068	.176
	Real Interaction	26	3.73	.667	.131
I felt embarrassed during the session.	Video	37	3.41	1.013	.166
	Real Interaction	26	3.81	.801	.157
I had difficulty understanding Effie.	Video	37	4.14	.751	.124
	Real Interaction	26	4.19	.801	.157
I don't like the way she looks.	Video	37	3.24	1.256	.207
	Real Interaction	26	3.35	.797	.156
It would be difficult to meet and talk with Effie.	Video	37	3.24	1.065	.175
	Real Interaction	26	3.27	.919	.180
Communicating with Effie felt natural.	Video	37	3.22	.976	.160
	Real Interaction	26	2.88	.909	.178
Interacting with Effie was believable.	Video	37	3.00	1.130	.186
	Real Interaction	26	2.65	.892	.175
Effie was not empathic towards me.	Video	37	3.46	.767	.126
	Real Interaction	26	3.54	.859	.169
Effie was warm and caring.	Video	37	2.59	.832	.137
	Real Interaction	26	2.65	1.018	.200
I felt that Effie was interested in what she was doing.	Video	37	2.68	.915	.150
	Real Interaction	26	2.27	.724	.142
I felt I was able to engage with Effie.	Video	37	2.89	1.075	.177
	Real Interaction	26	2.65	1.018	.200
I think doing EFT with Effie would be impossible.	Video	37	3.68	1.002	.165
	Real Interaction	26	3.58	.809	.159
Seeing Effie helped me to focus on EFT.	Video	37	2.54	.960	.158
	Real Interaction	26	2.27	.667	.131
Following Effie's actions helped me to focus on EFT.	Video	37	2.38	.828	.136
	Real Interaction	26	2.00	.400	.078

**Table B-2: The 40 rapport questions Independent Sample Test for the two studies**

The highlighted rows indicate the questions with a significant p-value.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
I liked Effie.	Equal variances assumed	1.958	.167	.622	61	.536	.126	.202	-.279	.530
	Equal variances not assumed			.656	60.862	.514	.126	.192	-.257	.509
Effie was weird.	Equal variances assumed	1.042	.311	-.732	61	.467	-.212	.290	-.791	.367
	Equal variances not assumed			-.747	57.489	.458	-.212	.284	-.781	.356
I felt I had a connection with Effie.	Equal variances assumed	2.384	.128	.930	61	.356	.213	.229	-.245	.672
	Equal variances not assumed			.959	59.033	.342	.213	.222	-.232	.658
I think that Effie and I understood each other.	Equal variances assumed	.106	.746	.112	61	.911	.028	.251	-.475	.531
	Equal variances not assumed			.112	55.149	.911	.028	.250	-.472	.529
