Human-Centred Information Systems: Designing Avatars for Users from Arab Culture

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ABSTRACT

This research explores avatar design aimed at being part of a user interface, which is human-centred and enhances user experience. Avatars here refer to images or digital representations of users or computer agents in an online environment. We first carry out a comprehensive review of the relevant literature to investigate and synthesise findings related to avatar design. Through the review, we develop a theoretical framework to capture commonly investigated constructs, interaction types, application domains, and design considerations for digital representations. We also identify the knowledge gaps and establish our research objectives.

Based on the established research objectives, we conducted two qualitative studies exploring avatar design in the context of health applications. To derive avatar design guidelines, we adopted a co-design approach, which involved stakeholders in the design process. For the first study, we focused on empathic avatar design for stroke rehabilitation in a culturally neutral manner. Here, empathic design refers to paying attention to users' needs and building an emotional relationship between users and avatars. This study was rooted in *behaviour change theory* to engage stroke survivors. For the second study, we focused on designing avatars for Arab culture by creating a health scenario that provided a context for participants' responses. Here, in designing avatars, we considered the expertise of stakeholders who have experience with Arab culture. This study was based on *social response theory*, which posits that humans behave socially to computers. To the best of our knowledge, this is the first time that Arab culture has been considered in developing design guidelines for avatars comprehensively.

Based on the design guidelines developed in the second study, a set of 12 avatars covering the dimensions of culture, gender and clothing were designed. For the Arab avatars, we additionally considered Arab *cultural markers*, which involve design elements prevalent

within Arab culture. Then, we investigated the appropriateness of avatar design, i.e., the extent to which an avatar was perceived as culturally appropriate to Arab culture. We collected data from Arab users through an online questionnaire to test our research model and hypotheses. This study broadens our understanding of the influence of cultural appropriateness. The findings reveal that Arab avatars yield higher cultural appropriateness, which, in turn, is associated with higher trust and usage intention.

This research as a whole enriches our understanding of avatar design, as it explains why involving users in the design of avatars can provide a heightened user experience. The findings reveal that including design considerations that match the context, address users' needs, and reflect users' culture can provide better human–avatar interactions. Our work emphasises the importance of *empathic elements* and *cultural markers* in achieving human-centred design. The research adds to the existing knowledge base through the development of design guidelines that assist designers create more suitable avatars. The research also offers a deeper understanding of how avatars that are culturally appropriate can improve usage intention. It provides designers of user interfaces with a better understanding of how to design avatars for health applications in Arab culture.

STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision.

The thesis contains no material that has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968.

Hussain M. Al Jaroodi

ACKNOWLEDGEMENT OF AUTHORSHIP

I hereby certify that the work embodied in this thesis contains published paper/s/scholarly work of which I am a joint author. I have included as part of the thesis a written declaration endorsed in writing by my supervisor, attesting to my contribution to the joint publication/s/scholarly work.

Hussain M. Al Jaroodi

By signing below, I confirm that Hussain M. Al Jaroodi contributed to the following papers:

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
ACE	Arab Culture Expert
AGFI	Adjusted Goodness of Fit Index
ANTH	Perceived Anthropomorphism
AVE	Average Extracted Variance
CA	Perceived Cultural Appropriateness
CASA	Computers are Social Actors
CB-SEM	Covariance-Based Structural Equation Modelling
CFI	Comparative Fit Index
CR	Composite reliability
FAM	Perceived Familiarity
H2A	Human to Avatar Interaction
H2EA	Human to Embodied Agent Interaction
H2SA	Human to Self-Avatar Interaction
HCI	Human–Computer Interaction
HCIS	Human-Centred Information System
HTMT	Heterotrait–Monotrait Ratio
IS	Information System
IT	Information Technology
ITU	Intention to Use
KSA	Kingdom of Saudi Arabia
mHealth	Mobile Health
NCD	Non-Communicable Disease
NIH	National Institutes of Health
PSP	Perceived Social Presence
PSY	Psychologist
RMSEA	Root Mean Square Error of Approximation
RT	Representation Theory
SA2A	Self-Avatar to Avatar Interaction
SA2EA	Self-Avatar to Embodied Agent Interaction
SEM	Structural Equation Modelling
SLR	Systematic Literature Review
SRMR	Standardised Root Mean Square Residual
SRT	Social Response Theory
TLI	Tucker Lewis Index
TRT	Trust
UI	User Interface
WHF	World Heart Federation
WHO	World Health Organisation
α	Cronbach or Alpha Coefficient

Chapter 1: Introduction

CHAPTER 1 OVERVIEW

This chapter sets the scene for this research project by providing an introduction to the field of study and clarifying the motivation, objectives, context and scope, as well as the main research questions. We also outline the research methodology and approaches that have been used to investigate the research questions. We describe the ethical aspects that need to be considered when conducting research with human participants. The chapter also provides a summary of our research contributions and ends with an outline of the structure of the thesis.

1.1 BACKGROUND AND MOTIVATION

Human-centred information systems (HCIS), sometimes also known as user-centred information systems (Gulliksen et al., 2003), refer to system design that specifically focuses on a user's needs, activities, and requirements (Ritter et al., 2014). In other words, it is about designing systems in which "the needs of users should dominate the design of the user interface and the needs of the user interface should dominate the design of the rest of the system" (Norman, 1986, p. 61). Humans need to be considered as the central part of an information system (IS) and must be "*designed in*" (Ritter et al., 2014, p. 43). In HCIS, the design should avoid elements that make users uncomfortable and instead focus on design elements that enrich the user experience and their engagement. Therefore, HCIS design should focus on elements of user interface (UI) design that better facilitate the user experience through higher levels of interactivity, sociability, or usability.

One way to achieve this is by employing digital representations, such as *avatars* and *embodied agents,* within the UI. An avatar is defined as a digital representation that characterises the user in a virtual environment and enables them to have mediated interactions with other users (Bailenson et al., 2005). An embodied agent is "a perceptible digital representation whose behaviours reflect a computational algorithm designed to

accomplish a specific goal or set of goals" (Bailenson & Blascovich, 2004, p. 64). The distinction between an avatar and an embodied agent lies in the entity that is in control of the digital representation. Digital representations are often designed to purposefully employ graphical embodiments that resemble human features (e.g., eyes, face, hair, body).[1] UI design plays an important role in how users perceive their interaction with an IS and their usage intentions. In the context of decision support systems, for instance, employing social cues such as human features can promote an engaging user experience and increase the user's trust in a system (Qiu & Benbasat, 2009).

In recent years, many individuals frequently interact with avatars, or use them, in digital environments such as websites (Keng & Liu, 2013), virtual worlds such as *Second Life*[2] (Grinberg et al., 2014; J. E. R. Lee & Park, 2011), as well as mobile applications (Kang & Watt, 2013; Lyles et al., 2017). It has become increasingly important to understand the implications of human–avatar interactions in such settings in terms of how avatars can be designed for specific application areas and different cultures, and to evaluate the effectiveness and suitability of their digital representations. Importantly, what are the behavioural outcomes related to human–avatar interactions as well as their influences and effects on human psychological constructs? A psychological construct here refers to things that exist in the user's mind and are not directly observable by others (MacCorquodale & Meehl, 1948). It is therefore important to understand how avatar design can be specifically designed to positively affect a user's psychological constructs – notably in a specific application area such as health and across diverse cultures – in order to provide a better and

[1] Strictly speaking, the term *avatars* refers to a computerised graphical representation of a user or another (human) user in a computer-mediated environment (Bailenson & Yee, 2005). However, the term is often used synonymously for the representation of computer agents (also known as embodied agents). Importantly, this distinction between an avatar and embodied agent is not the primary focus of this research. The primary focus is on the visual (graphical) appearances of these digital representations.

[2] *Second Life* is is "a computer-based virtual world, simulated multi-media environment, usually running over the Web, and designed so that users can 'inhabit' and interact via their own graphical self-representations known as avatars" (Boulos et al., 2007, p. 233).

engaging user experience. In terms of this thesis, we are looking for better acceptability and suitability to a specific culture.

In practice, a useful paradigm for studying and investigating avatar design is "Computers are Social Actors" (CASA). CASA, first proposed by Nass at al. (1994), is the most common paradigm employed as the main theoretical foundation for studying and exploring avatar design and for understanding human–avatar interactions. CASA suggests that, fundamentally, humans consider computers as social actors when they exhibit human-like characteristics. Here, the degree to which humans consider computers as *social actors* hinges on the degree to which computers exhibit human-like features such as voice, gestures, behaviours, expressions, emotions, and appearance. Conceptually derived from the CASA paradigm is social response theory (SRT), which states that users behave socially to computers, even though they know that computers do not have emotions, distinctive personalities, or even human motivations (Nass & Moon, 2000). More specifically, when computers are equipped with human-like features, people apply social rules or behaviours when responding to them because human-like features provide social cues (Reeves & Nass, 1996).

In making culture-specific designs, adhering to the cultural appropriateness of the targeted cultural group is essential because there is no benefit in designing an attractive UI that is culturally inappropriate. Cultural appropriateness, in the context of UI design, refers to the degree to which the UI design of a system is perceived as culturally appropriate by the target user and which subsequently promotes usage intention. A culturally appropriate design should incorporate design elements from the user's physical environment. These elements may include people from the community, iconic and cultural locations and places, the use of appropriate local language, colours commonly used or found in a given culture, and clothing styles that appear familiar to, and are favoured by, the targeted cultural group (Resnicow et al., 1999). Cultural appropriate design is important in UI design because systems that are

designed in a culturally appropriate manner are seen as relevant to the user's culture and build credibility (Moriarty, 1994).

The aim of this research project is to carry out a systematic and comprehensive study of avatar design, which promotes usage intentions, keeps users engaged in a specific health application, and represents users' culture. The importance of studying avatar design is clear, given the fact that humans are frequently seen to interact with avatars in their daily lives. Besides that, the practical implications of avatar design are wide ranging, since avatars are employed or applicable to a variety of applications including business, education, and entertainment. Furthermore, several studies in the literature (e.g., Chattaraman, Kwon, & Gilbert, 2012; Kwon, Powell, & Chalmers, 2013; S. Lee & Choi, 2017) have shown that avatars can attract enormous practical benefits. However, conclusions drawn from a user interacting with an avatar, in particular one that provides general health advice in a design reflecting the typical features of a Western or Asian culture, cannot simply be assumed valid for more specific health applications, such as one for stroke rehabilitation, or for one requiring Arab culture's avatars.

The remainder of this chapter is organised as follows. In Section 1.2, we present information on the context and scope of this research. Then, Section 1.3 highlights research questions that will be investigated and how they will be addressed; we also provide the motivations behind each question along with justifications for conducting the research. Section 1.4 presents an overview of the adopted research methodologies and approaches, including analysis techniques and data collection methods as well as other relevant information. Section 1.5 summarises the contributions of this research project in terms of its relation to the existing body of knowledge as well as discussing contributions of the use and design of avatars specifically to health applications and Arab culture (including my country). Section 1.6 sets out the ethical considerations and approvals needed when conducting

research with human participants. We then outline the structure of the research project in Section 1.7. Finally, in Section 1.8, we provide a summary of this introductory chapter.

1.2 RESEARCH CONTEXT AND SCOPE

The focus of this research project is centred around *avatar design*. First, we consider health applications as the context in which we enter into meaningful discussions and responses with participants; it is also the context in which we derive suitable avatar designs. In addition, in recent years, health applications have become common areas for researchers to explore human–avatar interactions (e.g., Javor, Ransmayr, Struhal, & Riedl, 2016). In this research, we consider the use and design of avatars in health applications due to the fact that the avatar–human relationship can help promote healthy lifestyles, e.g., physical activity (Behm-Morawitz, 2013), and promote recovery (Pessoa et al., 2014).

Second, we also explore avatar design through the lens of culture. We consider *culture* within avatar design because it has been shown that users may feel psychologically detached and disconnected from their interactional environment when their culture is not represented (e.g., J. E. R. Lee & Park, 2011). Culture here refers to "the collective programming of the human mind that distinguishes the members of one human group from those of another. Culture in this sense is a system of collectively held values" (Hofstede, 1981). Also, representing a user's culture and ethnicity has been shown to play an important role in building trust (e.g., Bente, Dratsch, Kaspar, et al., 2014; Tamborini et al., 2018), intention to use (e.g., Borning & Muller, 2012; Yusof & Zakaria, 2007), and technology adoption (e.g., Baker, Al-Gahtani, & Hubona, 2010; Papadimitropoulos et al., 2015). In other words, this research project considers *culture* as an aspect that promotes psychological attachment between the user and their avatar. Avatars that resemble the user's own culture will be shown to have an important role in promoting positive behaviours and better user engagements and interactions.

More specifically, in this research the health application we consider is related to stroke survivors and stroke rehabilitation programs. This was chosen because current rehabilitation programs focus primarily on providing written instructions to stroke survivors, which, given their impaired condition, may be hard to follow. Further, digital representations have been used to a lesser extent than have traditional methods (e.g., written instructions) and we wanted to explore how avatars might be used to provide interactive interactions and motivate post-stroke users. In addition, in terms of culture-specific design, despite the large volume of theoretical and empirical research on avatar design, previous work has focused predominantly on Western and Asian cultures (Beege et al., 2017; Nowak et al., 2015; Nowak & Rauh, 2006; Tamborini et al., 2018). Less attention has been devoted to avatar design appropriate to Arab culture. Therefore, this research project focuses particularly on Arab culture, mainly because Arab culture has been largely overlooked in terms of avatar design for human-computer interactions (HCI) and has received limited attention in IS research and avatar design more generally.

1.3 RESEARCH QUESTIONS AND OJECTIVES

By acknowledging the primary importance of avatar design in IS and HCI research, their effects on human perceptions and behaviour (i.e., the user's psychological constructs), and their effectiveness in providing an engaging and interactive user experience, this research project sets out to specifically address the following four research questions (RQs).

> **RQ1:** *What is the current body of knowledge in experimental IS research on design considerations, application contexts, behavioural outcomes, and influences on users' psychological constructs of avatars and embodied agents?*

In order to address RQ1, we performed a systematic literature review (SLR) in Chapter 2 for several reasons. First, we wanted to provide the necessary background information for readers to understand and appreciate our work. Further, performing an SLR allowed us to analyse and synthesise the current body of knowledge on design considerations for digital

representations in experimental IS research, their application contexts, user behavioural outcomes, and the effects on users' psychological constructs. Here, we focus on experimental IS research due to the fact that, through experiments, researchers are able to observe, under controlled conditions, actual interactions between users and avatars or embodied agents and their responses. Importantly, experiments allow researchers to identify causal effects through controlled variations in order to investigate how different design features of avatars and embodied agents affect outcomes (Shadish et al., 2002). In this way, we develop a theoretical framework for our SLR findings that conceptualises interactions between humans and their digital representations. In addition, we performed the SLR in order to identify knowledge gaps and suggest new directions for future research.

> **RQ2:** *How can empathic avatars be designed in health applications for stroke rehabilitation?*

The findings of the SLR suggest that digital representations are used to a lesser extent than traditional methods (e.g., written instructions) in health applications. Here, we address the question by conducting an exploratory study to define and derive design requirements and principles for empathic avatars in health applications for stroke rehabilitation. The objective of this study is to enhance stroke survivors' capabilities by using empathic avatars. In other words, we set out to explore how health solutions designed with empathic avatars can support stroke survivors in effective rehabilitation. This addresses the problem of current stroke rehabilitation programs, which predominantly rely on written text. This particular study will focus on the effectiveness of the use of avatars in stroke rehabilitation by identifying design requirements and principles for empathic avatars in health applications. Notably, the cultural background of users was not the primary concern of this study; thus, we have adopted a culturally neutral perspective in order to derive design requirements and principles for empathic avatars in stroke rehabilitation.

RQ3: *How can avatars for Arab culture be employed by system designers in UI design?*

The SLR findings indicate that, in the realm of avatar design within IS and HCI research, Arab culture has been overlooked and has received limited attention. In brief, we found that avatar design was often not geared towards Arab culture. Here, we explore the design of avatars by taking Arab culture into consideration (see Chapter 4). Although avatar design in IS research is well understood, designing avatars for users from Arab culture is not straightforward, mainly because previous research has predominantly focused on Western and Asian cultures, so the design of avatars is often not geared towards Arab culture. We address this question by conducting semi-structured interviews aiming at the development of design guidelines for avatar design in a health advice scenario for users from Arab culture. In order to do so, we develop design propositions based on the concepts developed within previously published studies on human–avatar interaction and UI design in Arab culture. Then, by exploring this research question, we also address the fact that the knowledge of avatar design for Arab culture is limited. In fact, there are only a few studies that have used Arab avatars in their work (e.g., Bente, Dratsch, Kaspar, et al., 2014; Pepe & Santarelli, 2009; Šisler, 2006). This earlier work has not placed much emphasis on the design of avatars from the Arab cultural perspective, even though other research has clearly noted the importance of taking into account a user's culture and values (Borning & Muller, 2012; Hassanein et al., 2009; J. E. R. Lee & Park, 2011; Yusof & Zakaria, 2007) in order to engage them and increase their intention to use. To the best of our knowledge, there has been no research on exploring and defining suitable design guidelines for Arab avatars involving stakeholders with a background in Arab culture.

Our RQ2 (addressed in Chapter 3) and RQ3 (addressed in Chapter 4) use qualitative methods to define the design requirements and principles (or design guidelines) specifically for avatars. First, by addressing RQ2, we aim to define design guidelines for empathetic

avatars by adopting a culturally neutral design. Second, by addressing RQ3, we aim to define design guidelines for avatars by adopting a culturally specific design for users from Arab culture. These two research questions are aimed at exploring how design guidelines for users from Arab culture differ from culturally neutral design guidelines. In other words, we want to compare and demonstrate how design guidelines for an avatar in a health application differ between a culturally neutral design and one for users from Arab culture.

> **RQ4:** *How does cultural appropriateness of avatar design affect the usage intention and degree of trust for users from Arab culture?*

In order to address RQ4, we evaluated avatar design quantitatively in terms of how cultural appropriateness affects usage intention and the degree of trust by investigating Arab users' psychological constructs. The study provides a high-level understanding of how Arab users perceive avatars (Arab and non-Arab) in an online health application. While most previous research on avatar design has focused on users from non-Arab cultures (Beege et al., 2017; J. Kim & Park, 2011; Seo et al., 2017), this study is one of the first to focus specifically on users from Arab culture. Of the previous studies, none of them has explored the cultural appropriateness of an avatar to a particular culture. In other words, no systematic work has been conducted to empirically assess the effect of cultural appropriateness of avatar design for users from Arab culture. This study aims to broaden our understanding of how avatar design and cultural appropriateness can affect the psychological constructs of users. The study will also provide insights into the considerations that Arab users apply when selecting an avatar that does or does not represent their culture, its cultural appropriateness, and whether it reflects their gender.

1.4 RESEARCH METHODOLGY

To investigate the design of avatars and their effectiveness in health applications, as well as explore avatar design in Arab culture and evaluate these avatars in an empirical setting, four

studies were conducted. The four were aimed at addressing the research questions and achieving the overall objectives of this research project. The studies were 1) an SLR on the field of this research; 2) a qualitative study involving a workshop approach coupled with a design science approach (i.e., co-design); 3) a qualitative study involving a semi-structured interview coupled with a design science approach; and 4) a quantitative study using an online questionnaire to evaluate the cultural appropriateness of Arab and non-Arab avatars in the eyes of users from Arab culture. Details on the selected research methods and approaches are provided in the following subsections, which also describe the techniques used in analysing the data collected from each method.

1.4.1 Systematic Literature Review Methods

An SLR, often referred to as a systematic review, is a means of classifying, identifying, assessing, evaluating, and interpreting all available research relevant to a specific research question, subject area, phenomenon, or theme of interest (Kitchenham & Charters, 2007). SLRs are usually carried out to 1) provide a concise summary of the existing research relevant to the field of research; 2) identify and shed light on gaps in the current knowledge base in order to propose avenues for further and future research; and 3) provide a conceptual framework or background in order to appropriately position new and future research activities. We selected the SLR method because it is an essential component of every research project, facilitates new directions of research, and provides essential background information. In addition, it serves as the foundation for advancing current knowledge, facilitates theory development, identifies mature research areas, and uncovers novel avenues of research (Webster & Watson, 2002). Frank & Hatak (2014) refer to a literature review as a "knowledge map" that is usually performed in order to conduct analysis, provide synthesis, and give insights from prior published research about the field of interest, and to guide future research projects.

1.4.2 Qualitative Methods

A qualitative method is both exploratory and descriptive. Qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter (Denzin & Lincoln, 2005; Malterud, 2001). Qualitative researchers explore the topic at hand in its natural setting, attempting to make sense of, or unravel, phenomena in terms of the meanings, or opinions, that participants bring to them (Denzin & Lincoln, 2005). This method is useful because the issues that are being investigated often have limited understanding, and how to tackle these issues is often challenging. Although avatar design has been explored in delivering health information for Western and Asian cultures, only limited existing research has explored avatar design geared towards stroke rehabilitation or Arab culture. A qualitative method has been selected due to the fact that it plays an important role in understanding users' needs and evaluating the effectiveness of a new system (Blandford, 2013). The qualitative methods adopted by this research have been coupled with a design science approach (also known as co-design or participatory design), in which stakeholders, including users, are involved throughout the design process.

A design science approach was selected and coupled with other qualitative approaches adopted by this research project, i.e., workshops and semi-structured interviews, due to the fact that this approach goes beyond traditional methods by directly involving users in the design. The approach involves multiple stakeholders who contribute in a way which ensures that the design solution aligns with users' needs and experiences (Sanders & Stappers, 2008). The design science approach formally refers to "seek[ing] to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts" (Hevner et al., 2004, p. 75), and this approach is predominantly a problem-solving approach (Hevner et al., 2004).

Our workshops, which involved multiple stakeholders from multiple disciplines (including users), focused on empirically defining the design requirements and principles of

empathic avatars for a health application useful for stroke survivors. The workshop approach was selected because workshops "provide a platform that can aid researchers in identifying and exploring relevant factors in a given domain by providing means for understanding complex work and knowledge processes that are supported by technology" (Ørngreen & Levinsen, 2017, p. 70). Also, workshops were selected since other researchers have indicated that they are appropriate when events have a limited duration and when a small number of participants who share a common domain (i.e., participatory design) are targeted (Ehn & Kyng, 1987).

Then, in Chapter 4 we utilise a semi-structured interview approach, which is used because it gives the interviewees or participants the opportunity to freely express their opinions and views – in their own terms – in relation to a particular subject (Bernard, 1988; Mirzaei et al., 2014). Semi-structured interviews are typically explicitly structured around some theory or subject of interest, although they are not entirely structured (Blandford, 2013) in order to allow researchers to identify new ways of looking at, and understanding, the research topic. Also, semi-structured interviews can deliver dependable and comparable qualitative data for researchers (Rubin & Rubin, 1995). Specifically, semi-structured interviews were used to identify the requirements for designing Arab avatars in a health context designed especially for Arab culture. In the semi-structured interviews, a collection of avatars (based on design concepts and consideration identified in the SLR) were shown as examples to interviewees in order to create a mental image of avatars from previous studies (e.g., A. Davis, Khazanchi, Murphy, Zigurs, & Owens, 2009). Interviews were transcribed and coded according to recurring thematic elements following the process of performing thematic analysis on qualitative data introduced by Braun & Clarke (2006). In this way a set of general design guidelines for avatar design could be derived and identified, which could be effectively

implemented for use in Arab cultures, where they would be considered suitable and appropriate.

Further, we developed a set of 12 avatars using all possible combinations, namely culture (Arab, non-Arab), gender (male, female), and clothing (medical, athletic, everyday). The Arab avatars were designed following the results of the semi-structured interviews and thematic analysis (the design guidelines of avatars suitable for Arab culture are developed in Chapter 4). These avatars were designed with the help of an external company in the Middle East who are experienced in user experience design and who followed the instructions of the research team involved in this research project. The Arab avatars were designed around the recurring design elements derived from, or mentioned by, the interviewees. The design guidelines of these Arab avatars included appropriate or cultural clothing, colours common to Arab users, and the physical appearance of Arab males and females. In addition, the non-Arab avatars were designed based on the design considerations and concepts identified in the literature review (e.g., anthropomorphism, androgyny, gender).

1.4.3 Quantitative Methods

A quantitative method was used to examine and validate the relationships between the variables. The primary goal was to analyse and represent relationships mathematically based on statistical analysis and then draw conclusions from the results (Malhotra, 2016). This type of research approach is commonly used in scientific research problems (Labaree, 2009). A common way to collect data in quantitative methods is through the use of surveys and questionnaires. A questionnaire approach is a research instrument consisting of a series of questions (or other types of prompts) with the purpose of collecting data from participants (Malhotra, 2016). The questionnaire may include closed-ended and open-ended questions.

Further, in Chapter 5 we quantitatively evaluate Arab and non-Arab avatars on users from Arab culture in order to understand how such avatars are perceived in terms of cultural

appropriateness. The avatars were developed as health advisors in an online questionnaire, with the aim of evaluating cultural appropriateness of the avatar design based on the reactions of users from Arab culture; the effects on the psychological constructs of the users, such as their usage intentions, were also evaluated. The assignment of participants to each avatar was random in order to elicit honest responses from participants. The designed avatars were displayed to Arab participants in an online setting (as on a website) in which they filled out a survey that included questions about the displayed avatar in terms of, for example, its cultural appropriateness and the intention to use the avatar within Arab culture. A questionnaire approach was chosen because it measures the effectiveness of the designed avatar in terms of its appropriateness to Arab culture and usage in a health context. The collected data was pre-processed in order to identify and eliminate participants who did not qualify as Arab users. These were then analysed by structural equation modelling (SEM) using SPSS AMOS version 24 in order to test the developed hypotheses and research model (Arbuckle, 2013).

1.5 RESEARCH SIGNIFICANCE AND CONTRIBUTIONS

This research project provides several significant contributions to the body of knowledge for the field of HCI specifically and IS in general. In addition, the research provides insights into the design of avatars for Arab culture. In the following, an overview of the research contributions is discussed.

To begin, the main contributions of the SLR can be summarised as follows. First, we have developed a framework that sets out how to select parameters for avatars and embodied agents from the various interaction types. These interaction types include a user interacting with their own avatar or a user interacting with another user's avatar or embodied agent. Second, we set out the application domains in which avatars and embodied agents are usually employed. Third, we pinpoint key theories applicable to designing avatars and embodied agents. Fourth, we discern common design concepts, and fifth we identify methods used for

studying avatars, embodied agents, and their effects on users' perceptions and behaviour. This SLR might therefore serve as a reference point for research related to avatars and embodied agents, providing a guide on common design parameters and concepts; it also gives an overview of theories of interactions between humans, avatars, and embodied agents. This review could serve as a starting point for practitioners designing avatars and embodied agents.

Second, the main contributions emerging from addressing RQ2 is to show how avatars can be effectively designed for stroke rehabilitation programs and how they might increase stroke survivors' ability and motivation for rehabilitation, that is a *cost-effective* strategy for promoting healthier lifestyles, e.g., increased physical activity and healthier diets. In order to do so, we follow a design science approach (Hevner et al., 2004) to explore how health solutions can support the rehabilitation of stroke survivors. Existing approaches for stroke rehabilitation are primarily about providing stroke survivors with *information* on exercise and medication regimes, usually conveyed by means of simple text documents with detailed instructions from their healthcare professional. In contrast, the study is rooted in *behaviour change theory* (Michie et al., 2011; Noorbergen et al., n.d.), engaging stroke survivors in an empathic and meaningful way to increase compliance with exercise and medication regimes and to improve overall health outcomes. In particular, we have designed, implemented, and evaluated a health application with empathic avatars referred to as *Regain*, which aims to make stroke survivors stay engaged with their rehabilitation program. To ensure that our approach adequately considers the various perspectives in the complex landscape of stroke rehabilitation, we adopted a *co-design approach* that included workshops with multiple stakeholders including carers, clinicians, health behaviour psychologists, and actual stroke survivors.

Further, the main contribution of addressing RQ3 is that we address, in Chapter 4, the fact that Arab culture has been generally overlooked, both in terms of basic avatar design and in the development of guidelines for avatars that are appropriate for users from Arab culture. This could provide a reference set of general design guidelines for researchers and practitioners on how to develop and implement avatars in Arab culture. In doing so, we follow a hybrid approach of deductive and inductive reasoning. Firstly, we review the body of previous literature on designing UIs for Arab culture and designing (non-Arab) avatars in HCI research (deduction). This body of literature enables us to (1) develop propositions that shed light on how avatar design may affect user perceptions, and (2) identify stakeholder groups for designing avatars for Arab culture. Secondly, building on this theoretical groundwork, we conducted exploratory semi-structured interviews with the three identified stakeholder groups (Arab culture experts, psychologists, and potential users), leading to the development of six guidelines for designing avatars for Arab culture (induction). Through this study, our aim is to contribute to the design of more effective avatars for users from Arab culture.

In addition, the quantitative study provides several important contributions to the body of knowledge for designing UIs for users from Arab culture. First, while previous research on avatar design has focused on users from non-Arab cultures (Beege et al., 2017; J. Kim & Park, 2011; Seo et al., 2017), our study is one of the first to focus specifically on users from Arab culture. This provides important insights on how UIs can be designed in a more inclusive way, which cater to a diverse range of cultural backgrounds. Second, we contribute to the existing literature on SRT by theorising on how users' psychological constructs are linked to the cultural appropriateness of an avatar. After all, any human image inherently carries a cultural connotation derived from the human features it portrays. To the best of our knowledge, no existing research has investigated the theory of how cultural appropriateness

may affect the important drivers of trust and usage intention for users from Arab culture. The present study might be helpful in generating innovative ideas and better knowledge about the impact of cultural appropriateness of avatar design in Arab context. This might give a good overview of what might be considered culturally appropriate or inappropriate by Arab users. Third, the findings of this study may also provide insights into the considerations Arab users apply when selecting an avatar.

Importantly, in achieving the proposed objectives, this research will also contribute to the existing knowledge base and increase the effectiveness of health applications, which employ avatars. The findings might contribute to the future development of avatar design in Arab culture.

Furthermore, in Chapters 4 and 5, we primarily focus on users from Arab culture, which includes my country, the Kingdom of Saudi Arabia (KSA). The findings of these two chapters will present design considerations for designing avatars for Arab culture, which might benefit my country in several ways. First, the design guidelines will help designers develop avatars that are suitable for Arab cultures in general. In addition, this will guide organisations to effectively develop and use avatars that engage Saudi users. Importantly, the findings will provide design guidelines for designers aiming to implement avatars in, e.g., websites and other mobile applications, to provide general information to Saudi users on a topic of interest. These topics could include advertising of new products and services. Importantly, the findings will inform how public agencies in the KSA (e.g., the ministry of health) could use and develop their own avatars and include them in their online communications with Saudis users (e.g., Twitter announcements). This would provide a more engaging user experience, and the interactive delivery of a message would help establish credibility.

Further, these design guidelines and perceived cultural appropriateness of avatar design might provide a reference guide for international companies who wish to operate, or are currently operating, in the KSA in terms of how UIs should be designed (e.g., on their websites and in public announcements, informing them about what Arab users consider appropriate or inappropriate). The guidelines developed in this research project could help provide companies with a cost-effective strategy for attracting Saudi users to their online communications. This could also help in providing interactive access for Saudi users seeking online information, e.g., product recommendations, services offered, and medical information, without visiting a physical office. This could better engage Saudi users and help them in positive behavioural change, e.g., healthier diet, and provide a better user experience when interacting with an avatar in a digital environment. To sum up, public and private organisations (local or international) in the KSA could use these design guidelines to create appropriate avatars, which would better engage Saudi people.

1.6 ETHICAL CONSIDERATIONS

To address the research questions and achieve its objectives, this research project has involved human participation. Prior to conducting the studies, all were approved by the ethics committee for conduct of research involving human participants. The approval was granted by the Human Research Ethics Committee at the University of Newcastle, Australia, as well as the respective organisations involved. The approval numbers were: HREC/16/HNE/307 (Chapter 3); H-2017-0177 (Chapter 4); and H-2018-0178 (Chapter 5).

Participants received information sheets that clearly outlined the aims and objectives of the research, and were provided with a description of the procedures involved. The information included a statement, which said that participation in the research project was voluntary, and that participants would not be at a disadvantage if they chose not to participate or chose to withdraw from the research at any stage without reason. Also, participants were

allowed to request removal of any comment that could identify them or any other comments they wished to remove from the recordings (for the qualitative section). In order to participate, participants needed to sign and return a consent form. Finally, in order to ensure anonymity of the participants, the PhD candidate used code names to mask their real names and identities when reporting the data in research papers, conferences, as well as in this thesis.

Further, the information statement informed participants about the potential risks and benefits of participating in the research, how their privacy would be ensured and protected, and how the collected data would be used in the research. Also, participants were informed that the responses collected were anonymous, so that once submitted they could not be identified or linked to the data in any way. They were also informed that all data collected would be stored on a secure server (a password-protected computer) for a minimum of 5 years and would only be accessible to members of the research team. The information statement informed the participants that, because of the anonymous nature of the survey (the questionnaire), they would not be able to withdraw their responses after they had been submitted. Also, participants in this study provided implied consent when they clicked "Next" on the first page of the online questionnaire.

1.7 THESIS STRUCTURE

To achieve the above aims and address the research questions of this project, this thesis is organised into six chapters as illustrated in Figure 1.1. The present chapter sets the scene by offering an introduction to the field and clarifying the motivation, objectives, context, and scope, and highlighting the main research questions. It also describes the research methodologies and approaches used to investigate the research questions.

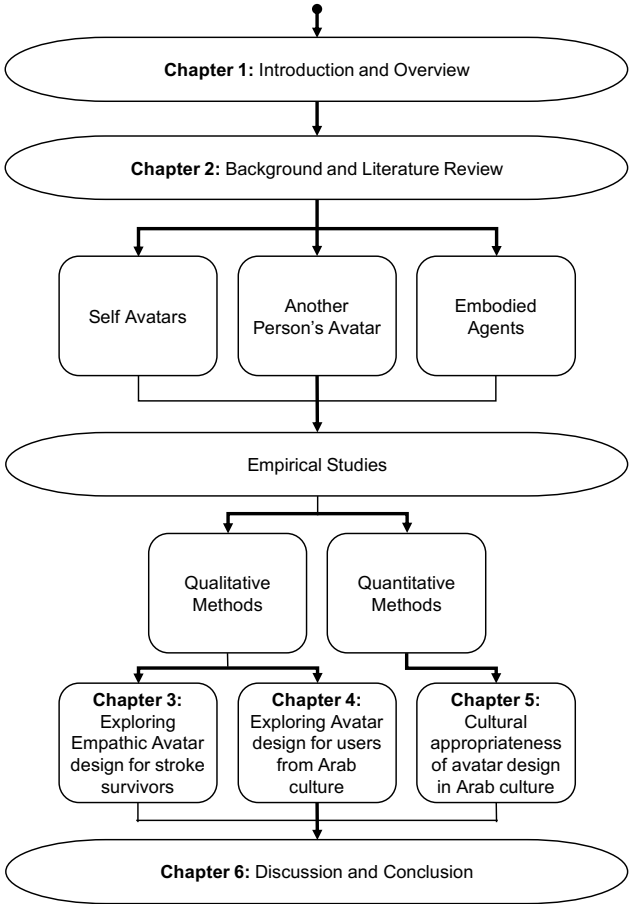


Figure 1.1 Overview of thesis structure

Next, in Chapter 2, we provide a comprehensive review of the literature on avatars and embodied agents in experimental IS research. The review provides an overview of the relevant concepts and background necessary to appreciate the work undertaken. It starts with a brief introduction to digital representations, and is followed by the fundamentals of digital representations and the established theoretical framework. Subsequently, we review some important previous research in the field of IS, ranging from employing digital representation in virtual worlds to employing them on websites. The chapter ends by identifying knowledge gaps in the current research on digital representation and sets the groundwork for the studies included in this research project.

Then, in Chapter 3, we focus on exploring the design requirements and principles for constructing empathic avatars in health applications for stroke survivors; the approach is to use a well-established behavioural change framework with a culturally neutral design. It starts with brief background information on strokes, followed by a description of problems with current stroke rehabilitation programs. It then identifies the requirements for using empathic avatars in health applications by making use of the well-established behavioural change framework developed by Michie et al. (2011). Subsequently, appropriate design principles were developed through multiple workshops with multiple stakeholders. The chapter includes information on the methods used and presents results from the data. It ends with a general discussion on the findings as well as the limitations of the study.

Further, in Chapter 4, we provide details on the qualitative study that aimed to explore Arab avatar design. It starts with the need for this study, and is followed by an overview of UI design in Arab cultures and avatar design in HCI. The chapter sets out the research model of the qualitative study, which was used as the basis for interviewing stakeholders having experience in Arab culture. It also describes design options from the previous literature and then, through the semi-structured interviews, derives design guidelines for designing avatars in Arab culture. The chapter includes details of the research methodology, and is followed by results of the thematic analysis. Discussion of findings from the interviews, and limitations of the study, appear at the end of the chapter.

Then, in Chapter 5, we provide details on evaluating the cultural appropriateness of an avatar design in an online health scenario, including details of the constructs investigated and highlighting the research question investigated. General related work is reviewed, and then details of the proposed research model and of hypothesis development are described in more detail. Information on the research methodology and participants is set out. This is then followed by the results of statistical analysis using covariance-based structural equation

modelling (CB-SEM) on the effects of the cultural appropriateness of an avatar on trust and usage intention of an Arab user. It ends with a general discussion of the findings and their implications.

Finally, in Chapter 6, we provide an overall discussion of the research project as well as a summary of the overall contributions of this research project. We highlight the main findings and discuss how the research questions were addressed. This chapter concludes by suggesting possible avenues for future research and the application contexts that need to be explored in the area of human–avatar interaction in Arab culture.

1.8 CHAPTER SUMMARY

This introductory chapter has provided a general overview of the research project that will be carried out. The context of the research and the motivation for conducting it have been outlined. Further, this chapter has also presented an overview of the research methodologies that will be used to investigate the research questions. We have discussed the potential significance and contributions of this research, followed by the ethical considerations of conducting research with human participants.

Moving forward, Chapter 2 presents the SLR method, which explores the existing relevant empirical research in the field of experimental IS research. This work describes the design concepts relating to avatars, and how humans or users interact with them or embodied agents (digital representations). The main purpose of the next chapter is to set the scene for this research and provide the necessary background information on avatars and embodied agents for readers to appreciate and understand our work.

Chapter 2: Background and Literature Review

CHAPTER 2 OVERVIEW

This chapter presents an overview of the relevant concepts and background information on users interacting with digital representations, which is necessary for readers to appreciate and understand our work. It starts with a brief introduction of digital representations, and is followed by setting out the research question investigated. Subsequently, we review important studies in IS experimental research about users interacting with avatars or embodied agents. Then, a conceptual framework is developed that captures interactions between a person, someone else, or a computer representation, the associated designs and applications, and common psychological constructs. Findings of the review are discussed, setting the scene for the research project and highlighting the implications and knowledge gaps.

2.1 INTRODUCTION

As described in the previous chapter, digital representations have been used within system interfaces to improve user engagement and interactions and prompt social responses. Also, we noted how digital representations had frequently been used in a wide range of applications (including virtual business meetings; Guegan et al., 2017) in which users interacted with digital representations on social media platforms, ecommerce websites, or mobile applications. The objective of this chapter is to provide an understanding of how users interact with digital representations and its effect on human perceptions and behaviour. Here, we set out to synthesise previously published literature. We perform a systematic review of the literature on experimental IS research involving interactions between humans and avatars (or embodied agents) to better understand the effects on human psychological constructs. We investigate the studied literature in terms of design considerations for digital representations, the implications, application areas, interaction types, environments, and the levels of embodiment of the digital representations. We then identify limitations of what is known in existing IS research. In this chapter, we outline the research method for conducting a

systematic review on how users interact with avatars or embodied agents. We discuss our findings and identify gaps that need further investigation as well as establish our research objectives.

In Section 2.2, we provide background and motivation for conducting an SLR on avatars and embodied agents and shed light on the research question we want to investigate. Then, Section 2.3 describes the literature review methodology, setting out how we developed search strings to help us find papers relevant to our review. We provide details on the inclusion and exclusion criteria used. We then outline the fundamentals of avatars and embodied agents in the context of experimental IS research and establish a conceptual (theoretical) framework of how users interact with digital representations. The framework describes, in Section 2.4, the interactions that occur when a user interacts with a digital representation or other entity (i.e., another person or a computer agent).[3] Subsequently, in Sections 2.5, 2.6, and 2.7, we summarise and present our findings on digital representations and discuss the findings in term of self-avatars, avatars, and embodied agents. In Section 2.8 we discuss findings from the SLR by giving a summary of results, the practical implications, and limitations of the SLR. Finally, we suggest directions for future research and conclude the chapter in Section 2.9 with a summary highlighting the main findings of the SLR.

2.2 BACKGROUND AND MOTIVATION

At the nexus between the digital and physical worlds, and to facilitate computer-mediated transactions, UI designers frequently employ design elements with human features to digitally represent humans or computer agents. Digital representations of human users are commonly

[3] Following the terminologies used by Ang et al. (2012), the term *avatar* refers to an avatar representing another human being in a digital interaction. Other people's avatars are sometimes referred to as *personas* in some studies (Vasalou & Joinson, 2009). Clearly, what is a self-avatar and what is an avatar depends on the perspective taken, i.e. whether the user perceives their own avatar (*self-avatar*) or whether the avatar is perceived by another user (*avatar*). In other words, the distinction between self-avatars and avatars depends mainly on the perspective.

referred to as *avatars*, while representations of computer agents are referred to as *embodied agents* (Jesse Fox et al., 2015). In IS research and practice, digital representations have successfully been employed in a wide range of applications, such as recommendation agents in e-commerce (S. Lee & Choi, 2017; Qiu & Benbasat, 2009), chat bots (Burgoon et al., 2016), tools for behavioural change (Sebastian & Richards, 2017; Song, Kim, Kwon, et al., 2013), and tutors in e-learning (Beege et al., 2017; Heidig & Clarebout, 2011).

Over the past two decades, researchers have conducted experiments to better understand users' perceptions and behaviour when interacting with avatars and embodied agents. Through experiments, researchers are able to observe, under controlled conditions, actual interactions between users and avatars or embodied agents and their responses to these interactions. Importantly, through controlled variations, experiments allow researchers to identify causal effects and see how different avatar and embodied agent designs affect outcomes (Shadish et al., 2002). This chapter gives an account of the state of the art in experimental research on human interaction with avatars and embodied agents, both in 2D as well as 3D environments. By means of the SLR, we aim to address the following overarching research question of this research project:

> **RQ1:** *What is the current body of knowledge in experimental IS research on design considerations, application contexts, behavioural outcomes, and influences on users' psychological constructs of avatars and embodied agents?*

The review covers 90 articles published in top-tier IS journals and conferences. It provides an overview of users' perceptions of avatars and embodied agents, their effects on human behaviour, and how such graphical representations can be applied in a variety of settings to facilitate computer-mediated interactions between humans, avatars, and computer agents.

The main contributions of our SLR can be summarised as follows. First, we develop a framework that covers the design parameters for avatars and embodied agents, and the various interaction types. The interaction types include a user interacting with their own avatar and a

user interacting with another user's avatar or embodied agent. Second, we identify the application domains in which avatars and embodied agents are employed. Third, we pinpoint key theories used in designing avatars and embodied agents. Fourth, we discern common design concepts and, fifth, identify methods used for investigating avatars, embodied agents, and their effect on users' perceptions and behaviour. This chapter could therefore serve as a reference point for researchers working on avatars and embodied agents, providing them with a guide to common design parameters and concepts as well as an overview of theories for understanding interactions between humans, avatars, and embodied agents. For practitioners, this review may serve as a starting point for design considerations when employing avatars and embodied agents.

2.3 METHODS

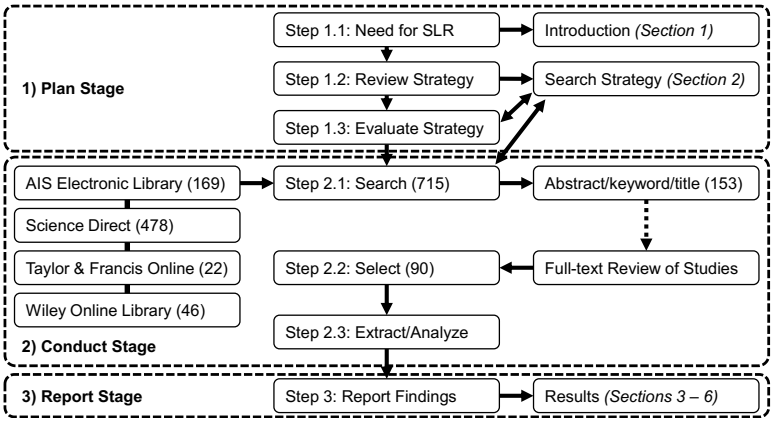
This chapter follows the methodological guidelines provided by Kitchenham & Charters (2007) for performing an SLR. We focus on studies on avatars and embodied agents conducted under controlled laboratory and field settings with human participants. The process is divided into three distinct stages: *plan*, *conduct*, and *report*, as shown in Figure 2.1. The plan stage identifies the need for an SLR, develop a review strategy, and evaluates it. During the conduct stage, we then execute the search in databases, select appropriate studies, and analyse them. Finally, we document and report findings in the report stage.

An initial exploratory search was conducted on Google Scholar using the search query "avatar" OR "virtual self" AND "experiment" as a starting point. While reviewing the obtained results, we extracted key terms used in these studies to further develop our search string. Next, we selected a well-established set of databases for conducting SLRs in the IS context (i.e., AIS Electronic Library, ScienceDirect, Taylor & Francis Online, Wiley Online Library). We then performed a full-text search on these databases using ("avatar" OR "embodied agent" OR "virtual self" OR "virtual presence") AND "experiment".

The initial search string included the term *virtual-self*, as this concept is frequently considered in research on avatars and embodied agents, and is hence in line with the research question we would like to address. After carefully screening through the results of the initial search, we extended the search string to include terms that appeared in the reviewed papers. Specifically, we included the concept of *presence* in the search string, as it represents one of the main constructs investigated in digital representations and human interactions, and the term *embodied agent* was included too, as it refers to graphical representations of computer agents and is sometimes used interchangeably with the term *avatar*. Finally, we constrained the search to include only experimental studies because such studies have the potential to reveal actual interactions between humans, avatars, and embodied agents under controlled conditions (see also the Background and Motivation section).

We included all academic journals in the category of *Information Management* (IM) in the ABS Academic Journal Guide 2015 (ABS, 2015). In addition, we included full research papers published in two top IS conferences as recognised by ACPHIS (2013).[4] In terms of selection criteria, we included only peer-reviewed papers reporting on experimental IS research with actual interactions between human participants and avatars or embodied agents. We excluded studies that 1) focused only on surveys without actual interactions between users and digital representations, 2) investigated robots rather than virtual representations, 3) included disembodied, that is, non-graphical representations, or 4) were research-in-progress.

