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# A TALE OF TWO VIRTUAL ADVISORS: AN EMPIRICAL STUDY INVESTIGATING THE EMPOWERMENT EFFECT OF MOBILE MENTAL-HEALTH ADVISORY SYSTEMS ON EMERGENCY RESCUERS

Manning Li

*Northeastern University*, [mnli@mail.neu.edu.cn](mailto:mnli@mail.neu.edu.cn)

Jie Hou

*Northeastern University*, [jiehouneu@gmail.com](mailto:jiehouneu@gmail.com)

Henry Zhang

*The Australian National University*, [henry.zhang.anu@gmail.com](mailto:henry.zhang.anu@gmail.com)

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# A TALE OF TWO VIRTUAL ADVISORS: AN EMPIRICAL STUDY INVESTIGATING THE EMPOWERMENT EFFECT OF MOBILE MENTAL-HEALTH ADVISORY SYSTEMS ON EMERGENCY RESCUERS

Manning Li, School of Business Administration, Northeastern University, Shenyang, Liaoning, China, mnli@mail.neu.edu.cn

Jie Hou, School of Information Science and Engineering, Northeastern University, Shenyang, Liaoning, China, jiehouneu@gmail.com

Henry Zhang, College of Engineering and Computer Science, The Australian National University, Canberra, Australia, henry.zhang.anu@gmail.com

## Abstract

*Virtual advisory services are very important tools for the psychological self-help domain. It is particularly valuable for emergency rescuers in relieving their psychological distress given the high-stress nature of their occupation. To investigate optimal design strategies for an effective virtual advisory service to empower emergency rescuers, this article explores how virtual advisor identity influences the empowerment effect of virtual mental-health advisory systems for emergency rescuers. Guided by empowerment theory and similarity theory, we developed and empirically tested our system artefact and design theory for our virtual advisory system MHAS. The results of our experiment, involving 120 emergency rescuers who have just finished their emergency tasks in Inner Mongolia, show that virtual advisor identity significantly impacts on a user's cognitive and emotional aspects, which are significant empowering enablers leading to positive empowerment outcomes as measured by a sense of control and perceived power. Implications for research and practice are then discussed.*

*Keywords: Social impacts of health information systems, Human computer interaction, Empowerment theory, Similarity theory, Emergency rescuers, Mental-health advisory systems*

# 1 INTRODUCTION

Due to increasing extremities in weather and geographical patterns in many parts of the world, frequent natural disasters not only bring victims loss of lives and properties, but also endanger the mental health of the emergency rescuers after being exposed to catastrophic scenes and challenging rescue tasks. Under occupational distress, there is a great chance that emergency rescuers will suffer from chronic mental problems if they do not receive timely support and treatments. Given the high demand and limited resources, currently there are limited methods to support emergency rescuers due to the lack of qualified psychologists to carry out large-scale intervention strategies. Further, as a response to the call by the World Health Organization (WHO, 2012), we focus on how to effectively leverage information systems to improve the mental well-being of citizens. This study in particular investigates emotional and information support for emergency rescuers, a largely ignored group needing more attention from the government and the public.

While there are sufficient attentions dedicated to virtual therapies for people through computers and networks (Hoffman et al., 2003; Reger & Gahm, 2008; Bickmore et al., 2009; Kethuneni et al., 2009; Thompson et al., 2010; Rizzo et al., 2011), very few study empirically examined various aspects of the system design implications. This is especially so in regards to the design characteristics of the virtual advisor, which are commonly used in many virtual advisory systems.

In practice, there is also a lack of understanding by practitioners on an optimal design strategy for the virtual advisors (DLP, 2013; Schueler, 2013; UQHS, 2013). As a result, our study empirically examines what features of a virtual advisor make it effective in empowering emergency rescuers who are seeking for emotional and information support. Based on a thorough review of existing systems in research and practice in Section 2, we investigate: *How does virtual advisor identity influence the empowerment effect of virtual mental-health advisory systems (MHAS) for emergency rescuers?*

The rest of the paper is organized as follows: First, we review extant literature related to mental health advisory system and design theories relating to the domain of MHAS, which is followed by the theoretical model and research hypotheses. Section 3 then presents details of the experiment. The fourth section discusses our experiment results. The remaining sections discuss the limitations, theoretical and practical implications of the study, and future work opportunities.