I would like to have someone like Effie help me.	Equal variances assumed	1.465	.231	.249	61	.804	.064	.259	-.453	.582
	Equal variances not assumed			.243	49.374	.809	.064	.265	-.467	.596
I would recommend Effie to a friend.	Equal variances assumed	1.991	.163	.813	61	.419	.188	.231	-.275	.651
	Equal variances not assumed			.847	60.064	.400	.188	.222	-.256	.632
I felt uncomfortable during the session.	Equal variances assumed	.959	.331	-1.215	61	.229	-.298	.246	-.789	.193
	Equal variances not assumed			-1.247	58.395	.217	-.298	.239	-.777	.181
I felt embarrassed during the session.	Equal variances assumed	3.099	.083	-.052	61	.959	-.014	.262	-.537	.510
	Equal variances not assumed			-.054	60.469	.957	-.014	.250	-.513	.486
I had difficulty understanding Effie.	Equal variances assumed	.058	.811	.005	61	.996	.001	.192	-.383	.385
	Equal variances not assumed			.005	51.872	.996	.001	.194	-.389	.391
I don't like the way she looks.	Equal variances assumed	3.758	.057	-.044	61	.965	-.011	.258	-.527	.504
	Equal variances not assumed			-.047	60.829	.963	-.011	.245	-.501	.478
It would be difficult to meet and talk with Effie.	Equal variances assumed	.162	.689	-.286	61	.776	-.073	.254	-.581	.435
	Equal variances not assumed			-.285	53.105	.777	-.073	.255	-.585	.439
Communicating with Effie felt natural.	Equal variances assumed	.224	.638	.558	61	.579	.125	.224	-.323	.572
	Equal variances not assumed			.565	56.250	.575	.125	.221	-.318	.567
Interacting with Effie was believable.	Equal variances assumed	1.290	.261	1.520	61	.134	.363	.239	-.115	.840
	Equal variances not assumed			1.550	57.425	.127	.363	.234	-.106	.831
Effie was not empathic towards me.	Equal variances assumed	2.769	.101	-.361	61	.719	-.091	.253	-.598	.415
	Equal variances not assumed			-.346	45.596	.731	-.091	.264	-.623	.440
Effie was warm and caring.	Equal variances assumed	.622	.433	.277	61	.783	.060	.218	-.376	.496
	Equal variances not assumed			.268	47.461	.790	.060	.225	-.392	.513
I felt that Effie was interested in what she was doing.	Equal variances assumed	2.753	.102	1.694	61	.095	.372	.220	-.067	.811
	Equal variances not assumed			1.788	60.882	.079	.372	.208	-.044	.788
I felt I was able to engage with Effie.	Equal variances assumed	.042	.838	1.362	61	.178	.343	.252	-.160	.847
	Equal variances not assumed			1.369	54.936	.176	.343	.251	-.159	.845