[4] Conferences included are the International Conference on Information System (ICIS) and European Conference on Information System (ECIS). These two conferences were selected as they are ranked A by IFIP (2015).



Distribution of Studies	#
Basket of Eight (i.e., EJIS, ISJ, ISR, JAIS, JIT, JMIS, JSIS, MISQ)	6
Top IS Conferences (i.e., ECIS, ICIS)	4
Other IS Outlets in ABS Ranking (e.g., CHB, DSS, ESwA, IJEC, IJHCS, I&M, I&O, IT&P, JCMC)	80
Σ	90

Figure 2.1 Stages of the SLR (left) and the distribution of studies (right)

We used the defined search string and searched the title, abstract, and keyword section of studies in the selected databases. This search resulted in 715 hits (see the conduct stage in Figure 2.2), of which 625 were journal publications and 90 were conference publications. Then, the PhD candidate and one of the supervisors independently screened the title, abstract, and keywords against the research question and the selection criteria to identify relevant papers. The agreement between the two researchers was 95% (679 out of 715 papers). Discrepancies were resolved by discussion with a member of the research team involved in the project (36 papers; 15 included and 21 excluded). As a next step, the PhD candidate performed a full text review on the studies, resulting in 90 research papers (86 from journals, 4 from conferences). This step also involved identifying and eliminating papers (duplicates) that appeared multiple times across the databases. Table C1 in Appendix C provides an overview of all included studies, providing information on the specific type of interaction, dimensionality, application contexts, investigated psychological constructs of the users, environments (laboratory or field experiment or a combination), and sample size.

2.4 CONCEPTUAL FRAMEWORK

According to Representation Theory (RT), the fundamental purpose of an IS is to provide users with a faithful representation of some real-world phenomenon (Recker et al., 2019). The main tenets of RT are that IS will 1) be employed if they provide users with a more *cost-*

effective way to obtain knowledge about a focal real-world phenomenon than observing it directly, and 2) yield higher usefulness if the phenomena are represented more *faithfully*. Common examples for the application of RT include data modelling, object-oriented modelling, and process modelling (Burton-Jones et al., 2017; Recker et al., 2019). Similar notions can be applied when it comes to avatar design: an avatar provides a digital representation of a person in the real-world, while an embodied agent represents a computer agent. Employing these representations can increase *cost-effectiveness*, e.g., in the provision of health and education services over a distance and/or to a large audience (Beege et al., 2017; Heidig & Clarebout, 2011; Noorbergen et al., 2019); it may also increase *faithfulness* of the representation, as avatars usually have human features that capture the naturalness of interpersonal encounters in the real world (Nowak & Rauh, 2006).

In this chapter, we distinguish two perspectives on human interactions with avatars, namely *self* and *other*. The "self" perspective refers to a user's interaction with their own avatar, often involving facial and body features, gestures, sound, or other forms of behaviour and expression. Following this perspective, the avatar is referred to as a self-avatar (Vasalou & Joinson, 2009). The "other" perspective refers to a user's view on other humans (computer agents) represented by avatars (embodied agents).

Through their self-avatars, users may directly or indirectly engage with others. Based on the different spheres and levels of interactions, we develop a conceptual framework that differentiates between five different interaction types, as shown in Figure 2.2. From the figure, we see that interactions with avatars can be distinguished as *human to self-avatar* (H2SA)*, human to avatar* (H2A)*,* and *self-avatar to avatar* (SA2A). Similarly, humans may interact with embodied agents directly (*human to embodied-agent,* H2EA) or through their avatars (*self-avatar to embodied-agent,* SA2EA). Among the 90 reviewed studies, a majority considered SA2A (34), followed by H2A (21), H2EA (20), H2SA (17), and SA2EA (8)

interactions. Note that here the total adds up to more than 90 because some studies investigated more than one interaction type. The framework captures commonly examined psychological constructs and specific interaction types. Table 2.1 provides definitions of the psychological constructs that appear in the framework and their usage in different types of interactions.

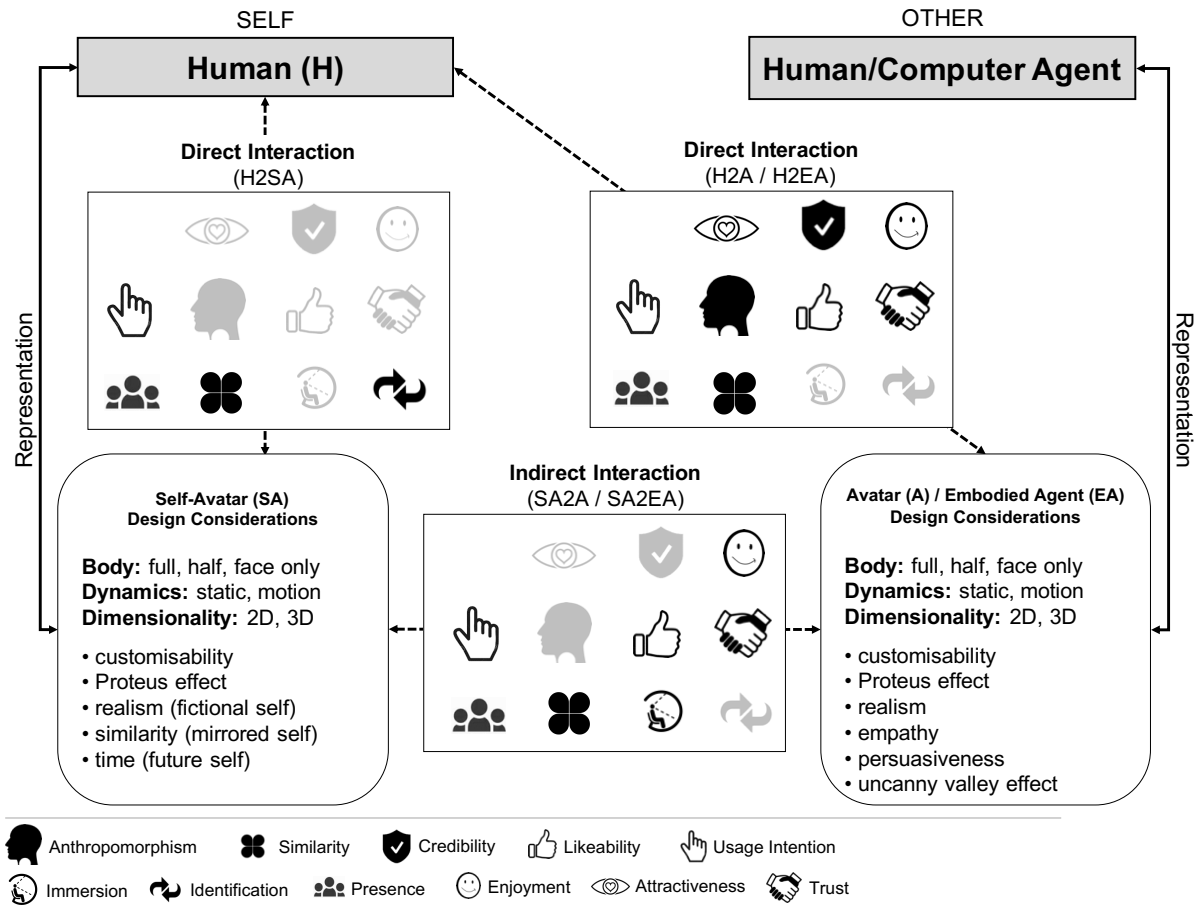


Figure 2.2 Conceptual framework of digital representations and their interactions

Note: All icons have been sourced from SVG Silh and Pixabay (https://svgsilh.com & https://pixabay.com; Creative Commons CC0 1.0). The greyed-out icons are not considered in the respective interaction type. For readability, only constructs that are used by at least two studies are shown. Realism includes behavioural, emotional, or visual realism. The complete list of constructs can be found in Table C1 of Appendix C.

Table 2.1 Definitions of constructs and their usage in different interaction types

Constructs	Description	Usage
Anthropomorphism	The degree of humanness of the digital representation as perceived by the user	**H2A:** Nowak et al. (2015); Nowak & Rauh (2006, 2008) **H2EA:** Y. Kim & Sundar (2012a); Krämer et al. (2013)
Attractiveness	The degree of attractiveness of the digital representation as perceived by the user	**H2A:** Keng & Liu (2013); Leding et al. (2015); Nowak et al. (2015); Nowak & Rauh (2006); Westerman et al. (2015) **H2EA:** Burgoon et al. (2016)
Credibility	The degree to which the digital representation is perceived as believable	**H2A:** Nowak et al. (2015); Nowak & Rauh (2006, 2008) **H2EA:** Y. Kim & Sundar (2012a)
Enjoyment	The degree to which the user enjoys the interaction with the digital representation	**H2A:** Li & Lwin (2016); Rodrigues et al. (2016) **H2EA:** S. Lee & Choi (2017); Qiu & Benbasat (2009, 2010) **SA2A:** Guadagno et al. (2011); Song Kim, Kwon, et al. (2013) **SA2EA:** Guadagno et al. (2011); Jin (2010)
Identification	The degree to which a user identifies themselves with the digital representation	**H2SA:** Seo et al. (2017); Song, Kim, Kwon, et al. (2013)
Immersion	The degree to which a user feels immersed in the virtual environment during the interaction with the digital representation	**SA2A:** Gerhard et al., (2004); Goel et al. (2013); Grinberg et al. (2014) **SA2EA:** Gerhard et al. (2004)
Intention to use	The user's intention to use the digital representation	**H2A:** Y. Lee et al. (2009); Nowak & Rauh (2006); Rodrigues et al. (2016); Westerman et al. (2015) **H2EA:** Gong (2007); S. Lee & Choi (2017); Qiu & Benbasat (2009, 2010) **H2SA:** Fox et al. (2013); Suh et al. (2011) **SA2A:** Fox et al. (2013); Galanxhi & Nah (2007); Lester & King (2009)
Likeability	The degree to which the user likes the digital representation	**H2A:** Bacev-Giles & Haji (2017) **H2EA:** Brave et al. (2005); Gong (2007); Groom et al. (2009); Kang & Gratch (2014); Nunamaker et al. (2011) **SA2A:** Ang et al. (2013); Guadagno et al. (2011); Hanus & Fox (2015) **SA2EA:** Guadagno et al. (2011)
Presence	The degree to which a user feels present in the virtual environment with the digital representation	**H2A:** (Kang & Watt, 2013; Y. Lee et al., 2009; Li & Lwin, 2016; Rodrigues et al., 2016) **H2EA:** Kang & Gratch (2014); Y. Kim & Sundar (2012a); Qiu & Benbasat (2009, 2010) **H2SA:** Fox et al. (2013); Seo et al. (2017); Won et al. (2015) **SA2A:** Felnhofer et al. (2018, 2014); Fox et al. (2013); Franceschi et al. (2009); Gerhard et al. (2004); Grinberg et al. (2014); Guadagno et al. (2011); Guegan et al. (2017); Hammick & Lee (2014); Jin (2012); Kohonen-aho & Tiilikainen (2017); Ratan & Sah (2015); Sutcliffe & Alrayes (2012); Wu et al. (2015) **SA2EA:** Felnhofer et al. (2018); Gerhard et al. (2004); Guadagno et al. (2011); Kohonen-aho & Tiilikainen (2017)
Similarity	The degree to which the user perceives that the digital representation is similar to them	**H2A:** Bacev-Giles & Haji (2017); J. Kim (2011); Nowak & Rauh (2006); Wrzesien et al. (2015) **H2EA:** Beege et al. (2017; Tamborini et al. (2018) **H2SA:** Seo et al. (2017); Suh et al. (2011); Vasalou & Joinson (2009); Wrzesien et al. (2015) **SA2A:** Dolgov et al. (2014); Fehrenbacher & Weisner (2017); Guegan et al. (2016); H.-K. Kim & Kim (2016); J. Kim (2009); J. Kim & Park (2011); Martens et al. (2018); Spence et al. (2013); Westerman et al. (2015)
Trust	The degree to which the digital representation is considered trustworthy by the user	**H2A:** Balas & Pacella (2017); Nowak et al. (2015) **H2EA:** Brave et al. (2005); Gong (2007); Nunamaker et al. (2011); Qiu & Benbasat (2009); Riedl et al. (2011, 2014); Tamborini et al. (2018) **SA2A:** Ang et al. (2013); Fehrenbacher & Weisner (2017); Galanxhi & Nah (2007); Guadagno et al. (2011); Jin (2012) **SA2EA:** Guadagno et al. (2011)

2.4.1 Avatars

Previous research has studied generic avatars (e.g., Franceschi et al., 2009), customised avatars (e.g., Nowak et al., 2015), or a combination of both (e.g., Suh et al., 2011). Generic avatars are pre-created with some characteristics such as gender, but cannot be customised by users (Dolgov et al., 2014; Ratan & Sah, 2015). Customised avatars, in contrast, allow users to make deliberate choices on appearance (Guegan et al., 2016).

In H2SA interaction, a user controls the movement and/or appearance of their self-avatar by some controlling device (Pessoa et al., 2014). Note that H2SA does not necessarily involve other users' avatars. Here, the interaction between the user and their self-avatar often only expresses the user's inputs through the avatar (Won et al., 2015). In H2A interactions, users interact with others' avatars. They may, for instance, observe the avatar's appearance and behaviour and implicitly evaluate the entity behind it (Nowak & Rauh, 2008). In SA2A interaction, human users control their respective avatars to interact with others through them (e.g., Sutcliffe & Alrayes, 2012). Typical purposes are collaborations and meetings in business contexts (Guegan et al., 2017; Huang et al., 2010), collaborative problem-solving (Guegan et al., 2016), or multi-person entertainment (Dolgov et al., 2014; Martens et al., 2018).

2.4.2 Embodied Agents

Embodiment refers to the visual representation of an abstract idea, a thing, or a person (Taylor, 2002). An embodied agent, in this sense, describes "a perceptible digital representation whose behaviours reflect a computational algorithm designed to accomplish a specific goal or set of goals" (Bailenson & Blascovich, 2004, p. 64). The majority of the reviewed studies investigated embodied agents that exhibited at least some human-like features. In this context, anthropomorphism refers to the degree of humanness of embodied agents, that is, "the extent to which an image is perceived to resemble human characteristics and has human morphology" (Nowak & Rauh, 2006, p. 154). Exemplary applications include

the provision of information (Carlotto & Jaques, 2016), product recommendations in e-commerce (Qiu & Benbasat, 2009), or screening interviews (e.g., Nunamaker et al., 2011). In SA2EA interaction, a user controls an avatar and interacts with an embodied agent through their avatar. Common examples can be found in automated business processes such as job interviews or information delivery (Y. Kim & Sundar, 2012b).

2.4.3 Artefact Design

For digital representations of humans, A. Davis et al. (2009) identified three main factors that affect people's perception of self-avatars and others' avatars. These are 1) avatar appearance, 2) perceived presence (i.e., the sense of being in an environment with another person) (Steuer, 1992; Won et al., 2015), and 3) immersion (i.e., users' perception of interacting with the virtual environment rather than their own physical environment) (Guadagno et al., 2007). These factors are inherently different to those in the human perception of embodied agents.

Our conceptual framework provides an overview of the different forms of appearances employed in the reviewed studies. It considers the dimensionality in which the interaction takes place (i.e., 2D and/or 3D), the dynamics of the visual interaction (i.e., static, motion), and the overall level of embodiment (i.e., face only, half body, full body). Furthermore, the framework lists a number of design considerations for the different types of digital representations that will be further explored in subsequent sections. Table 2.2 summarises the artefact design that has been considered for different interaction types.

Table 2.2 Artefact design for different interaction types

Artefact Design		Interaction Type					**Total**
		H2SA	SA2A	SA2EA	H2A	H2EA	
Body	Full	15	30	8	6	7	**66**
	Half	0	0	0	5	7	**12**
	Face only	2	4	0	6	6	**18**
Dynamics	Static	3	4	0	12	5	**24**
	Motion	14	30	8	6	15	**73**
Dimensionality	2D	2	6	0	10	9	**27**
	3D	16	31	8	8	12	**75**
Total		**52**	**105**	**24**	**53**	**61**	

Note: Numbers here refer to the number of studies for the respective artefact design and interaction type. The total number adds up to more than 90 because some studies investigated more than one interaction type or artefact design.

One important aspect in this regard is *customisation* (e.g., Guadagno et al. 2011; Nowak & Rauh, 2008). Customisability refers to the possibility of designing or modifying an avatar's appearance (Behm-Morawitz, 2013), that is, the degree "to which [it] can be created, selected, or changed to comply with user preferences" (Teng, 2010, p. 1549). In 36 out of the 90 reviewed studies, researchers allowed participants to customise their self-avatars with personalised features (e.g., see Vasalou & Joinson, 2009). In other experimental settings, the degree of visual realism of an avatar was controlled to achieve specific interactional outcomes, for instance, to increase an avatar's credibility (e.g., Nowak & Rauh, 2006). Here, self-avatars may depict photorealistic, fictional, or supernatural characters (Vasalou & Joinson, 2009).

2.4.4 Presence and Immersion

One central concept for understanding avatars and embodied agents is *presence*. In our framework, it represents one of the most frequently-investigated constructs. Digital interaction is generally considered an unnatural way of human communication, as the interaction partners are separated physically (Carter et al., 2015; Grudin, 2001). However, avatars can be used to establish presence anyway (Kang & Watt, 2013), that is, user A's sense of being in an environment with user B, where users are digitally represented across space or time, and react to each other or to stimuli (Heeter, 1992; Steuer, 1992; Won et al., 2015). There are different concepts of presence, which include individual, physical, social, co-, tele-, and virtual presence (see Franceschi et al. (2009) and Nowak & Biocca (2003) for details).

Closely related to presence, *immersion* refers to the degree to which users experience being within a virtual environment rather than being in their actual physical environment (Guadagno et al., 2007). Realistic environments yield higher presence, which in turn lead to higher immersion (Guadagno et al., 2007; Jin, 2012). In gaming, for example, Teng (2010)

found that higher immersion enhances user loyalty to the game. Immersed users can also be more socially engaged (Grinberg et al., 2014).[5]

2.4.5 Experimental Research on Avatars and Embodied Agents

Laboratory and field experiments are employed to investigate human behaviour when interacting with avatars and embodied agents. In fact, the majority of experimental studies in the field of IS involving avatars or embodied agents have been conducted in laboratory settings, where researchers are able to tightly control environmental parameters, mitigate confounding effects, and thus establish causality between system design and human perceptions, physiology, and behaviour. In the SLR, for example, as many as 84 studies were conducted in laboratory environments, while only 5 studies were conducted in the field and 1 based on both laboratory and field experiments (Figure 2.3). The 6 studies that conducted field experiments controlled different aspects of real-world settings. These included customers of an electronic banking application (Rodrigues et al., 2016), self-tracking of physical activities in users' everyday environments (Sanchez-Valdes & Trivino, 2015), airport security screenings (Nunamaker et al., 2011), and students' performance, engagement, and presence in an online course (Barata et al., 2017; Franceschi et al., 2009; Lester & King, 2009).

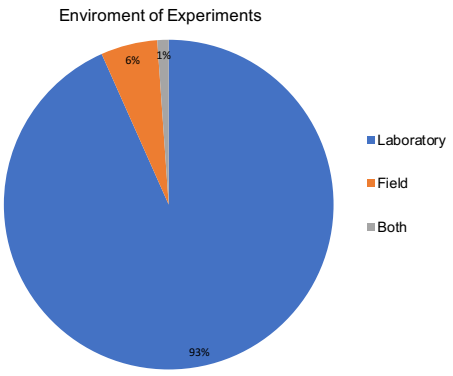


Figure 2.3 Distribution of laboratory and field experiments

[5] Importantly, the use of avatars can also increase involvement and trust between users behind the avatars. The outlined concepts of presence and immersion are central to research on avatars, and these notions will repeatedly be referred to in subsequent sections.

2.4.6 Application Contexts

Avatars and embodied agents have become widely used as design elements in IS research. By providing a graphical representation of humans and computer agents, they have been shown to create positive user experience (e.g., usability, collaboration), support learning processes (e.g., performance, engagement), and facilitate behavioural intention (e.g., physical activity, usage intention, purchase intention) in a wide range of applications. Based on the studies we reviewed, the application contexts include business, education, entertainment, health, and social interaction. Table 2.3 summarises the number of studies for each application context and interaction type.

Table 2.3 Application contexts for different interaction types

	Interaction Type					
Context	H2SA	SA2A	SA2EA	H2A	H2EA	**Total**
Business	1	6	1	6	8	**22**
Education	3	5	0	1	1	**10**
Entertainment	6	8	1	1	5	**21**
Health	2	0	2	1	1	**6**
Social	5	15	4	9	3	**36**
Total	**17**	**34**	**8**	**18**	**18**	

Note: Numbers here refer to the number of studies for the respective context and interaction type. The total number adds up to more than 90 because some studies investigated more than one interaction type.

2.5 INTERACTION WITH SELF-AVATARS

In this section, we specifically present and discuss findings on users interacting with their (own) self-avatars. Here, we present design concepts and dimensions of self-avatars that were considered in the reviewed studies. We then highlight the effects of users interacting with their self-avatars. The discussion is centred around the different design concepts that users may employ including future, fictional, mirrored, and ideal self. In addition, we discuss how such design considerations could play a role in affecting users' perceptions and behaviour in interacting with their (own) self-avatars when the avatars have been designed based on different concepts. In the following subsections, we discuss these results in more detail.

2.5.1 Self-Avatar Concepts

Digital environments allow users to interact and communicate in ways that go beyond those of traditional channels (Goel et al., 2013; Hämäläinen et al., 2008; Mccreery et al., 2012). To do so, they need to conveniently represent themselves (Mallan, 2009). Self-avatars function as tools for representation, immersion, and interaction with others in virtual worlds (Ducheneaut et al., 2009; Koles & Nagy, 2012). This section synthesises the results of studies on how a user interacts with their own avatar, covering the design dimensions of *customisability*, *realism*, and *time*, as well as the avatar's effects on user perceptions and behaviour. Overall, 11 studies (13% of our SLR) considered H2SA interactions in different contexts such as health (H. E. Kim et al., 2017; Sanchez-Valdes & Trivino, 2015), business and entertainment (Kaye et al., 2018; Peña & Chen, 2017; Won et al., 2015), and education and social interaction (Seo et al., 2017; Song, Kim, Kwon, et al., 2013; Vasalou et al., 2008; Vasalou & Joinson, 2009).

For the dimension of time, some avatar concepts refer to a *future* state of the represented person (Song, Kim, Kwon, et al., 2013), while avatars in a *now* state refer to the current or currently desired state. A special case of future self-avatars is the idealistic representation: based on the *self-idealism paradigm*, an ideal self refers to what the user *aims* to become in the future and may include aspects of education, socialisation, role models, societal norms, and preferences (Dunn & Guadagno, 2012).

For the dimension of realism, there are *mirrored* and *fictional* representations (e.g., Peña et al., 2016; Suh et al., 2011; Vasalou & Joinson, 2009). The concept of a *mirrored self* refers to self-avatars that resemble the actual person as much as possible (Vasalou et al., 2008), which may include mirrored behaviours and gestures, representing aspects of the user in the real world (Burton-Jones et al., 2017; Recker et al., 2019). It can be seen as a simulated, mirrored version of the self, perhaps reflective of the offline self, as well as having the

potential to affect the individual in meaningful ways. For example, previous research has demonstrated that avatars that show the consequences of smoking by means of altered physical appearance are capable of creating a sense of the risks associated with smoking (Song, Kim, Kwon, et al., 2013).

The concept of *fictional self,* in contrast, represents the user as a fictional, possibly fantastic character. Users may represent themselves as fictional characters to escape from their actual selves (Greenwood, 2008) or to gain new perspectives, experiences, and knowledge (Shedlosky-Shoemaker et al., 2014). For example, a user may hide their identity and use an authoritative or persuasive avatar for a new role.

2.5.2 Influences on User Perceptions and Behaviour

While much research considers how one user's avatar affects other users, *a user's (self-) avatar can also affect their own perceptions and behaviours* in the virtual environment and in the real world (Yee et al., 2009). This phenomenon is known as the *Proteus effect* (Yee & Bailenson, 2007). The effect is based in self-perception theory (Yee et al., 2009), positing that there will be modifications in self-perception based on the behaviour and/or characteristics of a user's avatar (Fox et al., 2013). For instance, users may adopt new behaviours (desirable or undesirable) from their self-avatars (Luppicini, 2012; Seo et al., 2017), and exhibit increased confidence and willingness to disclose information when being represented by attractive self-avatars (Yee & Bailenson, 2007). Similarly, users are found to exhibit increased physical activity when represented by an athletic instead of an obese self-avatar (Peña & Kim, 2014). To understand the Proteus effect, it is important to consider how the characteristics of a user's avatar specifically affect behaviour. Relevant mediating constructs in this regard include 1) self-relevance, 2) self-identification, 3) emotional attachment, 4) presence, and 5) anthropomorphism (Behm-Morawitz, 2013; Jin, 2012;

Nowak & Rauh, 2006; Pessoa et al., 2014; Ratan & Dawson, 2016; Seo et al., 2017; Song, Kim, Kwon, et al., 2013; Vasalou et al., 2008).

Self-relevance describes "the extent to which the user of a mediated representation that appears and/or behaves like the user is closely connected to the self" (Ratan & Dawson, 2016, p. 3). *Self-identification* refers to "the cognitive connection between an individual and an avatar, with the result being that the individual regards the avatar as a substitute self or has such an illusion" (Suh et al., 2011, p. 715). Both concepts capture how users identify and relate to their digital representation. Importantly, customisability increases self-identification and self-relevance (R. Bailey et al., 2009; Lim & Reeves, 2010). In turn, self-identification and self-relevance are found to increase emotional attachment with the avatar (Suh et al., 2011). Also, users pay more attention and feel physically more similar to self-avatars when these avatars reflect them visually as compared to avatars that reflect others (including celebrities, ideal faces, or strangers) (Seo et al., 2017).

Next, *emotional attachment* describes "an emotion-laden, target-specific bond between a person and a specific object" (Thomson et al., 2005, p. 77). Higher degrees of self-relevance and self-identification typically yield stronger emotions when interacting with the environment through one's avatar (Ratan & Dawson, 2016; Ravaja et al., 2006). In addition, users who customise their self-avatar also experience greater emotional attachment to it – which, in turn, increases the avatar's power to affect their behaviour (H.-K. Kim & Kim, 2016). Emotional attachment with one's avatar also increases perceived *presence* in the virtual environment, which can be defined as the state in which "users experience their virtual self as if it were their actual self, perhaps even leading to an awareness of themselves inside the virtual environment" (Tamborini & Skalski, 2006, p. 227). Also, it has been shown that self-avatars can stimulate presence for blind users, helping them to explore environments

virtually and identifying objects in virtual space before visiting the actual site (Cobo et al., 2017).

Anthropomorphism captures how a human-like avatar appears, including naturalness and richness with regards to typical human cues (Nowak & Rauh, 2006). In the context of self-avatars, it has been shown that this factor increases users' emotional attachment and their perceptions of the avatar's credibility (Nowak & Rauh, 2006). Evil-looking and corpse-like avatars, on the other hand, negatively affect users' perception of engagement and behaviour when contrasted with heroic and attractive avatars (Peña & Chen, 2017).

2.6 INTERACTION WITH ANOTHER PERSON'S AVATAR

This section presents findings on a user interacting with another person's avatar. Here, we present and discuss avatar design concepts that were considered in the reviewed studies. The concepts include persuasive and emotional design. We then highlight the effects of interacting with another person's avatar on a user's perceptions and behaviour. We will discuss the results in more detail in the subsequent sections.

2.6.1 Avatar Concepts

In this section, we explore how users interact with other users represented by avatars. Overall, 22 of the reviewed studies (26%) considered H2A interactions, that is, the direct interaction of a user with another user's avatar. Moreover, 28 studies (33%) considered SA2A interactions, that is, interactions between avatars. The studies come from various contexts such as entertainment (e.g., Dolgov et al., 2014; Dunn & Guadagno, 2012; Goel et al., 2013; Martens et al., 2018), education (e.g., Ang et al., 2013; Franceschi et al., 2009; H. E. Kim et al., 2017; Lester & King, 2009; Sutcliffe & Alrayes, 2012), business (e.g., Hanus & Fox, 2015; Nowak et al., 2015), health (e.g., Spence et al., 2013), and social interaction (e.g., Jin, 2012; Kohonen-aho & Tiilikainen, 2017; Wu et al., 2015).

Previous research has suggested two marked goal-directed dimensions of avatar design, namely *persuasiveness* and *empathy/emotionality*. Persuasive avatars, also referred to as authoritative avatars (Beale & Creed, 2009), are avatars designed to affect users' choices (Bengtsson et al., 1999; Hanus & Fox, 2015). One way to achieve persuasiveness is to give users the ability to customise the avatar before the interaction (Hanus & Fox, 2015). For instance, an avatar may be customised to represent a doctor with high authority in the medical field (Peña et al., 2009). In contrast, the concept of empathic/emotional avatars refers to avatars designed with non-verbal cues and behaviours such as smiling, which can create an emotional connection with the user (H.-K. Kim & Kim, 2016). Felnhofer et al. (2018) found that users interacting with avatars that are controlled by other users reported higher levels of empathy and involvement than users interacting with embodied agents.

2.6.2 Influences on User Perceptions and Behaviours

How an avatar is perceived by its interaction partner(s) is crucial for how it affects their behaviours. First, avatars of high anthropomorphism are perceived as more credible by their interaction partners (Nowak & Rauh, 2008) and can improve communication (Kang & Watt, 2013; Khashe et al., 2017). Visually realistic avatars are found to have a higher capacity to mitigate undesired behaviour and facilitate desired behaviour than unrealistic ones (Nowak et al., 2015), e.g., promoting compliance (Khashe et al., 2017). In this vein, Kang & Watt (2013) found that more visually realistic avatars elicited higher levels of immersion, presence, and trust, which enriches interaction between users and creates more truthful interactions (Hooi & Cho, 2013; Sutcliffe & Alrayes, 2012) and increases a user's intention to work together to achieve a common goal (Lim & Reeves, 2010). Ang et al. (2013) found that perceived trust and likeability increased if an avatar exhibited human-like behaviour. Thus, conveying perceptions of presence and trust, visually realistic avatars typically have a stronger impact on user behaviour (Khashe et al., 2017). H. E. Kim et al. (2017) found that

avatar-based training can lower anxiety and facilitate interpersonal encounters for patients with social anxiety.

Second, similarity refers to the perceived degree of psychological and/or physiological resemblance between a user and their interaction partner's avatar, including visual appearance, demographic factors, values, beliefs, behaviours, education, training, or knowledge (McCroskey et al., 1975; Nowak & Rauh, 2006). Higher similarity yields stronger perceptions of group belonging and virtual team identification (Guegan et al., 2017; J. Kim & Park, 2011; Midha & Nandedkar, 2012), playing an important role in interaction effectiveness (McCroskey et al., 1975; Webster & Wong, 2008). Guegan et al. (2017) and Wrzesien et al. (2015) also noted that a similarity between avatars and users impacts social behaviours and group structuring. Bailenson et al. (2006) pointed out that users tend to find others who are physically and psychologically similar to themselves more attractive and more persuasive. However, this perception of similarity and presence depends on a user's sense of shared context with other users (Kohonen-aho & Tiilikainen, 2017). Users pay more attention within a virtual environment when avatars reflect their own gender (Martens et al., 2018). Users represented by foreign avatars are perceived as not similar to them and are considered as out-group members, and hence excluded from the group (Schneider et al., 2017). Moreover, the perception of similarity is not limited to gender and physical appearance, but is also related to ethnicity and culture. For example, Spence et al. (2013) found that avatars that reflect a user's ethnicity are associated with an increased usage intention compared to avatars that do not.

Third, beyond realism and similarity, Leding et al. (2015) showed that avatars with high perceived attractiveness exert strong influences on human behaviour. In this regard, Westerman et al. (2015) found that users are more inclined to interact with physically attractive rather than unattractive avatars. For online social interaction, Bacev-Giles & Haji

(2017) found that users rated avatars as more attractive and likeable if the avatars were perceived as similar to them. For online advertisements, Keng & Liu (2013) found that using dynamic, attractive, and 3D avatars (as compared to static, unattractive, or 2D avatars) increased advertisement effectiveness. Moreover, Guadagno et al. (2011) found that a smile can create a sense of connection and increase trust between the interaction partners, provide enjoyment, and increase satisfaction. However, when avatars are compared to real human images directly, Balas & Pacella (2017) found that users rated avatars less trustworthy. Also, people would refuse to share knowledge with a colleague represented by an avatar (Fehrenbacher & Weisner, 2017). Fabri et al. (2005) found that the use of emotional (as compared to non-emotional) avatars increased user involvement in social communication tasks.

Fourth, users are more likely to be persuaded if an avatar exhibits an angry (rather than soft) and/or male (rather than female) voice (Lehto & Oinas-Kukkonen, 2011). In a recent study (Khashe et al., 2017), it was found that users were more easily persuaded when a message was communicated by avatars rather than by voice or text. In this regard, androgyny refers to "a rating of the avatar's (lack of) masculinity or femininity" (Nowak & Rauh, 2006, p. 154), affecting several perceptual and behavioural measures. For example, high avatar androgyny is found to reduce the user's credibility in the avatar (Nowak & Rauh, 2008). Similarly, inappropriately dressed avatars are rated as less anthropomorphic and less credible (Nowak et al., 2015).

Finally, uniqueness indicates that an avatar is different from other digital representations. Uniqueness of avatars, such as unusual physical features, or social or psychological differences, can impair interaction effectiveness (Kang & Watt, 2013; J. Kim, 2009). J. Kim (2011) stated that users represented by avatars with visual cues similar to those of their group

members engender a higher level of threat to their uniqueness, compared to those represented by avatars with unique visual cues, leading to lower rates of agreement with others.

2.7 INTERACTION WITH EMBODIED AGENTS

This section specifically presents and discusses findings on a user interacting directly or indirectly with an embodied agent. Here, we present design concepts and considerations of embodied agents that have been considered in the reviewed studies. We then provide detail on the *realism* design dimension and how this can play a role in affecting users' perceptions and behaviour. The realism design concept includes behavioural, visual, and emotional realisms. This effect will be discussed in terms of the uncanny 'valley effect'. We will discuss the results of embodied agents in more detail in subsequent sections.

2.7.1 Embodied Agent Concepts

In this section, we focus on embodied agents and their effects on interaction partners. Overall, 19 of the reviewed studies (23%) considered H2EA interactions and 4 (5%) considered SA2EA interactions. The studies are of multiple contexts such as business (e.g., S. Lee & Choi, 2017; Nunamaker et al., 2011; Qiu & Benbasat, 2009), entertainment (e.g., Brave et al. 2005; Mousas et al. 2018; Peña et al. 2016), education (e.g., Ang et al., 2013; Carlotto & Jaques, 2016), health (e.g., Beege et al., 2017; Jin, 2010; Y. Kim & Sundar, 2012b), and social interaction (e.g., Dechant et al., 2017; Kang & Gratch, 2014; Krämer et al., 2013).

The *CASA* paradigm posits that humans apply social rules and norms when interacting with computers (Bailenson & Blascovich, 2004; Nass et al., 1994). Specifically, visually and behaviourally realistic embodied agents yield higher engagement and involvement between interaction partners (Burgoon et al., 2016; Gerhard et al., 2004). Hence, much of the existing literature on embodied agents is centred around different forms of agent realism, where the differences between human, behavioural, visual, and emotional realism are distinguished.

Previous research has also suggested different design considerations for embodied agents in terms of 1) realism and 2) persuasive and empathic design.

2.7.2 Realism

First, *human* realism of embodied agents refers to behavioural, visual, and emotional characteristics (e.g., face or voice) of embodied agents that is consistent with human characteristics (Mitchell et al., 2011). It represents an important factor for humans as they are more likely to interact with human-like than non-human-like embodied agents (Groom et al., 2009; Parise et al., 1999). In this sense, higher human realism may contribute to a higher degree of faithfulness of the digital representation, as it more closely resembles interpersonal interactions in the real world.

Second, *behavioural* realism refers to the presence of natural movements, gestures, and reactions of embodied agents (von der Pütten et al., 2010). Manipulation of behavioural realism was found to influence human and avatar responses (Bailenson et al., 2005; Slater et al., 2009), where higher levels of behavioural realism lead to more likeable and trustworthy embodied agents (Groom et al., 2009). High levels of behavioural realism are usually considered more appropriate in terms of social behaviour and responses (Guadagno et al., 2007; Nass & Moon, 2000). Embodied agents equipped with realistic motion and physical appearance have greater influence than static or remoted embodied agents, as they stimulate genuine social interactions (Mousas et al., 2018).

Third, *visual* realism refers to "the degree to which the images of the simulated world are perceived to be real" (C. Lee et al., 2013, p. 548). According to Slater, Pérez Marcos, Ehrsson, & Sanchez-Vives (2009) Slater et al. (2009), visual realism has two components. First, geometric realism captures whether the digital representation looks like the real object that it represents. Second, illumination realism refers to the fidelity of lighting (Mel Slater et

al., 2009; Strauss, 1990). Notably, visually detailed embodied agents are found to create a better sense of social presence (Kwon et al., 2013).

Fourth, *emotional* realism refers to the expression of emotions similar to those of humans (Beale & Creed, 2009). Emotion expression entails the ability to establish empathy between the embodied agent and the user (H. Ahn et al., 2007). In e-learning, for instance, embodied agents with realistic emotional expression can enhance learning experiences and outcomes (Dickey, 2005). As Beale & Creed (2009) discussed, the importance of emotional consistency in embodied agents and appropriateness to the context can enhance the overall interaction.

2.7.3 Persuasive and Empathic Embodied Agents

Human-like embodied agents (e.g., a salesperson; Hanus & Fox, 2015) can be more persuasive when compared to using text or voice in the context of e-commerce (Qiu & Benbasat, 2010). Importantly, embodied agents that have human features are more likely to be viewed as authoritative and persuasive by their interaction partners (Qiu & Benbasat, 2009). For example, Bailenson & Yee (2005) found that embodied agents with high behavioural realism, which mimicked user gestures were more persuasive and likeable than agents without this feature. In the context of health, however, Sebastian & Richards (2017) found that embodied agents representing doctors are not more persuasive than actual medical doctors for mental health patients.

Empathic embodied agents display emotions, which can influence users by increasing likeability and trustworthiness (Brave et al., 2005). For education, Maldonado et al. (2005) found that emotional embodied agents positively enhanced students' performance, experience, and perceptions of the embodied agents' intelligence and credibility. Beege et al. (2017) noted that the embodied agent's age was irrelevant when activated alongside text. Additionally, Bickmore & Picard (2005) found that embodied agents equipped with a range of non-verbal behaviours (e.g., hand gestures, nod, eye gaze) increased the connection

between a user and an embodied agent, which led to greater likeability and trust. Importantly, users perceived empathic embodied agents as more caring, sociable, likeable, and trustworthy, and they reported significantly higher levels of support when an embodied agent created the *feeling* of an actual partner during the interaction (Brave et al., 2005; S. Lee & Choi, 2017).

2.7.4 The Uncanny Valley

While human realism is important, all too realistic embodied agents bear the risk of making people feel uncomfortable and often result in negative reactions (Burgoon et al., 2016; Mara & Appel, 2015). This effect is known as the "uncanny valley", which, according to MacDorman & Ishiguro (2006) and Mori (1970), refers to human-like digital representations that appear almost, but not exactly like real human beings and consequently stimulate feelings of eeriness and revulsion. Since people usually *know* that the displayed entity is artificial (regardless of whether it represents a human or not), and is not a video of an actual human being, interaction design should keep a safe distance from realism in order to avoid the uncanny valley effect. In this sense, designers may employ a stylised or "comic-like" representation with empathic features (Teubner et al., 2014)

It is also essential to ensure a balance between the appearance and behaviour of an embodied agent in order to avoid the uncanny valley effect (Allbeck & Badler, 2004; Groom et al., 2009; Mitchell et al., 2011). On one hand, users dislike embodied agents that are too realistic (e.g., human replica; Groom et al., 2009) and exhibit negative responses to unrealistic (non-human-like) embodied agents such as zombies (Mousas et al., 2018). On the other hand, people experience lower levels of satisfaction when communicating with a less realistic (e.g., animal-like) digital representation. Hence, designers should include characteristics that increase relatedness, feelings of being understood, attractiveness, empathy, and so forth that appear natural to users in order to avoid a feeling of eeriness.

Interacting with embodied agents that do not reflect the user's ethnicity is rated as less trustworthy compared to interacting with embodied agents that do (Tamborini et al., 2018).

It is worth noting that this eeriness is not only about the human-like physical appearance of embodied agents, but also about the display of emotion states. The design of embodied agents should focus not only on human-like appearance and behaviour, but also on emotions displayed by embodied agents (Beale & Creed, 2009; Saygin, 2011). An embodied agent that smiles with a concerned voice is problematic, as it exhibits an obvious inconsistency (Beale & Creed, 2009), which may in turn reduce a user's perceived faith in the digital representation. Designers should therefore consider contextual appropriateness of emotional displays of the embodied agent to avoid an uncanny valley effect.

2.8 DISCUSSION

The following subsections discuss the overall results by providing a summary of findings on digital representations, focusing on the affected user's psychological constructs, an aspect that has been widely investigated by previous research. Here, we discuss practical implications emerging from the review by outlining what designers and practitioners need to consider when designing and implementing digital representations, and what design considerations will positively or negatively affect users' psychological constructs. In addition, we present our results, which stress the basic interaction types and design considerations, as well as the associated psychological constructs of users when they interact with a self-avatar, another person's avatar, or an embodied agent. We also provide implications of design choices for digital representations along with examples of interaction outcomes.

2.8.1 Summary of Findings

Over the past 20 years, researchers from the IS domain have conducted controlled experiments in laboratory and field environments to better understand the interactions human

users have with digital visual representations of humans (avatars) and computer agents (embodied agents). To stimulate research that extends the knowledge of avatars and embodied agents, and potentially enable innovative applications of such digital representations, we first conducted the present SLR. Based on the review, we came up with a comprehensive overview of the extant literature on experimental IS research on avatars and embodied agents, identifying key aspects that affect human perceptions and behaviour when interacting with them. Table 2.4 provides a summary of our findings.

Table 2.4 Summary of findings from the literature review

Interaction Types	Design Considerations	Psychological Constructs	Examples of Implications of Design Choices	Examples of Interaction Outcomes
H2SA	Customisation, Proteus effect	Similarity	Users feel more self-relevance and similar to their avatars if they can customise them	Positive effects on helping behaviour (e.g., Dolgov et al., 2014)
		Presence	Users feel more socially present using their self-avatars	Increased emotional attachment to avatars (e.g., H.-K. Kim & Kim, 2016)
H2A / SA2A	Customisation, Realism, Proteus effect	Similarity	Users feel similar to customised avatars that resemble them in terms of gender, physical appearance, and ethnicity	Increased sense of group belonging (e.g., Guegan et al., 2017)
		Attractiveness	Users prefer to interact with or use attractive avatars	Reduced risk-taking behaviour (e.g., H.-K. Kim & Kim, 2016)
		Anthropomorphism	Users prefer to interact with more human-like avatars in terms of visual, behavioural, and emotional realism	Perceptions of higher naturalness in interaction (e.g., Garau et al., 2003)
		Presence	Users feel more socially present in the interaction with human-like avatars	Higher degrees of immersion (e.g., Franceschi et al., 2009)
H2EA / SA2EA	Realism, Uncanny valley	Anthropomorphism	Users prefer adequately realistic and human-like embodied agents that exhibit consistency in terms of visual, behavioural, and emotional realisms (human-like realisms)	Irritation and disengagement for too low (e.g., Mousas et al., 2018) or too high (e.g., MacDorman et al., 2009) levels of anthropomorphism
		Enjoyment	Users perceive interactions with embodied agents as less enjoyable if these exhibit inconsistency in terms of visual, behavioural, and emotional realisms	Disengagement from the interaction if not enjoyable (e.g., Groom et al., 2009)
		Similarity	Users prefer to interact with embodied agents that are similar to them (e.g., in terms of gender, appearance, or ethnicity)	Higher involvement and trust in the embodied agent (e.g., Tamborini et al., 2018)
		Presence	Users prefer to interact with human-like embodied agents	Higher levels of liking and credibility as a source of information (e.g., Y. Kim & Sundar, 2012a)

In the context of human interaction with *self-avatars* (H2SA), experiments have shown that when people are given the freedom to customise their avatar, it does not necessarily reflect their actual selves (Vasalou & Joinson, 2009). Customisation enables users to create a

sense of relevance with their avatars, which, in turn, can increase identification with the self-avatar. Notably, if there is a strong sense of self-relevance, this may affect the user's behaviour positively or negatively (Proteus effect) (Fox et al., 2013). Emotional attachment with the self-avatar is an important aspect of digital representation if the purpose of the interaction is to change user behaviour. Perceived similarity and customisation of digital representations leads to emotional attachment with avatars (H.-K. Kim & Kim, 2016) and higher levels of self-presence (Seo et al., 2017). Basically, customisation should be available to facilitate behavioural change, allowing users to customise their avatars to their liking.

In the context of human and self-avatar interaction with *another person's avatar* (H2A and SA2A), the user or self-avatar interacts with another person's avatar to achieve a common goal. Research has shown that, because of anthropomorphism, representation of the avatar affects the user's perceptions. Garau et al. (2003) found that interactions with realistic avatars (meaning visually human-like and behaviourally realistic) are considered more natural (i.e., they feel more like a face-to-face interaction). The attractiveness of a digital representation affects the interaction partner's behaviour in terms of risk taking (H.-K. Kim & Kim, 2016). Psychological similarity emphasises how important it is for the avatar to be part of a team (Guegan et al., 2017), which means that customisation of the avatar should be consistent with it being part of a team or group. Uniqueness and similarity are two important constructs for ensuring that an avatar can be identified by the interaction partners. Immersion and presence, which work interchangeably, are important for H2A and SA2A interactions too. That is, presence increases immersion and vice versa. Presence is magnified when interaction partners can see and hear each other (Franceschi et al., 2009), which attracts user attention. Interacting with avatars can result in behavioural change due to the Proteus effect, which affects users' behaviours either by acting similarly or differently to other avatars in the interaction.

In the context of human and self-avatar interaction with an *embodied agent* (H2EA and SA2EA), research has shown that for human realism an embodied agent should reflect natural human behaviour, appearance, and emotion. It is important to ensure that all real human dimensions are matched to actual human behaviour, emotion, and visual cues in order to avoid uncanny valley effects (Groom et al., 2009), meaning that unrealistic human features will irritate people and lead to disengagement (Mitchell et al., 2011). Human realism is an important aspect of representing embodied agents, and it is necessary to create a digital representation that has human-like features and also has a sense of social cues in the interaction. This is because humans prefer to digitally interact with a representation that is similar to them. The perception of similarity here is not limited to physical appearance or gender, but also includes ethnicity and culture (Tamborini et al., 2018). Human realism and psychological similarity can increase the sense of presence, immersion, and involvement with the embodied agent. These in turn will ensure enjoyment, information credibility, likeability, and trust between the interaction partners. Similarly, information provided by an embodied agent is more credible and believable if it exhibits human-like features (Y. Kim & Sundar, 2012a) and if these features are consistent with actual human features. As expected, the likeability of embodied agents hinges on matching human features realistically. In summary, human realism can induce trust (Riedl et al., 2014), which enables the interaction partners to share information or work collectively with the embodied agent.