## 2 THEORETICAL BACKGROUND

### 2.1 Existing work

To ensure the study considers multiple design perspectives drawn from prior research projects, we reviewed a series of healthcare services for mental health well-beings.

First, we systematically examined mobile advisory systems in the health domain. Due to the convenience, portability, communicability and accessibility of mobile devices, a great number of mobile health applications emerged in recent years to provide affordable and efficient healthcare services for the general public. Liu and colleagues classified these mobile

healthcare applications into several important classes: (1) medical information reference; (2) educational tools; (3) tracking tools; (4) medical information database; (5) decision support; (6) medical calculators (Liu et al., 2011). Inspired by this research, we integrate several aspects of the functionalities into the design of our MHAS, such as providing medical information reference, serving as educational tools or tracking tools and advising on possible actions to be taken to relieve mental strains. With handy access to these support 24\*7 via mobile devices, users are expected to appreciate these functionalities with a better sense of control and to establish a stronger sense of self-efficacy out of the self-help process (Kendall & Rogers, 2007).

Our study focuses on the psychological need of emergency rescuers. Thus we also systematically reviewed various types of psychological applications on the Internet and those documented in the literature. Barak classified the psychological applications into ten categories based on a typology of functions (Barak, 1999). Following Barak's classification, our system modules include: 1) providing information resources on psychological concepts and issues, 2) self-help guides, 3) psychological testing and assessment, 4) help in deciding to go into therapy and 5) discussion groups, all of which can provide a full range of psychological assistance. Based on these reviews, several representative systems or studies are shown in Table 1.

From Table 1, we discover that most of the existing systems contain humanoid virtual advisors, which potentially enhance users' feelings of human touch and support. In addition, systems provide detailed psychological knowledge through various innovative ways, such as self-assessment quizzes, decision support tools and example case studies to promote users' understanding of their own situation. Further, a number of these systems contain self-resonance features that trigger user's feelings of familiarity and potentially draw the user emotionally closer, such as system content customization or self-referent mechanisms (e.g., depressed little prince). In order to design MHAS, we should also take note of the inadequacy of system design in prior studies, such as the lack of interactivity, limited accessibility time-wise and location-wise, and sometimes inadequate functions. Finally, we notice an interesting phenomenon that the virtual advisor's identity is either appearing as a domain expert or a self-referent character, yet no systematic research has investigated the potential impact of virtual advisor's identity. Therefore we explored the theories behind this phenomenon in the system design.

## **2.2 Empowerment Theory in the Healthcare Context**

In the context of patient-healthcare provider interactions, empowerment theory can be defined as "a social process of recognizing, promoting, and enhancing people's abilities to meet their own needs, solve their own problems and mobilize the necessary resources in order to control their lives"(Gibson, 1991). Furthermore, there are three key dimensions of the empowerment theory in this context: (1) patients control over their disease condition (patient domain); (2) patients engage in participation during the consultation (patient-physician interaction domain); (3) physician provides support and education to patients (physician domain)(Ouschan et al., 2000). Besides, it is essential to differentiate the two parts of the empowerment theory: empowering enabler/processes and empowered outcomes. Empowering enablers can be viewed as the sources or opportunities that can control patients' fate or influence their decision