I think doing EFT with Effie would be impossible.	Equal variances assumed	3.131	.082	-.355	61	.724	-.086	.243	-.572	.399
	Equal variances not assumed			-.372	60.503	.711	-.086	.232	-.550	.378
Seeing Effie helped me to focus on EFT.	Equal variances assumed	3.891	.053	1.555	61	.125	.333	.214	-.095	.760
	Equal variances not assumed			1.613	59.644	.112	.333	.206	-.080	.745
Following Effie's actions helped me to focus on EFT.	Equal variances assumed	.058	.810	.692	61	.491	.136	.197	-.257	.529
	Equal variances not assumed			.690	53.291	.493	.136	.197	-.260	.532
I liked Effie.	Equal variances assumed	1.254	.267	-.054	61	.957	-.014	.249	-.511	.484
	Equal variances not assumed			-.056	59.368	.955	-.014	.241	-.495	.468
Effie was weird.	Equal variances assumed	3.633	.061	-1.100	61	.276	-.304	.276	-.855	.248
	Equal variances not assumed			-1.155	60.623	.253	-.304	.263	-.829	.222
I felt I had a connection with Effie.	Equal variances assumed	.018	.893	.842	61	.403	.193	.230	-.266	.653
	Equal variances not assumed			.831	51.489	.410	.193	.233	-.274	.660
I think that Effie and I understood each other.	Equal variances assumed	1.628	.207	.423	61	.674	.101	.238	-.376	.577
	Equal variances not assumed			.432	57.709	.667	.101	.233	-.366	.568
I would like to have someone like Effie help me.	Equal variances assumed	.191	.663	-1.502	61	.138	-.394	.262	-.918	.130
	Equal variances not assumed			-1.480	50.932	.145	-.394	.266	-.929	.141
I would recommend Effie to a friend.	Equal variances assumed	1.782	.187	-.092	61	.927	-.024	.259	-.541	.493
	Equal variances not assumed			-.096	59.314	.924	-.024	.250	-.524	.477
I felt uncomfortable during the session.	Equal variances assumed	11.148	.001	-1.260	61	.212	-.298	.237	-.772	.175
	Equal variances not assumed			-1.363	60.296	.178	-.298	.219	-.736	.140
I felt embarrassed during the session.	Equal variances assumed	4.088	.048	-1.687	61	.097	-.402	.238	-.879	.075
	Equal variances not assumed			-1.758	60.072	.084	-.402	.229	-.860	.056
I had difficulty understanding Effie.	Equal variances assumed	.231	.633	-.289	61	.773	-.057	.198	-.452	.338
	Equal variances not assumed			-.286	51.740	.776	-.057	.200	-.458	.344
I don't like the way she looks.	Equal variances assumed	8.007	.006	-.368	61	.714	-.103	.279	-.662	.456
	Equal variances not assumed			-.397	60.481	.693	-.103	.259	-.621	.415
It would be difficult to meet and talk with Effie.	Equal variances assumed	.960	.331	-.101	61	.920	-.026	.258	-.542	.490
	Equal variances not assumed			-.103	58.351	.918	-.026	.251	-.529	.477
Communicating with Effie felt natural.	Equal variances assumed	.134	.716	1.366	61	.177	.332	.243	-.154	.817
	Equal variances not assumed			1.383	56.261	.172	.332	.240	-.149	.812
Interacting with Effie was believable.	Equal variances assumed	3.219	.078	1.302	61	.198	.346	.266	-.186	.878
	Equal variances not assumed			1.356	60.109	.180	.346	.255	-.164	.857
Effie was not empathic towards me.	Equal variances assumed	.030	.863	-.383	61	.703	-.079	.206	-.492	.334
	Equal variances not assumed			-.375	49.963	.709	-.079	.210	-.502	.344
Effie was warm and caring.	Equal variances assumed	.600	.442	-.254	61	.801	-.059	.234	-.526	.408
	Equal variances not assumed			-.245	46.829	.808	-.059	.242	-.546	.427
I felt that Effie was interested in what she was doing.	Equal variances assumed	2.446	.123	1.887	61	.064	.406	.215	-.024	.837
	Equal variances not assumed			1.965	60.052	.054	.406	.207	-.007	.820
I felt I was able to engage with Effie.	Equal variances assumed	.103	.749	.885	61	.380	.238	.269	-.300	.776
	Equal variances not assumed			.893	55.757	.376	.238	.267	-.296	.772
I think doing EFT with Effie would be impossible.	Equal variances assumed	.850	.360	.416	61	.679	.099	.237	-.376	.573
	Equal variances not assumed			.432	59.741	.667	.099	.229	-.359	.556
Seeing Effie helped me to focus on EFT.	Equal variances assumed	4.567	.037	1.244	61	.218	.271	.218	-.165	.707
	Equal variances not assumed			1.324	60.998	.191	.271	.205	-.139	.681
Following Effie's actions helped me to focus on EFT.	Equal variances assumed	18.857	.000	2.155	61	.035	.378	.176	.027	.729
	Equal variances not assumed			2.408	55.116	.019	.378	.157	.063	.693