To summarise, the appearance and behaviour of avatars and embodied agents are important antecedents of interaction outcomes and may lead to negative (e.g., disengagement and distrust) or positive (e.g., enjoyable) user reactions. According to Guadagno et al., (2007), the more anthropomorphic an embodied agent or avatar appears, the more realistic its interactional behaviour (such as facial expressions or smiles) needs to be for the digital representation to stimulate appropriate social/behavioural responses. Hence, in line with RT

(Burton-Jones et al., 2017; Recker et al., 2019), avatars and embodied agents may yield higher faithfulness (i.e., credibility, similarity, presence) if these representations closely resemble the real-world human cues (e.g., Groom et al., 2009; Nowak & Rauh, 2006). In contrast, less anthropomorphic representations – that is, with inconsistencies in behavioural, emotional, and visual cues –may lead to adverse outcomes in the interaction between humans and digital representations.

2.8.2 Practical Implications

Most digital interactions of avatars and embodied agents focus on stimulating changes in user experience (e.g., emotion) and facilitating targeted behaviours. Based on the present literature review, we have identified six factors designers should particularly take into account when considering the design and implementation of avatars and embodied agents.

First, designers should be aware of the *Proteus effect*, which relates an avatar's characteristics to its "owner's" own behaviour (Fox et al., 2013; Peña et al., 2009, 2016; Yee and Bailenson, 2007). The Proteus effect occurs when users are represented by avatars in a virtual environment (Yee et al., 2009). It can have positive implications when there is a need to change certain behaviours or perceptions. In this sense, the positive appearance of an avatar can increase user confidence – especially in conversations or negotiation tasks (Won et al., 2015; Yee & Bailenson, 2007). As expected, a negative connotation (e.g., an overweight avatar) can dampen user motivation and mood by reinforcing unhelpful judgments, while an athletic avatar may promote liveliness and boost physical activity (Peña & Kim, 2014). It is hence important for designers to carefully take into account the Proteus effect, as their virtual designs may have unimagined or undesired consequences in the physical world (H.-K. Kim & Kim, 2016).

Second, designers need to consider the *uncanny valley effect*, which occurs when the appearance of a representation looks almost human, but not fully so (Beale & Creed, 2009;

Tinwell et al., 2011). Since virtually all avatar designs will not achieve full human realism, designers should – despite efforts to embed human and social cues like facial features and gestures – keep a safe distance from all too realistic avatars. In this situation, deliberate abstraction and stylisation, for instance, using comic faces, may be a viable option. Moreover, they should employ attractive and empathetic avatars to reduce uncanny impulses.

Third, designers need to consider the concept of *presence* for the design of digital interaction, as this does not represent the natural form of communication among humans. Designers should focus on features that evoke presence to make the interaction appear *social*. Previous research has shown that digital representations that exhibit consistent behavioural realism yield greater social effects (Kang & Gratch, 2014). Importantly, digital representations that are similar to users are perceived as more sociable, enjoyable, and useful to interact with than dissimilar ones (Bacev-Giles & Haji, 2017; Qiu & Benbasat, 2010; Seo et al., 2017). Designers should be aware of this to stimulate presence.

Fourth, *persuasive* design of digital representations is a technique to influence users' behaviours or decisions towards a specific idea. Research has shown that users prefer to interact with powerful and authoritative avatars, which can achieve better outcomes (Fox et al., 2013; Schultze, 2011). Also, digital representations with strong facial expressions increase persuasiveness. Hence, for change in behaviour, more engaged avatars are preferable over passive ones (Hyde et al., 2015). Moreover, persuasion can be supported by higher anthropomorphism (e.g., using detailed facial expressions). Overall, more visually realistic avatars convey stronger messages, increase the chances to persuade users (Khashe et al., 2017), and in turn guide behaviour (Noorbergen et al., 2019).

Fifth, designers should consider *empathic* elements in designing digital representations. Empathy creates a sense of social interaction between the interaction partners. Experiments with digital representations have shown that a simple display of emotion can change the

result of an interaction. Importantly, users dislike embodied agents that display inconsistent emotions (Beale & Creed, 2009) and exhibit negative responses to agents with pale or gaunt appearances (Mousas et al., 2018). Additionally, empathic elements should be appropriately matched with human emotions (Burgoon et al., 2016). Empathic elements are important aspects of designing digital representations because they make the interaction more supportive, enjoyable, trusting, and open (Guadagno et al., 2011). Empathy leads to more positive interactions, including greater likeability and trustworthiness between the interaction partners (Brave et al., 2005). Designers should consider including characteristics of non-verbal and verbal behaviour to increase emotional attachment (Beale & Creed, 2009).

Lastly, designers should ensure that *customisability* is available to users, as it enhances the connection between users and their digital representations (Hanus & Fox, 2015; Ratan & Sah, 2015). Enabling users to create their own avatars makes users more engaged in preventive behaviours (e.g., quitting unhealthy habits) or proactive behaviour (e.g., picking up healthy routines) (Y. Kim & Sundar, 2012b). Customisation is used to change or enhance the user's behaviour and try to elevate the user's level of emotional attachment (Ducheneaut et al., 2009; Hanus & Fox, 2015). Although customisation of an avatar allows a user to make deliberate design choices about how they are self-represented, a user's offline characteristics can play an important role in how an avatar is customised (e.g., Bélisle & Bodur, 2010; Dunn & Guadagno, 2012); ultimately, however, users prefer avatars that reflect their own features in one way or another (Nowak & Rauh, 2006). Therefore, designers should ensure that digital representations can be customised by users to create a strong emotional connection. Avatar customisation is one of the ways to create a close relationship between a user and an avatar. In other words, giving users control over the appearance of an avatar plays a role in strengthening the emotional attachment between avatars and users (Ducheneaut et al., 2009; Hanus & Fox, 2015).

2.8.3 Limitations and Future Directions

Building on the findings of our literature review, we have identified three major directions for future IS research on avatars and embodied agents. First, in terms of *research methodology*, it needs to be noted that the majority of reviewed studies were exclusively experiments in laboratory settings (84 out of 90 studies) and only six studies considered a field setting (e.g., Barata et al., 2017; Rodrigues et al., 2016; Sanchez-Valdes & Trivino, 2015). There is limited knowledge as to how critical the real-world context is for transferring results of laboratory studies to the field. This can be addressed in future research by putting a stronger emphasis on field experiments. Further, so far only eight studies considered physiological measurements (e.g., see Lim & Reeves, 2010). However, it is known that human emotional responses involve unconscious processes (Walla & Panksepp, 2013). Hence, there is a need for more physiological studies to uncover the unconscious effects of digital representations on users and their links to user perceptions. It is also necessary to note that our review has focused exclusively on experimental research. There is thus a need for future research to discern whether the results presented here are intrinsic to experimental studies. This can be achieved through a complementary review that focuses on other (non-experimental) research methods or through multi-method approaches that combine experimental and non-experimental approaches (e.g., focus groups, interviews).

Second, the review has identified several interesting knowledge gaps in terms of *avatar appearance*. So far, studies on self-avatars have exclusively focused on face-only or full-body avatars (see Table 2.2). It would be interesting to investigate half-body avatars in the self-avatar context and contrast it to the results of face-only and full-body avatars. Further, while research has emphasised the importance of a high similarity between the user and a digital representation, the majority of studies on similarity considered just the avatar's physical appearance (e.g., body size, clothing, hair) or gender. Only three studies have

explicitly considered the user's ethnicity (Fehrenbacher & Weisner, 2017; Spence et al., 2013; Tamborini et al., 2018). In these three studies, digital representations were based on, and hence represented, the ethnicity of (1) African-American and Caucasian people (Spence et al., 2013; Tamborini et al., 2018), and (2) Asian and Caucasian people (Fehrenbacher & Weisner, 2017). It is known that visual appearances that are appropriate for one culture can be inappropriate in another (Abdallah & Douglas, 2010; Aljaroodi, Chiong, et al., 2017; Yusof & Zakaria, 2007). Therefore, further research is needed to explore the effects of similarity and other constructs (e.g., credibility, likeability) in the context of users' culture and ethnicity. Also, the scope should be broadened beyond Asian, African-American, and Caucasian cultures (e.g., Arabian and Indigenous cultures).

Third, the degree of overlap in the psychological constructs investigated by the different studies is quite low, even within the five interaction types (see Figure 2.3). While presence and similarity emerge as the most widely-used constructs, other constructs such as attractiveness, enjoyment, and likeability have only been investigated by about 10% of the studies. Also, there is no study that has simultaneously explored the 11 constructs listed in Table 2.1. There is thus a lack of understanding of the interrelationships between them (e.g., credibility, likeability, enjoyment, and similarity), and how the relationships between constructs may depend on whether the user is interacting with an avatar or an embodied agent.

2.9 CONCLUDING REMARKS AND CHAPTER SUMMARY

The study has provided an overview of the different digital representations investigated in experimental IS research, including avatars and embodied agents. The degree of anthropomorphism represents a pivotal lever for designers of digital user representations. Notably, digital representations can affect people in manifold ways, including via the Proteus and uncanny valley effects. Researchers and practitioners may find this systematic review

useful as a reference for experimental research on avatars and embodied agents. Others may also gain valuable background information.

To sum up, this chapter has reviewed the literature on computerised graphical representations of human users and computer agents (known as avatars and embodied agents) which have been extensively explored and investigated in IS research and practice. Such digital representations can be employed in either 2D or 3D. In order to facilitate research on user and digital representations and their applications in IS, the SLR has established the current state of research on human perceptions and behaviour when interacting with avatars and embodied agents. Our findings are based on an analysis of 90 articles published in top outlets in the IS field. This review identified 1) different types of avatar and embodied agent-mediated interactions with users, 2) the current application domains of such representations, 3) their dimensionality, 4) the affected users' psychological constructs, and 5) practical considerations for the design of such digital representations.

Moving forward, Chapter 3 presents the first qualitative study based on a design science (co-design) approach (Hevner et al., 2004). It entails exploring avatar design with the concept of *empathic design* in order to provide a better and engaging user experience in mobile health applications, in particular for stroke survivors, increasing their physical and psychological capabilities and motivation from interacting with avatars.

Chapter 3: Exploring Empathic Avatar Design for Stroke Survivors

CHAPTER 3 OVERVIEW

This chapter presents the first qualitative study in which we explore avatar design for stroke rehabilitation in a culturally neutral perspective. Related work on the use of avatars in health applications is first reviewed. After that, we describe the full details of the study, including the identification of current issues in rehabilitation programs, practical requirements based on a well-established behavioural change framework, and design principles and procedures. We then discuss how the design of the mobile application was evaluated with stakeholders. A summary of the main findings, limitations, and future directions appears at the end of the chapter.

3.1 INTRODUCTION

In the previous chapter, we conducted a literature review and provided background information for this research. We established that avatars have been effectively implemented and used in a wide range of applications. In addition, we presented a comprehensive review of the relevant literature on the design of digital representations as well as on the potential positive and negative effects they may have on human perception and behaviour. In this chapter we address and explore the issues and knowledge gaps in using avatars for health applications. In the background chapter, we identified one specific knowledge gap that researchers of human–avatar interactions have only investigated to a limited extent. Previous research has mainly focused on delivering health-related information to users to increase their awareness about specific issues, e.g., smoking (Song, Kim, Kwon, et al., 2013). Unlike in previous research, this research project used a co-design approach (Hevner et al., 2004), and in this case for the design of avatars for promoting recovery after stroke. It will explore the design and use of empathic avatars for stroke rehabilitation by using qualitative methods (i.e., workshops), which in a co-design approach includes users in the early design stages. What

we aim to do is provide an interactive design that improves engagement for stroke survivors by using empathic avatars rather than just text-based instructions. In this situation, we also aim to explore the concept of *empathic design* (Beale & Creed, 2009) in order to improve the effectiveness of stroke rehabilitation programs by increasing user engagement and the physical and psychological well-being of stroke survivors. This chapter explores and addresses the second overarching research question (RQ2) of this research project:

> **RQ2:** *How can empathic avatars be designed in mobile health applications for stroke rehabilitation?*

This chapter is organised as follows. Section 3.2 provides a brief background of the context and motivation of this study. Then related work on the use of avatars in health applications is reviewed in Section 3.3, where we identify the current problems and issues with existing rehabilitation programs. After that, we elicit the design requirements of empathic avatars as well as mobile health drawbacks in Section 3.4. Section 3.5 outlines design principles of the behavioural change framework chosen which we believe will improve stroke rehabilitation programs. In Section 3.6, details of the implementation and evaluation of an mHealth prototype using empathic avatars is provided, followed in Section 3.7 by a discussion of the results as well as limitations of this research. Also, avenues for future research are identified. Finally, Section 3.8 provides a summary of the chapter.

3.2 BACKGROUND AND MOTIVATION

Stroke is the second highest cause of death and disability worldwide (WHF, 2017), accounting for nearly 6 million deaths per year and another 5 million left with permanent disabilities. In a broader context, stroke is part of a global increase in non-communicable diseases (NCDs), linked, among other factors, to preventable lifestyle behaviours such as smoking, nutrition, alcohol over-consumption, and physical inactivity (RACGP, 2015). Stroke can be a devastating event in a person's life, leading to severe loss of mobility,

cognitive impairment, inability to participate in daily living activities, associated loss of independence, curtailment of social life, isolation, and depression. A critical component for the mid- and long-term effects of stroke on a person's life is rehabilitation. Effective rehabilitation can aid stroke survivors to reduce physical impairment, recover movement, increase participation in everyday life, and improve the overall quality of life. However, rehabilitation is often ineffective, as it requires a high level of physical participation and emotional engagement from the stroke survivor, both of which are challenging to achieve (Jelinek et al. 2011).

This chapter follows a design science approach (Hevner et al., 2004) to explore how a mobile health (mHealth) solution can support stroke survivors in effective rehabilitation. Existing approaches to stroke rehabilitation are primarily about providing stroke survivors with information on exercise and medication regimes, usually conveyed by means of simple text documents with detailed instructions from their healthcare professional. In contrast, this study is based on behaviour change theory (Michie et al., 2011; Noorbergen et al., n.d.), and builds on the rationale that engaging stroke survivors in an empathic and meaningful way can increase compliance with exercise and medication regimes and improve overall health outcomes. In particular, we designed, implemented, and evaluated an mHealth prototype we refer to as *Regain*, which aims to help stroke survivors stay engaged with their rehabilitation program. To ensure that our approach adequately considers the diverse perspectives in the complex landscape of stroke rehabilitation, we adopted a co-design approach that included workshops with multiple stakeholders such as carers, clinicians, health behaviour psychologists, and actual stroke survivors.

The next section provides a brief overview of related research investigating the use of avatars in health promotion and associated applications.

3.3 RELATED WORK: AVATARS IN HEALTH APPLICATIONS

mHealth describes the use of portable electronic devices with software applications to provide health services and manage patient information (Källander et al., 2013). The rapid growth of these portable electronic devices gives rise to opportunities for targeted health behaviours such as encouraging physical activities or improving diets. mHealth applications and interventions utilise a variety of clinical decision support systems and data collection tools suitable for healthcare professionals (Blaya et al., 2010). The tools aim to help patients change health behaviour and manage chronic disease (Cole-Lewis & Kershaw, 2010). For example, digital representations such as avatars[6] have been used to provide medical information to patients, monitor their recovery progress, and provide an engaging experience for them. mHealth offers interactive two-way communication, providing opportunities for improving self-monitoring for those with chronic diseases and for improving health outcomes (Källander et al., 2013).

As described in the background and literature review chapter, avatars can be designed in a variety of ways: self-avatar, mirrored self, future self, ideal self, and fictional self (Behm-Morawitz, 2013; Song, Kim, Kwon, et al., 2013; Vasalou et al., 2008; Vasalou & Joinson, 2009). There are also goal-directed aspects that can be considered such as empathic and persuasive designs (Beale & Creed, 2009; Hanus & Fox, 2015). These different design concepts can be used to positively affect users' perceptions and behaviours, and engage them in a meaningful way. Avatars are used in mHealth mainly as a means of increasing users' engagement and facilitate behaviour change. For example, avatars have been used in clinical research to stimulate behaviour change in lifestyle habits such as physical activity and diet

[6] When using the term "avatar", we consider visual design elements that resemble human features. We are aware that there is a distinction between cases where a human or a computer agent is represented, but for this research project this is not the primary concern.

change (Fox et al., 2009). It has been shown that the use of an avatar can increase the level of trust, e.g., for Parkinson's disease patients (Javor et al., 2016). Previous research also suggests that an avatar can be an effective method for communication (Parks et al., 2014). The use of avatars in mobile applications can help patients have a more engaging experience by giving real-time feedback. For example, with smoking, avatar-based mobile applications can show the risks and effects associated with smoking in terms of the physical appearance of a self-avatar over time, and this can increase the level of perceived risk associated with smoking (Song, Kim, Kwon, et al., 2013).

Furthermore, the results of a survey of users of Second Life indicated that representing users with avatars encouraged them to make positive health changes (e.g., exercise) in their real lives (Behm-Morawitz, 2013). Broadly speaking, previous research has established that virtual representations of users via avatars, e.g., in Second Life, can influence and promote changes in healthcare for users or patients (Hudson et al., 2014; Ruggiero et al., 2914) and for healthcare providers (Menzel et al., 2014; Rice et al., 2014). Other studies have revealed their effectiveness in the field of clinical psychology (Gorini et al., 2008). Menzel et al. (2014) conducted an experiment over a period of 3 months, in which they employed a physical weight loss program (in a face-to-face setting) and virtual weight loss program (in a virtual world, i.e., Second Life). They found that, compared to the participants in the face-to-face setting, Second Life participants reported a significantly greater ability to engage in physical activities and resisted excessive food intake. Additionally, users reported an increased level of enjoyment when exercising in an online (virtual) environment with an avatar (e.g., in Second Life) as compared with performing the same exercise on just a physical treadmill (Sullivan et al., 2013), which in turn provided an increased intention to exercise (Graves et al., 2010). Previous research also provides evidence that virtual representations, which stimulate a user's physical activity online can be transformed into healthy behaviour offline.

In this chapter, therefore, the aim is to explore the concept of empathic and avatar design for stroke rehabilitation programs, and to investigate how their effectiveness can be increased in terms of better stroke survivor capabilities and engagement with recovery programs.

3.4 PROBLEM IDENTIFICATION AND REQUIREMENT ELICITATION

Over the past decade, costs associated with NCDs have increased so rapidly that they threaten the healthcare systems of every developed nation (Mladovsky et al., 2012). As part of this development, there is growing pressure on healthcare professionals to discharge stroke survivors quickly from a hospital, creating a shift towards outpatient (i.e., out of hospital) rehabilitation in their home care environments. This shift, however, comes at the increased risk of non-compliance with medical advice in terms of exercise and medical regime (Linder et al., 2013), as the time and resources for clinician–patient interaction are scarce. In other words, current rehabilitation programs fail to effectively engage stroke survivors in complying with medical advice in a home care environment, a situation that leads to worse health outcomes because of non-compliance with medications and exercise programs and, ultimately, even higher costs for the healthcare system (Iuga & McGuire, 2014). While mHealth technology offers clear opportunities to increase patients' engagement in rehabilitation activities, the effectiveness of existing mHealth artefacts is low (Free et al., 2013).

Stroke rehabilitation can only be effective if stroke survivors actively engage in targeted behaviours, and this almost always entails a change in behaviour to align with the rehabilitation goals. The development of effective rehabilitation programs therefore has to take into account the psychology of behaviour change. Current rehabilitation programs focus primarily on providing detailed verbal and written advice on exercise and medication

regimes.[7] However, there is a large body of psychological literature showing that providing accurate information alone is necessary, but *not sufficient*, for achieving sustainable behaviour change. Based on a systematic review of the behaviour change literature, (Michie et al., 2011) developed a comprehensive framework that integrates the interacting components that make up and define human behaviour: namely *opportunity*, *capability*, and *motivation*. Engaging individuals in targeted behaviours requires that each of these components be adequately addressed in the given context. Building on behaviour change theory, we derive the following set of design requirements for effective stroke rehabilitation by means of avatars. Table 3.1 provides a summary of design requirements, which are derived based on the behaviour change framework of Michie et al. (2011).

Table 3.1 Summary of design requirements

Design Requirement	Description
R1: Psychological Capability	The design has to communicate medical advice in a way that increases stroke survivors' psychological capability to engage in rehabilitation activities, addressing their understanding of how to perform the activities as well as the benefits of these activities in terms of health outcomes.
R2: Physical Capability	The design has to select rehabilitation activities that individual stroke survivors are physically capable of performing, ensuring that the activities are sufficiently challenging while at the same time avoiding activities that are too challenging.
R3: Opportunity to Engage	The design has to create opportunities for stroke rehabilitation by prompting stroke survivors to engage in rehabilitation activities and show them how these activities can be performed in their home care environments.
R4: Motivation	The design artefact has to include elements that motivate stroke survivors to engage in rehabilitation activities.
R5: Accessibility	The design artefact has to enable healthcare professionals to have access to the stroke survivors' data remotely and in a secure way in order to assess the progress, and make adjustment to the rehabilitation program.

The first requirement (R1) refers to the stroke survivors' *psychological capability*, that is, "the necessary knowledge and skills" (Michie et al., 2011, p. 4) to engage in rehabilitation activities. Due to their medical condition, which usually involves some level of cognitive impairment, stroke survivors often find it difficult to understand the verbal and written

[7] Recent research has successfully explored the application of virtual reality for stroke rehabilitation (e.g., see Laver, George, Thomas, Deutsch, & Crotty, 2015; Silver, 2016). However, these approaches are used less often than traditional rehabilitation techniques.

instructions provided to them, limiting their psychological capacity to engage in rehabilitation activities (NIH, 2014), as well as understanding the personal health benefits that could accrue from following the rehabilitation plan. However, without the psychological capacity to engage in targeted behaviour, it is impossible for stroke survivors to perform the activities that are needed for effective rehabilitation. Hence, recent research suggests technological and methodological innovations to improve compliance by exploring new ways of communicating medical advice (de Jongh et al., 2012).

> **R1**: *The design prototype has to communicate medical advice in a way that increases stroke survivors' psychological capability to engage in rehabilitation activities, increases their understanding of how to perform the activities, and conveys the benefits of these activities in terms of health outcomes.*

The second requirement (R2) refers to the stroke survivor's *physical capability*, that is, the physical ability to perform the activities called for by the rehabilitation plan. In other words, stroke survivors should only perform activities that they are physically able to do. Ideally, these activities should be challenging to the patients, yet not too challenging, as this could lead to increased stress, despair, or even injury (Cornforth et al., 2015). As the negative impacts of a stroke on mobility, and the improvements from rehabilitation, vary strongly from person to person, the activities have to reflect the individual physical capabilities of the stroke survivor.

> **R2**: *The design prototype has to select rehabilitation activities that individual stroke survivors are physically capable of performing, ensuring that the activities are sufficiently challenging while at the same time avoiding activities that are too challenging.*

The third requirement (R3) refers to the stroke survivor's opportunity to engage in rehabilitation activities, that is, "the factors that lie outside the individual that make the behavior possible or prompt it" (Michie et al., 2011, p. 4), which may include restriction, environmental restructuring, and enablement. At present, limited information technology (IT)-mediated approaches exist for directly changing the home care environment of a stroke

survivor. However, there are several elements in the context of environmental restructuring that IT can address: e.g., enabling the survivor to adapt to their home care environment in a different way by showing them how to engage in rehabilitation activities in that environment.

> **R3**: *The design prototype has to create opportunities for stroke rehabilitation by prompting stroke survivors to engage in rehabilitation activities and showing them how these activities can be performed in their home care environment.*

The fourth requirement (R4) refers to increasing the motivation of stroke survivors to sustain behaviour change, that is, "all those brain processes that energize and direct behavior" (Michie et al., 2011, p. 4). Even when individuals have the physical and psychological capacity as well as the opportunity to engage in targeted behaviour, behaviour change will not occur unless there is a sufficient level of motivation. Motivation can be directly driven by increased levels of capability and opportunity (Michie et al., 2011), e.g., by understanding how rehabilitation activities will lead to benefits in terms of better health outcomes. However, if the benefits have no meaning to an individual, particularly if they do not translate into achievable, short-term milestones, behaviour change will not occur. Hence, when addressing motivation, it needs to go beyond the mechanisms associated with capability and opportunity, e.g., by leveraging the potential of social cues and short-term feedback.

> **R4:** *The design prototype has to include elements that motivate stroke survivors to engage in rehabilitation activities.*

The fifth requirement (R5) refers to allowing healthcare professionals to monitor the progress of stroke survivors, and making adjustment to the rehabilitation program based on that progress. In order to do so, it is necessary for a healthcare professional to select a set of adequate rehabilitation activities (R2), then measure progress against those goals. For instance, feedback from users, consisting of physiological measures such as heart rate and skin conductance, has been shown to permit the adjustment of difficulty in real-time during stroke rehabilitation in a study by Jelinek and colleagues (Cornforth et al., 2015). Such

measures can be used to assess the mood of the user (see Riedl, Davis, & Hevner, 2014, p. xiv) for some detailed discussion on content validity and construct validity in the context of physiological measurements); hence, the difficulty of a video game used in the context of stroke rehabilitation can be adjusted appropriately. IT systems can support R5 by providing data that can be sent back to the healthcare professional, in this way assisting them with assessment and providing opportunities for intervention in the form of modification of exercise programs or other aspects of a rehabilitation program.[8]

> **R5**: *The design prototype has to enable healthcare professionals to have remote access to the stroke survivor's data and be secure in order to assess progress and allow adjustment to the rehabilitation program.*

3.5 DESIGN

Recent reviews indicate that research into patient-centric mHealth IT systems is still at an early stage, and a wide range of existing mHealth approaches have shown to yield little or no effectiveness (Free et al., 2013; Samhan et al., 2013). Samhan et al. (2013) identified specific gaps in the literature, including limited knowledge of the effects of mHealth IT systems on health outcomes, and how these systems can be designed for patients with a particular disease. Co-design, sometimes also referred to as participatory design, is a methodology in which multiple stakeholders contribute to ensure that the design solution aligns with users' needs and experiences (Sanders & Stappers, 2008). Typical elements of co-design include idea generation, problem understanding, prototyping, and storytelling. Empirical evidence has shown that the best health outcomes are derived via models co-designed with inputs from users and healthcare professionals (Donetto et al., 2014). Co-design therefore goes beyond designing for a given audience but directly involves the audience in the design.

[8] Although the technology for such interventions exists, it seems that this opportunity has been overlooked: out of 29,000 medical apps in the US iTunes® store, 130 (16%) could be used in rehabilitation, but less than 1% specifically assist the caregiver to better face the challenges of stroke survivors (Piran et al., 2015). The prototype differs from these apps by building on the theory of behaviour change, having a co-design from multiple stakeholders, and having empirical validation using clinical trials.

This chapter builds on the co-design methodology, using workshops involving stakeholders, to explore issues of communication, accessibility, and motivation. These issues were approached through storytelling and prototyping, in order to achieve problem understanding and to collaboratively design and implement a useful prototype for stroke rehabilitation. After this, the multidisciplinary research team iteratively built interactive visual assets into compelling UI elements, using empathic patient-centred scenarios and characters. The underlying paradigm of this approach is that the resulting solutions will be more patient-centric and will meet the needs of stroke survivors, rather than being designed by researchers and health practitioners who have not experienced the illness themselves. Figure 3.1 illustrates the design process. It commences with informal workshops held with researchers (from design, health, and IT) to facilitate problem understanding through storytelling and explore the boundaries of what is possible through idea generation from the viewpoints of users and keeping in mind the capabilities of the technology. These workshops led to the production of an early prototype that enabled the research team to co-design, with the key stakeholders of both stroke survivors and healthcare professionals, a full prototype.

Figure 3.1 Illustration of the co-design process used in developing the prototype

In subsequent sections, we elaborate on the development of our design principles for the use of empathic avatars in mobile health applications for stroke rehabilitation. In addition, we specifically discuss the design principles in terms of how they address the design requirements for designing the prototype. Table 3.2 summarises the design principles that were derived to answer the design requirements identified in the previous section.

Table 3.2 Summary of our design principles

Design Principle		Description
P1	Empathic self-avatars	Use empathic, customisable self-avatars to convey social cues, increase stroke survivors' psychological capabilities, and ensure that they have a compelling experience to stay engaged with the rehabilitation program.
P2	Animations in a familiar environment	Use animations with the empathic self-avatar in a familiar environment to convey information on how the stroke survivor can perform the rehabilitation activities in an effective and motivating way, creating an opportunity to engage them in such activities in their home care environment.
P3	Shape aesthetics	Use gestalts (round face-like shapes) with an empathic self-avatar to indicate friendliness of the self-avatar while avoiding photorealistic features.
P4	Colour aesthetics	The design artefact has to include elements that motivate stroke survivors to engage in rehabilitation activities.

3.5.1 Empathic Self-Avatars

An important design aspect in addressing requirements R1 and R4 is to build interactive visual assets into the *Regain* app using empathic patient-centred scenarios and characters. Instead of simply communicating *information* on healthcare advice to stroke survivors, such empathic elements can be used to convey medical advice in a way that can be translated into the life of the user, increasing their psychological capacity (R1) and motivation (R4) to engage in targeted rehabilitation behaviours. Recent research has shown that so-called *self-avatars*, i.e., avatars that "resemble users' physical appearances" (Suh et al., 2011, p. 726), can be an effective way to convey social cues and encourage targeted behaviour. From a theoretical perspective, instigating behaviour change via self-avatars can be achieved through the *Proteus effect* (Yee & Bailenson, 2007). This effect describes the phenomenon in which the behaviour of an individual is changed by the visual characteristics of their avatar (Yee & Bailenson, 2007). Wrzesien et al. (2015) argued that the appearance of self-avatars can affects behaviour, and this change in behaviour can be utilised to encourage desirable behaviour. Importantly, *empathic* self-avatars may motivate users to adopt new behaviours (desirable or undesirable) associated with digital representations (Luppicini, 2012) (R4). Here, *empathy* is defined as the process of placing oneself in the place of someone else, seeing matters from the other's point of view, perceiving the other's emotion and thoughts,

and conveying this awareness to that specific individual (M. Davis, 1996).[9] Moreover, the expression of feeling by an avatar will increase the likelihood of behavioural change in the real world (Parks et al., 2014).

The use of empathic avatars in a co-design requires that the prototype incorporate scenarios based on the user's experience, in order to help make the avatar 'real' (Laurel, 2003). This can be achieved through systematic research, reviews, observations, and interviews (Minichiello et al., 2014). In the context of technology-enhanced learning, it has been shown that empathic avatars can encourage learners stay engaged with a learning program (Chen et al., 2012). In addition, empathic avatars can demonstrate the usefulness of engaging in desirable behaviours (R1), e.g., if the movement of the avatar gets better every time the avatar finishes an exercise, this helps to ensure that the stroke survivor follows the instructions of their rehabilitation program. Taken as a whole, the more empathic an avatar is, the more likely it will influence user behaviour towards targeted behaviours, and this emotional link can be strengthened by making the avatar customisable (H.-K. Kim & Kim, 2016). In the context of the *Regain* app, these behaviours refer to engaging in the rehabilitation program, where self-avatars are able to respond to stroke survivors and address their mood (Eslinger et al., 2002).

> **Design Principle 1 (P1)**: *Use empathic, customisable self-avatars to convey social cues, increase stroke survivors' psychological capabilities, and ensure that they have a compelling experience to stay engaged with the rehabilitation program.*

[9] It appears that the notion of empathy is of particular importance in healthcare settings when individuals are experiencing a life-changing event with potentially devastating consequences on their everyday lives. For instance, Javor et al. found that Parkinson's disease patients exhibit significantly lower trust levels towards other humans than healthy subjects do (Andrija Javor et al., 2015). In a follow-up study, Javor et al. (2016) showed that trust levels can be increased by using avatars

3.5.2 Animations in a Familiar Environment

The animation principle means illustrating the typical exercise that has to be performed by a stroke survivor, enabling them to better understand the activities that they need to engage in (R1) and reshaping their perception of their home care environment, which together create opportunities to engage in this behaviour (R3). Animation allows a more immersive illustration of exercise than textual descriptions or even line drawings, as the user can see how the avatar performs the entire exercise. Including animation with an avatar conveys more compelling and enhanced communication (Horain et al., 2005; Merz et al., 2016), which can provide an entertaining and motivating experience (R4), and ensures that the user follows and stays engaged with the program. Dodds, Mohler, & Bülthoff (2011) found that avatar animation can be used to simulate certain behaviour, enabling users to move and perform better. Animation can therefore be useful in stroke rehabilitation as a means of increasing the psychological capability of stroke survivors and providing them with the necessary knowledge and motivation to stay engaged with the program (R1). Animation shows stroke survivors how to perform a certain exercise, which in turn can increase their understanding of its benefits. Avatars can provide stroke survivors with an animated, personal, and engaging interaction, which in turn can influence patients' behaviour (Cruz-Cunha, 2016).

Importantly, the animation should be placed in a familiar context for stroke survivors, in a way that they feel more comfortable and relaxed with (Stephenson & Wiles, 2000). Previous research has shown that being in a familiar physical environment will help motivate targeted behaviours in patients and, overall, patients prefer home care (i.e., a familiar environment) over clinic-based therapy (Hong & Song, 2009). Hence, situating the animation in a familiar environment, e.g., a home garden or a living room, makes a stroke survivor feel more relaxed and comfortable while performing the rehabilitation activities (Nordin et al., 2015). In other

words, illustrating the empathic self-avatar in a familiar environment for stroke survivors will reduce their feeling of anxiety and increase their confidence because the activities will be performed in a familiar context (Stephenson & Wiles, 2000; Wottrich et al., 2007). In addition to the positive influence on stroke survivors' emotional states, the approach of using a familiar environment creates an opportunity for stroke survivors to engage in rehabilitation activities (R3), as it reshapes users' perceptions of their home care environment, demonstrating how this environment can be used to engage in behaviours while at the same time taking advantage of the relaxing environment of their home.

> **Design Principle 2 (P2).** *Use animations with the empathic self-avatar in a familiar environment to convey information to the stroke survivors on how to perform the rehabilitation activities in an effective and motivating way, creating an opportunity to engage in such activities in their home care environment.*

3.5.3 Shape and Colour Aesthetics

The shape and colour principles mean using shapes and colours that can positively influence stroke survivors' perceptions and behaviours. In terms of shape aesthetics, the prototype makes use of *gestalts* (i.e., shapes or forms) in the self-avatar design and animation. It has been shown that a more round (face-like) shape appears more friendly to users (Um et al., 2012), hence designing self-avatars with a round features suggests to stroke survivors friendliness of the character. A study has shown that round shapes with face-like features can induce positive emotions in learners (Plass et al., 2014). When such shapes are used in designing the empathic self-avatar to induce positive emotion in stroke survivors, this can keep them motivated (R4) and engaged (R4) with the rehabilitation program. Therefore, the empathic self-avatar will be designed using a round face-like characteristic to induce friendliness from the animations. Gestalts should have similar characteristics to human features, but not be too realistic to avoid affecting stroke survivors with the *uncanny valley effect*. This uncanny valley effect describes a phenomenon that arises when designing visual

artefacts that are intended to resemble human features (e.g., an avatar) in an overly realistic way, and can cause an aversive response in humans and make them feel uncomfortable (Mori et al., 2012; Riedl et al., 2014), which in turn may disengage stroke survivors from the rehabilitation program.

> **Design Principle 3 (P3).** *Use gestalts (round face-like shapes) with an empathic self-avatar to indicate friendliness of the self-avatar while avoiding photorealistic features.*

The visual design of the UI not only has to consider the shape aesthetics but also the colours used in combination with those shapes. Um et al. (2012) suggest that saturated warm colours and round face-like shapes can induce positive emotion in users, and increase their learning capability. Hence, warm colours and round face-like shapes can be used to induce positive emotion, and increase users' psychological capability and motivation (R1, R4). Colour theory is the study of the effect colours exert on the cognitive and affective processes of individuals (Birren, 2016). According to this theory, a colour can be used to trigger a broad range of emotional responses, e.g., to increase attention and deliver information (R1) (MacKay & Ahmetzanov, 2005). More importantly, colours can not only have beneficial but also detrimental effects on human behaviour (Jalil et al., 2012). Particularly strong hues, that is, pure colours with high levels of brightness and saturation such as red, blue, green, and yellow, have a strong effect on perception, physiology, and behaviour (R4) (Valdez & Mehrabian, 1994). For example, Greene, Bell, & Boyer (1983) found that warm colours (e.g., yellow, red, and orange) can prevent boredom and maintain activity. Such colours may motivate stroke survivors (R4) and increase their psychological capability (R1). Moreover, using the colour green has the ability to reduce stress and make users more calm and relaxed (Jalil et al., 2012). Applying strong colours and rounded shapes to the empathic self-avatars and background environment is therefore expected to create a positive impression and emotional appeal that will encourage use of the prototype.

> **Design Principle 4 (P4).** *Use strong colours (e.g., yellow, red, blue, and green) with the empathic self-avatar and animations in order to draw stroke survivors' attention to the empathic self-avatar and create an engaging user experience.*

3.6 IMPLEMENTATION AND EVALUATION

This section outlines the implementation stages of the mobile health application incorporating empathic avatars designed to make them *real* to stroke survivors. Here, we provide a discussion of the pilot study, which resulted in the development of an early prototype of the mobile application. Next, we present our full prototype resulting from feedback and suggestions from stakeholders in the workshops, followed by a discussion on the future development of the application. Then we provide detail on the evaluation of the mobile application.

3.6.1 Implementation

The prototype design presented in this chapter was developed in two stages (see Figure 3.1). In a pilot study in late 2014, a multi-disciplinary team of researchers with convergent interests, including clinicians, health informatic specialists, programmers, and designers was assembled. The output was an early prototype that demonstrated how empathic avatars could be created for stroke rehabilitation using a design featuring visual assets and animation. First, visual assets were created by the multidisciplinary team using a co-design process. The result of this stage was an early prototype, as shown in Figure 3.2.[10] Figure 3.2 shows an example of an empathic avatar (P1) in the early prototype, which features animated scenes illustrating typical rehabilitation exercises. The animation provides a more immersive illustration of an exercise than a set of line drawings, since the avatar performs the entire exercise (P2). A male version and a female version of the avatar were designed in consultation with experts in user experience design. The colour scheme was designed to avoid the dreary nature of illustrations

[10] The process is summarised in a short video: http://youtu.be/MV23MdmlfAg

commonly used in written healthcare advice, making use of compelling gestalts (P3) and bright colours (P4). Once the appearance was designed, pivot points were created, as indicated by circles on the avatar of Figure 3.2.

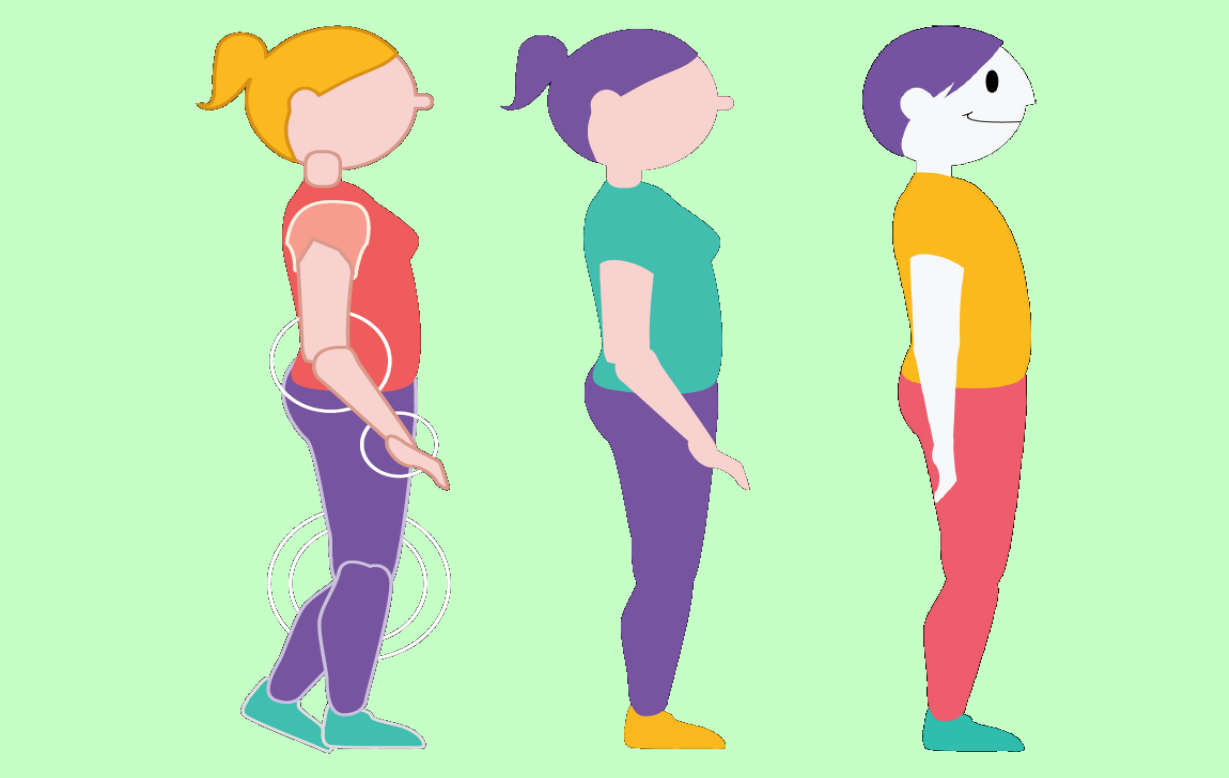


Figure 3.2 Empathic avatars developed for animation from the *early prototype*

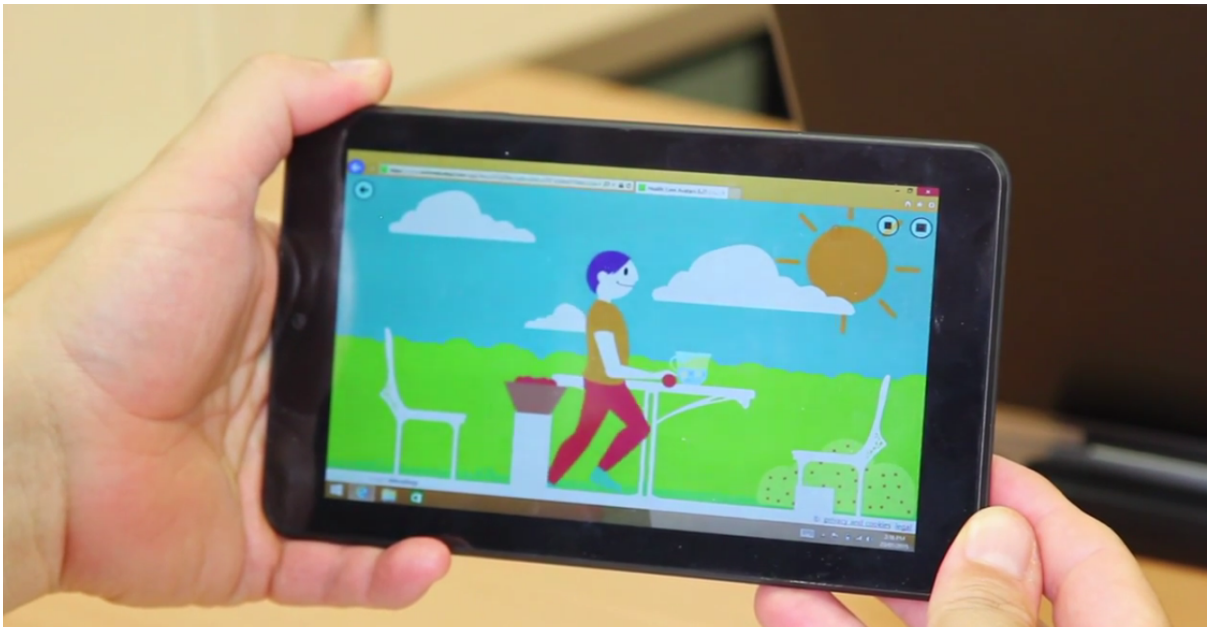


Figure 3.3 A screenshot of the *early prototype* with the avatar animated into a sequence

Figure 3.3 shows an animation created using the designed avatars. In this case, the exercise is “lift and carry” and it encourages the stroke survivor to improve balance and manipulation skills by grasping a small object and carrying it for a few steps. The animated avatar is situated in a familiar environment (P2), i.e., a home garden scene. This illustrates the possibilities of this technology, but also highlights the implied message, which in this case is one of escape, self-empowerment, and increased mobility, with recovery achieved by following the set of exercises. Once the preliminary design was realised, as shown in Figure 3.2, it was shown to healthcare professionals and health behaviour psychologists who had an interest in stroke rehabilitation – these people are important stakeholders for embedding the future product into a practical rehabilitation program. This early prototype was designed to explore the characteristics of an avatar in the context of a mobile app on a tablet. After informal and formal workshops and interviews, design goals were developed to assist in the production of an improved prototype. The full prototype was developed in collaboration with professionally experienced designers and software developers.

Figure 3.4 shows two screenshots from the full prototype. Based on comments received from stakeholders in the co-design workshops, the amount of text was reduced to the minimum required for explanation. This can be seen in the brief instructions for an individual exercise, coupled with an image representing the exercise, shown in Figure 3.4, and the small amount of text used in the exercise description, shown in Figure 3.5. Furthermore, following the advice of professional designers and health behaviour psychologists, the menu was implemented using images that represent the type of exercise (see Figure 3.4).