Source	Advisory Mechanism	System Type/Main Functions	Sense of Human Touch	Information Accessibility	Interpersonal Resonance	Others
Depressed little prince depression.edu.hk	Self-referent	<u>Educational tool</u> ; self-help guide; discussion groups ·Provide some basic knowledge of depression · Check emotional health status ·Join in a discussion group to share experiences and gain insights from other users	+A sense of affinity + A virtual companion appearance in the form of cartoon -Lack of interactivity	+Present the information with plain words and attractive cartoon +Provid detailed knowledge for depressed users	+ Depressed users saw themselves in little prince's story and recovery processes +Effective advices provided to 'little prince'. +Communicate with representative figures with stories to learn from similar experiences -Only target at people with depression	+ References to relevant institutions for further support +Attractive:Nice cartoon and Music
FreeMD freemd.com	Domain expert	<u>Decision support tool</u> ·Present a variety of symptoms by step-by-step guidance ·Generate a report about the cause of symptoms ·Help users determine the most appreciate time and place to receive healthcare	+Interact through both voice and text +The advisor appears in the form of virtual human with rich expressions and actions	+With pictures to elaborate the questions +Give detailed and effective advices -Lengthy questions	+Make an appropriate diagnose that caters for users' health states -Authoritative expert appearance that are dissimilar with patients -Produce a sense of distance and unfamiliarity	+Eye-catching -Limited functionalities
Simcoach (Rizzo et al., 2011)	Self-referent	<u>Medical information database and psychological test tool</u> ·Provide critical information relative to psychological health ·Facilitate seeking appropriate care with a live clinical provider ·Perform simple neurocognitive and psychological testing	+Interactive +Virtual human presence +Intelligent graphical characters +Use speech, gesture, emotion to interact -Limited speech interaction	+Provide a wide range of detailed psychological knowledge +Foster comfort and confidence by promoting users' better understanding their situations -Web-based system, unable to access the service anytime and anywhere	+Feel as positive as the VA, when interacting with the VA who has similar identities with the target user +Create a sense of familiarity and support during the interpersonal interaction process	+Print out a summary of computerized sessions to bring with them when seeking care with a real human +Intelligent +Engage the user by providing support and encouragement
Virtual nurse agents (Bickmore et al., 2009)	Domain expert	<u>Educational tool</u> ·Educate/counsel hospital patients ·Test patients' comprehension ·Produce a machine-readable index file, specifying the spatial location of the information that will be discussed ·Display unresolved issues to the human nurse	+ Animated and empathic virtual nurse +Simulate face-to-face conversation +Display animated behavior (voice, hand gestures, posture shifts and facial expressions) +Humor & Social chat before session +Address the patient by name	+Provide information in a consistent manner and in a low-pressure environment to make the patients thoroughly understand +Semiabstract graphics (Carton) +Hold and point at the image while explaining	+Design two female nurse characters to match patient demographics to evoke emotional resonance -The virtual nurse's identity is a medical expert who might make patients feel estrangement during the communication	+Easy to use +Touch screen needed +Keep utterance inputs as simple as possible -Limited functions
Beating the blues Beatingtheblues.co.uk	Self-referent	<u>Self-help guide</u> ·Contain a video introduction in the form of comics ·Provide treatment by eight weekly sessions of cognitive behavior therapy ·Arrange homework after each section and then receive feedback from the system	+ human cartoon characters are used to elaborate scenarios  -Lack of interaction with virtual human	+Provide knowledge via multi-media technology to promote understanding + Persuasive information on cognitive behavior therapy +Arrange homework to help consolidate learning effect	+ 3D human figures demonstrating relaxation exercises  -Limited interpersonal communication between the advisor and the user	+Fit for both patients and practitioners +Adjunct to treatment by health professionals. + Effective therapeutic effect -Treatment time too long

Table 1 Exemplar studies in the healthcare self-services area

-making and behaviour (Zimmerman, 1995). On the other hand, empowered outcomes usually refer to achieving a sense of control, perceived power, self-efficacy, mastery over things and resource mobilization, all of which are the consequence of empowering process (Perkins & Zimmerman, 1995; Aujoulat et al., 2008).