## Appendix C: Ethic Approval Letter

From: <[ethics.secretariat@mq.edu.au](mailto:ethics.secretariat@mq.edu.au)>  
Date: Thu, Oct 15, 2015 at 4:59 PM  
Subject: MQ Human Ethics: Approval notice  
To: [deborah.richards@mq.edu.au](mailto:deborah.richards@mq.edu.au)  
Cc: [hedieh.ranjbartabar@mq.edu.au](mailto:hedieh.ranjbartabar@mq.edu.au)

Re: 5201500740; "A Virtual Emotional Freedom Practitioner"

Dear Professor Richards

This research project was granted ethical approval by the relevant committee on 15/10/2015.

You may view this record online at the IRIS website (<https://iris.mq.edu.au/rmenet>) - this email is not your approval letter.

Please ensure that any institutional research governance requirements (e.g. insurance, Working with Children Check, approval to travel, etc.) have been completed before you commence this research.

If you need to advise Macquarie University that the project will not be completed, please log in to the IRIS website (<https://iris.mq.edu.au/rmenet>) to open and discontinue your application.

If you wish to make any future changes to this research project (including personnel), you will be required to process an "Amendment Request".

Regards  
Human Ethics Secretariat

## Appendix D: Qualtrics Survey

### D-1: Demographic Questionnaire

Please answer the following questions. Your answers will be in no way linked with your name or any other personally identifying information.

What is your gender?

Female

☐

Male

☐

Other

☐

How many years have you lived in an English speaking country?

All my life

☐

<1 year

☐

1-5 years

☐

> 5 years

☐

How old are you?

Please select your current studying degree:

undergraduate

☐

postgraduate  
coursework

☐

postgraduate  
research

☐

not studying

☐

Do you play computer games?

Yes

☐

No

☐

Have you experienced EFT before?

Yes

☐

No

☐

Have you experienced acupuncture before?

Yes

☐

No

☐

## **D-2: Rapport Questionnaire**

Please select your level of agreement/disagreement with each of the following statements in the 5-point likert scales from strongly agree to strongly disagree:

1. I liked Effie.
2. Effie was weird
3. I felt I had a connection with Effie.
4. I think that Effie and I understood each other.
5. I would like to have someone like Effie help me
6. I would recommend Effie to a friend
7. I felt uncomfortable during the session.
8. I felt embarrassed during the session.
9. I had difficulty understanding Effie.
10. I don't like the way she looks.
11. It would be difficult to meet and talk with Effie.
12. Communicating with Effie felt natural
13. Interacting with Effie was believable
14. Effie was not empathic towards me.
15. Effie was warm and caring.
16. I felt that Effie was interested in what she was doing.
17. I felt I was able to engage with Effie.
18. I think doing EFT with Effie would be impossible.
19. Seeing Effie helped me to focus on EFT.
20. Following Effie's actions helped me to focus on EFT.

## Appendix E: Poster Advertisement



### Want to experience Emotional Freedom Therapy with a virtual therapist **(On Campus)?**

You are invited to participate in a study on 'A Virtual Emotional Freedom Practitioner'. The purpose of the study is to explore whether a virtual Emotional Freedom Technique (EFT) therapist can deliver emotional benefits. The study is being conducted by Ms. Hedieh Ranjbartabar, Department of Computing, [hedieh.ranjbartabar@mq.edu.au](mailto:hedieh.ranjbartabar@mq.edu.au) to meet the requirements of Master of Research under the supervision of Professor Deborah Richards [deborah.richards@mq.edu.au](mailto:deborah.richards@mq.edu.au), of the Department of Computing, Faculty of Science and Engineering. The study has been approved by the Macquarie University Human Research Ethics Committee.

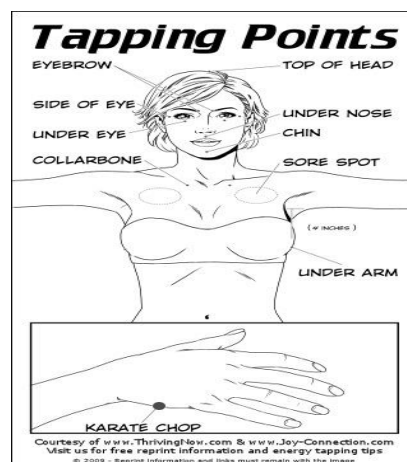


If you decide to participate, the study is conducted in Department of Computing, Faculty of Science & Engineering, building E6A, Room 328. The participant would come along to the building E6A, room 328 at the booked time slot. The researcher Ms. Hedieh Ranjbartabar would wait for the participant inside the room and will leave the room during interaction with the virtual character.

To book a time and for any queries please contact: [hedieh.ranjbartabar@mq.edu.au](mailto:hedieh.ranjbartabar@mq.edu.au)

We cannot offer any financial reward for participation. However you may find the session useful and learn about EFT and virtual agent technology.

**What is EFT?** *"The cause of all negative emotions is a disruption in the energy system."* Emotional Freedom Techniques (EFT) known as Tapping Method can identify the causes of energy disruptions, often resulting in permanent solutions....without medication! EFT generates its results by balancing the energy meridians while the client "tunes in" to their in a gentle, conversational manner while tapping on meridians points.



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