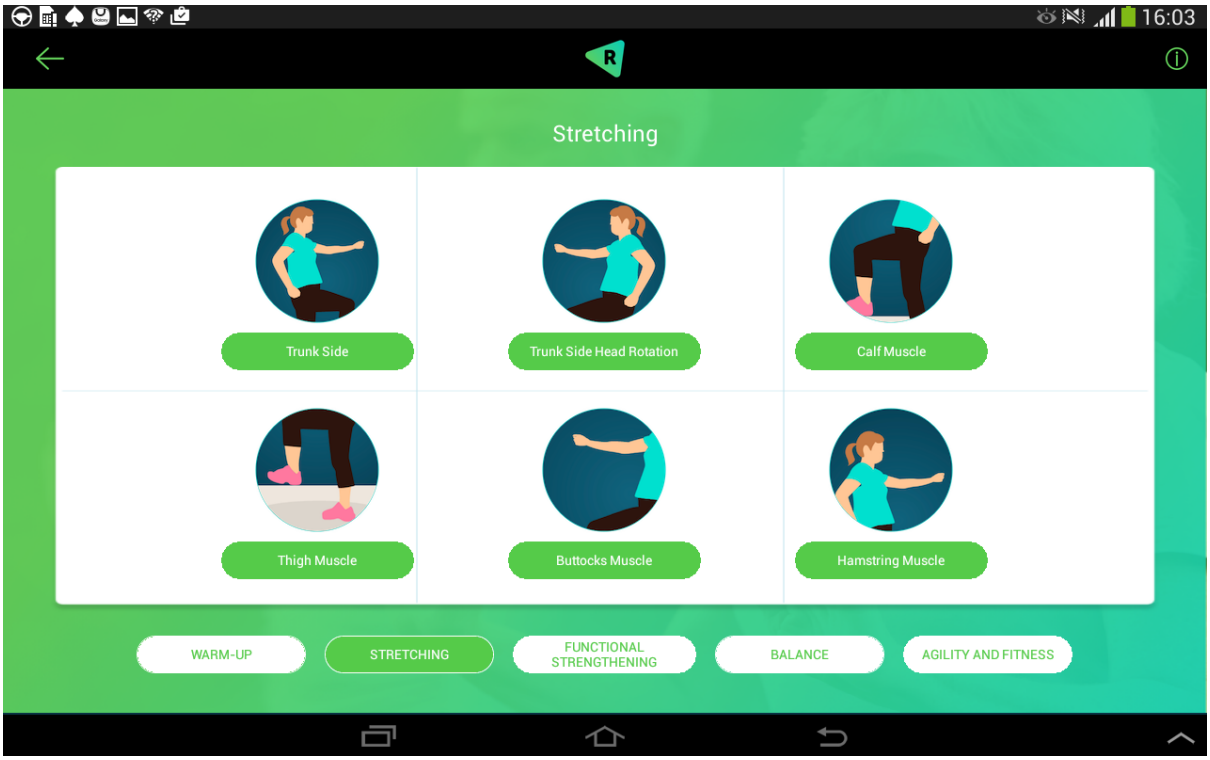


Figure 3.4 Selection of exercises in the *full prototype*

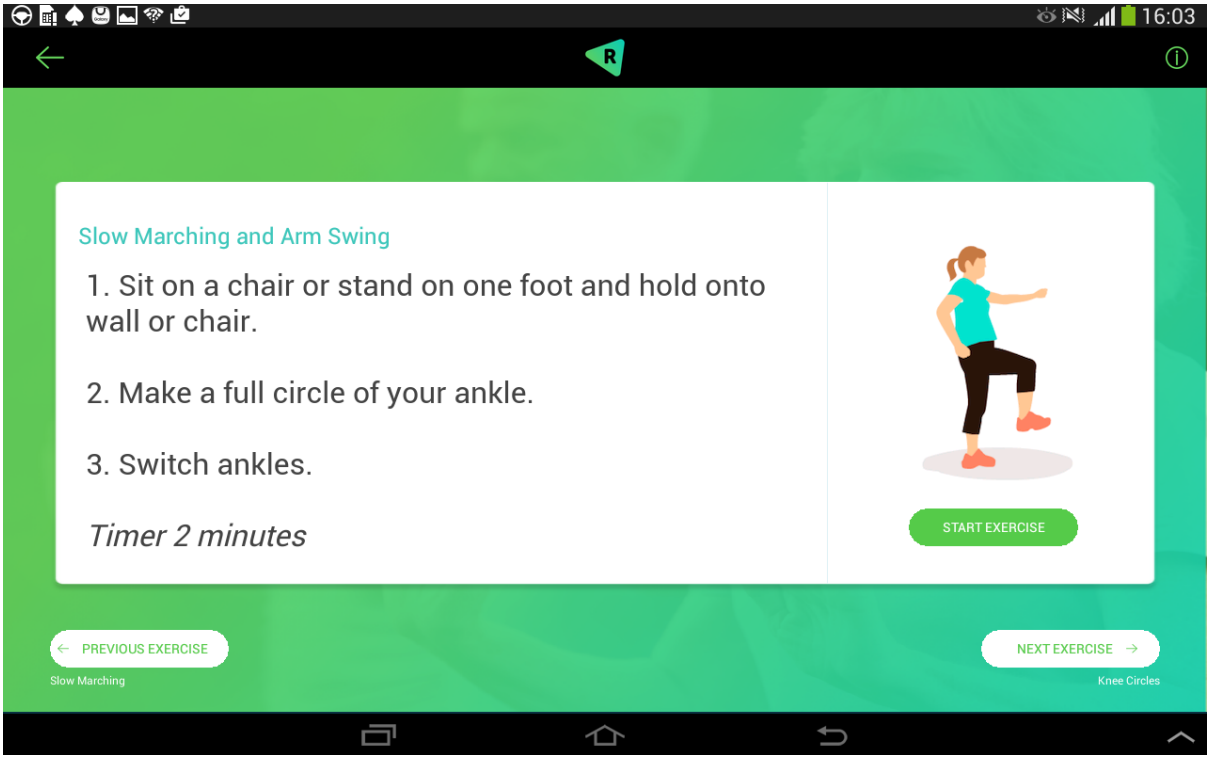


Figure 3.5 Instructions provided for a typical rehabilitation exercise in the *full prototype*

3.6.2 Future Development

Building on these existing prototypes, the *Regain* app will be iteratively evaluated and improved with users (stroke survivors) and carers. Future implementation will follow the process shown in Figure 3.6. The first step is to have focus groups comprised of stroke survivors and carers to introduce the full prototype of *Regain*. This will provide these important stakeholders with a venue to share their stories and have in-depth discussions about and the design of *Regain* and the benefits of mobile technology more generally, thus ensuring their current and future requirements are documented and addressed. Stroke survivors will be invited into the design process to work in focus groups to explore their experiences, collect feedback, and to continuously involve them in the design process. This will allow supervised interaction with the designed visual assets of the mobile platform. Participants will be invited to take home a tablet computer, loaded with the full prototype app, for an extended period. Then, data collection and analysis will take place after the full prototype of the *Regain* app has been used in clinical trials or home environments by users, to check their interactions with the app and gather their feedback. The *Regain* app will be refined based on the results from the data analysis and user feedback, and this will help in developing the final (commercial) app.

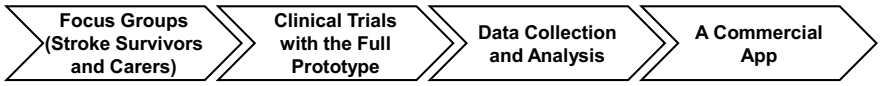


Figure 3.6 Illustration of the implementation process of the commercial app

3.6.3 Evaluation

At this stage, evaluation of functionality was achieved by face-to-face interviews with experts in the fields of UI design, clinical care, health informatics, software development, health behaviour psychology, health insurance, and health policy, as well as with stroke survivors (see Appendix I for details on the interview/workshop protocol). The mHealth literature supports the use of such a sample and taking an interdisciplinary approach (Burke et al.,

2015). In addition, the co-design approach requires the involvement of application-oriented practitioners who work in these mHealth contexts, encompassing industry, government, and technology viewpoints (Hevner et al., 2004). Existing networks within the University of Newcastle and Hunter New England Local Health District were used to identify and recruit participants, who were invited via email. Semi-structured interviews of approximately one hour in duration were used. Questions revolved around details of the prototype design, as well as more general questions about what elements or features were considered appropriate. Interviews were transcribed and coded according to thematic recurring elements. The thematic elements called for were: (1) user-created and customisable empathic avatars, as these assist user capability and motivation; (2) the appearance of the avatar should be similar enough to the user so that a connection can be made; (3) the avatar should not be too similar in appearance to make the user uneasy (as reflected in design principles P1–4).

These identified themes were taken into account in the iterative development of the above design principles and the co-design process. In relation to the design requirements, requirement R1 was met by the ability of the prototype to communicate medical advice. This directly addresses the psychological capability of stroke survivors (Michie et al., 2011). R3 was met by the technological innovation of presenting medical advice in this new format. The prototype was able to demonstrate the possibility of prompting stroke survivors to engage in rehabilitation activities, which can be performed in their own home care environment. R4 was met by the manner of the avatar-based training, which is designed to increase stroke survivors' motivation for sustained behavioural change. As to the other requirements, at present the prototype does not meet R2, which suggests that medical practitioners select the exercises. However, this is only a small addition to the *Regain* app and is planned to be included in the clinical trials. The current prototype also does not address R5, that is, to provide feedback to a medical practitioner. This is more of a challenge, but is planned for the

clinical trial. As for the specific design principles, feedback from the face-to-face interviews showed a high degree of convergence between the design principles and the operation of the prototype.

3.7 DISCUSSION

This section provides a summary of our findings, highlighting the interrelationships between the design requirements and principles which emerged from the multiple workshops for stakeholders. We also discuss the limitations of the current study and, based on these, we suggest possible directions for future research projects. Figure 3.7 maps the relationships between design principles and requirements that were developed while conducting this study. The relationships are set out in terms of how design requirements have been addressed by which design principles. As shown in Figure 3.7, R2 and R5 were not met by the current prototype of the mobile application, and we will return to these findings in later sections.

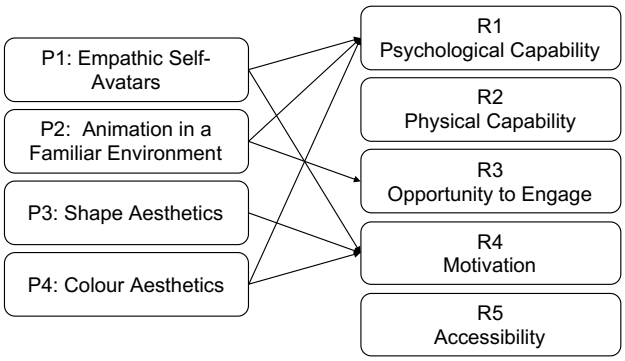


Figure 3.7 Mapping design principles with design requirements

3.7.1 Summary of Findings

Stroke has such a high prevalence in modern society that if this phenomenon was caused by an infection, it would be regarded as a pandemic (Marrero et al., 2012). Rehabilitation programs are employed to assist stroke survivors and promote recovery after leaving the hospital. In order to harness the full benefits of a rehabilitation program, it is important that stroke survivors are informed not only with written material, but also in other ways that are

entertaining and engaging. This is particularly challenging, as the general trend of an increase in NCDs will ultimately lead to a shift in responsibility from the collective to the individual, since treatment costs are rising unsustainably (Mladovsky et al., 2012). In addition, there is pressure on clinical personnel to discharge stroke survivors quickly from the hospital, increasing the risk of non-compliance with medical advice (Linder et al., 2013). As a consequence, there are issues with communicating information to stroke survivors as well as issues with depression and social impairment (Eslinger et al., 2002). This chapter uses a co-design approach to develop an mHealth prototype to support stroke rehabilitation. Based on behaviour change theory, it is designed to increase stroke survivors' psychological and physiological capability, motivation, and opportunity (Michie et al., 2011; Noorbergen et al., n.d.). The overall goal is for stroke survivors to receive better communication of health advice, become engaged with the rehabilitation program, and be motivated to follow that advice – all leading to better health outcomes.

First, based on workshops with design, health, and IT professionals, we identified five specific design requirements for a solution artefact (R1–5). The prototype has to impart the necessary skills and knowledge to stroke survivors that will assist them to build psychological capabilities, helping them understand how rehabilitation activities should be performed and what the benefits are (R1). In addition, the prototype has to suggest rehabilitation activities that are not too challenging for stroke survivors, while still helping them increase their physical capabilities (R2). The prototype has to create opportunities for stroke survivors to engage in the rehabilitation activities by changing their perception of their home care environment (R3). Also, the prototype has to increase motivation (1) indirectly through increased capability and opportunity, and (2) directly through attractive UI elements (R4). Importantly, healthcare professionals should also have access to the stroke survivors' data to allow progress to be assessed and adjustment made to the rehabilitation program (R5).

Second, we developed a set of specific design principles (P1–4) for the mHealth prototype in order to meet the identified requirements related to the interaction of the stroke survivor with the UI (R1, R3, R4). We proposed a new approach to the self-management of stroke rehabilitation in using a mobile device to assist with carrying out a rehabilitation program in a home care environment. This approach, which follows the co-design methodology, features frequent consultation with stakeholders (including stroke survivors, carers, clinicians, and IT specialists) to provide an end-product that meets the needs of its intended audience. An empathic self-avatar has been identified as a concept that will assist in creating a sense of emotional connection (i.e., attachment) with stroke survivors as well as a powerful medium to enable behaviour change (P1). In combination with the empathic self-avatar, animations in a familiar environment are used to increase the psychological capabilities of stroke survivors as well as provide an entertaining experience (P2). In a future extension of the prototype, one way to make the avatar more empathic might be to capture the user's facial expression with a camera and change the appearance of the avatar accordingly (Wei et al., 2004). Shape and colour aesthetics are used to deliver information to stroke survivors in friendly and engaging ways, designed to reduce anxiety and increase attention so as to keep stroke survivors engaged with their rehabilitation program (P3, P4). This is done not with static factual information, but through the medium of animated guidance of an avatar, which the user can identify with.

Third, we evaluated the effectiveness of the design prototype in workshops with multiple stakeholders such as carers, clinicians, health behaviour psychologists, and actual stroke survivors. To this end, a prototype was developed based on feedback from design, health, and IT professionals. Building on the early and full prototypes, future development and evaluation will include focus groups with stroke survivors and their carers, as well as clinical studies. The former will provide feedback on usability that will be used to improve the

prototype to the point of a commercially ready app, while the latter will provide clinical evidence of the efficacy of an intervention using the employed design principles (the comparison will be made to a control group that will receive only the conventionally used written instructions and line drawings). This approach will provide a positive experience for stroke survivors, which validates their importance and gives them a voice in the design of the next wave of rehabilitation assistance. In addition, this will provide knowledge to inform further research, including how avatars can help to convey various health messages, what kind of impact such technologies might have, and how the needs of stroke patients can be met.

3.7.2 Limitations and Future Directions

Our study must be seen in the light of several limitations. First, some functionality has not yet been implemented, because the design process has focused primarily on the UI for the stroke survivors rather than on data sharing, which requires consultation with additional stakeholders. This functionality relates to enabling healthcare professionals to select specific exercises and individually adjust the rehabilitation program (R2), and to assess and monitor the progress of stroke survivors (R5). However, these two functionalities are not crucial to the assessment of the empathic avatars, and are planned for inclusion in the commercial app. Second, the current design does not include 'serious' games (games designed for non-entertainment purposes; Staiano & Calvert, 2011) or gamification elements (the use of game design elements in non-game contexts; Deterding, Dixon, Khaled, & Nacke, 2011), which together might offer additional advantages to address user capability, opportunity, and motivation to engage in rehabilitation activities (Noorbergen et al., n.d.; Staiano & Calvert, 2011). Using game elements in the *Regain* app may add entertainment aspects for stroke survivors, which in turn may motivate them to follow the rehabilitation program and promote recovery. With certain avatars, a 5-minute gaming experience has been sufficient to reverse

behavioural patterns (G. Yoon & Vargas, 2014). A likely explanation is that immersion (Weinstein et al., 2009) derived from gaming experience imbues people with agency. Third, cultural aspects have not been included in the design of the visual assets in the *Regain* app. For instance, previous research has shown that culture may affect the meaning of colours and their influence on user perception and behaviour (Cyr, 2008). Hence, future research may explore how the colour schemes in apps for stroke survivors may need to be adapted for different cultures. The advantages and disadvantages of including these elements will be explored in focus groups with stroke survivors and their carers. Finally, the overall effectiveness of the prototype in improving the health outcomes of stroke survivors will have to be empirically established in clinical trials. Participants in the clinical trials will be invited to take a tablet computer loaded with the *Regain* app home for an extended period of time, after which a focus group will be held to gather feedback for refining the software.

3.8 CONCLUDING REMARKS AND CHAPTER SUMMARY

In this chapter, we noted that stroke is the second highest cause of death and disability worldwide. While rehabilitation programs are intended to support stroke survivors, and promote recovery after they leave the hospital, current rehabilitation programs typically provide only fixed written instructions and lack the ability to keep the survivor engaged with their rehabilitation program. This chapter explored how mobile technology may support stroke survivors in their rehabilitation program by providing an engaging experience and communicating information in an entertaining way by means of empathic avatars. We employed a co-design research approach, using qualitative workshops, to identify current problems of stroke rehabilitation programs. In turn, we developed the design requirements and principles of empathic avatars into a health application for stroke survivors, addressing their needs by incorporating the expertise of multiple stakeholders, including healthcare providers.

The use of a co-design approach is promising as it includes inputs from different disciplines and has ensured that stroke survivors, i.e., the potential users of the mobile application, have a say on the design of the *Regain* app, and makes sure that their requirements are addressed. Guided by these requirements, we developed design principles for the prototype pertaining to visual assets (i.e., the empathic avatars), which are essential in immersing users in the design. Importantly, the use of animated empathic self-avatars in a familiar environment, with warm colours and round face-like shapes, will help stroke survivors to increase their psychological and physical capabilities, as defined by the model of Michie et al. (2011). This will make sustained participation more likely. In addition, the *Regain* app facilitates recovery in a home care environment. Notably, we went through a two-stage development process by having workshops and follow-up interviews with experts. Following this, a prototype was developed and evaluated in a series of workshops with multiple stakeholders. Using such design principles will ensure that stroke survivors are motivated and engaged with their rehabilitation program.

Next, the following chapter presents the second qualitative study that aims to explore the design of avatars by taking into account the cultural background of users (in particular, Arab culture), unlike the more general study presented in this chapter.

Chapter 4: Exploring the Design of Avatars for Users from Arab Culture Through a Hybrid Approach of Deductive and Inductive Reasoning

CHAPTER 4 OVERVIEW

This chapter presents the second qualitative study in which Arab culture is considered for avatar design. Brief background information and the research question are first presented. After that, related work on UI design in Arab culture and avatar design in HCI is reviewed. Then, the full details of our qualitative methods, which include a hybrid approach of deductive and inductive reasoning and the proposed theoretical framework, are described. We then discuss the results of investigations into the design of avatars for users from Arab culture through conducting semi-structured interviews. A summary of the main findings appears at the end of the chapter.

4.1 INTRODUCTION

The previous chapter explored the design of empathic avatars in mobile health applications specifically for stroke survivors. We elicited design requirements based on the well-established behavioural change framework of Michie et al. (2011). Then, we developed design principles for empathic avatars to effectively engage stroke survivors in their rehabilitation programs. The development of these design requirements and principles was performed using a culturally neutral perspective. Further, the background and literature review chapter discussed how the culture of users is important for achieving an engaging user experience and better interactional outcomes. Some studies have already shown that representing the users and their cultures promotes positive outcomes. For example, representing the culture can induce trust (Fehrenbacher & Weisner, 2017; Tamborini et al., 2018), which, in turn, promotes usage intention (J. E. R. Lee & Park, 2011) and social presence (Hassanein et al., 2009). This chapter specifically addresses the fact that Arab culture has attracted limited attention in terms of avatar design. In the SLR (Chapter 2), we

found that Arab culture has been generally overlooked and has received limited attention in terms of avatar design. To the best to our knowledge, there are no well-established design guidelines for avatar design that could be used to inform avatar design and their implementations for users from Arab culture. Therefore, this chapter sets out to address this particular knowledge gap by adopting a qualitative method that aims to explore the design of avatars for users from Arab culture by a means of semi-structured interviews with three stakeholder groups. Here, we develop a set of design guidelines for avatar design that could, potentially, help designers and practitioners effectively implement avatars in Arab culture and provide a better engagement for Arab users.

The remainder of this chapter is organised as follows. In Section 4.2, we provide brief background information and motivation for conducting this study. In Section 4.3, we discuss previous research on designing UIs for Arab culture and designing (non-Arab) avatars in HCI. In Section 4.4, we describe the research methodology. Our integrative theoretical framework is then presented in Section 4.5. Based on thematic analysis of the interviews, we establish guidelines for designing avatars for Arab culture in Section 4.6. In Section 4.7, we discuss our findings and highlight the interrelationships between the identified design propositions and the developed design guidelines. Finally, we conclude this chapter in Section 4.8 with a summary.

4.2 BACKGROUND AND MOTIVATION

Recall that an avatar can be defined as "a perceptible digital representation whose behaviours reflect those executed, typically in real time, by a specific human being" (Bailenson & Blascovich, 2004, p. 64).[11] By employing human morphologies (e.g., human face, hair, eyes),

[11] The term "avatar" refers to a graphical representation that reflects human features. In the literature, there is a distinction whether this representation is for a human being or a computer agent (Bailenson & Blascovich, 2004), but for our research this is not the primary focus.

avatars play an important role in increasing the effectiveness of computer-mediated communication (Parks et al., 2014) and providing an engaging user experience (Fehrenbacher & Weisner, 2017; Sutcliffe & Alrayes, 2012). Previous studies have examined the use of avatars in different contexts including *health* (Beege et al., 2017; Sebastian & Richards, 2017), *education* (Barata et al., 2017; Carlotto & Jaques, 2016), *social interaction* (Felnhofer et al., 2018; Seo et al., 2017), *business* (Khashe et al., 2017; Kohonen-aho & Tiilikainen, 2017), and *entertainment* (Rosenthal-von der Pütten et al., 2019; Wasserman & Rittenour, 2019). While several of these studies have investigated the design of avatars as part of UI design for specific cultures, such as Asian (Seo et al., 2017) and Western (Beege et al., 2017), or considered a culturally neutral design (e.g., Aljaroodi, Adam, Chiong, Cornforth, & Minichiello, 2017; Bacev-Giles & Haji, 2017), no prior research has looked into design guidelines of avatars from an Arab perspective.[12]

In recent years, there has been an increasing use of avatars by Arab users. An example is shown in Figure 4.1, where the Saudi Students Club in London employed an avatar that resembles elements of Arab culture to convey information about a student competition.[13] Is the avatar in the figure appropriately designed for the target user group? Given the Arab context that the avatar is in, intuitively it seems that the answer is yes. To date, however, there has been no empirical evidence or design guideline available to support this conjecture. Clearly, the knowledge base for designing such avatars is limited and needs to be addressed.

Previous research on UI design has clearly emphasised the importance of taking into account users' culture and values (Borning & Muller, 2012; Yusof & Zakaria, 2007) for achieving an engaging user experience and increasing the intention to use. It has been shown that not considering a user's culture can lead to adverse outcomes (Hassanein et al., 2009),

[12] Arab culture here refers to culture that originates from countries located in the Middle East and North Africa (MENA), where Arabic is the primary language (Office of the Deputy Cheif of Staff for Intelligence, 2006).
[13] https://twitter.com/LonSSCUK/status/1086362094247788552

and that users feel psychologically disconnected and detached from the virtual environment when their cultural background is not represented (J. E. R. Lee & Park, 2011). While we acknowledge that research on avatar design based on Asian and Western cultures has provided valuable theoretical and practical insights and findings, it is unclear how these findings can be translated into guidelines for Arab avatar design, considering that Arab culture is known to have *high uncertainty avoidance* and *high power distance* (Hofstede et al., 2010). To the best of our knowledge, only a few studies have utilised Arab avatars in their work (e.g., see Bente, Dratsch, Kaspar, et al., 2014; Pepe & Santarelli, 2009; Šisler, 2006), but no research has focused on avatar design from a cultural perspective.

Figure 4.1 An example of a male avatar used in social media by Arab users (the image is used with permission from the Saudi Students Club in London; see Appendix H)

This chapter addresses this gap by conducting an exploratory study to inform the design of avatars for Arab culture. We followed a hybrid approach of deductive and inductive reasoning. Firstly, we reviewed the body of previous literature on designing UIs for Arab culture and designing (non-Arab) avatars in human–computer interaction (HCI) research (deduction). This body of literature enables us to (1) derive propositions that shed light on the theoretical pathways of how avatar design may affect user perception, and (2) identify stakeholder groups in the context of designing avatars for Arab culture. Secondly, building on this theoretical groundwork, we conducted 32 exploratory semi-structured interviews with the identified stakeholder groups (Arab culture experts, psychologists, and potential users),

leading to the development of six guidelines for designing avatars for Arab culture (induction). Through this study, we hope to contribute to the design of more effective avatars for users from Arab culture and address the overarching and third research question (RQ3) of this research project:

> **RQ3**: *How can avatars for Arab culture be employed by system designers in UI design?*

4.3 RELATED WORK

This section provides an overview of the literature on designing UIs in Arab culture. Here, we discuss how UIs can be designed for Arab culture in terms of design concepts and elements derived from an Arab user's social environment and the colours commonly used in UI design. Further, we discuss the theory for exploring and understanding human–avatar interactions as well as avatar design in the field of HCI. Finally, we discuss in more detail the gap that we wish to fill in this chapter and justify the need to explore avatar design by taking Arab culture into consideration.

4.3.1 User Interface Design for Arab Culture

System designers often include cultural elements in web interfaces ("cultural user interfaces," Yeo, 1996), since culturally appropriate design is found to positively affect user perception and behaviour (Moriarty, 1994). In particular, cultural appropriateness can capture sensitivity to a specific culture by "matching intervention materials and messages to observable characteristics of a target population" (Resnicow et al., 1999, p. 10). This may involve visual cultural elements such as imagery of people and locations that characterise a particular cultural group (Resnicow et al., 1999). Scholars refer to these elements as "culture attractors" (Smith et al., 2004) or "cultural markers" (Barber & Badre, 1998; Mushtaha & De Troyer, 2012).

For consistency, we use the term *cultural markers* throughout this chapter, referring to "interface design elements and features that are prevalent, and possibly preferred, within a

particular cultural group" (Barber & Badre, 1998, p. 5). Broadly speaking, there are two types of cultural markers. Firstly, *digital cultural markers* are UI design elements such as colours, colour combinations, images, layouts, or language cues that are "specific to a given culture" (Sun, 2001, p. 96). Secondly, *social cultural markers* involve customs, morals, traditions, and values that arise from a user's physical environment, such as their family, friends, and religion (K. -hsu. Huang & Deng, 2008).

In the context of Arab culture, Singh et al. (2008) found that Arab users have a strong preference for websites that include digital markers of their culture. Hence, rather than adopting a generic design from another culture, systems designed for Arab users should take into account their cultural background. Abdallah & Jaleel (2013) found that users from the United Arab Emirates (UAE) considered culturally oriented web pages to be more attractive, likeable, and user-friendly. Specifically, they identified UI design elements related to the country's identity (e.g., UAE flag and its colours) as well as imagery representative of the user's cultural environment (e.g., landmarks, native clothes) as facilitators for user willingness to use the website and increase the website's credibility. There is also evidence that Muslims[14] are more likely to buy from a website that represents their religion compared to a neutral or Christian site (Siala et al., 2004).

Another important cultural marker is clothing and its connection to gender in digital imagery. Khanum et al. (2012) found that most Arab-oriented websites have male images, and only a few have both males and females. Females typically wear a traditional veil, *abaya*, that reflects the social culture of Arab users. Alomar et al. (2016) noted that Arab users prefer to be represented by images that reflect how they dress and look culturally in terms of facial

[14] According to Pew Research Center (2009), about 95% of the populations in Arab countries are Muslim, and hence Arab culture is strongly influenced by the values and norms of Islam. Being the most common religion within the Arab region, values and norms related to Islam are common elements in the literature on cultural interfaces for Arab users. Despite the close relationship between the two, however, we need to be mindful that these two terms – Arab and Muslim – cannot be used interchangeably (Georgia, 2013).

hair for male users and hijabs for female users. Khashman & Large (2013) found that images with revealing clothes are perceived as inappropriate digital cultural markers for conservative Arab users, as they do not reflect their social culture.

As another vital digital cultural marker, scholars have found that colours employed for Arabian websites are usually slightly darker compared to websites from Western countries (Marcus & Hamoodi, 2009). For instance, blue is a dominant colour in Arabian websites (Marcus & Hamoodi, 2009), and is typically used as a menu background colour (Khanum et al., 2012). Green and blue are dominantly used in the design of logos and symbols (Khanum et al., 2012). White, which represents purity and peace in Arab culture, is frequently used as a background colour and also as a menu font colour (Khanum et al., 2012).

4.3.2 Social Response Theory and Avatar Design in Human–Computer Interaction

The CASA paradigm by Nass et al. (1994) is often used as the main theoretical underpinning for designing avatars in HCI. Emerging from the CASA paradigm, SRT (Moon, 2000; Reeves & Nass, 1996) states that people tend to consider computers as social actors (Bailenson & Blascovich, 2004; Guadagno et al., 2007; Nass & Moon, 2000; Nass et al., 1994). In other words, SRT posits that users apply social responses and behaviours when interacting with computers (Reeves & Nass, 1996; J. E. R. Lee & Nass, 2010). Accordingly, designers often employ human-like characteristics in interfaces to positively affect users' perceptions and behaviours (Leding et al., 2015; Wrzesien et al., 2015; Yee & Bailenson, 2007), as these perceptions play an important role in a person's intention to use an avatar (S. Lee & Choi, 2017).

In the realm of human–avatar interaction, a central psychological construct is *social presence*, which can be understood as "a social factor, specifically addressing the feeling of being present with another person in a virtual environment" (Allmendinger, 2010, p. 41). In order to engender social presence in human–avatar interaction, the design of the avatar

should be perceived to be similar to the user, both physically (S. J. Ahn & Bailenson, 2011; Seo et al., 2017) and psychologically (Leach et al., 2008). For simplicity, *perceived similarity* here refers to the physical similarity (e.g., clothing, skin colour) between a user and an avatar (Suh et al., 2011; Wrzesien et al., 2015), and *homophily* is the perceived psychological similarity between individuals and objects (e.g., similar aspirations, belief systems, norms, and values) (McCroskey et al., 1975; Nowak & Rauh, 2006). *Familiarity*, on the other hand, refers to knowledge and experience drawn from previous interactions of the user with their environment (Komiak & Benbasat, 2006). To this end, a person might look familiar to a user even though they do not look similar to them.

Avatars that are similar to users are perceived as more sociable, enjoyable, and useful to interact with than dissimilar ones (Bacev-Giles & Haji, 2017; Qiu & Benbasat, 2010; Seo et al., 2017). For example, avatars designed to resemble the facial features of their users can elicit greater engagement compared to dissimilar avatars (Blascovich & Bailenson, 2011). Bessière et al. (2007) found that users tended to design avatars that represented their ideal self, that is, similar to themselves, but with more favourable attributes. Via similarity, an avatar can even reveal information about the personality of the user behind it (e.g., agreeableness, extraversion; Bélisle & Bodur, 2010). Research has also shown that users tend to behave more cooperatively with avatars that are visually and psychologically similar to them (Fogg, 2003), and that users are more affected by a person that appears psychologically similar to them and identified as being a member of their group (Leach et al., 2008). Likewise, it has been shown that familiarity yields higher levels of social presence and trust for users compared to interacting with avatars that are unfamiliar to them (Liew, Tan, & Ismail, 2017; Komiak & Benbasat, 2006). In contrast, interacting with avatars that do not reflect the user's ethnicity is rated as less trustworthy compared to interacting with avatars that do (Tamborini et al., 2018).

Another way to stimulate social presence is to employ anthropomorphic avatars, or avatars with human-like features (Hanus & Fox, 2015; Seo et al., 2017). *Anthropomorphism* refers to an avatar's degree of humanness, that is, "the extent to which an image is perceived to resemble human characteristics and has human morphology" (Nowak & Rauh, 2006, p. 154). Information provided by an avatar is more credible (Y. Kim & Sundar, 2012a; Nowak & Rauh, 2008), convincing (Waddell et al., 2016), and influential (Hanus & Fox, 2015) if its features are consistent with those of human beings. Inappropriately dressed avatars, on the other hand, are rated as less anthropomorphic and less credible (Nowak et al., 2015). When it comes to interactive advertisements, users perceive product messages from human-like avatars as more informative than messages from non-human avatars (Jin & Bolebruch, 2009).

Androgynous avatars refer to avatars that have both masculine and feminine features, making it difficult to categorise them as either male or female (Nowak & Rauh, 2008). Androgynous avatars are found to reduce the associated user's credibility (Nowak & Rauh, 2008). Users pay more attention within a virtual environment when avatars reflect their own gender as compared to the opposite gender (Martens et al., 2018). In addition, users interacting with avatars that reflect their own gender exhibit higher perceptions of physical similarity and homophily compared to interacting with avatars that reflect the opposite gender (Ferchaud & Sanders, 2018).

4.3.3 Designing Avatars for Users from Arab Culture

From the previous sections, it is clear that much work has been done on UI and avatar design in HCI. Existing research on avatar design, however, has predominantly focused on users from Asian and Western cultures. Even though there are abundant findings and insights about the importance of specific design aspects and psychological constructs (e.g., familiarity, homophily, similarity), it is unclear whether and how these findings and insights can be translated to users from Arab culture. Indeed, designing interfaces or avatars for a specific

culture and applying them to a different culture requires more than just translation and pictures – it demands attention to the entire range of social and cultural norms in that specific culture (Katagiri et al., 2001). This may explain why users tend to reject avatars that are perceived as foreign (Schneider et al., 2017). For example, English-speaking avatars used in non-English speaking countries are treated as foreigners (Katagiri et al., 2001). When users interact with avatars that do not reflect their cultural background, users become psychologically disconnected and disengaged (J. E. R. Lee & Park, 2011).

Several studies have suggested the use of genderless (e.g., Nowak & Rauh, 2006) and culture-neutral avatars (Aljaroodi, Adam, et al., 2017; Y. Kim & Sundar, 2012a; Kwon et al., 2013). However, these design concepts may increase the level of uncertainty for Arab users, as Arab culture is known to have high uncertainty avoidance (Hofstede et al., 2010). Among the limited work on avatars for Arab users, Pepe & Santarelli (2009) and Šisler (2006) explored how Arab people are represented in digital games through the eyes of Western culture. Both studies included male avatars that were designed stereotypically. Bente, Dratsch, Kaspar, et al. (2014) found that Arab-looking avatars increase the level of trust for Arab users in an online trust game, but they did not discuss the design considerations for such avatars. Yusof & Zakaria (2007) and Abdallah & Douglas (2010) investigated digital game environments and suggested that in order to create a more appealing experience for Arab users, female avatars should be designed with a headscarf and modest clothing. While these findings shed light on the importance of clothing and clear gender classification for Arab users, to the best of our knowledge no other research has set out to comprehensively explore the design guidelines for Arab avatars. Furthermore, no relevant research has considered the expertise of Arab culture experts, psychologists, and users with experience in Arab culture.

4.4 RESEARCH METHODOLOGY

Despite the widespread use of avatars in HCI, there is little work aiming to better understand how avatars should be designed for users from Arab culture. To bridge this gap, this chapter employed an exploratory study and a hybrid approach that employs both deductive and inductive reasoning (Gregory & Muntermann, 2011). According to Trochim (2006), deduction starts with the general and moves to the specific, while induction moves from the specific to the general. In other words, deductive reasoning is based on concepts, while inductive reasoning is acquired empirically. Creswell & Clark (2017) state that the deductive approach is top-down, from theory to data. In contrast, the inductive approach is a bottom-up method, requiring participants' opinions to emerge from broad themes and generate theory by finding relationships between themes. Our hybrid approach allows us to build on the established literature about designing UIs for Arab culture and about incorporating theoretical aspects for designing avatars in HCI (CASA paradigm), while at the same time exploring a range of design recommendations based on the views of multiple stakeholders from different backgrounds.

4.4.1 Deduction: Development of an Integrative Theoretical Framework

In our deductive approach, we build on the extant literature on designing interfaces for Arab culture and designing avatars in HCI (see Sections 4.2) to investigate the theoretical pathways of how avatars can be designed for Arab culture, and conceptualise these pathways within a theoretical framework. This theoretical framework was iteratively developed in several workshops involving the PhD candidate and his supervisors, and presented for discussion at the Australasian Conference on Information Systems 2017 (Aljaroodi, Chiong, et al., 2017). We also built on the CASA paradigm developed by Nass et al. (1994) as the backbone for the development of the framework. Based on a set of propositions derived from the literature on UI design in Arab culture and avatar design in HCI, the framework

conceptualises the different ways by which avatars for users from Arab culture can be designed.

4.4.2 Induction: Qualitative Interviews

In our inductive approach, we built on the proposed framework and conducted semi-structured interviews to develop general design guidelines for creating Arab avatars. To enable a meaningful structure for the interviews, we used the case of avatars in mobile health (mHealth) as an example application area to develop the interview guide. mHealth is the process of health care and practice supported by mobile devices to manage an individual's health related information (WHO, 2011b). It is often seen as an important application area of avatars because of its potential to deliver and support personalised health services (Noorbergen et al., 2019).

4.4.2.1 Sampling

Based on our review of the literature, we identified the following stakeholder groups for the interviews: Arab culture experts (ACE), psychologists (PSY), and potential users (U). The ACE and PSY groups were recruited by conducting an Internet search on Google, Google Scholar, and LinkedIn for individuals with expertise in the respective areas (according to their experience, study, or exposure to Arab culture; see Table 4.1 for details of the participants' backgrounds). These individuals were contacted by the PhD candidate via email with information about the study to seek their consent to participate (see Appendix B). More specifically, the ACEs were recruited because of their specific expertise in Arab culture, while the PSYs were recruited based on their understanding of psychological processes and their individual experience with Arab culture. The U group was solicited from two different mailing lists consisting of users with an Arab cultural background, and were recruited due to their exposure to Arab culture in their social life. Participants were considered recruited if

they returned their filled consent form. Participation was entirely voluntary and did not involve any monetary reward or other compensation.

Table 4.1 Participants' background information

Stakeholder	ID	Background	Gender
Arab Culture Experts (ACE)	ACE01	Designer who has experience with Arab customers for more than 5 years	Male
	ACE02	Professor at a public training institute in an Arab country for more than 10 years	Male
	ACE03	Professor in Arab culture and language at a Western university for more than 10 years	Female
	ACE04	Lecturer at a public training institute in an Arab country for more than 10 years	Male
	ACE05	Visual communications designer at a private company in an Arab country for 5 years	Female
	ACE06	Professor in Arab and Islamic culture at a Western university for 5 years	Male
	ACE07	Professor working as cultural expert at a Western university for more than 20 years	Male
	ACE08	Expert as a user experience designer at a private company in an Arab country for more than 10 years	Male
	ACE09	Professional designer at a private company in an Arab country for 5 years	Female
	ACE10	Arab language and culture tutor at a Western university for 5 years with previous experience working in different Arab countries	Female
Psychologists (PSY)	PSY01	Psychologist working at a private clinic in an Arab country with Arab patients for more than 5 years	Female
	PSY02	Psychologist working at a public company in an Arab country with Arab patients for more than 3 years	Female
	PSY03	Psychologist at a Western university for more than 2 years	Female
	PSY04	Psychologist working in a private clinic in an Arab country with Arab patients for more than 6 years	Female
	PSY05	Psychologist working in a private clinic in an Arab country with Arab patients for more than 5 years	Female
	PSY06	Psychologist working in a private clinic in an Arab country with Arab patients for more than 8 years	Female
	PSY07	Professor of psychology at a Western university for more than 15 years with Arab cultural background	Male
	PSY08	Psychologist working in a private clinic in an Arab country with Arab patients for more than 5 years	Female
	PSY09	Psychologist at a private clinic in an Arab country for more than 5 years	Female
	PSY10	Psychologist at a private clinic in a Western country for more than 8 years and has an Arab cultural background	Female
	PSY11	Senior psychologist at a private clinic in an Arab country for more than 10 years with Arab patients	Female
Potential Users (U)	U01	Professional staff member at a public company in an Arab country	Male
	U02	Student at a public university in an Arab country	Male
	U03	Professional staff member at a private company in an Arab country	Male
	U04	Professional staff member at a public company in an Arab country	Male
	U05	Professional staff member at a public company in a Western country with experience in Arab culture	Female
	U06	Professional staff member at a public company in an Arab country	Male
	U07	Student at a public university in an Arab country	Male
	U08	Student at a public university in a Western country with an Arab cultural background	Male
	U09	Student at a public university in a Western country with an Arab cultural background	Female
	U10	Student at a public university in a Western country with an Arab cultural background	Female
	U11	Professional staff member at a public company in an Arab country	Male

To take part in the study, participants needed to be at least 18 years old and have sufficient English proficiency to engage in an in-depth interview in English. Data collection and analysis (see Sections 4.4.2.3 and 4.4.2.4 for details) ran concurrently. The recruitment process continued until a saturation point where no further unique themes emerged from the

analysis (i.e., inductive thematic saturation; Saunders et al., 2018). At the point when no further themes emerged in the interviews that were scheduled, we concluded that the final sample of 32 interviews (17 females and 15 males) was sufficient for our study. Table 4.2 summarises the number of interviews as well as interview length for each stakeholder group. All participants were from an Arab background except for one ACE and one potential user who came from a Western culture. This study was approved by the ethics committee at the University of Newcastle, Australia (approval number: H-2017-0177).

Table 4.2 Interviews' summary table

Stakeholder Group	Number of Interviews	Interview Length
Arab Culture Experts (ACE)	10 (4 female, 6 male)	25 to 45 minutes
Psychologists (PSY)	11 (10 female, 1 male)	20 to 45 minutes
Potential Users (U)	11 (3 female, 8 male)	15 to 35 minutes
Total	32 (17 female, 15 male)	15 to 45 minutes

4.4.2.2 Procedure

An information statement (see Appendix A for detail) informed participants about the topic of the interview, and that the interview would be audio-recorded and transcribed. Individuals who expressed interest in participating in the study were interviewed by the PhD candidate at a mutually convenient time. Depending on the location and preference of each participant, the interviews were conducted either face-to-face or online via video conferencing. In the end, 13 interviews were conducted face-to-face and 19 were conducted online. In order to minimise potential inconsistencies between face-to-face and online interviews, the PhD candidate made sure that all interviewees had access to the same documents (i.e., definitions of terms, example avatars, and the information statement) and closely followed the same interview guidelines (see Appendix D for details of the questions). After the interviews were complete, the transcripts were carefully checked for potential differences in responses from face-to-face compared to online participants. No systematic differences were identified between the cohorts.

Before the interview began, the PhD candidate ensured that the interviewees were familiar with the terms used in the questions. Specifically, the PhD candidate provided each participant with a list defining key terms (e.g., avatars, mHealth) and a set of example avatars to illustrate the respective concepts. These example avatars were collated from imagery that had been published in some existing avatar studies (i.e., A. Davis et al., 2009; Fox et al., 2013; Groom et al., 2009; Jin, 2010; Kwon et al., 2013; Leding et al., 2015; Nowak & Rauh, 2008; Qiu & Benbasat, 2009, 2010; Song, Kim, Kwon, et al., 2013; Suh et al., 2011; Wrzesien et al., 2015). The interviewees were encouraged to ask any questions they might have about these terms and concepts before the start of the interview. The PhD candidate also informed the interviewees that they could ask questions during the interview to prevent any potential misunderstanding. All interview participants confirmed that they were familiar with the concept of mHealth.

The interviews were of a semi-structured nature, with the interviewer using a protocol composed of open-ended questions (see Appendix D for detail) and probing for additional information when required. Every interview was centred around the framework with the goal of developing design guidelines for Arab avatars. Participants were first asked to describe how they would visualise Arab avatars (e.g., for an mHealth system), considering physical attributes such as skin colour, eye colour, and clothing for typical Arab male and female users. Open-ended questions were asked to give the interviewees opportunities to speak freely and to guide the discussion in directions of interest. At the end of each interview, participants were thanked for their involvement in the study.

4.4.2.3 Data Collection

The entire interview data collection process was carried out between October 2017 and March 2018. The interviewees received a one-page information statement via email before the interviews. This statement included information on the following points: the study

purpose (design of avatars for Arab culture), planned interview duration of up to 60 minutes, and assurance the data would only be used for research purposes in an anonymised form. Then, before the interviews started, participants were given the opportunity to ask questions regarding the study's objectives and were assured that their identities would remain confidential. The PhD candidate conducting this research project transcribed all the interviews in English.

4.4.2.4 Data Analysis

The audio-recorded interviews had a total duration of more than 15 hours (86,589 words). In order to develop the design guidelines, the PhD candidate and one of the supervisors of this research project coded the transcripts following the procedure of Braun and Clarke (2006). Braun and Clarke's thematic analysis consists of a number of steps including 1) familiarisation with the data, 2) coding, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) writing up. NVIVO was used to code the transcripts. Initially, we identified 58 codes from all the interviews (e.g., eye colour, modesty in clothing, landmarks). We carefully read and colour-coded the transcripts using thematic analysis to identify themes for developing the design guidelines (e.g., Arab cultural markers, colours). These codes and themes were then checked by the supervisors, validated against the interview data, and linked to the psychological constructs in the theoretical framework. After that, in several meetings and discussions between the PhD candidate and his supervisors, the identified themes became the foundation of the design guidelines, which were further iteratively improved. We provided the final design guidelines via email to all interview participants for feedback. These final design guidelines can be found in Section 4.6. Examples of our coding are illustrated in Table 4.3.

Table 4.3 Examples of our coding

Example	Code (first order)	Theme (second order)	Psychological constructs
"The user would relate to the location and would be familiar with the location." (ACE07)	Locations [landmarks]	Arab cultural markers	Anthropomorphism, Familiarity, Social presence
"Arabian background would be like feeling more in town." (PSY11)			
"The hijab is definitely a key element and I think it is a good selling point. It definitely will engage the vast majority of the Arabs, even though there are a number of Muslims in our country or other countries who do not wear hijab." (ACE08)	Cultural clothing		Cultural appropriateness, Homophily, Similarity, Social presence
"I see avatars in hijab or thobe, wearing our traditional clothes. This is what I see about the avatar in our culture." (From U03)			
"Avatar that is similar to human increases similarity, that would increase with cultural clothing like hijab or thobe." (U09)			
"I think if you are trying to find the happy medium there, definitely the avatar's arm covered, and the leg covered" (ACE07)	Modesty in clothing		Cultural appropriateness
"The majority of people in this region have brown eyes, darker hair, that should be taken into account" (PSY04)	Eye colour	Colours common in Arab culture	Familiarity, Homophily, Similarity
"I would feel closer [similar] to an avatar that is dark-haired for example." (ACE03)	Hair colour		
"I think about the colours, you know in Arab countries in the Middle East, the colour for the skin is like brown and something like that. Not really white, like brown skin." (U04)	Skin colour		
"I think you have to make distinctions between females and males." (U04)	Clear gender	Non-androgynous design	Anthropomorphism, Homophily, Similarity, Social Presence
"I want to know what I am seeing, and I want to know exactly who I am talking to. Genderless takes some sort of reality away, and I like to maintain that reality." (ACE08)			
"The avatar should have a clear gender classification because the main idea is that the avatar should represent me, something from me." (PSY02)			
"The avatar should have a clear gender classification because […] the avatar should similar to me to encourage me, it would represent even myself image, body image." (PSY02)			
"Showing that this is a female, and this is a male is going to help a lot and increase the social presence." (U01)			

4.4 THE FRAMEWORK

The development of our framework was informed by a review of the existing literature on designing avatars in HCI research and designing Arab culture-oriented UIs. Based on the CASA paradigm, we have already discussed (Section 4.3) how different design dimensions of an avatar affect users' perceived anthropomorphism, cultural appropriateness, familiarity, homophily, similarity, and social presence. These pathways are the underlying building blocks of our framework, as can be seen in Figure 4.2. Further, we built on existing research on UIs for Arab culture (see the left part of Figure 4.2).

In our framework, we argue that the use of colours that are common to Arab culture (P1) and the use of Arab cultural markers (P2) will increase the perception of homophily, similarity, and familiarity with the avatars. In addition, Arab cultural markers (P2) increase the perception of anthropomorphism, cultural appropriateness, and social presence of avatars. Non-androgynous avatars (P3) increase the perception of anthropomorphism, similarity, homophily, and social presence between users and avatars. We specifically selected these propositions for three reasons. First, P1, which is heavily discussed and used in designing UIs in Arab culture, was included to capture the notion of digital culture (Mushtaha & De Troyer, 2012) for Arab users. Second, P2 was included because of the notion that avatars can also convey elements of the social culture related to their physical environment (K. -hsu. Huang & Deng, 2008). Third, P3 was included to reduce uncertainty in avatar design for Arab users (Hofstede et al., 2010).

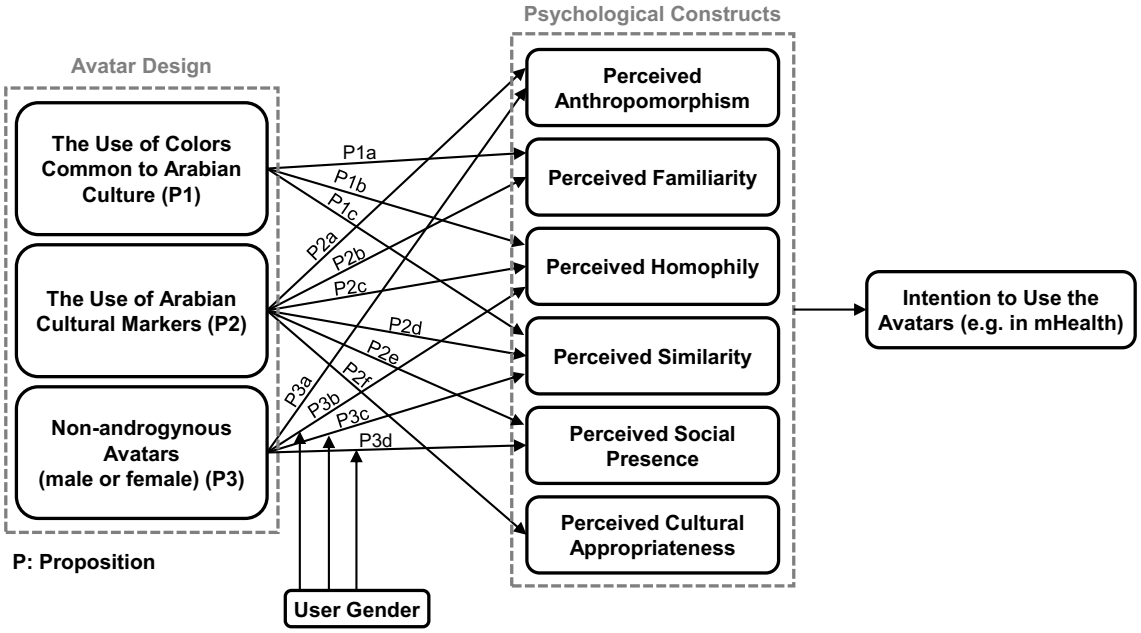


Figure 4.2 An integrative theoretical framework for designing avatars in Arab culture

While understanding the impact of avatar design on user perceptions (e.g., cultural appropriateness, similarity, social presence) is essential to facilitate a positive user experience, these perceptions can also support positive attitudes towards the avatar in terms

of increased usage intention. Hence, our framework also includes a link between the identified constructs and the user's *intention to use* the avatar. Previous research has found that human-like avatars (Nowak et al., 2009; Nowak & Rauh, 2006; Qiu & Benbasat, 2009) yield higher social presence (Qiu & Benbasat, 2009), which leads to higher usage intention (Nowak & Rauh, 2006; Qiu & Benbasat, 2009). Research has also found that higher (visual) similarity and homophily between users and avatars, as well as familiarity in terms of previous experiences and interactions (Komiak & Benbasat, 2006), can lead to higher usage intention (Li & Lwin, 2016; Nowak et al., 2009; Nowak & Rauh, 2006; Suh et al., 2011). Lastly, use of culturally appropriate design, catering specifically to the user's cultural background, has also been found to facilitate adoption and usage intention (Papadimitropoulos et al., 2015).

The following subsections elaborate on details of the propositions in our framework and their relationship to psychological constructs.

4.5.1 Colours in Avatar Design for Arab Users (P1)

Using colours that are common in Arab culture is likely to increase users' perceptions of familiarity, homophily, and similarity (K. -hsu. Huang & Deng, 2008). For example, the use of black for an avatar's hair and eyes may positively affect these psychological constructs because, according to Hasan et al. (2012), black or darker colours (such as brown) are common for Arab users' hair and eyes. Grewal (2009) also noted that the majority of people from Arab culture have darker skin ('*asmar*' colours[15]).

The colours of blue, green, and white are often found in Arabian-oriented UI designs (Marcus & Hamoodi, 2009). Hence, to be part of the users' digital culture, use of these colours for Arab avatar design (e.g., clothing) is likely to increase their perceptions of familiarity, homophily, and similarity. Specifically, white is frequently used as a background

[15] Asmar is an adjective and refers to the brownish skin colour of Arab people.

colour in Arabian websites (Khashman & Large, 2011) because it represents purity in Arab culture (Khanum et al., 2012). Blue and green are dominant in the design of logos in Arabian websites (Khan & Alhusseini, 2015; Khanum et al., 2012; Marcus & Hamoodi, 2009). Green-coloured items represent strength and generosity (Alomar et al., 2016), and blue is associated with protection (Khanum et al., 2012). It is also argued that multiple colours can be used in logos and images, but designers should include the dominant colours in their design (Al-kwai et al., 2014). The above leads to our first proposition:

> **Proposition 1 (P1):** *Employing colours (green, blue, and white for clothing, and darker colours for skin, hair, and eyes) that are commonly found in Arab culture in avatar design increases Arab users' **(a)** perceived familiarity, **(b)** perceived homophily, and **(c)** perceived similarity.*

4.5.2 Cultural Markers in Avatar Design for Arab Users (P2)

Cultural markers are used to facilitate user engagement in HCI (Barber & Badre, 1998; Mushtaha & De Troyer, 2012). Due to the implicit link to the user's culture, employing cultural markers in avatar design is likely to increase users' perception of anthropomorphism, cultural appropriateness, familiarity, homophily, similarity, and social presence. For example, modesty and appropriateness play an important role in the design of UIs in Arab culture (e.g., Abdallah & Douglas, 2010). Hence, we expect that avatar design for Arab users needs to take into account modesty and appropriate clothing. The use of traditional clothing from Arab countries is likely to not only increase users' perceived similarity and familiarity with the avatar, but also their perception about whether the avatar is culturally appropriate.

Kritz & Shonfeld (2013) noted that users usually represent themselves online with avatars that are socially acceptable. Khanum et al. (2012) found that images of females on websites in Arab culture are usually clothed with an abaya, which covers their body. Similarly, many females in Arab culture wear a hijab because of cultural tradition (Shakir, 1997). Here, the use of abaya or hijab for female avatars (Yusof & Zakaria, 2007) and thobes for male avatars (Winter Jr & Chevrier, 2008) enables system designers to include cultural markers that

represent the social culture of Arab users, thereby adding a sense of *cultural appropriateness* to the avatars (K. -hsu. Huang & Deng, 2008).

In addition to clothing, system designers can also employ cultural landmarks from Arab culture (e.g., in the background of the avatar). Singh et al. (2008) found that including landmarks from the user's country in website design can create a perception of being within the social culture. For instance, websites that include landmarks from the UAE increase users' perceived likability of those sites (Abdallah & Jaleel, 2013). Hence, the use of landmarks from Arab culture may increase users' perceived familiarity with the avatar.

In general, users are more affected and influenced by an avatar that represents an authoritative figure (Jesse Fox et al., 2013). In the case of mHealth, for instance, authoritative figures such as doctors, nurses, or personal trainers can be considered to represent authority. Arab culture in particular is categorised as 'high power distance' in the Hofstede cultural model (Hofstede et al., 2010). This indicates that Arab users are likely to exhibit a higher intention to use an avatar that represents authority in the respective application area. At the same time, linking the notion of authoritative avatars with the above rationale around cultural appropriateness, designing avatars that represent authoritative figures needs to take into account the intricacies of Arab culture (e.g., modest clothing for doctors and nurses).

Anthropomorphic avatars increase social presence, which leads to an increased intention of the user to use the avatar (Qiu & Benbasat, 2009) and creates a feeling of face-to-face interaction (Bailenson et al., 2003). Importantly, human-like avatars are associated with credibility (Nowak & Rauh, 2008) and higher levels of influence (Hanus & Fox, 2015). Human-like avatars are more likely to work in a high uncertainty avoidance culture, such as the Arab culture (Hofstede et al., 2010). Alomar et al. (2016) found that Arab users tend to use real images of people with their cultural clothing in gamified systems. Also, the high

level of uncertainty avoidance makes users from Arab culture *hesitant* to interact with or use animalistic or unrealistic avatars. The above leads to our second proposition:

> **Proposition 2 (P2):** *Employing cultural markers (cultural clothing, modesty in clothing, and landmarks) in the design of avatars and their background increases Arab users' **(a)** perceived anthropomorphism**, (b)** perceived familiarity, **(c)** perceived homophily, **(d)** perceived similarity, **(e)** perceived social presence, and **(f)** perceived cultural appropriateness.*

4.5.3 Androgyny in Avatar Design for Arab Users (P3)

The majority of Arab males have facial hair of some sort (Shora, 2009). Shaheen (2003) explored how Westerners visualise an Arab male, and the participants indicated that typical Arab males have a black beard and headdress (ghutra). In website imagery, females usually wear an abaya and hijab (Khanum et al., 2012). In this vein, system designers may use a dark beard and headdress (ghutra) for male avatars, and hijab and abayas for female avatars, to increase perceived similarity.

To avoid ambiguity in online interactions, Arab users tend to choose usernames that reveal their biological sex. For example, Saudi users tend to select usernames that distinctively identify their actual gender (Madini & de Nooy, 2013), to reflect gender role differences in Arab culture (Hofstede et al., 2010). In this sense, avatars for Arab culture should include distinctive male or female features. In the context of Twitter, AlSukhni & Alequr (2016) relate how usernames are a good indicator for identifying the gender of an Arab user. Arab users, therefore, are more comfortable interacting with an avatar that reflects their gender and is less androgynous.

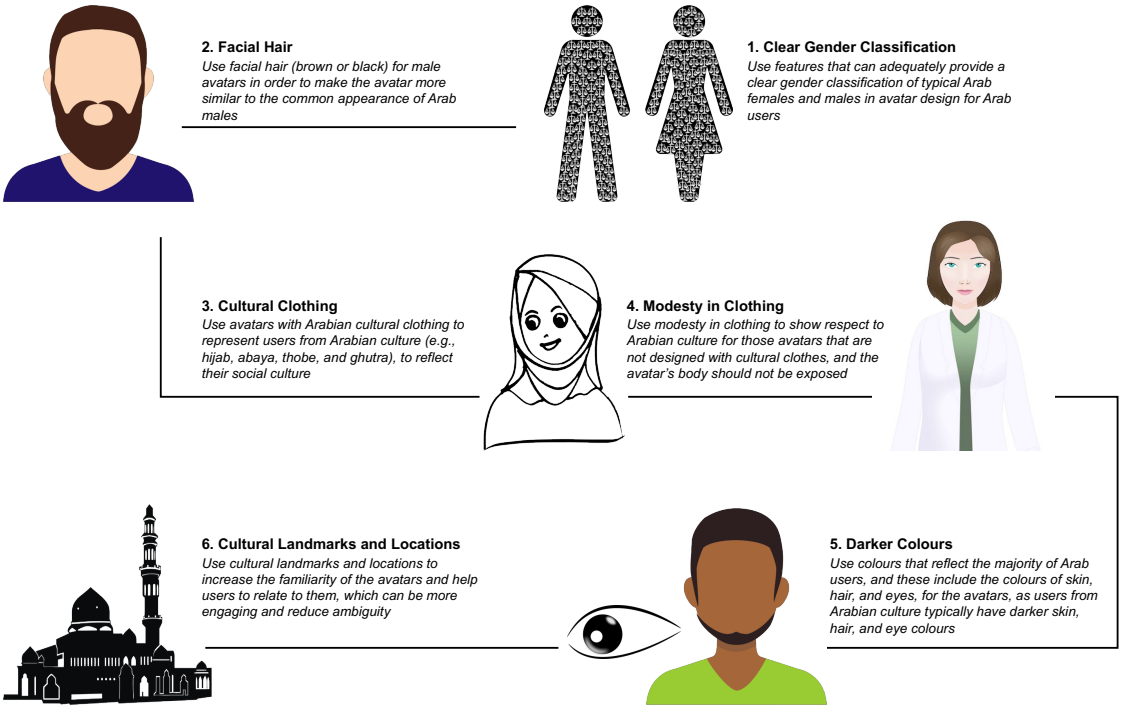
The above is in line with previous research on avatar design in HCI, showing that users prefer avatars that appear human and reflect their own gender, or appear similar to them (Nowak & Rauh, 2006). In Arab culture, it is expected that clarifying the avatar's gender will decrease uncertainty, which will lead to a higher level of social presence. Genderless or gender neutral (androgynous) avatars are difficult to classify (Nowak & Rauh, 2008), and

hence increase ambiguity for Arab users. In fact, Arab users may consider genderless avatars as imaginary or unrealistic. Our third proposition is thus as follows:

> **Proposition 3 (P3)**: *Employing distinctive gender features from the Arab regions (facial hair, ghutra, abaya, hijab) to reduce the avatars' androgyny increases Arab users' **(a)** perceived anthropomorphism, **(b)** perceived homophily, **(c)** perceived similarity, and **(d)** perceived social presence.*

4.6 RESULTS: DESIGN GUIDELINES

This section presents the six general design guidelines that have emerged as a result of our thematic analysis, along with exemplary statements from the participants. Figure 4.3 provides a high-level summary of these design guidelines. Further, at the end of this section, Table 4.4 provides a summary of the six design guidelines for designing avatars for users from Arab culture. The ensuing discussion elaborates on the relationships between the design guidelines and the propositions from our theoretical framework (see Figure 4.4 in Section 4.7).



Note: With the exception of Design Guideline 4, all images have been sourced from Public Domain Vectors (https://publicdomainvectors.org; Creative Commons CC0 1.0). The imagery for Design Guideline 4 is owned by the research team of this paper.

Figure 4.3 Design guidelines

4.6.1 Guideline 1: Clear Gender Classification

Guideline 1 refers to making avatars non-androgynous, that is, the use of characteristics that distinctively classify avatars as male or female in Arab culture. The majority of participants supported the notion of clear gender classification (ACE: 80%, PSY: 64%, U: 100%).[16] Particularly, features that provide the basis for maintaining a clear gender classification for the avatars and make them more anthropomorphic to Arab users should be included. Below some illustrative statements are provided:

> *You should make definite female features in the female avatars and definite male features in male avatars, that would be more appealing to the users. (*PSY04)

> *Of course, I would like to know the gender of the avatar. I don't want to see an avatar that I cannot identify the gender of it.* (U06)

One ACE explicitly mentioned that a clear gender classification maintains reality in the design of the avatars. The comment suggested that androgynous avatars somewhat diminish the avatar's level of realism:

> *I want to know what I am seeing, and I want to know exactly who I am talking to. Genderless takes some sort of reality away and I like to maintain that reality.* (ACE08)

Another psychologist argued that reducing ambiguity around the gender of the avatar can increase the perception of similarity for Arab users. Based on this rationale, female users can relate to female avatars and the same can be applied for male users and male avatars:

> *A clear gender classification would truly make a difference, especially if you want to make users relate to those avatars.* (PSY03)

Generally speaking, the participants agreed on the sentiment that avatars with the same gender as the user can be an encouragement to use the avatar (ACE: 90%, PSY: 64%, U: 82%). This is reflected in the following comments:

[16] The percentages in this section (which are also used in next section) refer to the portion of interviewees who directly supported a particular guideline relative to the total number of interview participants for a particular stakeholder category. The remaining interview participants did not explicitly oppose the guideline (i.e., they either did not mention this aspect or did not say that it was important to them).

> *The main idea is that the avatar should represent me, something from me [my gender], similar to me that would be very encouraging for me to use the avatar*. (PSY02)

> *Exactly, I would say female users to female avatars and male users to male avatars. You have to play on the emotional aspects [emotional attachment between users and avatars]*. (ACE05)

> *I think this is related to the culture [also] because many females here, for example, in Saudi Arabia, would like to interact with female doctors. They do not like go to male doctors in real life. So, I think the situation will be the same. They [may] prefer to have female avatars.* (ACE02)

> *Females would prefer females [female avatars]. I believe [that] because I could see that almost every day in my culture*. (U08)

Altogether, our data suggested that the lower the degree of the avatar's androgyny, the higher the Arab user's intention to use the avatar. In this sense, non-androgynous avatars engender a sense of social presence and activate appropriate social responses, as per the CASA paradigm. The use of male and female features to design avatars is vital and supported by most of the participants. Avatars for Arab users need a clear gender classification to reduce uncertainty avoidance (Hofstede et al., 2010) and make users more comfortable in the interaction.

4.6.2 Guideline 2: Facial Hair

Guideline 2 specifically refers to the appearance of male avatars. In particular, our data suggested that male avatars should have facial hair (i.e., moustache or/and beard), which resembles the appearance of the majority of Arab males. This was directly supported by the majority of ACEs (90%) and about half of the psychologists (46%) and potential users (55%). For instance, two ACEs stated:

> *In terms of facial hair and appearance, I would say the avatar needs to match the physical appearance of the typical Arab males. I would make the avatar […] match people in my community, I would tend to give the avatar some kind of moustache that is very similar to people [who] live in the neighbourhood.* (ACE04)

> *Exactly, it [beard] has to be various, there have to be a lot of options that cover each single style that is available*. (ACE05)

The statements of other participants echoed the sentiment of the positive effect of including facial hair for male avatars, drawing on the notion of perceived similarity and reduced androgyny:

> *The male avatar that is similar to me and has same gender. I want to see the same beard in the avatar.* (U11)

> *The male avatar should have [a] beard and I would say for the Arab culture, having facial hair might add to the realness if you will. [The beard] makes it really real and it reflects the reality of the viewer or the user.* (PSY11)

Our data also revealed that having darker facial hair for the avatars is important to increase the perception of similarity and influence for the Arab male users. Two potential users stated:

> *A male avatar with darker facial hair will be more persuasive [for Arab users].* (U03)

> *A darker beard [in the male avatar] could increase similarity [for Arab users].* (U08)

In sum, our data suggest that having darker colour and facial hair in male avatars will increase the perception of similarity for Arab male users. This feature can also decrease the androgyny of the avatar, making them more representative of male Arab users.

4.6.3 Guideline 3: Cultural Clothing

Guideline 3 refers to designing avatars for Arab culture with Arab cultural clothing (ACE: 90%, PSY: 82%, U: 100%). Clothing specific to Arab culture increases physical similarity between users and avatars, and makes them more comfortable in the interaction. Cultural clothing will capture users' attention towards mHealth applications and increase the perception of similarity. For example, the following three statements supported the idea of including cultural clothing in avatar design to increase perceived similarity:

> *I think cultural clothing would increase similarity and make users more comfortable. I think that in general if anybody is using something that has similar attributes to themselves, I think that helps.* (PSY03)

> *For Arab culture, especially in Saudi Arabia, they care about hijab, I think when you design the avatar […] wearing hijab, if it is a female, I think it is going to be more comfortable to the people.* (U04)

> *I think the avatar here will be more persuasive because the user will think that this avatar is close [similar] to him and then the influence will be more in this case.* (ACE02)

Other participants echoed the sentiment that, for Arab users, cultural clothing is very important for increasing social presence and intention to use. Supporting the positive effect of cultural clothing on intention to use, two potential users stated:

> *Cultural clothing is really important to increase intention to use, social presence, and connection between users and avatars.* (U07)

> *An avatar with cultural clothing would make me feel like I want to keep listening or watching and feel like this person [avatar] represents or respects my culture and increase my intention to use the application. So, it will be very helpful and important for me.* (U08)

The ACEs' perspective reinforces that cultural clothing used in Arab avatar design will represent Arab users and reflect the social culture better. Three ACEs supported the positive effect of including cultural clothing in the avatar design:

> *I think if the avatar looks like the actual representation of how people actually wear in Arab countries.* (ACE10)

> *I think [cultural clothing] is a positive thing, yes, I think it is a positive thing because I could relate to an avatar with cultural clothing.* (ACE03)

> *It would be nice to dress the female avatars in abayas as more people would relate to the avatar, this is based on experience.* (ACE05)

Summing up, our data suggested that cultural clothing increases Arab users' intention to use the avatars. The use of cultural clothing is supported by previous research (e.g., Khanum et al., 2012) where females in Arabian website imagery typically wear a traditional veil or abaya. To make male avatars similar to Arab users, the avatars should be designed with thobes and ghutras (Winter Jr & Chevrier, 2008). In this vein, having cultural clothing in Arab avatar design can increase the perception of similarity for Arab users.

4.6.4 Guideline 4: Modesty in Clothing

Guideline 4 refers to avatars that are not designed in Arab traditional clothing (e.g., hijab for females, thobes for males) but with modest clothes that are appropriate for Arab culture. Here, the terms *clothing modesty* and *appropriateness* are used interchangeably in the relevant literature. They refer to the notion that Arab males and females should not wear revealing clothes that expose their body (Lewis, 2019; Tawfiq & Ogle, 2013). An example of clothing modesty for Arab culture is that Arab females usually cover their arms and legs in order to minimise bodily exposure (Hammoud et al., 2005; Yamani, 2004). Similarly, Arab males are expected to cover their chest and upper legs (Hammad et al., 1999). Modesty in clothing is also expected from visitors when traveling to Arab countries (e.g., travel advice for UK citizens, UK Government, n.d.).

Based on our interview data, the majority of participants supported the notion of not using revealing clothes when designing avatars for Arab users (ACE: 80%, PSY: 100%, U: 100%). For example, three of the participants made the following comments:

> *The avatar has to come with modesty clothing. I think if you are trying to find the happy medium there, definitely [the avatar] arm covered, and the leg covered […] and head mostly covered as well at least with a white veil and show a little bit of hair.* (ACE07)

> *I would say the avatars with appropriate clothing would be more acceptable than the ones with revealing clothes.* (PSY03)

> *If you provided […] female avatars [with miniskirts and their body exposed], no one will listen to those avatars or interact with them.* (U06)

In summary, our data suggest that the use of modest clothes in the design of avatars rather than revealing clothing that exposes the body is very important for Arab culture. This result is in line with findings from previous work, where Arab users found images with revealing clothes to be inappropriate (Khashman & Large, 2013). Another study conducted on the Second Life platform for users from the UAE found that avatars are considered inappropriate when designed with revealing clothes that expose their body (Abdallah & Douglas, 2010).

4.6.5 Guideline 5: Darker Colours for Hair, Eyes, and Skin

Guideline 5 specifically refers to the use of darker colours for the avatar's hair, eyes, and skin colour to increase the perception of similarity. The majority of people in the Arab region have black hair (Hasan et al., 2011), and darker eyes and skin colour (Grewal, 2009). The notion of dark hair repeatedly surfaced in the interviews (ACE: 50%, PSY: 55%, U: 82%). Three participants explicitly made the following comments:

> *You need here to select the features that reflect the culture, for example, the majority of Arab people have black hair, the majority have dark colours […], so you need to reflect these features in the avatar.* (ACE02)

> *The hair colour, blond versus non-blondes, I would feel closer [similar] to an avatar that is dark-haired for example. Of course, we have different colours for the hair for example. It does not make sense for him [male avatar] or her [female avatar] to be blonde. I know we have blonde Arabic speaking people, but the norm is not really blonde.* (ACE03)

> *The avatar should have darker hair […] that appears similar to me.* (U09)

In terms of eye colour, participants echoed the sentiment of having darker eye colour in avatar design for Arab users (ACE: 40%, PSY: 36%, U: 45%). For example, two ACEs stated:

> *We do not have too many people with green and blue eyes, so it would be something like brown, brownish, and black; those are the common colours for the eyes.* (ACE04)

> *The male avatars should have dark brown for the eyes as well as for the female avatars.* (ACE09)

For the skin colour, several participants suggested that having darker skin in avatar design could better represent the majority of Arab users and increase the social presence of the avatars (ACE: 40%, PSY: 64%, U: 55%). For example, three participants made the following comments:

> *I think about the colours, you know in Arab countries in the Middle East, the colour for the skin is like brown and something like that, [it] is not really white, like brown skin.* (U04)

> *Usually, we would have a darker skin. If you really wanted to get it right, you would go to a darker skin.* (PSY10)

> *Darker skin colours in the avatar will increase social presence for me and most of Arab users*. (U09)

Taken together, our data confirm that having darker colour for hair, eyes, and skin will make avatar interaction more sociable based on a perceived similarity.

4.6.6 Guideline 6: Cultural Landmarks and Locations

Guideline 6 indicates that avatars being placed in front of landmarks/locations that reflect Arab culture or designed with Arab countries' flags can increase the perception of familiarity and social presence. In total, seven participants explicitly mentioned the importance of cultural locations to increase familiarity (ACE: 30%, PSY: 27%, U: 9%). Familiar locations or landmarks can also trigger positive emotional memory for the user. Three participants supported the positive effect of cultural landmarks with the following comments:

> *The avatar should be placed in front of a background that has to be from Arab countries […] and Arab background would be like feeling more in town.* (PSY11)

> *The Arab users would relate to the location and would be familiar with the location.* (ACE07)

> *Cultural landmarks would be a factor in increasing social presence and comfort, of course, for Arab users.* (ACE05)

In sum, our data suggest that the use of landmarks or locations from Arab culture stimulates the social culture of Arab users and increases the perceived familiarity of the avatars. These cultural landmarks can also increase social presence, as users are able to identify the location of the presented avatar.

Table 4.4 A summary of design guidelines for avatars for users from Arab culture

Design Guidelines	Brief Description
Guideline 1: Use features that can adequately provide a **clear gender classification** of typical Arab females and males in avatar design to reduce uncertainty and increase credibility of the avatars for Arab users.	Non-androgynous avatars enable Arab users to perceive them as humans and allow the avatars to be categorised as male or female. Including features for a specific gender will increase the perception of physical and psychological similarities between the users and avatars. Non-androgynous avatars can decrease "uncertainty avoidance" for users from Arab culture. Genderless is a foreign concept for Arab culture and could lead to negative results.
Guideline 2: Use **facial hair** to convey the message that an avatar represents a male user in Arab culture, and the colour should be black or brown, which is common for typical Arab users.	Arab males typically have facial hair of some sort. Adding darker facial hair will provide a clear perception of the gender of the avatar. This increases the perception of similarity between male users and male avatars. Including facial hair in male avatars for Arab users can be more influential as that represents how they look in real life.
Guideline 3: Use avatars with **Arab cultural clothing** to represent users from Arab culture, including hijab, abaya, thobe, and ghutra, to reflect the social culture that could make avatar design more appropriate for Arab users.	Cultural clothing increases physical similarity between users and avatars and makes them more comfortable in the interaction. This feature represents the social culture of users. Avatars in this sense are more similar to Arab users and that can increase the intention to use the avatars. This guideline can activate appropriate social response based on the perception of clothing similarity as the CASA paradigm predicts.
Guideline 4: Use **modesty in clothing** to show respect to Arab culture for those avatars that are not designed with cultural clothes, and the avatar's body should not be exposed.	Modesty in clothing is a sign of respect to the user's social culture. In this sense, avatars should be designed with appropriate clothing that respects the social culture of Arab users. The use of revealing clothes could hinder the intention to use the avatars by Arab users.
Guideline 5: Use **colours** that reflect the majority of Arab users, and these include the colours of **skin, eyes, and hair** for the avatars, as users from Arab culture typically have darker skin, eyes, and hair colour.	The colour of the avatars' skin should be darker. For example, it should have a brownish '*asmar*' colour for the skin. The use of darker colours represents the majority of Arab people. Such colours should be applied to eyes too, where most Arab people have black or dark brown eyes. Black hair increases the perceived similarity, which in turn would lead to higher use of the avatars.
Guideline 6: Use **cultural landmarks and locations** to increase the familiarity of the avatars and help users to relate to them, which can be more engaging and reduce ambiguity.	Cultural landmarks increase the perception of familiarity of the avatars. The resemblance of cultural landmarks may evoke a positive emotional memory response and could achieve a higher level of use of the avatars. The use of cultural landmarks that are familiar to the users from Arab culture will make the interaction with avatars more enjoyable and engaging.

4.7 DISCUSSION

This section discusses the results by outlining the interrelationships between the design propositions and design guidelines derived in this study. Further, we discuss the limitations of this particular study and, based on these, we suggest directions for future research.

4.7.1 General Discussion

While there is extensive research on the use of avatars in HCI, the current design of avatars is primarily dominated by non-Arab cultures. Only limited research has considered avatars for

Arab culture. Contributing to the body of knowledge for Arab avatar design, we first utilised a deductive reasoning approach (Section 4.4.1) to derive an integrative theoretical framework and three propositions, and later combined them with an inductive approach (Section 4.4.2) in which we conducted 32 semi-structured interviews with ACEs, psychologists, and potential users. This led to a set of six guidelines for designing avatars for Arab users. The theoretical framework and design guidelines may provide researchers and practitioners with a reference guide for developing Arab avatars.

Overall, participants expressed support for the propositions and psychological pathways captured in the framework. Specifically, participants supported all three propositions P1 (ACE: 80%, PSY: 73%, U: 91%), P2 (ACE: 100%, PSY: 100%, U: 91%), and P3 (ACE: 80%, PSY: 64%, U: 91%). Furthermore, their response indicated that following the design guidelines developed in this study will increase an Arab user's intention to use avatars (ACE: 100%, PSY: 100%, U: 100%). Figure 4.4 provides a summary of the theoretical propositions and design guidelines, as well as their relationships.

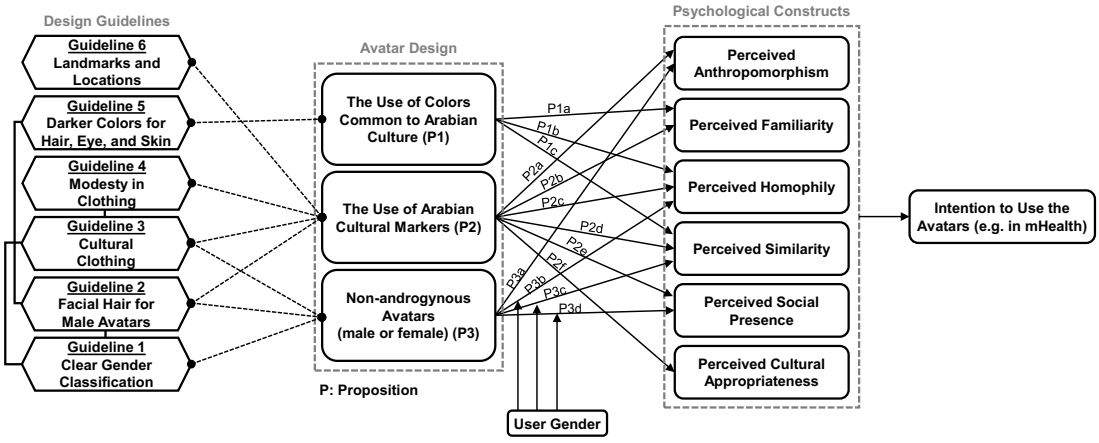


Figure 4.4 Mapping of theoretical propositions and design guidelines

Emphasising the importance of gender, **Guidelines 1–3** articulate the establishment of non-androgynous avatars (**P3**) by adding features that can intuitively classify the avatar's gender as either male or female. **Guidelines 2** and **3** also articulate the use of cultural markers (**P2**) in avatars to differentiate male and female avatars, for example, by designing male

avatars with thobes and ghutras (Winter Jr & Chevrier, 2008) and facial hair (Shaheen, 2003), or designing female avatars with abayas and hijab (Yusof & Zakaria, 2007). Applying these guidelines will increase the appropriateness of an avatar to an Arab user by better representing their social culture. These guidelines will also help increase perceived familiarity, homophily, and similarity between users and avatars, and activate social responses that allow users to consider the avatars as members of their culture.

Furthermore, **Guidelines 1–3** play an important role in increasing the perception of physical and psychological similarities that may decrease ambiguity in avatar design for Arab users. **Guidelines 1–3** are also important for maintaining appropriateness in Arab avatar design. That is, non-androgynous avatars will appear more human-like or anthropomorphic (Nowak & Rauh, 2008). In contrast, androgynous avatars will be considered unrealistic to Arab users, since they tend to maintain gender role differences in their social and online interactions, as suggested by Hofstede et al. (2010) (i.e., masculine culture). The comment of ACE08 further asserted: "genderless takes away some sort of reality, and I like to maintain that reality". Hence, categorising the gender of avatars will increase perceived humanness for Arab users, thereby creating a more engaging and encouraging experience.

Avatars for Arab culture should come with modest clothing. **Guideline 4** addresses the need to design avatars with appropriate clothing. That is, an avatar's body should not be exposed, otherwise it could hinder the adoption of such avatars by Arab users. **Guideline 4** indirectly relates to **P2** in our theoretical framework, via designing avatars that respect the Arab culture. For example, avatars that represent personal trainers should be designed appropriately with long pants and sleeves in order to be attractive to conservative Arab users. As indicated by ACE09 and PSY04, "the female avatar should be dressed appropriately, so the pants are going to be long pants" (ACE09), and "avatars should be designed with modest clothing, preferably long sleeves, trousers, or [a] long skirt" (PSY04). Modesty in clothing is

considered a sign of respect in Arab culture, even if the avatar represents a Western user. U08 noted: “the design should respect the culture, which is very important for Arab users”.

Colours play an important role in increasing the perception of physical and psychological similarities as well as familiarity between users and avatars. **Guideline 5** pertains to the use of colours (**P1**) that reduce ambiguity in avatar design for Arab culture. The majority of Arab people have darker skin; hence, avatars should be designed with a darker skin colour, e.g., *asmar* or brownish (Grewal, 2009) that reflects the majority of Arab users. This notion is supported by several participants. For example, ACE07 stated that Arab avatars should be “darker rather than blonde skinned-avatars”. U04 preferred the brownish colour for avatars’ skin by emphasising “I think about the colours, you know in Arab countries, in the Middle East, the colour for the skin is like brown and something like that, not really white, like brown skin”. U10 supported the use of colours that reflect the culture by favouring “a dark skin [darker skin] and maybe darker hair”.

Avatars that represent the social culture of Arab users stimulate a familiar environment that could be more appealing to them. In this sense, **Guideline 6** articulates the use of cultural landmarks that resemble elements from Arab culture (**P2**). By reflecting the physical environment of Arab users, applying this guideline can create an immediate connection between users and avatars, add familiarity to the avatar, and make them feel like being in their own town. ACE05 suggested that using landmarks from Arab culture will be profound, stating that “the atmosphere, the surrounding of the avatar, it would be nice to include such landmarks, […] they have strong effect on the perception of [an] audience”.

4.7.2 Research Limitations

Despite the insightful findings of this study, there are limitations that need to be addressed. First, our study explored the design of avatars for Arab culture. However, we did not design and evaluate specific avatars with Arab users. Second, while we believe that our design

guidelines constitute an important foundation for developing avatars for Arab culture, we must acknowledge that the guidelines may not be applicable to all applications, and that some tailoring to a specific domain may be needed. Specifically, it is worth pointing out that we contextualised the interviews to the application area of mHealth, a complex and multi-faceted domain with nuanced user expectations around a person's health (Noorbergen et al., 2019). Hence, further research is needed to understand whether, and if so how, the guidelines can be applied in other contexts (e.g., business, education, online shopping). In other words, these guidelines can form a benchmark for future experiments and refinements. Finally, it is necessary to note that we are confident that the guidelines established in this study are general enough to work for the majority of Arab users. However, this does not mean that there should not be options that support a diversity of users (e.g., non-Arab users in Arab countries).

4.7.3 Future Research

Findings from this study can be expanded in several directions. To further evaluate the results of this study (which is of a qualitative nature), future research has to consider how avatars that are designed according to the guidelines are perceived and responded to by users from Arab culture (e.g., a quantitative study). One way to achieve this is to employ a conjoint analysis approach (See-To & Ho, 2016), where users choose between differently designed avatars (e.g., blonde vs. dark hair) from which researchers can draw conclusions about the relative importance of individual design elements. Further, surveys with psychometric scales can be used to measure differences in user perception (e.g., cultural appropriateness, social presence) in response to avatars with certain design characteristics (e.g., modest clothing vs. revealing clothing).

While our work here was placed in an mHealth context, future studies should also consider the effectiveness of the proposed design guidelines in various other contexts (e.g.,

business, education, online shopping). Finally, it is worth noting that a culture may change over time (Beugelsdijk et al., 2015). In other words, what is being considered culturally inappropriate now could become culturally appropriate in the future and vice versa. Future research should be mindful of such cultural change when designing or implementing avatars in Arab culture and explore the views of older and younger generations of users of such avatars.

4.8 CONCLUDING REMARKS AND CHAPTER SUMMARY

While the use of avatars holds a great potential in Arab culture, it is vital to consider Arab users' cultural values and norms to ensure that the avatars can be more engaging, effective, and encouraging. In this chapter, we asked the question of how can avatars for Arab culture be employed by system designers in UI design? Here, we used a hybrid approach of deductive and inductive reasoning, first reviewing the literature on UI design for Arab culture, avatar design (non-Arab) in HCI research, and SRT. We then conducted 32 semi-structured interviews with three stakeholder groups, which included ACEs, psychologists, and potential users, resulting in the development of the six general design guidelines for designing avatars for users from Arab culture.

The results show that avatars for Arab users should be designed to have darker colours for their hair, eyes, and skin, use cultural and modest clothing with a clear gender classification, and make use of Arab landmarks and locations. Further, based on the extant literature and our interviews, we derived propositions that outline how avatar design may affect user perception along six psychological constructs (perceived anthropomorphism, familiarity, homophily, similarity, social presence, and cultural appropriateness). System designers need to carefully consider these pathways when designing avatars for Arab users. We anticipate that the propositions and design guidelines developed in this chapter may provide a reference point in

assisting researchers and practitioners to design and implement appropriate avatars for users from Arab culture.

The next chapter presents the quantitative study investigating cultural appropriateness of avatar design and how that affects trust and usage intention for users from Arab culture.

Chapter 5: Designing Avatars for Arab Users: The Impact of Cultural Appropriateness on Trust and Usage Intention

CHAPTER 5: OVERVIEW

This chapter presents a research model in which we hypothesise that the cultural appropriateness of an avatar design will affect Arab users' trusting beliefs and usage intentions. First, we review related work on avatar design, SRT, the role of cultural appropriateness in UI design, and UI design in Arab culture. After that, the full details of our research model are described, which include the effects of cultural appropriateness on the perceptions of anthropomorphism, familiarity, social presence, and usage intention. Subsequently, details of our research methods are outlined, including the scenario presented to the participants, procedures and sampling, and particular measures devised. Results of a statistical analysis on the effects of the cultural appropriateness of avatar designs are then presented. After that, we provide a supplementary analysis on avatar selection and participants' responses to the open-ended questions. A discussion of the main findings concludes the chapter.

5.1 INTRODUCTION

The previous chapter explored avatar design for users from Arab culture. In doing so, we developed a set of general design guidelines for designing avatars in Arab culture through deductive and inductive reasoning (via qualitative, semi-structured interviews). This chapter evaluates and quantitatively examines – via online questionnaires – the cultural appropriateness of avatars that were designed based on guidelines that were developed through interviewing Arab culture experts, psychologists, and potential Arab users.

Here, this chapter addresses the fact that no previous research has empirically evaluated the cultural appropriateness of avatar design to Arab culture, and how that might affect users' trust and usage intentions. This chapter therefore aims to address the research gap by devising a quantitative method of collecting data from Arab users which demonstrates the effects of cultural appropriateness on Arab users' perceptions of anthropomorphism, familiarity, and

social presence, as well as their intention towards using particular avatars. Additionally, unlike the theoretical framework developed in the previous chapter, we link the perceptions of avatars' anthropomorphism, familiarity, and social presence to *trust*, since previous research has shown that trust is a necessary precondition for promoting intention to use an avatar (Qiu & Benbasat, 2009; L. C. Wang et al., 2007).

This chapter is organised as follows. In Section 5.2, we provide background information and outline the research question investigated in this study. After that, related work is reviewed in Section 5.3, followed in Section 5.4 by the research model and the hypotheses developed. We detail the research methods in Section 5.5. Section 5.6 presents the results of a statistical and supplementary thematic analysis of the data that was collected on the perception of avatar designs. A discussion of the main findings, which includes theoretical and practical contributions made by this study, appears in Section 5.7. Finally, in Section 5.8 we conclude the chapter with a summary.

5.2 BACKGROUND AND MOTIVATION

UI design plays an important role in how users perceive and interact with information systems, and indeed whether they actually use them. In decision support systems, for instance, employing human-like characteristics can promote an engaging user experience and increase users' trust towards the system (Qiu & Benbasat, 2009). In this vein, UIs often employ graphical embodiments, also known as *avatars*, that portray human features (e.g., eyes, face, hair).[17] However, research on avatars and UI design has centred primarily on users from East Asia, Europe, and North America (J. Bailey et al., 2016; Beege et al., 2017; Hassanein et al., 2009; Seo et al., 2017). As such, only limited work has investigated culture-

[17] Strictly speaking, the term "avatar" refers to a computerised graphical representation of another (human) user in a computer-mediated environment (Bailenson & Yee, 2005). However, the term is often used synonymously for the representation of computer agents (also known as embodied agents). For this research, this differentiation is not a focus.

specific designs for users from Arab culture[18] (Abdallah & Douglas, 2010; Al-Gahtani et al., 2007; Yusof & Zakaria, 2007) or even tested them experimentally (Bente, Dratsch, Kaspar, et al., 2014; Pepe & Santarelli, 2009; Sisler, 2006).[19] This stands in contrast to the finding that cultural appropriateness (CA) is an important driver of technology adoption (Baker, Al-Gahtani, & Hubona, 2010; Kreuter et al., 2003; Papadimitropoulos et al., 2015), and that not considering users' culture in UI design can lead to adverse outcomes (e.g., see Hassanein et al., 2009; J. E. R. Lee & Park, 2011). Given that the group of Internet and e-commerce users from Arab culture exhibits growth rates of 24% p.a., it is of utmost importance to understand how to appropriately design UIs for such users for any commercial website operator (Fabre et al., 2019).

The necessity to investigate the role of CA for Arab users becomes evident when taking into account the distinct normative differences across cultures. For instance, some popular Western clothing styles are deemed inappropriate in Arab culture (Yusof & Zakaria, 2007). In particular, Arab users were found to perceive avatars in Second Life[20] as culturally inappropriate, mainly because of their clothing styles, exposed skin, and nudity, thereby impeding system adoption (Abdallah & Douglas, 2010). Scholars found that Arab users even perceive inappropriately designed avatars as less human and less credible (Nowak et al., 2015). In contrast, appropriately designed avatars can promote perceptions of credibility (Nowak & Rauh, 2006) by providing users with the impression that they reflect actual

[18] Arab culture here refers to the culture in countries that are located in the Middle East and North Africa, where Arabic is the main language (Office of the Deputy Chief of Staff for Intelligence, 2006).
[19] Here, Arab avatars are defined as avatars designed with Arabian characteristics, such as Arab cultural clothing (e.g., abayas, ghutra, hijabs, thobes), facial hair for male avatars, and dark hair color (black or dark brown). The definition of Arab avatars is inspired by Bente Dratsch, Rieger, & Al-Issa. (2014) and the Office of the Deputy Chief of Staff for Intelligence (2006).
[20] Second Life is "a computer-based virtual world, simulated multi-media environment, usually running over the Web, and designed so that users can 'inhabit' and interact via their own graphical self-representations known as avatars" (Boulos et al., 2007, p. 233).

features of their counterparts (Slater et al., 2009) or simply by appearing familiar (Wakefield et al., 2011).

Against this backdrop, this study aims to address the unanswered question of CA in avatar design affects trusting beliefs and usage intentions of Arab users. Based on SRT (Reeves & Nass, 1996), we develop a research model that maps out the theoretical links between CA and usage intention via the pathways of anthropomorphism, familiarity, and social presence. We then evaluate the research model via a survey of 313 users from Arab culture. The survey is framed in the context of an online health advice service[21], which has become a widely-used application domain for avatars (e.g., Aljaroodi, Adam, et al., 2017; Javor et al., 2016; Song, Kim, Kwon, et al., 2013).

This study provides several important contributions to the knowledge base for designing a UI for Arab culture. First, while there exists ample research on avatar design (e.g., Beege et al., 2017; J. Kim & Park, 2011; Seo et al., 2017), our study is one of the first to focus specifically on users from Arab culture. This provides important insights for how a UI can be designed in a more inclusive way, which caters to a diverse range of cultural backgrounds. Second, we contribute to the existing research on SRT by theorising on how user perceptions of anthropomorphism, familiarity, social presence, and trust are linked to the CA of avatar design. After all, any avatar inherently carries a cultural connotation through the human features it portrays. To the best of our knowledge, no existing research has investigated the theoretical pathways for how CA may influence these important drivers of trust and usage intention. Third, our study also provides important insights into the considerations Arab users apply when selecting an avatar to interact with.

[21] We considered a health advice scenario because the World Health Organisation reported that non-communicable diseases (NCDs), such as cardiovascular disease, cancer, chronic lung diseases, and diabetes are not only a growing health concern in Western countries but also in Arab countries (WHO, 2011a). NCDs in Arab culture have increased mainly due to physical inactivity (Sharara et al., 2018; WHO, 2011). However, the number of health applications specifically utilising avatars to engage users from Arab culture is scant.

5.3 RELATED WORK

This section reviews the main theory used in investigating avatar design, and related work in avatar design in the field of HCI. Further, we provide background information on the role of cultural appropriateness in UI design, and then present related work on designing a UI for Arab culture. Finally, we discuss a gap in designing avatars for users from Arab culture and the need to consider cultural appropriateness.

5.3.1 Social Response Theory and Avatar Design

The CASA paradigm, first proposed by Nass at al. (1994), is often employed as the main theoretical foundation for avatar design and understanding of avatars in HCI. Conceptually derived from the CASA paradigm is SRT, which states that users behave socially to computers even though the users know that computers do not have emotions, distinctive personalities, or even human motivations (Nass & Moon, 2000). Here, the degree to which humans consider computers as *social actors* hinges on the degree to which computers exhibit human-like features (such as appearance, behaviour, emotion, and expression). Social responses occur unconsciously (Y. Kim & Sundar, 2012a; Nass & Moon, 2000) and are closely linked to perceptions of anthropomorphism, social presence, and familiarity (S. J.-G. Ahn & Fox, 2017; Nowak & Rauh, 2006; Qiu & Benbasat, 2009; Tanner & Maeng, 2012; Yuan & Dennis, 2019), which, in turn, engender users' trust in the avatar (Qiu & Benbasat, 2009; L. C. Wang et al., 2007).

Anthropomorphism refers to the extent to which users perceive an image "to resemble human characteristics and has human morphology" (Nowak & Rauh, 2006, p. 154). Human-like avatars trigger stronger social responses compared to non-human-like avatars (Y. Kim & Sunder, 2012; E. J. Lee, 2010), and are considered more believable (Waddell et al., 2016). A way to achieve this is through the use of stylised human features such as eye colour or hair style (Schrader, 2019). Avatars that employ human features yield more effective digital

interactions (Parks et al., 2014), improved user experience (Fehrenbacher & Weisner, 2017; Sutcliffe & Alrayes, 2012), and higher success rates for behaviour change (Song et al., 2013; L. Wang et al., 2019) as compared to avatars without (or with less-pronounced) human features (Ebrahimi et al., 2018; Mohd Tuah et al., 2016). Anthropomorphism is also driven by non-ambiguity of the avatar's gender as either male or female (Nowak & Rauh, 2006).

Social presence is commonly understood as "a social factor, specifically addressing the feeling of being present with another person in a virtual environment" (Allmendinger, 2010, p. 41). It has been extensively explored in human–avatar interaction research (Behm-Morawitz, 2013; Felnhofer et al., 2014; Qiu & Benbasat, 2009, 2010) and website design (Hassanein et al., 2009; Wakefield et al., 2011; L. C. Wang et al., 2007). Two factors in this regard are gender and ethnicity, where same-gender and ethnicity constellations between an avatar and its user are found to increase social presence (K. M. Lee & Nass, 2003; Qiu & Benbasat, 2009).

Familiarity refers to the extent to which the visual characteristics of an object, e.g., an avatar, matches or reflects the characteristics known to the perceiver (i.e., the user) (White & Shapiro, 1987). It encompasses people's understanding of other individuals, often drawn from previous interactions, experiences, and knowledge (Luhmann, 1979). Previous research has shown that avatars that evoke higher perceptions of familiarity yield higher trust (Komiak & Benbasat, 2006), social presence (Liew et al., 2017), and treatment effectiveness (S. J.-G. Ahn & Fox, 2017). These relations have also been confirmed in the context of recommendation avatars in e-commerce (Cherif & Lemoine, 2014; Dash & Saji, 2008; Gefen & Straub, 2004).

5.3.2 Cultural Appropriateness

In the context of UI design, *cultural appropriateness* (CA) refers to the degree to which the UI design of a system is perceived as culturally appropriate by the target user, which,

subsequently, promotes usage intention. CA has been widely investigated in the context of health intervention and health promotion programs (Hunter-Jones et al., 2016; Kreuter et al., 2003; Pornpitakpan, 2004; Resnicow et al., 1999). In this regard, CA captures sensitivity to a specific culture by adopting visible characteristics of the target culture and uses them in designing health intervention and promotion programs (Resnicow et al., 1999). CA may include people from the community, cultural locations and places, language, colours, and clothing familiar to (and favoured by) the targeted cultural group (Resnicow et al., 1999). Moriarty (1994) noted that culturally appropriate design elements in a system can promote interest and establish credibility.

With respect to social cues in particular, Maldonado & Hayes-Roth (2004) suggested that character designers should take into account gender roles in the respective local culture, traditional clothing, and cultural norms and values. Kreuter et al. (2003) found that health promotion programs that are designed in a culturally appropriate manner are deemed more effective in Hispanic culture. Also, Bechtel & Davidhizar (1999) noted that the use of culturally appropriate images used in patient education were associated with familiarity and comfort. Hence, materials that involve social cues need to consider the targeted population and the use of clothing that will also be considered suitable by the targeted culture (Maldonado & Hayes-Roth, 2004).

With respect to web design, Hassanein et al. (2009) argued that websites should be localised to a targeted culture and include culturally appropriate design elements. Specifically, to facilitate trust towards the website, they recommended the use of local language, images reflecting local people, and common clothing styles of the culture. As one example of such localised design, American wedding websites commonly portray white wedding dresses in their imagery, whereas those on Chinese wedding websites are usually red, since in Chinese culture the colour white is associated with grief and death (Maldonado

& Hayes-Roth, 2004). With respect to language, Papadimitropoulos et al. (2015) found that employing culturally appropriate language can increase the acceptability of health applications. Further, CA depends not only on appropriate clothing styles, but also the language utilised by the avatar. For example, in terms of language, when English-speaking avatars are used in non-English speaking countries, they are considered foreigners rather than as individuals from their own culture (Katagiri et al., 2001).

5.3.3 User interface design for Arab culture

As discussed in the previous section, CA can play an important role in how users perceive and interact with a system (Evers & Day, 1997). Key drivers of such appropriateness are *cultural attractors* (Smith et al., 2004) or *cultural markers* (Barber & Badre, 1998; Mushtaha & De Troyer, 2012), that is, "interface design elements and features that are prevalent, and possibly preferred, within a particular cultural group" (Barber & Badre, 1998, p. 5). They incorporate elements from the users' physical environment, including their social network, daily life artefacts, religion (K. -hsu. Huang & Deng, 2008), and other elements such as images, colours, or linguistic cues (Sun, 2001).

Arab users have a comparatively strong preference for websites that reflect their culture (Singh et al., 2008). In this regard, Abdallah & Jaleel (2013) found that users from the United Arab Emirates (UAE) considered culturally-appropriate websites as more engaging and as having a better user experience. Specifically, they identified design elements that are linked to and associated with their country's identity (e.g., the UAE's flag and its colours) and imagery reflecting their cultural and physical environments (e.g., typical landscapes, iconic places and landmarks, local clothing styles). Such elements are found to be associated with higher usage intention and website credibility. In the context of users from Saudi Arabia, Khan & Alhusseini (2015) found that websites displaying elements from this culture such as

images of political leaders and traditional clothing were associated with increased levels of social presence for Saudi users while not so for non-Saudi users.

Human imagery is used in most Arab-oriented websites, where mostly men are displayed and only a few include both men and women (Khanum et al., 2012). In such websites, women are normally dressed in cultural clothing, that is, with traditional veil (*abaya*). Also, Arab men are usually displayed in typical or traditional clothing (e.g., with a head dress *ghutra* and a long white dress *thobe*; Winter Jr & Chevrier, 2008). Alomar et al. (2016) noted that Arab users prefer image representations that reflect how they dress and look in terms of facial hair for men and hijabs for women. Khashman & Large (2013) and Al-Badi & Mayhew (2004) found that images that expose skin are deemed inappropriate by Arab users.

5.3.4 Avatar design for Arab culture

From the previous sections, we conclude that only a few studies on avatar design have considered Arab culture specifically and how CA perceptions affect the interaction between Arab users and avatars. One example can be seen in the work of Bente, Dratsch, Kaspar, et al. (2014), who found that, in an online trust game, Arab users tended to have more trust towards avatars with similar ethnicity, giving them higher reputation scores (as compared to low reputation or cooperativeness scores). However, the study did not focus on design of the avatars nor examine CA. More specifically, no previous research has considered the role of avatars' CA for engendering trust and usage intention among Arab users. In the realm of avatar design, Abdallah & Douglas (2010) found that Arab users considered most *Second Life* avatars inappropriate. However, the study did not consider Arab users' trust nor the usage intentions generated by the avatars. Despite the widespread use of avatars in HCI, relatively little is known about how avatar design can affect users' trust and usage intentions, and very limited work has explicitly considered the appropriateness of avatar design in Arab culture. While Arab culture has been considered for UI design, limited attention has been

paid to the design of avatars for this culture. This chapter sets out to examine how the CA of avatar design affects trust and usage intention of Arab users.

5.4 RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Our research model builds on CASA and SRT to theorise on the relationships between CA, trust, and usage intention (see Figure 5.1). As indicated by the dashed arrows, we also take into account the well-established relationships between perceived familiarity, social presence, anthropomorphism, and trust. We derive our research hypotheses in the following subsections.

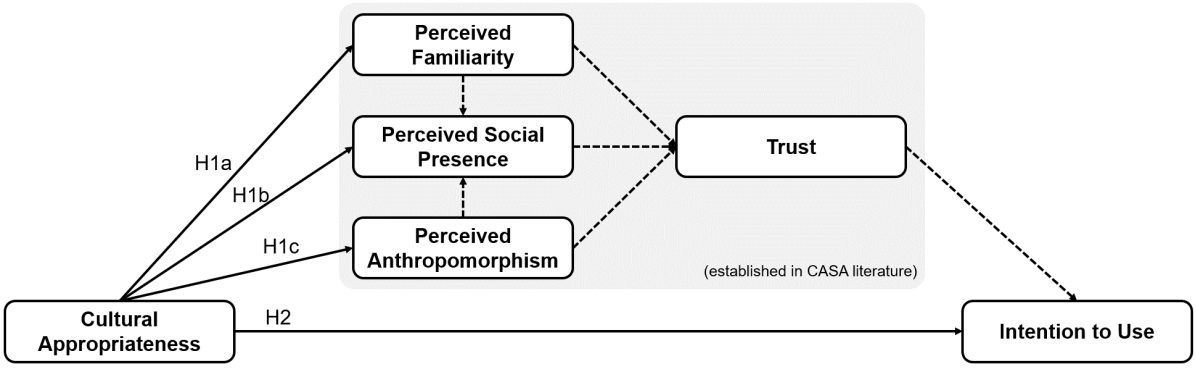


Figure 5.1 Research model

5.4.1 Impact of cultural appropriateness on perceived familiarity, social presence, and anthropomorphism

Culturally appropriate design needs to consider the target users, their typical appearances (e.g., skin colour, facial hair), and clothing styles (Hassanein et al., 2009; Resnicow et al., 1999). As suggested by SRT, culturally-appropriately designed avatars will be easy to recognise by users as members of their cultural spheres because these avatars possess familiar features that users frequently encounter and interact with in their social and physical environments. Specifically, for Arab users with high levels of uncertainty avoidance (Hofstede et al., 2010), culturally different or unfamiliar design is likely to trigger feelings of avoidance and rejection (Katagiri et al., 2001) (e.g., typical imagery in Western media with often sexualised display, exposed skin, etc.). What is more, Arab cultural spheres are known

to be strict in terms of enforcing implicit (and explicit) cultural rules. This also holds for imagery employed in website UI design (Khanum et al., 2012). Within Arab culture, experiencing elements that are *not* culturally appropriate is hence uncommon in public day-to-day life. Thus, by implication, culturally-appropriate design is a *prerequisite* in order for Arab users to consider an avatar suitable and compatible with themselves, and hence to engender a high level of familiarity (as compared to an inappropriate design). There is some (but limited) empirical evidence suggesting that higher CA is in fact associated with higher perceived familiarity, for instance, in health promotion (Bechtel & Davidhizar, 1999). Based on the above reasoning, we argue that this relationship can be extended to avatar design and hypothesise that:

> **H1a**: *Higher Cultural Appropriateness of avatar design is associated with higher levels of Perceived Familiarity for Arab users.*

Beyond familiarity, users' affective (social) responses are also influenced by the social cues provided by an avatar (Takeuchi et al., 2000). Users will more easily identify avatars as culturally appropriate and members of their cultural in-group when their design features resemble elements commonly experienced in day-to-day social interactions, including online environments. For Arab users, avatars that do not employ culturally appropriate design are likely to trigger feelings of detachment, causing users to avoid interactions with them (J. E. R. Lee & Park, 2011). There is reason to believe that these findings are linked to lower perceptions of social presence. In particular, studies have shown that culturally appropriate design plays an important role in promoting social presence on websites (Hassanein et al., 2009; Khan & Alhusseini, 2015). We therefore suggest that, in addition to familiarity, CA is associated with users' perceptions of social presence:

> **H1b**: *Higher Cultural Appropriateness of avatar design is associated with higher levels of Perceived Social Presence for Arab users.*

When using imagery of people in a UI design, most Arabian-oriented websites display images of *actual* humans dressed appropriately for the targeted group's culture (e.g., Khanum et al., 2012). Hence, images of people or avatars that include fictional or supernatural characteristics are a violation of this implicit cultural norm. Arab users are likely to link such characteristics to figures they only experience through mediated channels (e.g., TV, fiction; Al-Shamiri, 2017). It would seem that Arab users consider avatars that are not culturally appropriate as fictitious characters rather than representations of real humans. This may hold particularly for non-photorealistic but stylised or cartoon-like avatars. There is some evidence that an Arab user has a tendency to use an actual image to represent themselves in gamified online systems (Alomar et al., 2016). Likewise, Arab Twitter users often use their own actual name (or other common name) rather than a made-up name (Madini & de Nooy, 2013). We hence propose that culturally appropriate avatars are associated with higher degrees of anthropomorphism:

> **H1c**: *Higher Cultural Appropriateness of avatar design is associated with higher levels of Perceived Anthropomorphism for Arab users.*

5.4.2 Impact of cultural appropriateness on intention to use

The breadth of backgrounds and cultures makes users inherently different and yet distinctive in their own way (Dix et al., 2004). This diversity can affect the ways in which a user from a specific culture will use a system and, in turn, on whether or not they intend to use it at all. Taking such cultural diversity into consideration, culturally appropriate designs for one group are not likely to be deemed appropriate by other groups. As we have stated before, certain appearances (such as clothing and nudity) that are acceptable in Western cultures, but atypical for Arab culture, are deemed inappropriate in UI design for Arab users (Abdallah & Douglas, 2010; Yusof & Zakaria, 2007). In fact, while investigating the appropriateness of application design, Papadimitropoulos et al. (2015) found a positive link between

appropriateness and usage intention of the system. Inappropriate designs may be considered as a *foreign* concept (or as a sign of disrespect) of the culture and thus lead to decreased usage intention. There is evidence that avatars used in *Second Life* are perceived as highly inappropriate for Arab culture (e.g., Abdallah & Douglas, 2010). We suggest that culturally appropriate avatar design (compared to inappropriate designs) will facilitate usage intention – both with regard to avatars and associated services. Thus, we hypothesise:

> **H2**: *Higher Cultural Appropriateness of avatar design to Arab culture is positively associated with higher Usage Intention for Arab users.*

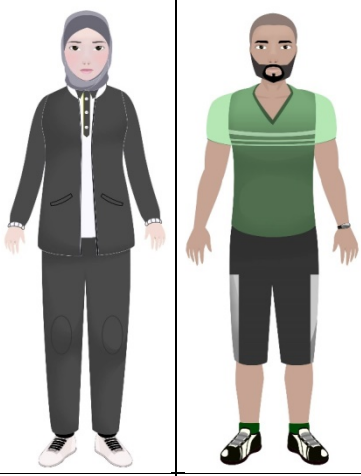
5.5 METHODS

In order to evaluate our research model, we conducted a scenario-based online experiment with 313 Arab participants. In the survey, participants faced 1 of 12 different avatars (randomly assigned) within a health advice scenario.

5.5.1 Scenario

To enable meaningful responses, we used the context of health as an example application area. Participants were asked to consider using a new website that provides health advice on nutrition and physical activity. The website uses an avatar to provide this advice (see Table 5.1 for more detail). One of the avatars was selected for the website for just this purpose. We then explained that we would ask the participant a set of questions on how they perceive that avatar in the context of a typical Arab user.

Table 5.1 Avatars used in the study

	Athletic Clothing		**Everyday Clothing**		**Medical Clothing**	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**
Arab						
Non-Arab						

5.5.2 Treatment Design

Each participant was shown only one avatar (between-subjects design). The avatars were based on all possible combinations of a 2 × 2 × 3 full-factorial treatment design, conflating the dimensions of *culture* (Arab, non-Arab) and *gender* (male, female). Further, in order to better understand whether the effects of culture and gender are pertinent to the context, we considered three different clothing styles for the avatars, namely athletic, medical, and everyday clothing. The athletic and medical clothing were chosen to reflect the health advice

context provided by the website. The everyday clothing was chosen to reflect an everyday setting that is independent of the health context (see Table 5.1 in Section 5.5.1).

The 12 avatars used in the study were custom made on the PhD candidate and supervisors' behest by an external company in the user experience design sector. In this way, the design of the Arab avatars was informed by the existing literature on UI design for Arab culture (e.g., Arab cultural clothing styles, facial hair, skin tone) and the design guidelines for designing avatars for users from Arab culture developed in Chapter 4. Furthermore, we also weighed up the design considerations and concepts (e.g., anthropomorphism, gender) that have been found, explored, and investigated in HCI research (see Section 5.3).

5.5.2 Procedure and Sample

Participants were recruited via an email invitation sent to about 750 individuals from Arab student clubs in Australia and Saudi Arabia. Overall, 327 individuals (181 male, 146 female) completed the survey. However, we had to remove 14 participants because they did not self-classify as being from Arab culture. The final dataset contains 313 participants (173 male, 140 female). Table 5.2 shows the distribution of participants across the treatment conditions. Table 5.3 provides an overview of demographic information of participants.

Table 5.2 Participants' distribution across avatar treatments

	Gender	
Culture	Female	Male
Arab	29 athletic clothing 30 medical clothing 27 everyday clothing	26 athletic clothing 26 medical clothing 27 everyday clothing
Non-Arab	26 athletic clothing 24 medical clothing 20 everyday clothing	28 athletic clothing 25 medical clothing 25 everyday clothing

Table 5.3 Participants' demographic information

Measure	**Item**	**Number**	**Percentage**
Gender	Male	173	55.3%
	Female	140	44.7%
Age	18–24	41	13.1%
	25–34	188	60.1%
	35–44	81	25.9%
	45–54	2	0.6%
	>55	1	0.3%
Education	High School	12	3.8%
	Diploma	34	10.9%
	Undergraduate	152	48.6%
	Postgraduate	111	35.5%
	Other	4	1.30%

The survey was conducted anonymously in *Lime Survey* between 18 September 2018 and 12 November 2018. The first page of the online survey introduced the scenario including the avatar, as well as an information statement including the study's purpose, requirements, and eligibility (see Appendix A for detail). Participants provided implied consent by clicking the "next" button. Participants were not compensated for their participation. The study was approved by the ethics committee at the University of Newcastle, Australia (H-2018-0178).

5.5.3 Measurement and instrument

All constructs were measured using previously validated instruments (see Table 5.4). In particular, we measured cultural appropriateness (CA; based on Corrales, 2014), perceived anthropomorphism (ANTH; based on Bartneck et al., 2009), perceived familiarity (FAM; based on Ludden et al., 2004), perceived social presence (PSP; based on Gefen & Straub, 2004), trust (TRT; based on Yoon, 2009), and intention to use (ITU; based on K. C. Lee et al., 2007). The items were linguistically adapted to the context of this study.

Table 5.4 Constructs dimensions (items)

Measure (Source)	**Adapted Items**
Perceived Familiarity Ludden et al. (2004)	FAM1: I feel that I have seen this avatar before.
	FAM2: This avatar looks familiar.
	FAM3: I know some people that resemble this avatar.
Perceived Anthropomorphism Bartneck et al. (2009)	ANTH1: The avatar appears natural to me.
	ANTH2: The avatar appears humanlike to me.
	ANTH3: The avatar appears lifelike to me.
	ANTH4: The avatar has human features similar to me.
Perceived Social Presence Gefen & Straub (2004)	PSP1: I feel a sense of human contact in the avatar.
	PSP2: I feel a sense of personalness in the avatar.
	PSP3: I feel a sense of sociability in the avatar.
	PSP4: I feel a sense of human warmth in the avatar.
	PSP5: I feel a sense of human sensitivity in the avatar.
Trust C. Yoon (2009)	TRT1: The avatar appears reliable.
	TRT2: The avatar appears trustworthy.
	TRT3: I would trust this avatar.
Intention to Use K. C. Lee et al. (2007)	ITU1: Assuming I have access to the website, I would intend to use the avatar for obtaining health advice.
	ITU2: Assuming I have access to the website, I predict I would use the avatar for obtaining health advice.
	ITU3: Assuming I have access to the website, I would plan to use the avatar for obtaining health advice.
Cultural Appropriateness Corrales (2014)	CA1: The design of this avatar acknowledges customs and beliefs of my culture.
	CA2: The avatar's clothing is designed appropriately for my culture.
	CA3: The design of this avatar includes symbols related to my cultural background.

Further, as a manipulation check, we included items to assess participants' perception of the culture and gender of the avatar. Further, we confirmed that all participants in the dataset were Arab users by asking them to self-assess whether they consider themselves from Arab culture. Table 5.5 presents the self-assessment of culture and assessment for avatar gender and culture.

Table 5.5 Self-assessment of culture and manipulation checks

Measure	**Item**
Self-assessment of culture	SAC1: I consider myself as a person from Arab culture.
Avatar's culture assessment	MC1: The avatar looks like it comes from Arab culture.
Avatar's gender assessment	MC2: The avatar looks female.
	MC3: The avatar looks male.

As control variables, we also collected information on participants' gender, age, and education. Finally, while during the main part of the survey participants only saw one avatar (between-subjects design), at the end of the survey participants were additionally presented *all 12* avatars and asked to state which of them they would prefer, along with an explanation for their selection.

5.6 RESULTS

This section presents our results. More specifically, we first confirmed that our manipulation checks that were implemented in the survey were successful in terms of whether users perceived Arab avatars as Arab and whether they perceived female and male avatars as female and male (or not). Second, we set out how avatars were perceived in terms of their cultural appropriateness. We then present our measurement model, in which we test the structural properties of the components and dependent variables. We test our hypotheses in order to check whether they were supported or rejected. Further, we perform multi-group analysis to discern differences in path coefficients between groups. Finally, we supplement our quantitative analysis with a thematic analysis of participants' free text responses at the end of the survey. Further results from our data analysis can be found in Appendix F.

5.6.1 Manipulation Checks

We ran multiple ANOVA tests to discern whether our manipulation checks were successful or not. As expected, participants in the Arab avatar condition exhibited higher scores in terms

of perceiving the avatar as coming from Arab culture (M=4.48, SD=.838) than participants in the non-Arab condition (M=1.47, SD=.884; $F(1,307)=953.8$, $p<.001$). Further, participants in the *female avatar* condition exhibited higher scores in terms of perceiving the avatar to be female (M=4.83, SD=.592) than participants in the *male avatar* condition (M=1.45, SD=1.040; $F(1,307)=1321.8$, $p<.001$). Conversely, participants in the *male avatar* condition exhibited higher scores in terms of perceiving the avatar to be male (M=4.59, SD=.947) than participants in the *female avatar* condition (M=1.22, SD=.694; $F(1,307)=1386.2$, $p<.001$). Hence, we conclude that our manipulation of avatar culture and gender was successful.

5.6.2 Cultural Appropriateness

Next, we confirm whether participants indeed perceived the Arab avatars as having higher CA than the non-Arab avatars. As shown in Figure 5.2, this is consistently the case for all treatment conditions. An ordinary least squares (OLS) regression (Table 5.6) confirms this visual assessment ($F(9,303) = 52.73$, $p<.001$, $R^2 =.712$). Interestingly, the effect of Arab vs. non-Arab avatars on CA is slightly more pronounced for female users (see interaction term in regression models (3) and (4) in Table 5.6). In other words, female users perceived non-Arab avatars (1.45 vs 2.09) as even less culturally appropriate and Arab avatars as even more culturally appropriate (4.53 vs 4.17) than male users did (see Figure 5.3).[22]

[22] Of the non-Arab avatars, the medical male avatar yielded significantly higher cultural appropriateness than the other conditions. In contrast, for the Arab avatars, the male athletic avatar yielded the lowest values. An explanation for this could be that Arab users may find it inappropriate for males to present themselves in athletic clothing publicly, which can be considered immodest in Arab culture.

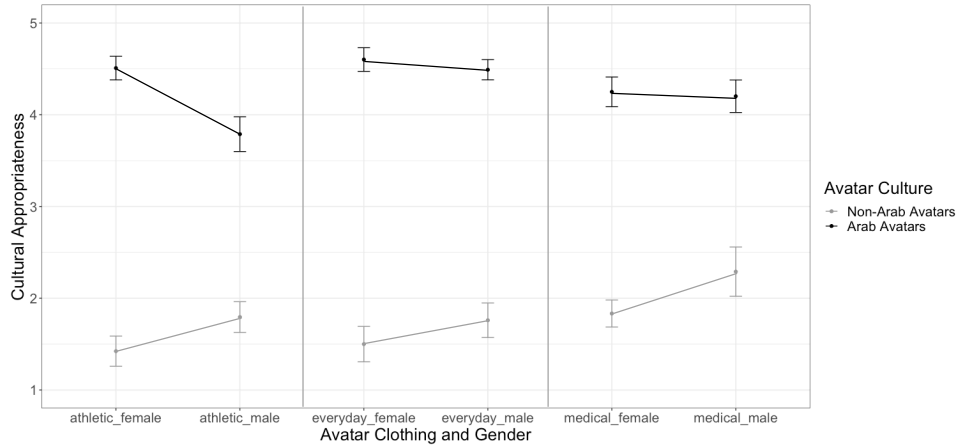


Figure 5.2 Cultural appropriateness across avatar culture, gender, and clothing

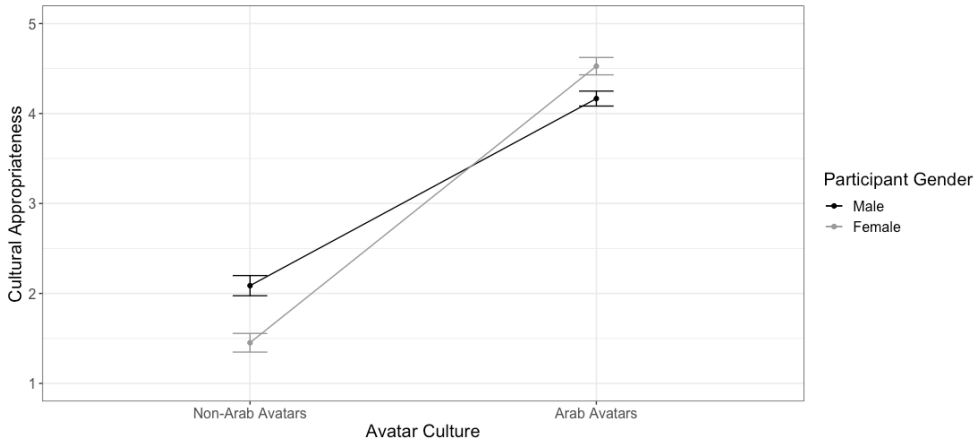


Figure 5.3 Female and male participants' perception of cultural appropriateness of avatar culture

Table 5.6 A regression summary of avatars' cultural appropriateness perception

	Dependent variable			
	Cultural Appropriateness			
Independent variables	(1)	(2)	(3)	(4)
Avatar culture: Arab	2.522***	2.568***	2.060***	2.304***
	(.103)	(.200)	(.133)	(.207)
Avatar gender: Female	.016	-.385	.053	-.142
	(.108)	(.209)	(.139)	(.242)
Avatar clothing: Medical	.014	.494*	-.118	.360
	(.126)	(.214)	(.159)	(.227)
Avatar clothing: Athletic	-.213	-.144	-.333*	-.142
	(.125)	(.209)	(.168)	(.224)
Participant gender: Female	-.100	-.129	-.726**	-.604*
	(.110)	(.107)	(.230)	(.236)
Arab avatar × female avatar		.679***		.387
		(.198)		(.209)
Arab avatar × medical avatar		-.760**		-.648**
		(.246)		(.244)
Arab avatar × athletic avatar		-.372		-.403
		(.244)		(.240)
Female avatar × medical avatar		-.134		-.226
		(.245)		(.252)
Female avatar × athletic avatar		.276		.217
		(.243)		(.258)
Female participant × Arab avatar			1.032***	.859***
			(.199)	(.211)
Female participant × female avatar			-.143	-.130
			(.211)	(.212)
Female participant × medical avatar			.310	.287
			(.248)	(.258)
Female participant × athletic avatar			.217	.060
			(.242)	(.259)
Constant	1.889***	1.882***	2.224***	2.057***
	(.121)	(.165)	(.148)	(.177)
Observations	313	313	313	313
R^2	.671	.695	.700	.712
Residual Std. Error	.899	.873	.866	.854
F Statistic	$F(5,307)$ = 125.5***	$F(10,302)$ = 68.9***	$F(9,303)$ = 78.4***	$F(9,303)$ = 52.7***

Note: Regression coefficients with standard errors in parentheses.
*p<.05; **p<.01; ***p<.001

5.6.3 Measurement Model

We ran confirmatory factor analysis (CFA) to examine the structural properties of components and the dependent variables in the study. Table 5.7 presents the results of CFA involving factor loading for each item.

Table 5.7 Items' loadings

Measure (Source)	Items	Factor Loading
Perceived Familiarity Ludden et al. (2004)	FAM1	.934
	FAM2	.949
	FAM3	.859
Perceived Anthropomorphism Bartneck et al. (2009)	ANTH1	.887
	ANTH2	.914
	ANTH3	.920
	ANTH4	.840
Perceived Social Presence Gefen & Straub (2004)	PSP1	.937
	PSP2	.862
	PSP3	.939
	PSP4	.933
	PSP5	.938
Trust C. Yoon (2009)	TRT1	.960
	TRT2	.963
	TRT3	.963
Intention to Use K. C. Lee et al. (2007)	ITU1	.985
	ITU2	.991
	ITU3	.988
Cultural Appropriateness Corrales (2014)	CA1	.974
	CA2	.973
	CA3	.967

In order to determine the model fitness and evaluate research hypotheses, we used for our analysis a covariance-based structural equation model (CB-SEM) in AMOS SPSS (Arbuckle, 2013). All conventional thresholds indicated a good model fit (Chi-square = 508.156; p<0.001; df = 199; CFI = 0.967; TLI = .962; NFI = .948; AGFI = .831; RMSEA = .070; SRMR = .067) (Doll et al., 1994; Hooper et al., 2008; Hu & Bentler, 1999). Moreover, Cronbach's alpha (α), composite reliability (CR), average variance extracted (AVE), correlations, Heterotrait–Monotrait ratios (HTMT), and item loadings indicated convergent and discriminant validity as well as consistency (see Tables 5.8 and 5.9). Specifically, all Cronbach's alpha and CR values were above the suggested threshold of 0.70, indicating that all measures are reliable. Convergent validity was investigated based on AVE (>.50) and main item loading (>.70). Both criteria were met.

Table 5.8 Construct descriptive, reliability measures, and correlations (n = 313)

	Descriptive		Composite Reliability	Cronbach's Alpha	AVE		Correlation Matrix					
	Mean	SD					1	2	3	4	5	6
ITU	3.25	1.462	.992	.988	.976		-					
TRT	3.76	1.109	.974	.960	.925		.673	-				
CA	3.11	1.599	.986	.982	.947		.614	.598	-			
PSP	3.69	1.065	.966	.956	.851		.599	.680	.633	-		
FAM	3.69	1.216	.939	.901	.837		.412	.565	.527	.578	-	
ANTH	3.81	1.135	.939	.906	.794		.550	.643	.563	.615	.503	-

Table 5.9 Discriminant validity (Heterotrait–Monotrait Ratio; HTMT)

	ITU	TRT	CA	PSP	FAM	ANTH
ITU	-					
TRT	.693	-				
CA	.615	.615	-			
PSP	.616	.709	.654	-		
FAM	.503	.699	.559	.717	-	
ANTH	.577	.682	.591	.661	.634	-

5.6.5 Hypotheses Testing

The results show that CA was significantly related to perceived familiarity (β_{1a}=.533; p<.001; H1a supported), perceived social presence (β_{1b}=.315; p<.001; H1b supported), and perceived anthropomorphism (β_{1c}=.578; p<.001; H1c supported). Moreover, there is also a direct relation between users' perceptions of CA and their intention to use (β_2=.323; p<.001; H2 supported). These results are summarised in Figure 5.4.

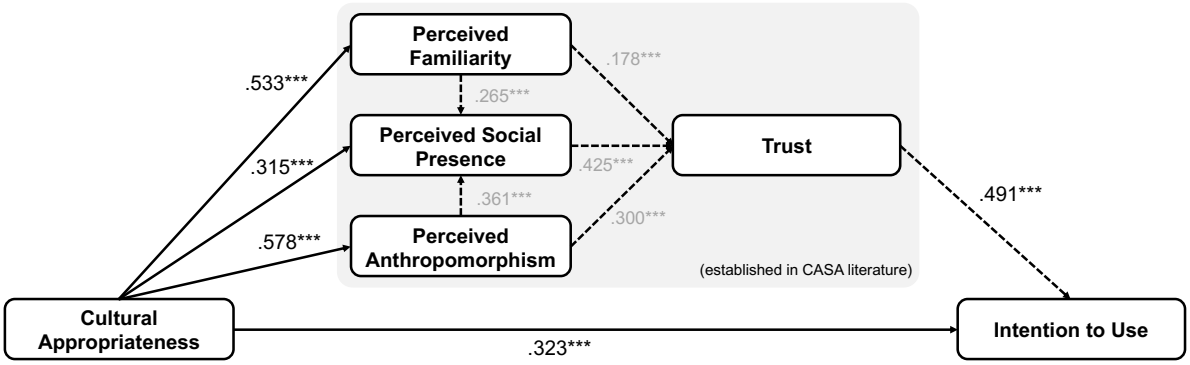


Figure 5.4 Structural model results (n = 313)

Figure 5.5 illustrates participants' usage intentions across avatar culture, gender, and clothing. Overall, we observe significantly higher usage intentions for Arab avatars. Interestingly, in the non-Arab condition, the avatars with medical clothing yielded higher

usage intentions than avatars with athletic or everyday clothing. Specifically, for female avatars with medical clothing, Arab and non-Arab avatars yielded similar usage intentions.

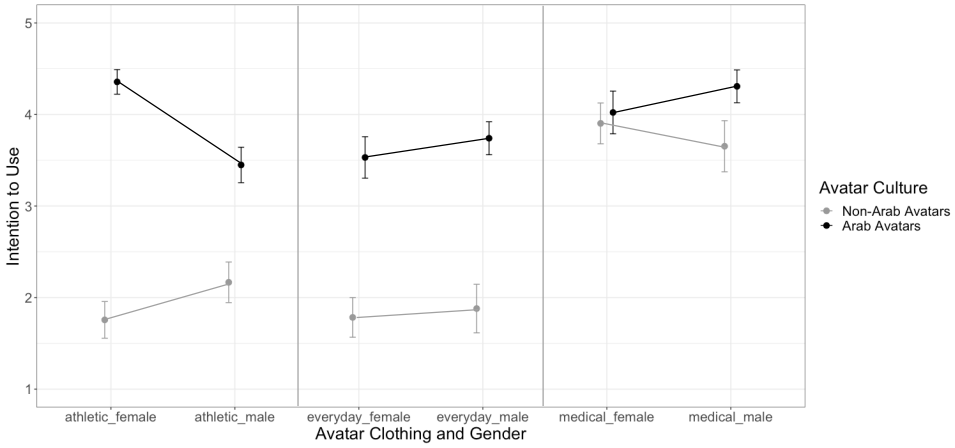


Figure 5.5 Participants' usage intentions across avatar culture, gender, and clothing

5.6.5 Multi-Group Analysis

In order to discern potential differences in path coefficients, we perform multi-group analysis considering several groups, *namely*: i) female/male participants (n = 140, n = 173); ii) female/male avatars (n = 156, n = 157); iii) participant and avatar having same/different gender (n = 207, n = 106); and iv) contextually fitting (i.e., medical) vs. non-fitting (i.e., i.e., athletic and everyday clothing) (n = 105, n = 208). The results yield several insights (see Table 5.10). Firstly, the effect of perceived anthropomorphism on trust is stronger for male participants (β_{male} = .456 vs. β_{female} = .148; z = –2.251; p<.05), while the effect of perceived familiarity on trust (β_{male} = .034 vs. β_{female} = .265; z = 2.654; p<.001) is stronger for female participants. Secondly, the effect of CA on perceived familiarity is stronger for male avatars as compared to female avatars (β_{male_avatar} = .501 vs. β_{female_avatar} = 301; z = 2.631; p<.001). Thirdly, the effect of CA on perceived social presence ($\beta_{medical}$ = .102 vs. $\beta_{non\text{-}medical}$ = .240; z = 2.089; p<.05) and intention to use ($\beta_{medical}$ = .037 vs. $\beta_{non\text{-}medical}$ = .548; z = 6.246; p<.001) is stronger for non-medical than for medical clothing. Conversely, the effect of trust on intention to use is stronger for avatars with medical clothing ($\beta_{medical}$ = .906 vs. $\beta_{non\text{-}medical}$ = .277; z = –4.838; p<.001) than for avatars with non-medical clothing. We did not discern any statistically

significant differences pertaining to whether user and avatar have the same gender or not. We will return to these results in the discussion.

Table 5.10 The outcomes of the multi-group analysis

Path	**Male Participant**		**Female Participant**		
	β	*p*	*β*	*p*	z-score
ANTH ⟶ TRT	.456	<.001	.148	.026	-2.251*
FAM ⟶ TRT	.034	.549	.265	<.001	2.654***
Path	**Female Avatar**		**Male Avatar**		
	β	*p*	*β*	*p*	z-score
CA ⟶ FAM	.301	<.001	.501	<.001	2.631***
Path	**Medical Clothing**		**Non-Medical Clothing**		
	β	*p*	*β*	*p*	z-score
CA ⟶ PSP	.102	.037	.240	<.001	2.089*
TRT ⟶ ITU	.906	<.001	.277	<.001	-4.838***
CA ⟶ ITU	.037	.548	.542	<.001	6.256***
Notes: *p<.05; **p<.01; ***p<.001					

5.6.6 Supplementary Analysis: Avatar Selection

This section drills further down into the reasons for participants selecting a particular avatar when having the choice among all 12 designs. To do so, we supplement the quantitative analysis with a thematic analysis of participants' free text responses at the end of the survey. Thematic analysis is a qualitative method used for identifying patterns (i.e., themes) within written or spoken data (Braun & Clarke, 2006). Recall that at the end of the survey, participants were shown *all 12* avatars and asked to provide a free text justification for which one they would choose. We analysed these responses by following the thematic analysis steps suggested by Braun & Clarke (2006), namely 1) familiarisation with the data; 2) coding; 3) searching for themes; 4) reviewing themes; 5) defining and naming themes; and 6) write-up.

The thematic analysis was performed by the PhD candidate, with each step independently verified by one of the supervisors and any discrepancies resolved with the other supervisor. In the first step, the PhD candidate and supervisors familiarised themselves with the data by reading participants' free text responses. In the second stage, we engaged in open coding and assigned each data item a short set of codes which summarised its content in an open-ended manner. We identified 64 codes in total. In the third step, we collated these diverse codes into

more holistic themes that summarised the data in a meaningful and complete way. In the fourth step, we reviewed the themes until a comprehensive set of themes was produced that fully accounted for every data item (5 themes, 28 codes). In the fifth step, we defined and named the themes.

A summary of the thematic analysis, including themes, codes, and their frequencies are provided in Table 5.11. In total, we identified five general themes that participants mentioned when choosing a particular avatar, *namely*:

1) A *self-reference* theme (164 mentions) refers to users mentioning their similarity with the avatar (72 mentions), their culture (64 mentions), their gender (33 mentions), familiarity with the avatar (27 mentions), and similar clothing (26 mentions).

2) An *appearance* theme (162 mentions) refers to the general appearance of the avatar in terms of medical clothing (95 mentions), its trustworthiness (34 mentions), athletic clothing (28 mentions), professional appearance (19 mentions), and attractiveness (13 mentions).

3) A *culture* theme (114 mentions) refers to different cultural aspects of the avatars, including the notion that the avatar relates to Arab culture (45 mentions), a general reference to culture without specifically mentioning Arab culture (44 mentions), and the notion of cultural clothing (32 mentions). Only 4 participants selected an avatar because it was not from Arab culture and 3 participants selected an avatar because it appeared culturally neutral to them.

4) A *gender* theme (93 mentions) refers to different aspects of the user's or avatar's gender. Overall, female users appear to be more sensitive to the avatar gender than male users (61 mentions by females, 32 mentions by males). This includes pointing to the avatar being male (57 mentions) or female (46 mentions) or using 'she' (24 mentions) and 'he' (31 mentions) when referring to the avatar. Only 18 participants mentioned that the avatar had the same gender as them, rendering it the least-mentioned code in the gender theme.

5) The *other* theme (76 mentions) captures a diverse range of considerations that did not align with the other four themes and were only mentioned rarely.

Table 5.11 Themes, codes, and their frequencies

Theme		Code		Percentage	
Name	Count (Participant gender)	Name	Count (Participant gender)	Total	Relative to theme
Self-reference	164 (85 female,79 male)	similarity	72 (34 female, 38 male)	23.0%	43.90%
		culture	64 (31 female, 33 male)	20.45%	39.02%
		gender	33 (27 female, 5 male)	10.54%	20.12%
		familiarity	27 (14 female, 13 male)	8.63%	16.46%
		clothing	26 (14 female, 12 male)	8.31%	15.85%
Appearance	162 (80 female, 82 male)	medical	95 (52 female, 43 male)	30.35%	58.64%
		trustworthy	34 (14 female, 20 male)	10.86%	20.99%
		athletic	28 (14 female, 14 male)	8.95%	17.28%
		professional	19 (4 female, 14 male)	6.07%	11.73%
		attractive	13 (10 female, 3 male)	4.15%	8.02%
Culture	114 (57 female, 57 male)	Arab	45 (21 female, 24 male)	14.38%	39.47%
		overall	44 (20 female, 24 male)	12.78%	35.09%
		clothing	32 (20 female, 12 male)	9.90%	27.19%
		non-Arab	4 (2 female, 2 male)	1.28%	3.51%
		neutral	3 (0 female, 3 male)	0.96%	2.63%
Gender	93 (61 female, 32 male)	male	57 (38 female, 19 male)	18.21%	61.29%
		female	46 (37 female, 9 male)	14.70%	49.46%
		he-reference	31 (19 female, 12 male)	9.90%	33.33%
		she-reference	24 (19 female, 5 male)	7.67%	25.81%
		same as me	18 (13 female, 5 male)	5.75%	19.35%
Other	76 (26 female, 50 male)	likeable	25 (7 female, 18 male)	7.99%	32.89%
		misc.	20 (9 female, 11 male)	6.39%	26.32%
		acceptable	10 (4 female, 6 male)	3.19%	13.16%
		idk	8 (3 female, 5 male)	2.56%	10.53%
		age/experience	8 (3 female, 5 male)	2.56%	10.53%
		visual design	6 (0 female, 6 male)	1.92%	7.89%
		encouraging	5 (4 female, 1 male)	1.60%	6.58%
		human-realism	4 (0 female, 4 male)	1.28%	5.26%

Table 5.12 shows an overview of the selection popularity of the 12 different avatars. Overall, Arab avatars were selected 276 times, accounting for all 6 most-selected avatars. By contrast, non-Arab avatars were only selected 37 times. Indicating the importance of the application context, medical clothing was selected most frequently (163 selections), followed by everyday clothing (89 times) and athletic (61 selections). Overall, the Arab medical female avatar (88 selections) and the Arab medical male avatar (58 selections) were selected

most frequently. Together, these two avatars accounted for 46.6% of all selections. The 6 non-Arab avatars only accounted for about 11.8% of the selections, with the medical female avatar (12 selections) and the male athletic avatar (8 selections) being the most frequent choices.

Table 5.12 Selection popularity of the 12 different avatars (ordered by selection frequency)

Avatar Characteristics			Selection Popularity		
Culture	**Gender**	**Clothing**	**Female Participants**	**Male Participants**	**Overall**
Arab	Female	Medical	62 (44.3%)	26 (15.0%)	88 (28.1%)
Arab	Male	Medical	13 (9.29%)	45 (26.0%)	58 (18.5%)
Arab	Male	Everyday	8 (5.71%)	46 (26.6%)	54 (17.3%)
Arab	Female	Athletic	21 (15.0%)	6 (3.47%)	27 (8.63%)
Arab	Female	Everyday	21 (15.0%)	6 (3.47%)	27 (8.63%)
Arab	Male	Athletic	3 (2.14%)	19 (10.98%)	22 (7.03%)
Non-Arab	Female	Medical	6 (4.29%)	6 (3.47%)	12 (3.83%)
Non-Arab	Male	Athletic	0 (0.00%)	8 (4.62%)	8 (2.56%)
Non-Arab	Male	Everyday	2 (1.43%)	5 (2.89%)	7 (2.24%)
Non-Arab	Male	Medical	0 (0.00%)	5 (2.89%)	5 (1.60%)
Non-Arab	Female	Athletic	4 (2.86%)	0 (0.00%)	4 (1.28%)
Non-Arab	Female	Everyday	0 (0.00%)	1 (0.58%)	1 (0.32%)
Arab	-	-	128	148	276 (88.2%)
Non-Arab	-	-	12	25	37 (11.8%)
-	Female	-	114	45	159 (50.8%)
-	Male	-	26	128	154 (49.2%)
-	-	Medical	81	82	163 (52.1%)
-	-	Everyday	31	58	89 (28.4%)
-	-	Athletic	28	33	61 (19.5%)

Note: The avatars are sorted by overall selection popularity. Percentages for selection popularity for female and male participants are relative to the total number of female and male participants in the dataset, respectively.

In order to discern whether there were differences in the selection popularity between female and male participants, we conducted several logistic regressions (see Table 5.13). The results showed that female users were more likely to select a female avatar, while male users were more likely to select a male avatar. Selection of avatar culture and clothing did not exhibit significant differences between female and male participants.

Table 5.13 Avatar selection based on participant gender

	Dependent variable				
Independent variable	Arab Avatar (vs. non-Arab) *Estimate*	Female avatar (vs. male) *Estimate*	Everyday avatar *Estimate*	Athletic avatar *Estimate*	Medical avatar *Estimate*
Participant: Female	.501 (.363)	2.523*** (.278)	-.573 (.260)	.059 (.287)	.392 (.229)
Constant	1.778*** (.216)	-1.045*** (.173)	-.684*** (.161)	-1.445*** (.194)	-.104 (.152)
Observations	313	313	313	313	313
AIC	229.468	332.705	368.732	308.722	430.575

Note: Logit regression coefficients with standard errors in parentheses.
*p<.05; **p<.01; ***p<.001

5.7 DISCUSSION AND CONCLUSION

CA of avatar design is an important factor for users from Arab culture. Yet past research on avatar design has not accounted for CA and, overall, only few studies have investigated avatar design for Arab users (e.g., Bente, Dratsch, Kaspar, et al., 2014; Pepe & Santarelli, 2009; Šisler, 2006). By developing and empirically testing a research model on the impact of avatars' CA on usage intention, this study provides important insights into the role of (Arab) culture in UI design. Further, we have explored the design considerations that Arab users apply when selecting an avatar. In the following, we provide theoretical and practical implications emerging from this study.

5.7.1 Theoretical Contributions

This study contributes to the research by demonstrating that cultural-appropriately designed avatars positively affect Arab users' perceptions and usage intentions. As expected, CA facilitates usage intention through a perception of anthropomorphism, familiarity, social presence, and trust. In this vein, we link key psychological constructs in the CASA literature to the CA construct. While it is known that human-like features facilitate social responses (Qiu & Benbasat, 2009), the results additionally capture the notion that these features inherently carry *cultural markers* that, through users' perception of their CA, can enhance perceived anthropomorphism, familiarity, social presence, and trust for Arab users.

Specifically, the findings have shown that Arab avatars, wearing traditional clothing and resembling similar ethnicity in terms of colour of skin and hair, were found more culturally appropriate than non-Arab avatars. In this vein, the use of Arab cultural clothing associated with the user's everyday environment creates a sense of familiarity and social presence in avatar design. This echoes Hassanein et al. (2009) and Bechtel & Davidhizar (1999)'s recommendations to use images that reflect local people and clothing fashion from the user's environment when designing artefacts or characters that can increase social familiarity. These findings are also in line with SRT and CASA, where it is known that the use of images that reflect familiar people and clothing can lead to higher levels of engagement and, in turn, can trigger positive social responses. In this vein, the study supports findings of previous research showing that avatars that reflect the ethnicity of the user yield higher trust (Bente, Dratsch, Kaspar et al., 2014; Spence et al., 2013; Tamborini et al., 2018) and usage intention (Lisetti et al., 2013; Suh et al., 2011).

Further, results from the multi-group analysis showed that when the avatar's clothing matched the context, trust became a dominant factor. Specifically, when avatars with medical clothing were used as health advisors, trust was the central driver of usage intention and, overall, users exhibited higher trust towards the avatars. This echoes the results of previous research, which showed that matching avatar design to the application context is important to produce high credibility (Nowak et al., 2015). By contrast, when participants were shown avatars with non-medical clothing, CA (independently of trust) affected usage intention. In other words, when there is a mismatch between avatar design and the context, CA also has a direct effect on usage intention, one that is not mediated by trust.

While overall the 6 Arab avatar conditions are clearly preferred over the 6 non-Arab avatar conditions (88.2% vs. 11.8%, see Table 5.12), it is striking that the two top selections both have medical clothing (Arab medical female and male). Together, these two avatars

account for almost half of all selections (46.6%). This result provides an important insight into the considerations Arab users apply when choosing an avatar. This might be explained by the notion that users find avatars that represent authority figures[23] in a specific field to be more trustworthy and persuasive (e.g., a salesperson in e-commerce; Hanus & Fox, 2015; Qiu & Benbasat, 2009; a medical doctor in eHealth; Anam et al., 2016; Tongpeth et al., 2018). Further, based on cultural studies, it is known that Arab culture is characterised by a large power imbalance (Hofstede et al., 2010), indicating that Arab users would normally accept information provided by an authority figure without any further justification required.

Interestingly, female participants perceived Arab avatars as more culturally appropriate than male participants, and non-Arab avatars as less culturally appropriate than did male participants. In other words, our findings showed that female users are *more sensitive* to the CA of avatar design than are male participants. This is a novel insight since, to the best of our knowledge, none of the existing studies on Arab UI design have investigated differences related to the user's gender. Our result could perhaps be explained by the idea that females have traditionally had a stronger sense than males of belonging to their ethnicity or culture (e.g., Abu-Ali & Reisen, 1999). Applied to this study, it is conceivable that female participants, being more sensitive to CA towards avatar design than male participants, are more inclined to use ethnicity as a social cue of interaction with avatars.

Finally, the thematic analysis showed that Arab participants were more likely to select an avatar that reflects their gender. In fact, the vast majority of users (77.3%) chose an avatar that had the same gender as them. Overall, this result further emphasises the importance of gender classification of avatars for Arab users, and supports the notion that Arab culture exhibits strong gender role differences (Hofstede et al., 2010). For instance, previous research

[23] Authoritative avatars are avatars that are purposefully designed to influence users' decisions by resembling authority figures that match the respective application context (e.g., doctors, teachers; Bengtsson et al., 1999).

has found that Arab Twitter users often choose usernames that reflect their gender (Madini & de Nooy, 2013) in order to maintain gender role differences and avoid uncertainty (Hofstede et al., 2010). Further, this selection preference is in line with the findings of Nowak & Rauh (2006) who found that Western users reported a preference to interact with, and represented by, avatars that reflect their gender. Finally, it is noteworthy that even though 43.6% of females and 18.5% of males referred to gender in their justification for avatar selection, only 5.75% explicitly stated that they selected an avatar because it had the same gender as them ("same as me"). This hints at the possibility that the selection of an avatar representing their own gender was either an unconscious choice or it was so inherently obvious to users that they did not feel it was worth mentioning.

5.7.2 Practical Implications

Our research has several practical implications. Although practitioners widely employ avatars in business, education, and health settings, avatar design is often not geared towards Arab culture. Building on previous work showing that CA is critical for UI design and health intervention programs (Anderson et al., 2003; Moriarty, 1994; Resnicow et al., 1999), this study provides insight into the importance of CA of avatar design to facilitate positive user perceptions and increase usage intention.

Specifically, our findings showed that Arab participants are more inclined to select an avatar that reflects their culture (88.2%) and gender (77.3%). This implies that for effective implementation of avatar design for users from Arab culture, emphasis should be placed on capturing cultural markers for avatars that establish Arab users' trust and usage intentions. This includes a careful consideration of clothing styles, which are known drivers for social presence and trust in website design (Hassanein et al., 2009). Practitioners should also carefully consider the avatar's gender and ensure that it is easily identifiable (e.g., using gender-specific cultural clothing) to reduce uncertainty for Arab users.

Another practical contribution is the choice of context-appropriate clothing, which can engender user trust in the avatar (Nowak et al. 2015). This study provides practical insights into the interplay between CA of avatar design and Arab culture. Our findings show that Arab users have a higher tendency to select an avatar that reflects their own culture (Arab avatars: 88.2%) and context (medical clothing: 52.1%). Hence, in addition to CA, UI designers also need to carefully consider the application context when devising an avatar's clothing style. For instance, a male avatar wearing a ghutra would be considered an appropriate choice for a business setting, but that particular design yields low context-appropriateness for health applications.

5.7.3 Limitations and Future Directions

As with most research, this study has limitations. First, the level of interaction between the user and the avatar was very limited. Future research may explore the role of CA in more dynamic interactions, which may also involve body movements, gestures, and/or auditory cues from the avatar, thereby increasing the level of *tacitness* of the avatar. Further, it will be important to investigate how the CA of avatar design affects user perception and behaviour over an extended period (e.g., in the context of sustainable health behaviour change; Song et al., 2013; L. Wang et al., 2019). Second, avatar customisability is an important factor for usage intentions and user identification with the avatar (e.g., R. Bailey et al., 2009; Dolgov et al., 2014). Future research may determine to what extent avatar customisability can support CA, and the particular design elements that are required to support users from Arab culture. Third, the present study was specifically contextualised to the application area of online health advice. The results showed that here the use of medical clothing is an important additional design consideration, which facilitates user trust and usage intention. This finding emphasises the need to investigate the interplay of CA and clothing in other application areas (e.g., business, education). Fourth, we did not consider the interplay of the avatar

visualisation with other aspects of the UI design (e.g., background imagery). Based on previous research, it is known that cultural markers in the UI background (e.g., iconic cultural landmarks and locations) play an important role for Arab culture (Abdallah & Jaleel, 2013; Singh et al., 2008). Finally, it is important to note that in addition to Arab culture there are also a range of other cultural contexts that have so far received only little research attention (e.g., indigenous cultures). Hence, in order to facilitate broader diversity and cultural inclusiveness, it will be important to consider how specific design elements (e.g., cultural clothing, hair style) can support CA for a wider set of cultural settings.

5.8 CONCLUDING REMARKS AND CHAPTER SUMMARY

Taken as a whole, this study highlights the importance of the CA of avatar design for Arab users. Although there is increased recognition in the literature that UI design, and health promotion programs in particular, will be more effective if they are culturally appropriate, only limited research has considered the CA of avatar design. Building on SRT and the CASA paradigm, the findings of this study emphasise that Arab users find avatars that reflect cultural markers from Arab culture more culturally appropriate; Arab users also exhibit higher trust and usage intentions towards such avatars. UI designers may utilise these findings to design avatars that appear culturally-appropriate to Arab users by utilising Arab cultural clothing styles and physical features that are typically found in the Arab culture. Emphasising the importance of the application context, this study also shows that UI designers need to carefully consider the interplay of the avatar's clothing context with the perceived level of CA.

While previous research has indicated that culture plays an important role in technology adoption, there is only limited research into how systems can be designed for users from Arab culture. This study focused specifically on the design of avatars as a UI element for facilitating positive user experience. Building on the theoretical lenses of SRT and the CASA

paradigm, we studied how cultural appropriateness of avatar design determines usage intention. we developed a theoretical model for how the cultural appropriateness of avatars determines users' intention to use them. We evaluated the theoretical model through an online survey of 313 Arab users in the context of online health advice. In the survey, participants stated their perceptions in response to 12 avatars that differed in culture (Arab, non-Arab), gender (male, female), and clothing (athletic, medical, everyday). Our results showed that Arab avatars yielded higher cultural appropriateness which, in turn, was associated with higher trust and usage intention. Further, we identified the considerations Arab users apply when choosing an avatar. Finally, we discussed theoretical and practical contributions of these findings for researchers, designers, and users of avatars.

In the next chapter, we conclude by providing a summary of the work that has been done, discussion of contributions, validity of the results, limitations of the research, and future directions.

Chapter 6: Discussion and Conclusion

CHAPTER 6 OVERVIEW

This chapter offers a summary of this research project by providing an overview of what has been done. Details of the work, which include a review of the investigated research questions, are described. After that, a summary of key research findings is provided. The research contributions are then outlined, followed by a discussion of how the results from the research align with the literature. The chapter also outlines limitations of the research and, with these in mind, suggests future research directions. Finally, the chapter ends with concluding remarks.

6.1 INTRODUCTION

The field of HCIS is vast and encompasses the use of UI design in order to provide an interactive and innovative way of better engaging users and improving their usage intentions of a system. Specifically, this research project has focused on the design and use of avatars as design elements of the UI of a system in order to achieve a human-centred design, which both addresses the user's requirements as well as representing their culture. Avatars and embodied agents have become widely used as design elements in IS research and practice to understand the effects on users' perceptions and behaviours and elicit appropriate social responses from users. By providing a graphical representation of humans and computer agents, avatars have been shown to create positive user experiences (e.g., through usability, collaboration, interactivity), support learning processes (e.g., performance, engagement, motivation), and facilitate behavioural intention (e.g., physical activity, usage intention, purchase intention) in a wide range of applications. These applications are wide ranging: from the use of digital representations in distant (virtual) business meetings (Guegan et al., 2016, 2017) and e-commerce (Qiu & Benbasat, 2009) to online education and virtual classes (Barata et al., 2017), multiplayer gaming and entertainment (Martens et al., 2018), health management and

promotion (Sebastian & Richards, 2017), and social or leisure interactions (Felnhofer et al., 2018).

It has been shown that digital representations can, potentially, be used as a means of achieving human-centred design by utilising various design concepts and dimensions, which was identified in the literature review (Chapter 2). The avatars can be constructed in such a way that addresses users' needs and requirements as well as respects their culture. Importantly, while the use of digital representations as part of the interface can achieve better interactivity, sociability, or usability, we also discussed the potentially negative effects of digital representations (the uncanny valley effect; Mori et al., 2012), which can lead to adverse interactional outcomes and irritate users, which, in turn, may result in disengagement from the interaction and dissipate a user's usage intention.

This final chapter offers a summary of the research project and is organised as follows. In Section 6.2, we give an overview of how we addressed the research questions. After that, a summary of key findings is provided in Section 6.3, followed by discussions of the overall contributions of the research project in Section 6.4. In Section 6.5, we discuss how results of the qualitative studies in Chapters 3 and 4, and the survey items adapted from previous research in Chapter 5, were validated. Subsequently, we discuss research limitations in Section 6.6, followed by suggestions for future research in Section 6.7. We end this thesis with Section 6.8, which provides final concluding remarks.

6.2 ADDRESSING THE RESEARCH QUESTIONS

To address RQ1, we performed a systematic review of the literature in Chapter 2. In doing so, we synthesised previously published research in experimental IS research on digital representations, i.e., avatars and embodied agents, and identified research and knowledge gaps. This provided us with the design concepts and dimensions to create effective designs for human–avatar interactions. It also provided us with information on what particular aspects

of these digital representations can be utilised to positively affect users' perceptions and behaviour. A positive effect of interacting with a digital representation can be achieved through the Proteus effect (Jesse Fox et al., 2013; Yee et al., 2009; Yee & Bailenson, 2007). Moreover, the literature review showed what design elements should be avoided in order to produce a more realistic interaction. A negative effect is identified as the *uncanny valley effect* (Mitchell et al., 2011; Mori, 1970; Mori et al., 2012). Furthermore, the literature review provided insights into practical design considerations that enable fruitful interactions between users and avatars or embodied agents.

To address RQ2, we conducted an exploratory study in Chapter 3. Here, we utilised a design science approach (Hevner et al., 2004) that was executed with workshops involving multiple stakeholders. As a result, we identified a set of design principles and requirements based on the well-established behavioural change framework (Michie et al., 2011) from which we could design culturally neutral empathic avatars for stroke rehabilitation. A mobile application prototype was developed in order to evaluate the effectiveness of the empathic avatar.

To address RQ3, in Chapter 4 we performed a comprehensive qualitative study involving semi-structured interviews with three groups of stakeholders who had expertise and knowledge of Arab culture. The stakeholder groups included Arab culture experts, psychologists, and potential Arab users. In this particular study, we conducted 32 semi-structured interviews with the identified stakeholders. The interviews were audio-recorded and transcribed by the PhD candidate and validated by one of the two supervisors. Then, we followed the process of Braun & Clarke (2006) in performing a thematic analysis on the words used. After multiple discussions with the supervisors, we subsequently derived a set of six general design guidelines for avatars based on the recurring themes we identified.

To address RQ4, a set of 12 avatars was designed based on culture (Arab, non-Arab), gender (male, female), and clothing (medical, athletic, everyday). The design of these avatars adopted some of the design guidelines we developed in Chapter 4 for designing avatars from Arab culture. Then, in Chapter 5 we evaluated with Arab users these 12 avatars in terms of cultural appropriateness. Arab users regarded the avatars designed with Arab cultural clothing styles as more culturally appropriate than non-Arab avatars that were designed with clothing styles from non-Arab cultures. Also, we found that female participants were more sensitive than male participants to the avatar's cultural appropriateness and gender. We also found Arab users selected an avatar that reflected their gender.

6.3 SUMMARY OF KEY RESEARCH FINDINGS

First, our findings from the literature review showed that there are key considerations that designers should take into account when implementing digital representations. These include understanding of the Proteus effect (Yee & Bailenson, 2007) and the uncanny valley effect (Mori, 1970; Mori et al., 2012), different types of presence (Franceschi et al., 2009), persuasiveness and empathic design (Beale & Creed, 2009; Peña et al., 2009), and customisability (Hanus & Fox, 2015) of the digital representations.

The workshops involving multiple stakeholders had several key findings. First, they showed the importance of empathic avatar designs – empathic scenarios and characters – in order to engage stroke survivors in a meaningful way. In health applications, the notion of empathy is important because it can create an emotional connection between the user and the avatar. The empathic scenarios should include an environment that appears familiar to the user, such as a home garden, in order to create an immediate or emotional connection. The use of empathic avatars can elicit social responses from the users, which can affect their offline selves in the real world (Parks et al., 2014). For example, this can be done by displaying an avatar's movements as getting better every time the avatar finishes an exercise.

Further, this research has shown that animated motion (as compared to a static display) gives a more engaging illustration of exercise than textual descriptions or even line drawings, as the user can see how the avatar completes the entire exercise.

For the application context, the design of an avatar should have a round face-like shape in order to induce positive emotions in the user (Um et al., 2012). Our research indicates that for specific application areas such as stroke rehabilitation, avatars should be human-like, but not too realistic in order to avoid the uncanny valley effect (Mori, 1970; Mori et al., 2012). Our findings showed that colours play important roles in attracting attention. In the context of stroke rehabilitation, avatars should exhibit warm colours that induce feelings of calm and relaxation. Colour schemes differ when it comes to specific cultures as colours have different meanings in different cultures. To sum up, our research has shown that it is important that users, i.e. in our case stroke survivors, are informed not only by written instructions, but also in a way that is entertaining and engaging, and here the research suggests that avatars can help communicate effectively with users.

The thematic analysis of the interview data gave a number of key findings. First, in regard to the design propositions developed for designing avatars for users from Arab culture, participants expressed support for the design propositions of our research project. Specifically, the majority of participants supported all three propositions; P1 (81% of participants), P2 (97% of participants), and P3 (87% of participants). Furthermore, their responses indicated that the design guidelines developed in this research project will increase Arab users' intention to use avatars (100% of participants). In regard to the gender of the avatars, gender classification is important for Arab users since Arab culture scores relatively high in uncertainty avoidance (Hofstede et al., 2010), so that a genderless avatar is likely to be viewed as imaginary or unrealistic in Arab culture. Achieving a clear gender for the avatar

in Arab culture can be done by: 1) utilising gender-specific clothing from the Arab culture and 2) giving male avatars facial hair reflecting the majority of Arab male users.

In terms of colours, our findings indicate that the use of commonly found colours in Arab culture is better for the avatar. The common colours should be used for skin, hair, and eyes as well as clothing. The majority of Arab people have darker skin, and so avatars should be designed with a darker skin colour, e.g., brownish. It is considered unrealistic to present an Arab user with a blonde-haired avatar, as this colour is not commonly found in Arab culture and does not represent the majority of Arab people.

In terms of cultural markers, our participants suggested that avatars should be designed with cultural clothing and if that is not feasible (e.g., for physical activity, doctor avatars), the avatars should be designed with appropriate clothing. Here, it would be more acceptable to Arab users if the avatar exhibited long pants and sleeves in order to show respect to Arab culture. Last, the avatar design should include iconic places from the user's physical environment in order to increase the perceptions of familiarity and reduce ambiguity in the design, thus promoting interaction between users and avatars. In other words, by reflecting the physical environment of Arab users, cultural landmarks can create an immediate connection between users and avatars, add familiarity to the avatar, and make them feel like being in their hometown.

6.4 OVERALL CONTRIBUTIONS OF THE RESEARCH PROJECT

To the best of our knowledge, this research project is distinctive in its objectives, aims, and deliverables. The research project has thus contributed to the body of knowledge on human–avatar interactions and UI design in health applications as well as in Arab culture, and has shown the importance of contextual design for human–avatar interactions. It offers a number of theoretical and practical contributions to the field of research related to human–avatar interactions.

6.4.1 Theoretical Contributions

An important contribution to the academic literature has been made through conducting a comprehensive systematic review of the literature on users interacting with digital representations in IS experimental research, and a theoretical framework has been developed to capture commonly used interaction types, application domains, psychological constructs, levels of embodiment, and dimensionality of the interaction. The review also provided background information to appreciate this research. It formed the basis and set the scene for the research project in designing avatars, specifically for health applications by taking Arab culture into account.

Findings of this research demonstrated that the cultural appropriateness of an avatar plays an important role in a user's intention to use the avatar. We have made a significant contribution to the body of knowledge by linking key psychological constructs (i.e., familiarity, anthropomorphism, and social presence) in the SRT and CASA literature to the construct of cultural appropriateness. This research project is, to the best of our knowledge, the first to investigate the cultural appropriateness of avatar design in Arab culture. The findings and outcomes of this research are unique in the field of human–avatar interaction and might be useful in determining whether solutions emphasising cultural markers will lead to improved user engagement. The findings of this research might be considered not only by Arab countries and organisations, but also by international organisations that are looking to expand into Arab countries and culture. The international organisations might be able to attract Arab users to their services or adopt their platforms if avatars and other UI elements are designed in a culturally appropriate manner.

In terms of avatar gender, our findings showed that the vast majority of Arab users chose an avatar that had the same gender as themselves. This finding suggested that the selection of an avatar representing their own gender was an unconscious choice. Further, even though our

findings showed that the context played an important role in facilitating Arab users' usage intentions and trust, for a medical avatar it was even more important that they had the correct cultural clothing and physical features (e.g., darker hair colour), as these design elements yielded even stronger levels of usage intention. When medical avatars are used as health advisors on a website, trust becomes the central driver of usage intention and, overall, users exhibit higher levels of trust towards a medical avatar. In contrast, when participants are shown non-medical avatars, cultural appropriateness emerges as a second driver of usage intention, independent of trust. In other words, when there is a mismatch between avatar design and the context, the cultural appropriateness of the avatar becomes the primary driver of usage intention, even stronger than, and independent of, trust.

6.4.2 Practical Contributions

This research project adopted a design science approach (Hevner et al., 2004), including users throughout the design process, unlike previous research on the use of avatars in health applications. We also framed our design principles and requirements on a well-established behavioural change framework (Michie et al., 2011), which became the foundation for designing the stroke rehabilitation avatars. The integration of a design science approach, behavioural change framework, avatars, and an empathic design to a mobile application contributed to the body of knowledge in the field of human–avatar interactions. This knowledge will inform further research, including how avatars can help convey various health messages, what kind of impact such technologies might have, and how the needs of stroke patients can be met. In other words, this contribution can be used as a springboard for further investigations, developments, and evaluations of avatars in stroke rehabilitation or other health issues of interest. Adopting a design science approach makes it more likely that participation from users will be sustained. Furthermore, we have contributed to the field by exploring the design requirements and principles with interdisciplinary stakeholders in a

workshop setting. Researchers and practitioners in this area of research can use the developed design guidelines to explore avatars' effectiveness in health applications.

The findings of this research project provided a holistic framework for designing avatars in Arab culture. The framework is a unique contribution in the field of designing avatars in Arab culture, and can be used as a guide for how avatars should be designed to engage Arab users and promote their usage intentions. In this research project, we have contributed to the field by exploring the design guidelines with sets of stakeholders who were experienced in Arab culture. We conducted semi-structured interviews with three stakeholder groups. Researchers and practitioners in this area of research can use this framework and develop their own design guidelines and solutions, an approach that might lead to improved interactivity, engagement, usage intention, and ultimately adoption. We anticipate that the propositions and design guidelines developed in this research project will provide a reference point that will assist not only researchers, but also practitioners and online advertising companies in designing and implementing appropriate avatars in online communications with users from Arab culture.

Further, the findings showed that Arab participants are more inclined to select an avatar that reflects their culture and gender. This implies that for effective implementation of avatar design for users from Arab culture, emphasis should be placed on capturing cultural markers for avatars that establish Arab users' trust and usage intentions. This includes a careful consideration of clothing styles, which are known drivers for social presence and trust in website design (Hassanein et al., 2009). Practitioners should also carefully consider the avatar's gender and ensure that it is easily identifiable (e.g., using gender-specific cultural clothing) to reduce uncertainty for Arab users.

Another practical contribution is the choice of context-appropriate clothing, which can engender user trust in the avatar. Our research provides practical insights into the interplay

between cultural appropriateness of avatar design and Arab culture. Our findings show that Arab users have a higher tendency to select an avatar that reflects their own culture and context. Hence, in addition to cultural appropriateness, UI designers also need to carefully consider the application context when devising an avatar's clothing style.

6.5 RESEARCH VALIDATION

In Chapter 3, we derived design principles and requirements for empathic avatars for stroke rehabilitation in multiple workshops with multiple stakeholder groups. These were validated with the involved stakeholders in multiple workshops. Further, these were also evaluated and validated through the implementation of the mobile health application that employed the empathic avatars for stoke survivors. Additionally, we evaluated the effectiveness of the design prototype in workshops with carers, clinicians, health behaviour psychologists, and actual stroke survivors in order to ensure that the design principles and requirements promoted and motivated stroke survivors to increase their physical capabilities, thereby increasing the effectiveness and value of the stroke rehabilitation program.

In Chapter 4, we developed a set of general design guidelines for Arab avatars by conducting semi-structured interviews. The design guidelines were derived from participants' responses to our questions included in the interview protocol (see Appendix D for details). Based on the thematic analysis performed on these responses using the method of Braun & Clarke (2006), we developed a set of six general design guidelines for Arab avatars. These were then validated by sending the design guidelines, identified on the basis of recurring themes, to the involved stakeholders asking them for feedback, suggestions, and comments on their suitability. The final design guidelines were slightly modified based on the recommendations and feedback we received from the stakeholders.

For the quantitative study in Chapter 5, we considered that research validity was an important step which needed to be assessed. Assessing the validity of the developed

measuring instrument helps the researcher determine the accuracy of the collected data (M. Saunders et al., 2009). The data collected in this particular study was the questionnaire/survey data, and was validated by comparing it to the constructs adopted in previous research involving human–avatar interactions. We adopted the following constructs: perceived anthropomorphism (Bartneck et al., 2009), perceived familiarity (Ludden et al., 2004), perceived social presence (Gefen & Straub, 2004), trust (C. Yoon, 2009), intention to use (K. C. Lee et al., 2007), and perceived cultural appropriateness (Corrales, 2014).

The adopted items were also validated by calculating the internal consistency of scale constructs using the Cronbach or alpha coefficient (a measure used to assess the internal consistency of a construct, that is, how closely related a set of items in a group are, and is considered to be a measure of scale reliability; Cronbach, 1951). Composite reliability (CR, also referred to as construct reliability), is a measure of internal consistency in scale items, and is similar to Cronbach's alpha (Netemeyer, Bearden, & Sharma, 2003). Average extracted variance, AVE, was also used (AVE is a measure of the amount of variance captured by a construct in relation to the amount of variance due to measurement error; Fornell & Larcker, 1981). Finally, Heterotrait–Monotrait (HTMT) ratio was also used (HTMT is a measure used to assess discriminant validity and test whether concepts or measurements that are not supposed to be related are actually unrelated; Henseler, Ringle, & Sarstedt, 2015). All these measures enabled us to test our research model and hypotheses and assess their reliability, validity, and consistency.

We utilised CB-SEM in AMOS SPSS in order to determine how well the collected data fitted our research model and calculated fit indices or fit statistics for our model as well as for evaluating our research hypotheses. This step confirmed that our research model had a good overall fit to the data collected from our research participants. This conclusion was reached by judging the fit indices against conventional threshold criteria, including Chi-square,

Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Adjusted Goodness of Fit Index (AGFI), Standardised Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA). Based on the calculated numbers, all the fit indices were above recommended thresholds (Doll et al., 1994; Hooper et al., 2008; Hu & Bentler, 1999) and showed that the collected data fitted our research model.

6.6 RESEARCH LIMITATIONS

It is impossible for a single study to cover every aspect within the research field of interest. This study is no exception. Although this research has achieved its objectives, there are a number of components that limit its findings from being generalised to a wider context. First of all, the design principles and requirements for stroke rehabilitation did not consider the user's culture, a deliberate omission in order to compare design guidelines developed for any culture. Even though the design guidelines were derived in a culturally neutral way, in this research project we have been able to show that they provide a technique for facilitating the recovery of stroke survivors by increasing their capabilities, motivation, and engagement in the rehabilitation program.

Another limitation in the second qualitative study is that the design guidelines for Arab avatars were developed for a general Arab culture. In the interviews with stakeholders, we did not discuss differences between age groups. It is acknowledged that not all of our general design guidelines may be applicable for designing Arab avatars in any specific country. Our design guidelines were also derived from semi-structured interviews, which meant that we only interviewed one participant at a time.

The measures used to assess the psychological constructs (cultural appropriateness, familiarity, social presence, anthropomorphism, trust, and intention to use) were drawn from previous studies. While these measures were validated to ensure their suitability for this research, it might have been a better if these measures, especially cultural appropriateness,

had undergone an individual validation process, e.g., in interviews with experts. However, given that these measures have been used and validated in many previous studies (and given the time limitations of the current research), it was deemed sufficient that the measures were linguistically modified to fit the context of this research. This judgement was supported by the factor analysis, which indicated strong convergent and discriminant validities and large Cronbach alpha scores, which also confirmed the reliability of the adopted scales.

Finally, a possible limitation emerging from Chapter 5 is that we did not include, due to multicollinearity between constructs, all the constructs from Chapter 4. Also, the quantitative data was collected at single point of time. This method was deemed adequate for this project due to the fact that the main objective from this data collection was to obtain a general view of whether cultural appropriateness of an avatar had an impact on an Arab user's trust and usage intention.

6.7 FUTURE RESEARCH DIRECTIONS

Avatars are promising tools for motivating and facilitating better user experience when interacting with a system. Based on the present research, there are several future research directions that can be identified. In the following, we provide suggestions along three major themes.

First, in terms of *age group*, future research should look at the design of avatars for different Arab age groups. This could be done by interviewing different stakeholders (e.g., older users), and derive design guidelines suitable for their age and perceptions. Another way to achieve this would be to invite older Arab users to evaluate the Arab avatars that were used in this research and assess their perceptions. Another option is to interview young Arab users (e.g., less than 18 of age), and see how avatars are best designed for this age group.

Another possibility for future research is based on the *research sample* approach in which one explores the design of avatars for a specific Arab country. It would be interesting to see

how design guidelines for a specific Arab country might differ from our developed design guidelines. Future studies could use a qualitative approach, e.g., focus groups or workshops, with participants from a specific country asked to identify specific design guidelines for avatars. It would also be interesting to have an open discussion on designing avatars for Arab culture using multiple participants at the same time. Likewise, users from a specific Arab country could be invited to evaluate avatar design and their appropriateness.

Furthermore, in terms of *user psychological constructs*, it would be beneficial for future studies to investigate the cultural appropriateness of those constructs (e.g., androgyny, similarity), which were not included in the quantitative study due to multicollinearity. This could potentially determine the extent to which cultural appropriateness can affect the perceptions of similarity (gender, ethnicity) between Arab users and avatars. Also, re-visiting the research model and its hypotheses in various applications and assessing an avatar's cultural appropriateness to the context at hand would help provide a deeper understanding of this research project's findings and, potentially, reveal insights into other related research areas. Moreover, to extend this study's findings on the cultural appropriateness of an avatar on a user's trust and usage intention, future studies could be directed at exploring the differences between data collected at two or more points of time with the same participant, providing interesting insights into reproducibility.

In this research, we indicated that an avatar can be more empathic when the user's facial expression is captured with a camera. However, this might directly lead to an uncanny valley effect. Future research should explore the uncanny valley deflection point; that is, the point at which the avatar's similarity to a human affects the user's decision on not liking it. Finally, we focused on two Hofstede's cultural dimensions. Future work could explore the design of avatars against all the six dimensions, *namely* 1) power distance, 2) individualism vs.

collectivism, 3) uncertainty avoidance, 4) masculinity vs. femininity, 5) long-term vs. short-term orientation, and 6) indulgence vs. restraint.

6.8 CONCLUDING REMARKS

While in general the use of avatars holds great potential to achieve better interactional outcomes, the design of such avatars needs to take into account the targeted user's needs so that every aspect of the avatar reflects their requirements. Specifically, it has been shown that including target users in the design process ensures their requirements are met, and so digital representations are likely to achieve better outcomes. It has also been shown that one simple, yet empathic, avatar design might be a viable option when it comes to stroke rehabilitation, even though the user's culture is not specifically considered. We confirmed that using an avatar can engage a user and motivate them to use the system. A contextual design also appears to improve interactions. For example, appropriate clothing styles for avatars can play an important role in achieving the intended objectives of a human–avatar interaction. What is more, it has been shown that reflecting users' culture in an avatar design promotes better interactional outcomes and yields stronger levels of usage intention. By employing appropriate Arab avatars, practitioners and researchers can utilise the design guidelines developed in this research as a reference guide for developing avatars for health applications. Finally, this research has shown that the cultural appropriateness of avatar design to Arab culture is important in increasing users' trust and usage intentions towards avatars.

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APPENDICES

Appendix A – Information statements

In this section, we present information statements of the studies included in the research. These information statements were sent to potential participants in order to give them an overview of the research projects and, potentially, recruit them to participant.

1. Qualitative study – Exploring avatar design for Arab culture in a semi-structured interview setting.

Faculty of Engineering and Built Environment

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Information Statement for the Research Project:
Designing Avatars for Users from Arabic Cultures: A Qualitative Study
Document Version 3; dated [16/10/17]

You are invited to participate in the research project identified above which is being conducted by Hussain Al Jaroodi, a PhD candidate from the School of Electrical Engineering and Computing at the University of Newcastle. You are being invited because you are considered as a professional or a potential user in a field of interest to the researcher and his thesis. The research is part of Hussain Al Jaroodi's studies at the University of Newcastle, supervised by Dr Raymond Chiong and Dr Marc Adam from the School of Electrical Engineering and Computing.

Why is the research being done?

The research is about Human-Centred Information Systems (HCIS), where the design of a system should always be developed on the basis of users' needs and requirements. The overarching aim of this research is to investigate the use and design of HCIS in the Arabic context, through the use of avatars as elements of user interface design. Importantly, what we want to achieve in this research is to design engaging user interfaces in the domain of mobile health (mHealth), taking into account the cultural background of the user. mHealth describes the use of mobile devices, such as smartphone, to manage and monitor a person's health. So far, the majority of research in this area has looked into avatars in the Western context, and there is limited research on whether avatars would have to be designed differently for Arabic users. Therefore, this project aims to identify design requirements and principles for avatars in the context of mHealth that are culturally acceptable in Arabic countries.

Who can participate in the research?

We are seeking participants from across three stakeholder groups namely psychologists, Arabic cultural experts, and potential users.

What choice do you have?

Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the project. Whether you decide to participate or not, your decision will not disadvantage you. If you do decide to participate, you may withdraw from the project at any time without giving a reason and have the option of withdrawing any data which identifies you.

What would supervisors (if applicable) be asked to do?

The researcher wishes to conduct a face-to-face or skype interview with participants who fit the criteria above. You are asked for consent to allow the researcher to have access to participants for which you are responsible, as well as access to a suitable area within your building the interviews can take place. If you agree to participate in this study, please send the signed consent form via email to either the principal researcher or the project supervisor.

What would participants be asked to do?

The researcher wishes to conduct a face-to-face or skype interview with participants who fit the criteria above. During the interview, you will be asked a series of questions surrounding the design guideline for Arabic Avatars based on identified constructs such as the degree of humanness (anthropomorphism) and psychological similarity (homophily), with the mHealth setting, of which you'll be asked to respond based on your knowledge and experience. We are particularly interested in how novel areas such as avatars could be applied to mHealth and how they can be designed to facilitate an engaging user experience. The questions will revolve around *IS constructs (physical and psychological similarity, social presence, the degree of humanness), Arabic user interface design, national culture framework*, and *intention to use into mHealth contexts*. The interview will be recorded and later transcribed by the researcher. During the interview, you can ask for the tape to be stopped and edited or erased. You will also have the opportunity to review the transcript of your interview and edit your contribution if you wish. If you agree to participate in the study, please send the signed consent form via email to either the principal researcher or the project supervisor, upon which you'll be contacted to arrange a date and time for the interview.

How much time will it take?

The interview should last no longer than 1 hour, with the possibility of return to discuss issues or matters that arise in interview.

***What are the risks and benefits of participating*?**

There are no identified risks associated with taking part in this research. We also cannot promise you any benefit from participating in this research. However, it is hoped your contribution will potentially lead to improvements in the designing of avatars for Arabic users from Arabic countries in an mHealth context.

How will your privacy be protected?

Information collected such as audio-recordings and soft copies of transcripts will be stored on a secure server (password protected computer) for a minimum of five years and only accessible by members of the research team. All information received from you will be strictly confidential. For instance, code numbers will be used in place of names throughout the research process, and responses will be paraphrased to protect participants' privacy.

How will the information collected be used?

The information collected will be presented in the form of a written thesis to be submitted as part of Hussain Al Jaroodi's PhD thesis. The information may also be reported within books and for journal submissions and conference presentations.

You will not be identifiable in the written thesis or any future publications in any way. If you decide to participate you will be able to review your contribution/audio transcripts prior to release. You will also be provided with a summary of the findings upon the completion of the study.

The collected data may be used for future research conducted by the chief investigator or student researcher. Participant data will only be used for future research where the participant has provided clear consent to do so. Any future use of data will also be de-identified by the use of paraphrasing, and the replacement of names with code numbers.

***What do you need to do to participate*?**

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact the researcher. If you would like to participate, please complete the attached consent form and return it to the email address hussain.aljaroodi@uon.edu.au. I will then contact you to arrange a time convenient to you to participate in the research.

Further information

If you would like further information please contact:

Hussain Al Jaroodi
Principal Researcher and PhD Candidate
Mobile: +61 (0) 432 432 725
Email: hussain.aljaroodi@uon.edu.au

Dr Raymond Chiong
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Tel: +61 (0) 2 4921 7367
Email:
raymond.chiong@newcastle.edu.au

Dr Marc Adam
CI and Co-Supervisor
Tel: +61 (0) 2 4921 5197
Email:
marc.adam@newcastle.edu.au

Research Team

Mr Hussain Al Jaroodi PhD Candidate and Principal Researcher	Dr Raymond Chiong CI and Supervisor	Dr Marc Adam CI and Co-Supervisor

Thank you for considering this invitation.
Your participation would be greatly valued.

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. **H-2017-0177**. Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research & Innovation Services, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone +61 (0) 2 49216333, email Human-Ethics@newcastle.edu.au.

2. Quantitative study - Cultural appropriateness of avatar design to Arab culture

FACULTY OF ENGINEERING AND BUILT ENVIRONMENT

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THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Information Statement for the Research Project:
Designing Avatars for Users from Arabic Cultures: A Survey Study
Document Version 3; dated 07/09/18

You are invited to participate in the research project identified above which is being conducted by Hussain Al Jaroodi. The research is part of Hussain's PhD studies at the University of Newcastle, supervised by Dr Raymond Chiong and Dr Marc Adam, from the School of Electrical Engineering and Computing.

Why is the research being done?

The purpose of the research is to design avatars for users from Arabic cultures. Understanding how avatars influence users will help designers to create effective and engaging Avatars for Arabic users. The research is about Human-Centred Information Systems (HCIS), where the design of a system should always be developed on the basis of users' needs and requirements. The questions will involve the perception of physical and psychological similarity between users and avatars, social presence which could make users feel like it is face-to-face interaction, how avatars are represented to be similar to human beings, how avatars are perceived to be culturally appropriate for Arabic users, do avatars appear familiar to users from Arabic culture, and intention to use or the likelihood of using the avatar in mHealth applications for example, physical activity or healthy diet. So far, the majority of research in this area has looked into avatars in the Western context, and there is limited research on whether avatars would have to be designed differently for Arabic users.

Who can participate in the research?

You are invited to participate if you are over the age of 18 and have an Arabic background.

What would you be asked to do?

If you agree to participate, you will be asked to look at different avatars, and then complete an anonymous online survey about your response toward using avatars in Mobile Health (mHealth) applications in Arabic countries. The survey will contain series of questions surrounding the Arabic Avatars based on identified constructs such as the degree of humanness (anthropomorphism) and psychological similarity (homophily), with the mHealth (the use of mobile application to monitor users' health and provide real time feedback) setting, for example, physical activity or healthy diet, of which you'll be asked to respond based on your knowledge and experience. We are particularly interested in how novel areas such as avatars could be applied to mHealth and how they can be designed to facilitate an engaging user experience.

What choice do you have?

Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you. If you do decide to participate, you may withdraw from the project at any time prior to submitting your completed survey by closing the browser window.

How much time will it take?

Participating in the research is likely to take about 20-30 minutes.

What are the risks and benefits of participating?

There are no anticipated risks associated with participating in this research. As a participant you will see different avatar designs that considered Arabic and Western cultures, and rate them based on, e.g., similarity. Additionally, all data collected is anonymous, meaning there will be no link between you and your responses. Whilst there are no anticipated benefits to you personally in participating in this research, the findings will help contribute to the available literature on the role of avatars. Thus, the research findings may contribute to the design of avatars for Arabic cultures.

How will your privacy be protected?

All survey responses collected are anonymous, so you cannot be identified or linked to your data in any way once you have submitted your response. All data collected will be stored on a secure server (password protected computer) for a minimum of five years and will only be accessible to members of the research team. Please note that due to the anonymous nature of the survey, you will not be able to withdraw your response after it has been submitted. The online survey is hosted in LimeSurvey which uses suitable technical and organisational security measures. LimeSurvey security measures are continuously updated according to technological developments. Please visit the following link for more information https://www.limesurvey.org/policies/privacy-policy.

How will the information collected be used?

The collected data will contribute towards Hussain's PhD thesis and may be presented in academic journal, conference, or book chapter publications. It may also form the basis or guide the direction of future studies. Non-identifiable data may be shared with other parties to encourage scientific scrutiny and to contribute to further research and public knowledge, as required by law. Individual participants will not be named or identified in any reports arising from the project. Also, participants can request the result of the study by contacting the research team via their email addresses found at the bottom of this document.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, please contact a member of the research team. Your consent to participate will be indicated by continuing to the study. If you would like to participate, please click on the following link, **Click Here**, and complete the online survey. If you choose not to participate in the research, please close the browser window.

Further information

If you would like further information, please contact:

Hussain Al Jaroodi
Principal Researcher and PhD Candidate
Mobile: +61 (0) 432 432 725
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Dr Marc Adam
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Research Team

Mr Hussain Al Jaroodi PhD Candidate and Principal Researcher	Dr Raymond Chiong CI and Supervisor	Dr Marc Adam CI and Co-Supervisor

Thank you for considering this invitation.
Your participation would be greatly valued.

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2018-0178. Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Services, NIER Precinct, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone +61 (0) 2 49216333, email Human-Ethics@newcastle.edu.au.

Appendix B – Consent form

This section provides the consent form sent to participants of the qualitative study and gain their agreement to participant. As shown in the form, participants should sign and return the form in order to participant in the study.

1. Qualitative study – Exploring avatar design for Arab culture by adopting semi-structured interviews

Faculty of Engineering and Built Environment

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

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Email: Hussain.aljaroodi@uon.edu.au

Consent Form for the Research Project:

Designing Avatars for Users from Arabic Cultures: A Qualitative Study
Researcher: Hussain AL Jaroodi

Document Version 2; dated [16/10/17]

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I consent to:

- permitting the researcher to have my phone contact and email address;
- participating in an interview and having it audio-recorded;
- allowing the researcher to use the information provided in his PhD thesis

I would like a copy of the findings/thesis? **Yes / No**

I consent to my de-identified contribution being used in other publications as described in the Information Statement? **Yes / No**

I consent to my de-identified contribution being used in future research **Yes / No**

I understand that I will be given the opportunity to review any audio recorded interview material prior to being released.

I understand that my personal information will remain confidential to the researchers except as required by law.

I have had the opportunity to have questions answered to my satisfaction.

Print Name: _____

Phone Contact: _____

Email Address: _____

Signature: _____ **Date:** _____

Appendix C – A summary of studies included in the literature review

This appendix provides a detailed summary of the studies that were reviewed as part of SLR study and included in the background and literature review chapter. Table C1 presents a brief description of studies, design considerations for digital representations, interaction types considered, their applications, and the users' psychological constructs that were investigated in each study, and the number of participants as well as whether the study was conducted in a laboratory or field setting.

Table C.1 Experimental studies on avatars and embodied agents in IS literature

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Gerhard et al. (2004) [IJHCS]	Explores hybrid avatar/agent model to achieve permanent users' presence and increase user experience	full body, motion, 3D [SA2A/SA2EA]	collaboration [business]	awareness, immersion, involvement, presence	20 (Lab)
Brave et al. (2005) [IJHCS]	Effects of an embodied agent's emotions upon users	face only, static, 2D [H2EA]	blackjack game [entertainment]	emotionality, likeability, trust	96 (Lab)
Nowak & Rauh (2006) [JCMC]	Effects of avatars physical appearance on users' perceptions	face only, static, 2D [H2A]	interaction [social]	androgyny, anthropomorphism, attractiveness, credibility, intention to use, similarity	255 (Lab)
Galanxhi & Nah (2007) [IJHCS]	Effects of avatars on deceptions vs. truth on users in online chats	face only, static, 2D [SA2A]	interaction [social]	deceptiveness, intention to use, trust, user anxiety	94 (Lab)
Gong (2007) [IJHCS]	Effects of a happy talking-head EA on users' trustworthiness, and competence of the EA	face only, motion, 2D [H2EA]	book review [entertainment]	competence, emotionality, intention to use, likeability, trust	24 (Lab)
Hämäläinen et al. (2008) [CHB]	Effects of avatars on group learning activity performance in collaborative environments	full body, motion, 3D [SA2A]	collaboration [education]	knowledgeability	64 (Lab)
Nowak & Rauh (2008) [CHB]	Effects of a user's avatar on other's perceptions of the avatar	face only, static, 2D [H2A]	interaction [social]	androgyny, anthropomorphism, credibility	255 (srv) 230 (Lab)
Vasalou et al. (2008) [IJHCS]	How users present themselves via avatar in social media (actual self and ideal self)	full body, motion, 3D [H2SA]	social media [social]	emotional attachment, self-representativeness	20 (Lab)
Franceschi et al. (2009) [JMIS]	Compares presence in text-based virtual environment (blackboard), virtual world (second life), classroom	full body, motion, 2D/3D [SA2A]	eLearning [education]	group presence, presence, user engagement	24 N. A. 24 (Fld) 24 N. A.
Groom et al. (2009) [IJHCS]	Effects of EA's behavioural realism on people's responses	full body, motion, 3D [H2EA]	survival game [entertainment]	likeability, persuasiveness, behavioural realism, user comfort	80 (Lab)
J. Kim (2009) [CHB]	Effects of avatars' visual similarity on group identity and conformity	face only, static, 2D [SA2A]	group identity [social]	similarity	164 (Lab)
Y. Lee et al. (2009) [DSS]	Explores how users perceive avatar email differently from traditional email	full and half body, static, 2D [H2A]	communication [business]	intention to use, presence	742 (srv) 505 (srv) 452 (Lab)

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Lester & King (2009) [JCMC]	The study compares student performance between traditional classroom and virtual classroom (blackboard and second life)	full body, motion, 2D/3D [SA2A]	classroom [education]	knowledgeability	161(Fld) 173 (Fld)
Qiu & Benbasat (2009) [JMIS]	Effects of an embodied agent on users' social presence, trust, and enjoyment	half body, static, 2D [H2EA]	eCommerce [business]	enjoyment, intention to use, presence, trust, usefulness	168 (Lab)
Vasalou & Joinson (2009) [CHB]	Explores the different self-presentation designs via avatar for blogging, dating, & gaming	full body, static, 3D [H2SA]	blogging, dating, gaming [social]	attractiveness, self-awareness, self-representativeness, similarity	71 (Lab)
Huang et al. (2010) [CHB]	Effects of avatars on team's performance interaction in a virtual meeting	full body, motion, 3D [SA2A]	virtual meeting [business]	cooperativeness, satisfaction	485 (Lab)
Jin (2010) [CHB]	Effects of a virtual agent on enjoyment and evaluation of computer-aided education	full body, motion, 3D [SA2EA]	stress management [health]	educational value, enjoyment, self-efficacy	60 (Lab)
Qiu & Benbasat (2010) [IJHCS]	Effects of an embodied agent on users' social experience	half body, static, 2D [H2EA]	eCommerce [business]	enjoyment, intention to use, presence, usefulness	188 (Lab)
von der Pütten et al. (2010) [CHB]	Evaluates whether interacting with either an avatar or an agent lead to higher level of attention	full body, motion, 3D [H2EA/H2A]	social behaviour [social]	behavioural realism, presence, rapport	83 (Lab)
Guadagno et al. (2011) [CHB]	Effects of empathy on people when interacting with virtual human representation	full body, motion, 3D [SA2A/SA2EA]	interaction [social]	emotionality, enjoyment, likeability, presence, satisfaction, trust, user comfort, supportiveness	38 (Lab)
J. Kim (2011) [JCMC]	Explores how group visual similarity strengthen the group identification	face only, static, 2D [H2A]	discussion [business]	similarity	258 (Lab)
J. Kim & Park (2011) [CHB]	Effects of an avatar's uniform appearance on users' willingness to agree to a majority opinion in virtual groups	face only, static, 2D [SA2A]	discussion [social]	similarity	345 (Lab)
Nunamaker et al. (2011) [JMIS]	Effects of an automated interviewing agent on arousal, behaviour, and cognitive effort	face only, motion, 3D [H2EA]	interview [business]	knowledgeability, likeability, trust	88 (Lab) 81 (Lab) 29 (Fld)
Riedl et al. (2011) [ICIS]	Investigates trust in terms of participants playing against humans or against embodied agent	face only, static, 2D [H2H/H2EA]	trust game [business]	trust	18 (Lab)
Schultze (2011) [ICIS]	Explores how virtual worlds users construct agency (possible and ideal self), identity, and worlds within in-worlds experience	full body, motion, 3D [H2SA]	second life [entertainment]	agency	35 (Lab)
Suh et al. (2011) [MISQ]	Explores effects of avatar similarity to actual self on users' attitudes towards the use of avatar and identification	full body, motion, 2D/3D [H2SA]	virtual store [business]	intention to use, similarity	92 (Lab)
Dunn & Guadagno (2012) [CHB]	Effects of users' gender and personality type on avatar representation	full body, motion, 3D [SA2A]	video game [entertainment]	gender, personality type, self-esteem, self-representativeness	174 (Lab)
Jin (2012) [CHB]	Effects on avatars on user's self-disclosure interpersonal communication	full body, motion, 3D [SA2A]	interaction [social]	presence, trust	117 (Lab) 148 (Lab)
Y. Kim & Sundar (2012a) [CHB]	Effects of computer anthropomorphism on presence and credibility	full body, motion, 2D [H2EA]	health information [health]	anthropomorphism, credibility, presence	93 (Lab)

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Y. Kim & Sundar (2012b) [CHB]	Effects of realistic self-avatar on risk-taking behaviour	full body, motion, 3D [SA2EA]	health information [health]	attractiveness, visual realism	95 (Lab)
Mccreery et al. (2012) [CHB]	Effects of the big five personality dimensions on users' helping behaviour in virtual environment	full body, motion, 3D [SA2A]	video game [entertainment]	personality type, self-interest, self-representativeness	39 (Lab)
Sutcliffe & Alrayes (2012) [IJHCS]	The study compares students' performance in blackboard and second life in terms of usability and user experience	full body, motion, 2D/3D [SA2A]	collaboration [education]	emotionality, presence, user collaboration	38 (Lab) 63 (Lab)
Ang et al. (2013) [CHB]	Effects of avatar body gestures on performance and satisfaction in school tasks	full body, motion, 3D [SA2A]	school task [education]	intelligence, likeability, satisfaction, trust	64 (Lab)
Fox et al. (2013) [CHB]	Influences of choosing avatar that is sexualised or non-sexualised on user's self-objectification	full body, motion, 3D [H2SA/SA2A]	interaction [social]	intention to use, presence	86 (Lab)
Goel et al. (2013) [ISJ]	Investigates what influences users to return to a virtual world	full body, motion, 3D [SA2A]	interaction [social]	immersion, intention to return, presence, social awareness	175 (Lab)
Kang & Watt (2013) [CHB]	Effects of avatar realism on communication socially	face only, motion, 2D [H2A]	communication [social]	anthropomorphism, presence, realism (visual, behavioural), satisfaction	198 (Lab)
Keng & Liu (2013) [CHB]	Effects of an avatar's attractiveness on online advertisement	face only, static, 2D [H2A]	advertising [business]	attractiveness, purchase intention	1514 (lab) 687 (Lab)
Krämer et al. (2013) [IJHCS]	Effects of an agent's smile on participants' evolution and smiling behaviour	half body, motion, 3D [H2EA]	conversation (smiling) [social]	anthropomorphism, emotionality (smile)	104 (Lab)
Kwon et al. (2013) [IJHCS]	Effects of various virtual environment conditions upon users' level of anxiety	half body, motion, 2D/3D [H2EA]	job interview [business]	visual realism, user anxiety	60 (Lab) 20 (Lab)
Song, Kim, Kwon, et al. (2013) [CHB]	Effects of smoking avatar representations on users' perceived risk of smoking	full body, motion, 3D [H2SA]	game [education]	identification, intention to quit	62 (Lab)
Song, Kim, Tenzek, et al. (2013) [CHB]	Effects of an avatar on competing in exercise video games on users' playing time	full body, motion, 3D [SA2A]	exergame [entertainment]	competitiveness, enjoyment, mood, self-efficacy	72 (Lab)
Spence et al. (2013) [CHB]	Effects of the avatar ethnicity and similarity on health-related information	face/ shoulder only, static, 2D [H2A]	communication [health]	behavioural intentions, similarity (ethnicity)	207 (Lab)
Dolgov et al. (2014) [CHB]	Effects of avatar customisation on helping behaviour	full body, motion, 3D [SA2A]	video game [entertainment]	identification, similarity	54 (Lab) 25 (Lab)
Felnhofer et al. (2014) [CHB]	Effects of users' gender and age on presence, empathy, and collaboration	full body, motion, 3D [SA2A]	café [social]	empathy, gender, presence	124 (Lab)
Grinberg et al. (2014) [CHB]	Effects of avatar on social engagement and immersion in the virtual environment	full body, motion, 3D [SA2A]	interaction [social]	immersion, presence, user engagement	35 (Lab)
Hammick & Lee (2014) [CHB]	Effects of an avatar on shy users to express themselves freely	full body, motion, 3D [SA2A]	communication [social]	interactivity, presence	58 (Lab)
Kang & Gratch (2014) [CHB]	Effects of embodied agents' behavioural realism on users' self-disclosure	half body, motion, 3D [H2EA]	counselling interviews [social]	behavioural realism, emotional state, presence, likeability	171 (Lab)
J.-E. R. Lee (2014) [CHB]	Effects of avatar' diversity on offline racial identity	half body, motion, 3D [H2A]	social identity [social]	user willing to reveal racial identity	56 (Lab)
Peña & Kim (2014) [CHB]	Effects of avatars' size on physical activity in exergame using accelerometers	full body, motion, 3D [SA2A]	video game [entertainment]	NA	96 (Lab)

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Riedl et al. (2014) [JMIS]	Investigates trust in terms of participants playing against humans or against embodied agent to make decision and learn	face only, static, 2D [H2H/H2EA]	trust Game [business]	trust	18 (Lab)
Sylvia et al. (2014) [CHB]	Effects of playing video games with an unrealistic male body on actual body satisfaction	full body, motion, 3D [H2SA]	video game [entertainment]	satisfaction, body and self-esteem	50 (Lab)
Hanus & Fox (2015) [IJHCS]	Effect of customising an avatar on intrinsic motivation, brand liking and purchase intention	full body, motion, 3D [SA2A]	sale [business]	agency, likeability, motivation, purchase intention	80 (Lab)
Leding et al. (2015) [CHB]	Effects of an attractive avatar on the perception of viewing actual human	full body, static, 3D [H2A]	attractiveness [social]	attractiveness	120 (Lab) 234 (Lab)
Nowak et al. (2015) [JCMC]	Effects of an avatar's clothing and anthropomorphism on trust and message clarity	full body, static, 2D [H2A]	dating or job interview [business]	anthropomorphism, appropriateness, attractiveness, credibility, trust	397 (Lab)
Ratan & Sah (2015) [CHB]	Effects of an avatar's identity characteristics on avatar users' behaviours	full body, motion, 3D [SA2A]	video game [entertainment]	engagement, motivation, self-representation, presence, self-relevance	64 (Lab)
Sanchez-Valdes & Trivino (2015) [ESWA]	Effects of an avatar emotion on users' physical activities	face only, static, 2D [H2SA]	physical activity [health]	emotionality, motivation	3 (Fld)
Westerman et al. (2015) [CHB]	Effects of different types of avatars created for social or dating/ romantic situations on users	half body, static, 2D [H2A]	networking [social]	attractiveness, intention to use, similarity	206 (Lab)
Won et al. (2015) [JCMC]	Effects of an avatar's movement on user's movements on the real world	full body, motion, 3D [H2SA]	communication [entertainment]	motivation, presence	53 (Lab) 20 (Lab)
Wrzesien et al. (2015) [CHB]	Influence of the physical similarity of avatars on user's emotion regulation training	full body, motion, 3D [H2A/H2SA]	emotion regulation [education]	similarity	22 (Lab)
Wu et al. (2015) [CHB]	The study explores the effects on verbal behaviour in virtual interaction	full body, motion, 3D [SA2A]	communication [social]	behavioural intention, presence	32 (Lab)
Burgoon et al. (2016) [IJHCS]	Effects of an embodied agent on the outcomes of decision-making tasks	face only, motion, 3D [H2H/H2EA]	communication [business]	attractiveness, expectedness, dependability, receptiveness	70 (Lab)
Carlotto & Jaques (2016) [IJHCS]	Effects of an embodied agent on users' in a learning environment	full body, motion, 2D [H2EA]	learning [education]	expressiveness, motivation, relevance, satisfaction, willingness to repeat	72 (Lab)
Guegan et al. (2016) [CHB]	Effects of avatars on users' creativity Performance in collaborative meeting	full body, motion, 3D [SA2A]	meeting [business]	similarity	114 (Lab) 54 (Lab)
H.-K. Kim & Kim (2016) [CHB]	Explores the emotional bonds between the individual and their avatar	full body, motion, 3D [SA2A]	driving [social]	attractiveness, emotional closeness, similarity	111 (Lab)
Li & Lwin (2016) [CHB]	Effects of self-avatars on user's presence and enjoyment	full body, motion, 3D [H2A]	video game [entertainment]	enjoyment, identification, presence	322 (Lab)
Peña et al. (2016) [JCMC]	Influences of avatar's body size on physical activity using accelerometers	full body, motion, 3D [SA2EA]	exergame [entertainment]	NA	96 (Lab)
Rodrigues et al. (2016) [CHB]	Effects of avatars use in business application on customers	half body, static, 3D [H2A]	gamification e-banking app [business]	ease of use, enjoyment, usefulness, intention to use, presence	183 (Fld)
Bacev-Giles & Haji (2017) [CHB]	Examines impressions of avatar online profiles for gender stereotype impressions	full body, static, 3D [H2A]	interaction [social]	gender, likeability, similarity	239 (Lab)

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Beege et al. (2017) [CHB]	Investigates the influence of stereotypes on learning, cognitive load and motivation as well as time spent with the embodied agent	full body, motion, 3D [H2EA]	health material [health]	gender, similarity	84 (Lab)
Balas & Pacella (2017) [CHB]	Examines the perceived trustworthiness of avatars' and humans' faces	face only, static, 2D [H2A]	interaction [social]	sensitivity, trust	51 (Lab) 20 (Lab)
Barata et al. (2017) [CHB]	Examines students' performance in gamified collage course	full body, motion, 3D [H2SA]	learning [education]	ease of use, continuity, engagement	35 N.A. 52 N.A. 54 (Fld)
Cobo et al. (2017) [CHB]	Examines distant exploration of places and time spent with avatar for blind people using smart phone	full body, motion, 3D [H2SA]	interaction [social]	NA	19 (Lab)
Dechant et al. (2017) [CHB]	Examines virtual reality to diagnose social anxiety	full body, motion, 3D [SA2EA]	interaction [social]	user anxiety	119 (Lab)
Fehrenbacher & Weisner (2017) [ICIS]	Examines knowledge sharing while interacting with real human images vs avatars	face only, static, 3D [SA2A]	communication [social]	similarity (ethnicity), trust	97 (Lab)
Guegan et al. (2017) [CHB]	Examines the effects of visual cues of social identity on group performance	full body, motion, 3D [SA2A]	brainstorming [business]	identification, presence (social cues)	72 (Lab)
Hofer et al. (2017) [CHB]	Examines the effects on avatars' expression on users fear reactions.	full body, motion, 3D [H2SA/SA2A]	video game [entertainment]	agency, physical appearance (avatar embodiment)	103 (Lab) 104 (Lab)
Khashe et al. (2017) [CHB]	Investigates influence of avatars' communication style and gender on user compliance	half body, motion, 3D [H2A]	communication [business]	communication style, gender	214 (Lab)
H. E. Kim et al. (2017) [CHB]	Examines the effects of mobile-based self-training performance for social anxiety	full body, motion, 3D [H2SA]	self-training [health]	avoidance	22 (Lab)
Kohonen-aho & Tiilikainen (2017) [ICIS]	Examines the effects of virtual world in virtual team performance of informal interaction	full body, motion, 3D [SA2A]	virtual team [business]	presence	36 (Lab)
Kothgassner et al. (2017) [CHB]	Examines a virtual social exclusion scenario and tests for behavioural consequences	full body, motion, 3D [SA2A/SA2EA]	interaction [social]	emotional state, presence, self-esteem	45 (Lab)
S. Lee & Choi (2017) [IJHCS]	Investigates embodied agents' recommendations for movies on users' experience and self-disclosure	full body, motion, 3D [H2EA]	online services [business]	enjoyment, intention to use, satisfaction	225 (Lab)
Peña & Chen (2017) [CHB]	Examines how activating prosocial and antisocial concepts affect successive prosocial behaviours and intentions	full body, motion, 3D [H2SA]	video game [entertainment]	prosocial behaviour (helping), prosocial intention	309 (Lab)
Schneider et al. (2017) [CHB]	Examines the effects of online exclusion	face only, static, 2D [H2A]	interaction [social]	belongingness, emotional state, self-esteem	105 (Lab) 85 (Lab)
Sebastian & Richards (2017) [CHB]	Examines the effects of educational embodied agents on performance of mental health patients using videos for intervention	half body, motion, 3D [H2EA]	training [health]	NA	245 (Lab)
Seo et al. (2017) [CHB]	Investigates self-presence when users are exposed to self-avatars	face only, static, 3D [H2SA]	interaction [social]	identification, presence, similarity	25 (Lab)
Tamborini et al. (2018) [CHB]	Examines the effect of embodied agents' ethnicity on trust	motion, full body, 3D [H2EA]	video game [entertainment]	similarity (ethnicity), trust	205 (Lab)
Felnhofer et al. (2018) [CHB]	Investigating social avoidance and prosocial behaviour towards avatars and agents	full body, motion, 3D [SA2A/SA2EA]	interaction [social]	agency, empathy presence, user anxiety	95 (Lab)

Authors (year) [Outlet]	Brief Description	Avatar / Embodied Agent Design [Interaction]	Application [Context]	Psychological Construct(s)	#P (Env)
Kaye et al. (2018) [CHB]	Examines the effects of explicit priming and avatar gender	full body, motion, 3D [H2SA]	video game [entertainment]	competence, identity, self-esteem	120 (Lab)
Martens et al. (2018) [CHB]	Examines avatars' and users' difference and similarities on time spent with avatar	full body, motion, 3D [SA2A]	video game [entertainment]	similarity	124 (Lab)
Mousas et al. (2018) [CHB]	Examines the effects of appearance and motion of embodied agents on users' emotional reactivity	half body, motion, 3D [H2EA]	virtual character [entertainment]	emotional reactivity, emotional valence	72 (Lab)

Note: **MISQ**: Management Information System Quarterly; **JMIS**: Journal of Management Information System; **ISJ**: Information System Journal; **ESWA**: Expert Systems with Application; **DSS**: Decision Support System; **JCMC**: Journal of Computer-Mediated Communication; **ICIS**: International Conference on Information System; **IJHCS**: International Journal of Human Computer Studies; **CHB**: Computer in Human Behaviors**; H2H**: human to human interaction; **NA**: not applicable; **lab**: laboratory experiment, **srv**: survey; **Fld**: field experiment; **N.A.**: No Avatars used; **#P**: Number of Participants; **2D:** Two dimensional; **3D:** Three dimensional; **Env.**: Interaction environment

Appendix D – Interview guide used for the semi-structured interviews in Chapter 4

Opening:

The PhD candidate introduced himself to the interviewees and thank them for their participation in the research. Then, background information, definitions of terms, justification of conducting the research are clearly explained to the interviewees. Further, the interviewer and interviewees engaged in an open discussion in order to clarify any misunderstanding before conducting the interview.

Opening questions:

- Could you describe an avatar (virtual human) in terms of Arab culture?

Cultural markers questions:

- Do you think that avatars for Arab users of mHealth applications should be designed to reflect cultural elements such as hijab, thobe, colours (Green, blue, and white) … etc.?
  - Yes? Why? Increase perceived similarity? Social presence? Humanness? Reflect Cultural elements?
  - No? What would be the main features that need to be included in the design?
- Would an avatar that is reflect cultural values (Hijab, appropriate clothing, facial hair (beard), colours …etc.) be more persuasive to you? Why? Why not?

Perception of similarity question:

- Would an avatar that is similar to you or to in-group members (realistic, but not too realistic) be more persuasive? Why? Why not?
  - Would that increase social presence? Intention to use the avatar in mHealth application? Why?
- Would avatar with human-like features would be enough to be persuasive? Why? Why not?

Authoritative avatars questions:

- Would an authoritative avatar (such as parent, doctor, teacher, powerful figure) be more persuasive to you? Why? Why not?

Fictional avatars questions:

- Would a fictional avatar (animal like, cartoon like, unrealistic character) be more persuasive? Why? Why not?

Gender questions:

- Would an avatar that has a clear gender classification would be more persuasive to you? Why? Why not?
- Do you think that female users want to interact with female avatars? Why? Why not?
- Do you think that male users want to interact with male avatars? Why? Why not?
- Should the gender of the avatar play important role in persuasiveness?
    - Same gender as the user?

Preference questions:

- What types of avatars do you think would persuade you the most? (e.g. authoritative, similarity, etc.) Why?

Customisation questions:

- Would Arab users like to be able to customise the avatar? How? Would this be persuasive to you? Would this increase intention to use the mHealth application?
- Should the background or environment be customisable? Why?
    - In what environment or what background?

General questions:

- What are the most important aspects of an avatar that would make you care about it? Why?

Closing question:

- What else would you include to make the avatar design similar to Arab users?

Appendix E – Sample Survey/Questionnaire used in Chapter 5

User Perceptions and the Design of Avatars[24]

Scenario provided to participant **One of the avatars used in the study**

Consider that you are using a new website that provides health advice for your diet and physical activity. The website uses an avatar (virtual assistant) to provide this advice.

The avatar shown on the right side of this text has been selected by the website for this purpose. Below, we ask you a set of questions about your perception of the avatar.

Demographic Information

What is your gender?

What is your gender?	Male ☐	Female ☐	Prefer not to say ☐

What is your age in years? (18 - 99)

What is your age in years?	

What is your cultural background? (Self-cultural assessment)

I consider myself as a person from Arab culture	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Please answer the following questions regarding your perception of the avatar

Anthropomorphism (Humanness)	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The avatar appears natural to me	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar appears humanlike to me	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar appears lifelike to me	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar has human features similar to me	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Cultural Appropriateness	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The avatar acknowledges customs and beliefs of my culture	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar's clothing is designed appropriately for my culture	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar includes symbols related to my cultural background	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar includes colours and reflects the image of users from my culture	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

[24] The sample survey can be viewed at http://limesurvey.newcastle.edu.au/index.php/936589?lang=en

Perceived Familiarity	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I feel that I have seen this avatar before	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
This avatar looks familiar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I know some people that resemble this avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Intention to use	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Assuming I have access to the website, I would intend to use the avatar for obtaining health advice	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
Assuming I have access to the website, I predict I would use the avatar for obtaining health advice	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
Assuming I have access to the website, I would plan to use the avatar for obtaining health advice	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Perceived Social Presence	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I feel a sense of human contact in the avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I feel a sense of personalness in the avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I feel a sense of sociability in the avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I feel a sense of human warmth in the avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I feel a sense of human sensitivity in the avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Trust	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The avatar appears reliable	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar appears trustworthy	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
I would trust this avatar	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

What is the cultural background of this avatar? (Manipulation Check)

Culture of the avatar	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The avatar looks like it comes from Arab culture	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

What is the gender of this avatar? (Manipulation Check)

Gender of the avatar	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The avatar looks female	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐
The avatar looks male	5 ☐	4 ☐	3 ☐	2 ☐	1 ☐

Selection of avatars

Which avatar would prefer to interact with?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Why did you choose this avatar?

<enter reason here>

Appendix F – Further results of constructs included in Chapter 5

Chapter 5 provided detailed analysis on how avatars' cultural appropriateness was perceived by participants. Also, it provided analysis on usage intention across avatar's culture, clothing, and gender. This section provides further analysis of other psychological constructs included in our research model.

Figure F.1 provides an overview of how avatars' culture, clothing, and gender were perceived in terms of trust. In addition, Figure F.2 provides graphical overview of how avatar culture is perceived in terms of trust by Arab female and male participants. Arab avatars were consistently perceived as more trustworthiness than non-Arab avatars across all treatment conditions by Arab users.

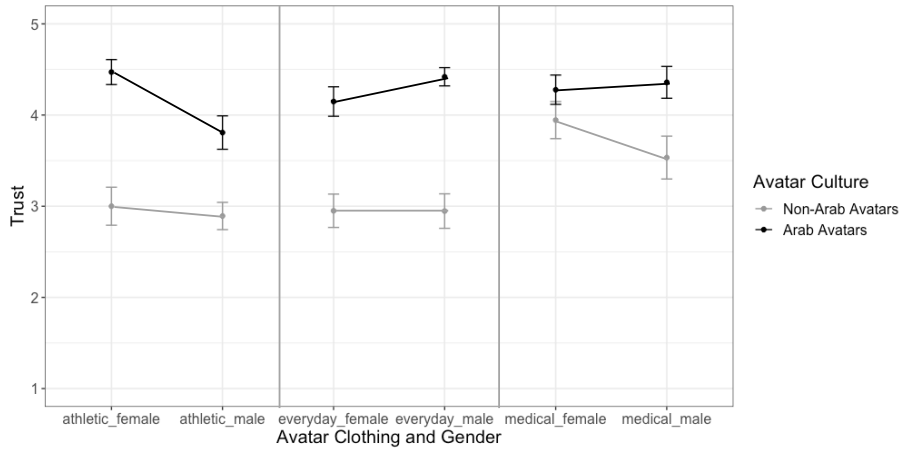

Figure F.1 Trust across avatar culture, gender, and clothing

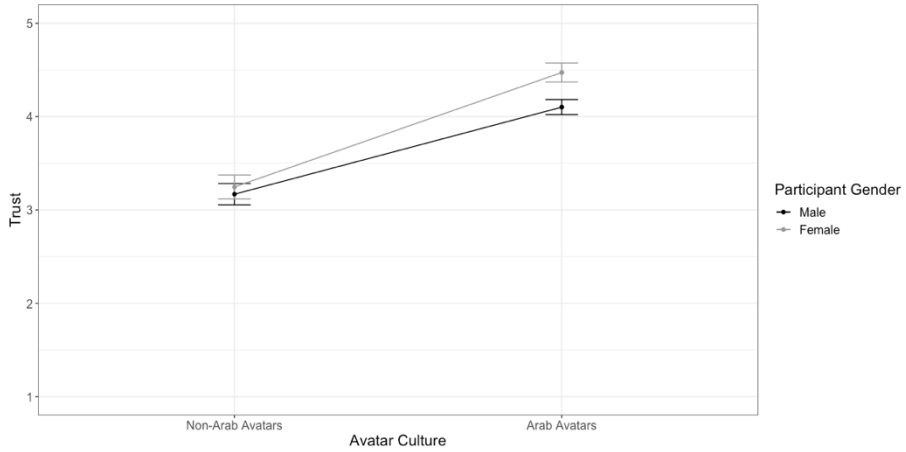

Figure F.2 Female and male participants' perception of trust of avatar culture

Figure F.3 provides an overview of how avatar culture, clothing, and gender were perceived in terms of familiarity. In addition, Figure F.4 provides graphical overview of how avatar culture is perceived in terms of familiarity by Arab female and male participants. Arab avatars were consistently perceived as more familiar than non-Arab avatars across all treatment conditions.

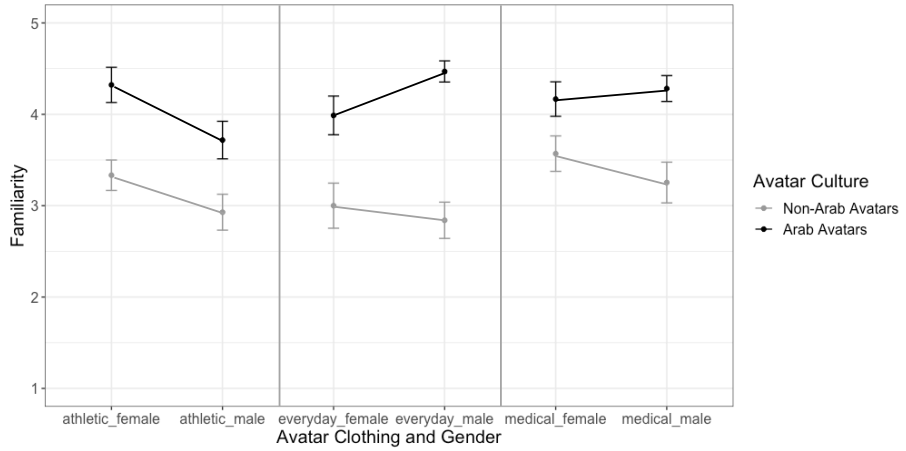

Figure F.3 Familiarity across avatar culture, gender, and clothing

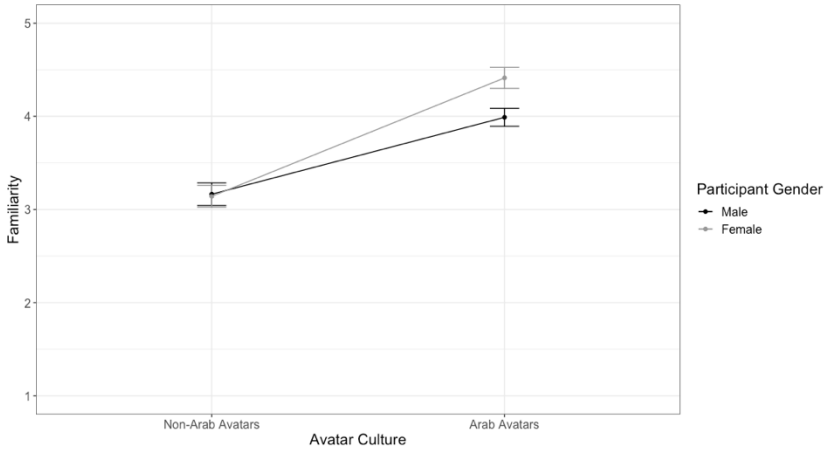

Figure F.4 Female and male participants' perception of familiarity of avatar culture

Figure F.5 provides an overview of how avatar culture, clothing, and gender were perceived in terms of anthropomorphism. In addition, Figure F.6 provides graphical overview of how avatar culture is perceived in terms of anthropomorphism by Arab female and male participants. Arab avatars were consistently perceived as more anthropomorphic than non-Arab avatars across all treatment conditions.

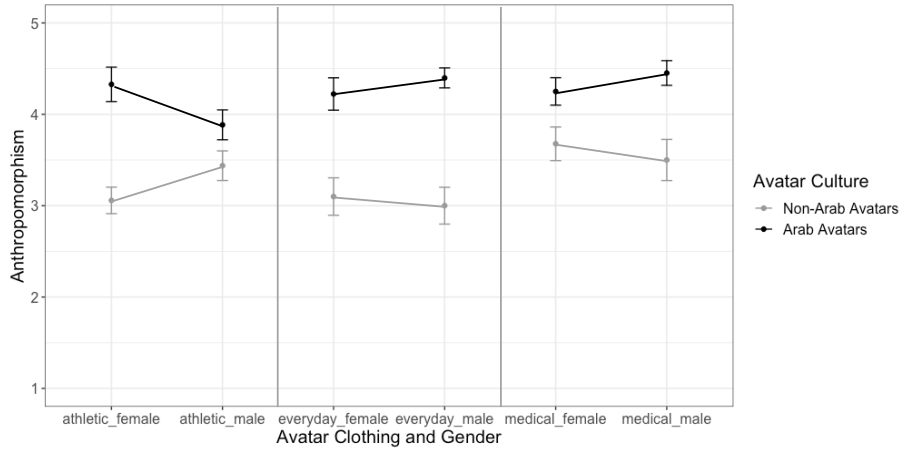

Figure F.5 Anthropomorphism across avatar culture, gender, and clothing

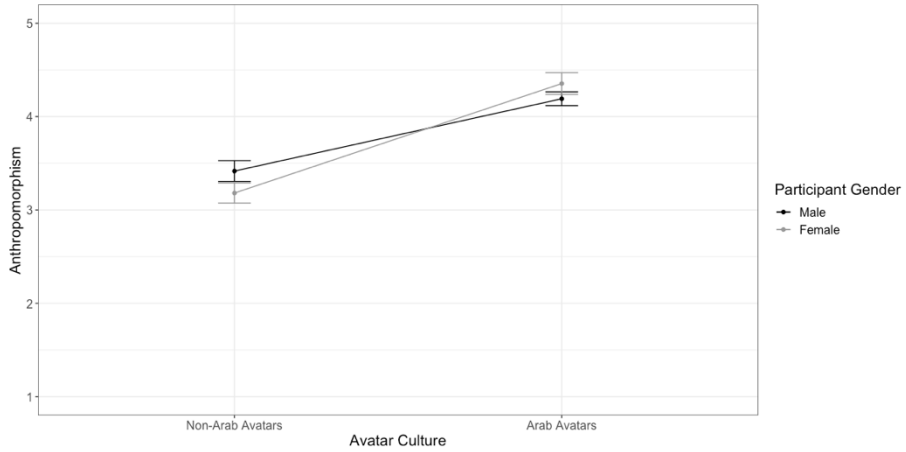

Figure F.6 Female and male participants' perception of anthropomorphism of avatar culture

Figure F.7 provides an overview of how avatar culture, clothing, and gender were perceived in terms of social presence. In addition, Figure F.8 provides graphical overview of how avatar culture is perceived in terms of social presence by Arab female and male participants. Arab avatars were consistently perceived as more social present than non-Arab avatars across all treatment conditions.

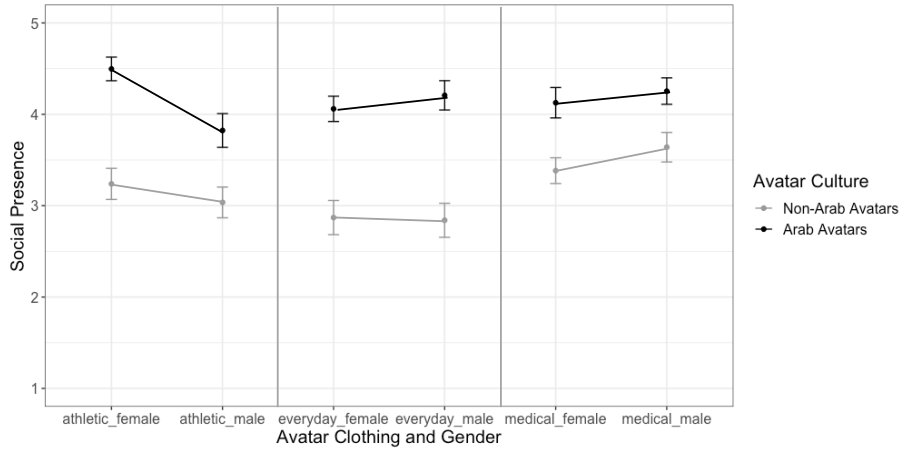

Figure F.7 Social presence across avatar culture, gender, and clothing

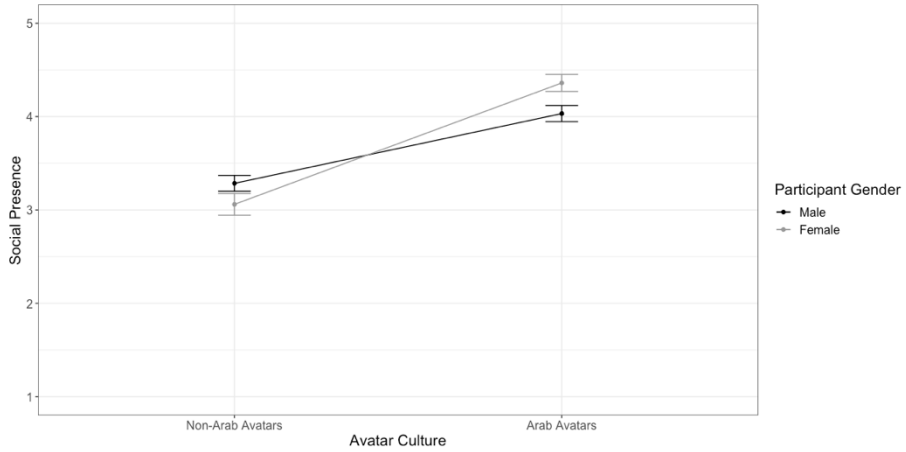

Figure F.8 Female and male participants' perception of social presence of avatar culture

Further, in Chapter 5 we focused our discussion around cultural appropriateness and intention to use of avatars (Arab vs. non-Arab avatars). Here, we provide further results aiming at providing the mean and standard deviation (SD) between Arab and non-Arab avatars in terms of the perceptions of Arab female and male participants for avatars' social presence, anthropomorphism, familiarity, and trust. Table F.1 summaries these results. By looking at the results, Arab avatars are consistently perceived higher in the perceptive constructs than non-Arab avatars. In addition, based on these results, one can see that female participants are more sensitive than male to the avatar culture and perceived Arab avatars higher in the respective psychological constructs. In other words, female participants

perceived Arab avatars as more socially present, anthropomorphic, and familiar, trustworthy, culturally appropriate, and they have more usage intention than male participants.

Table F.1 Female and male participants perception of avatar for respective constructs

Construct	Avatar Culture	Female participant		Male participant	
		Mean	SD	Mean	SD
PSP	Arab	4.361	.748	4.032	.852
	Non-Arab	3.060	.994	3.285	.731
ANTH	Arab	4.355	.952	4.191	.736
	Non-Arab	3.285	.924	3.417	.965
FAM	Arab	4.413	.927	3.989	.954
	Non-Arab	3.142	1.003	3.164	1.050
TRT	Arab	4.473	.833	4.102	.794
	Non-Arab	3.246	1.090	3.169	.987
CA	Arab	4.526	.789	4.166	.822
	Non-Arab	1.452	.886	2.087	.969
ITU	Arab	4.124	1.074	3.761	1.040
	Non-Arab	2.288	1.511	2.760	1.389

Table F.2 provides information on how avatar culture was perceived for the entire sample (n = 313). The results show that avatars that were designed with Arab cultural clothing were perceived higher in the respective psychological constructs. More specifically, based on the result of t-tests, we can affirm the following:

1) The difference between Arab avatars (M = 4.166, SD = .825) and non-Arab avatars (M = 3.174, SD = .875) is significant ($t(311)= 10.313$, $p<.001$) in terms of avatars' perceived social presence for Arab users.

2) The difference between Arab avatars (M = 4.258, SD = .831) and non-Arab avatars (M = 3.301, SD = .949) is significant ($t(311)= 9.509$, $p<.001$) in terms of avatars' perceived anthropomorphism for Arab users

3) The difference between Arab avatars (M = 4.162, SD = .963) and non-Arab avatars (M = 3.153, SD = 1.024) is significant ($t(311)= 8.977$, $p<.001$) in terms of avatars' perceived familiarity for Arab users.

4) The difference between Arab avatars (M = 4.253, SD = .828) and non-Arab avatars (M = 3.207, SD = 1.036) is significant (t(311)= 9.903, p<.001) in terms of avatars' trust for Arab users.

5) The difference between Arab avatars (M = 4.312, SD = .825) and non-Arab avatars (M = 1.774, SD = .979) is significant (t(311)= 24.873, p<.001) in terms of avatars' cultural appropriateness for Arab users

6) The difference between Arab avatars (M = 3.909, SD = 1.066) and non-Arab avatars (M = 2.527, SD = 1.465) is significant (t(311)= 9.903, p<.001) in terms of avatars' usage intention for Arab users.

Table F.2 Participants' perceptions of avatars

Construct	Avatar Culture	Entire Sample		T-value [Arab – non-Arab]
		Mean	SD	
PSP	Arab	4.166	.825	10.313***
	Non-Arab	3.174	.875	
ANTH	Arab	4.258	.831	9.509***
	Non-Arab	3.301	.949	
FAM	Arab	4.162	.963	8.976***
	Non-Arab	3.153	1.024	
TRT	Arab	4.253	.828	9.903***
	Non-Arab	3.207	1.036	
CA	Arab	4.312	.825	24.873***
	Non-Arab	1.774	.979	
ITU	Arab	3.909	1.066	9.609***
	Non-Arab	2.527	1.465	

Notes: *p<.05; **p<.01; ***p<.001

Recall that in Chapter 5, we provided results of the multi-group analysis with significant differences between the four identified groups in our dataset. The groups were female and male participants, female and male avatars, participants having same gender as the avatars or different gender, and finally avatars with medical clothing and avatars with non-medical clothing, i.e., athletic and everyday clothing. In the following, we present the complete results of our multi-group analysis. First of all, Table F.3 presents the complete results of the first group comparing male (n = 173) and female (n = 140) participants in our research model in order to discern whether there are significant or insignificant differences in path coefficients.

Table F.3 Path coefficient between male and female participants

	Male Participant		Female Participant		
Path	Estimate	P	Estimate	P	z-score
CA → FAM	.424	<.001	.375	<.001	-.623
CA → ANTH	.332	<.001	.334	<.001	.035
FAM → PSP	.235	<.001	.204	<.001	-.381
ANTH → PSP	.308	<.001	.417	<.001	1.013
CA → PSP	.183	<.001	.211	<.001	.404
ANTH → TRT	.456	<.001	.184	.026	-2.251*
PSP → TRT	.498	<.001	.454	<.001	-.326
FAM → TRT	.034	<.001	.265	<.001	2.654***
TRT → ITU	.702	<.001	.732	<.001	.208
CA → ITU	.219	<.001	.315	<.001	1.069

Notes: *p<.05; **p<.01; ***p<.001

Table F.4 shows the results of the second group comparing female (n = 156) and male (n = 157) avatars in our research model in terms of significant and insignificant differences.

Table F.4 Path coefficient between female and male avatars

	Female Avatar		Male Avatar		
Path	Estimate	P	Estimate	P	z-score
CA → FAM	.301	<.001	.501	<.001	2.631***
CA → ANTH	.311	<.001	.378	<.001	1.050
FAM → PSP	.193	<.001	.238	<.001	.542
ANTH → PSP	.355	<.001	.389	<.001	.305
CA → PSP	.191	<.001	.188	<.001	-.040
ANTH → TRT	.292	.002	.352	<.001	.491
PSP → TRT	.444	<.001	.463	<.001	.146
FAM → TRT	.162	.014	.112	.048	-.570
TRT → ITU	.641	<.001	.767	<.001	.867
CA → ITU	.321	<.001	.240	<.001	-.907

Notes: *p<.05; **p<.01; ***p<.001

Table F.5 shows the results of the third group, in which we compare participants having same gender as the avatar (n = 207) and different gender (n = 106) avatars in our research model in terms of significant and insignificant differences. Particularly in this group, we did not discern any significant differences between participants having the same or different gender of the avatars.

Table F.5 Path coefficient between users having same or different gender to the avatar

	Same Gender		Different Gender		
Path	Estimate	P	Estimate	P	z-score
CA → FAM	.390	<.001	.386	<.001	-.053
CA → ANTH	.345	<.001	.314	<.001	-.463
FAM → PSP	.183	<.001	.198	.004	.165
ANTH → PSP	.357	<.001	.448	<.001	.722
CA → PSP	.185	<.001	.217	<.001	.442
ANTH → TRT	.330	<.001	.297	.016	-.234
PSP → TRT	.384	<.001	.556	<.001	1.227
FAM → TRT	.206	<.001	.084	.256	-1.342
TRT → ITU	.713	<.001	.736	<.001	.156
CA → ITU	.315	<.001	.190	.010	-1.355

Notes: *p<.05; **p<.01; ***p<.001

Table F.6 shows the results of the fourth group, in which we compare avatars with medical clothing (n = 105) and avatars with non-medical clothing (n = 208) in our research model for each path coefficient in order to discern whether there are significant and insignificant differences.

Table F.6 Path coefficient between avatars with medical and non-medical clothing

	Medical clothing		Non-medical clothing		
Path	Estimate	P	Estimate	P	z-score
CA → FAM	.318	<.001	.417	<.001	1.187
CA → ANTH	.290	<.001	.358	<.001	1.015
FAM → PSP	.193	.002	.206	<.001	.160
ANTH → PSP	.395	<.001	.345	<.001	-.458
CA → PSP	.102	.037	.240	<.001	2.089*
ANTH → TRT	.368	<.001	.321	<.001	-.378
PSP → TRT	.544	<.001	.377	<.001	-1.102
FAM → TRT	.064	.383	.200	<.001	1.523
TRT → ITU	.906	<.001	.277	<.001	-4.838***
CA → ITU	.037	.548	.542	<.001	6.256***

Notes: *p<.05; **p<.01; ***p<.001

Appendix G – Participants invitation email (Chapters 4 and 5)

This appendix provides invitation letters sent to recruit participants for our studies. The invitations were sent together with the information statements as well as the consent form (if applicable) as attachments.

- Invitation for the qualitative study – Semi-structure interviews for exploring avatar design for users from Arab culture

Dear <participant's name>,

We are conducting interviews as part of our research project "Human-Centred Information Systems: Designing Avatars for users from Arab culture". This research project is part of Hussain Al Jaroodi's PhD studies supervised by Dr Raymond Chiong and Dr Marc Adam. We would like to invite you to participate in a study aiming to identify design requirements and principles (design guidelines) for Arab avatars in the context of mobile health. Our goal is to derive design guidelines for mHealth solutions using avatars that are culturally acceptable in Arab countries.

The interview should not take more than 60 minutes. We hope to capture your thoughts and perspectives on designing avatars in the Arabic context. Your responses to the questions will be kept confidential. Each interview will be assigned a number code to help ensure that personal identifiers are not revealed during the analysis and write up of findings.

If you are willing to participate in the study, please return the attached consent form signed, and we will follow up with a date and time for the interview. If you have any questions, please do not hesitate to ask.

Your participation is much appreciated, and we look forward to hearing from you. Note: the interview can be conducted online via Skype or other application available to you.

Best Regards,
Mr. Hussain Al Jaroodi (PhD Candidate), Dr Raymond Chiong, and Dr Marc Adam

- Invitation for the survey/questionnaire study to evaluation the impact of cultural appropriateness on usage intention of avatars for Arab culture

Dear Potential Participant,

This is Hussain Al Jaroodi, a PhD candidate (Information Systems) at the University of Newcastle, Australia. You are invited to participate in a survey involving users' perceptions and the design of avatars.

The questions are about how the avatars would be designed for Arab users in terms of clothing, familiarity, humanness, trust, intention to use, and their cultural appropriateness to Arab culture. The survey will take about 20-30 minutes to complete. Your participation in the survey is completely voluntary and all of your responses will be kept confidential. No personally identifiable information will be associated with your responses to any reports of these data.

If you are interested in participating, please click on the following link, <Sample Survey>, for further information and to complete the online survey. If you choose not to participate in the research, please close the browser window.

Thank you very much for considering this invitation.

Best Regard,
Mr. Hussain Al Jaroodi (PhD Candidate), Dr Raymond Chiong, Dr Marc Adam

Appendix H – Written permission to use image in Chapter 4

From: Saudi Student Club in London <saudiclublondon@gmail.com>
Sent: Thursday, 31 January 2019 3:19 AM
To: Hussain M. Al Jaroodi
Subject: Re: Permission to use image

Yes, of course, you can use it.

On Tue, 29 Jan 2019 at 16:43, Hussain M. Al Jaroodi wrote:

The research is about the use of avatars (virtual humans) in Arab culture. In our research project, we want to show the readers how avatars are used in Arab culture. Could we use the image for research purposes only? We would appreciate the help.

Regards,
Hussain M. Al Jaroodi

On 29 Jan 2019, at 7:41 pm, Saudi Student Club in London <saudiclublondon@gmail.com> wrote:

Could you please provide more information about the research and what is going to be used for?

On Tue, 29 Jan 2019 at 14:07, Hussain M. Al Jaroodi wrote:

Greetings Saudi Student Club in London;

This is Hussain Al Jaroodi, a PhD candidate at the University of Newcastle, Australia. We would like to ask you to use this image from your Twitter account in our research project. We would appreciate your permission to do so.

The image can be found in the following link:
https://twitter.com/LonSSCUK/status/1086362094247788552

Best,
Hussain M. Al Jaroodi

Appendix I – Interview guide used for the interviews and workshops in Chapter 3

- Does the mHealth solution provide data that is valuable for you in order to assess the progress of patients and to make adjustments to their rehabilitation program? [staff]
- What data is missing that would enable you to accomplish these tasks? [staff]
- Do you find the mHealth solution motivating? If so, which aspects did you find most motivating? If not, what contributed most to this? [staff / users]
- Does the mHealth solution increase your understanding of how to perform exercises? If so, what aspects are most beneficial for accomplishing this? If not, why do you think this was the case? [users]
- Does the mHealth solution improve your understanding of the benefits of performing the exercises? If so, which aspects are most helpful? If not, why do you think this is the case? [users]
- Would you recommend the mHealth solution to other people? Why? [staff / users]
- Is there anything else you would like included in an mHealth solution? [staff / users]