In healthcare promotion, cognitive skills play a critical role in empowerment, which determines the motivation and ability to obtain, to understand and to use the information to stay healthy (Koelen & Lindström, 2005). The social cognitive theory states that people's cognitive ability has a significant influence on people's behaviour (Chiu et al., 2006). In consequence, we study the cognitive aspects (i.e., perceived understanding (PU) and actual understanding (AU) of the provided knowledge) to investigate its effect on emergency rescuers' behaviour and beliefs. From another perspective, mutual-help or self-help group is extremely effective in promoting sense of empowerment (Barak et al., 2008). Support from peers or similar others can help people obtain emotional relief and resonance through sharing similar experiences or confusion - this can result in better understanding of each other and provide emotional support and involvement to foster personal empowerment (Aujoulat et al., 2008). In our virtual MHAS, we consider social presence (SP) and perceived interpersonal resonance (IR) as two key elements of the emotional aspects of the user after using the MHAS system.

Further, the cognitive and emotional aspects as empowerment enablers have significant effect on empowerment outcomes. Patients can perceive a great sense of self-control over their mental condition and life values as they get empowered during the interaction (Aujoulat et al., 2007). Besides, the empowerment process can also reduce a feeling of powerlessness (Aujoulat et al., 2008), and gain more power over their lives (Aujoulat et al., 2007; Barak et al., 2008). In consequence, we regard sense of control (SC) and perceived power (PP) as primary dimensions of empowerment outcomes to be assessed in our research.

### **2.3 Similarity-Attraction Theory and its Impact on Empowerment**

The similarity-attraction theory states that individuals are attracted by persons who share similar characters with themselves (Byrne, 1971). People who are similar can get along well with each other and improve mutual understanding, which can result in spiritual and emotional support. As pointed out by Littlejohn and Foss in 'Theories of human communications', when communicators discover *similarities between each other*, 'their attraction to one another goes up, and their apparent need for more information goes down' (p. 131). Many existing researches have investigated similarity theory in different contexts, such as facial similarity (Vugt et al., 2010), personality and behaviour similarity (Al-Natour et al., 2006), decision process similarity (Al-Natour et al., 2011) and communication style similarity (Li et al., 2013). However, little study focuses on the identity similarity in the information system discipline. Thus we research the impacts of identity similarity on empowerment in the context of virtual advisory services for emergency rescuers.

To elaborate, identity similarity means that people share similar social identity, and they could have suffered from the same experience, which can enhance the feeling of the social support (Uden-Kraan, 2008). In our study, emergency rescuers consult with a virtual peer advisor who shares similar difficulties or misery. Rescuers can obtain helpful advices and relief from occupational distress, and enhance their feelings of support and sense of belonging.

Peer support is also associated with personal empowerment. Interacting with a peer advisor can strengthen people's personal competence, self-determination and social engagement (Barak et al., 2008). Consequently, there is an empowering effect when emergency rescuers consult with virtual peer advisors. They would feel empowered, in particular feeling more informed, having more confidence in social environments and perceiving more self-control and self-efficacy as a result (Uden-Kraan, 2008). On the other hand, emergency rescuers are people who frequently need to follow instructions from their officers or group leaders to ensure a rescue task being carried out effectively. We are interested to see: compared with an authoritative figure such as a virtual expert advisor, how will the emergency rescuers perceive a peer virtual advisor in the MHAS system? Consequently, we empirically examined in our research model the differences between these types of virtual advisors.

## **2.4 Research Model and Hypotheses Development**

Literature has shown that in contrast to non-professionals, knowledge provided by experts is regarded as more authoritative and professional. As a result, the majority of people perceived the knowledge provided by experts to be more acceptable (Marine et al., 2005). Further, compared with peer advisors, experts' advice can facilitate users' trust of the information with increased transparency (Levidow & Carr, 2007) and therefore people feel more informed of the knowledge being transferred to them. Consequently, we anticipate that:

H1: In contrast to virtual peer advisors (VPA), emergency rescuers' perceived understanding of the psychological knowledge provided by the mental-health advisory system is better with virtual expert advisors (VEA).

Prior study has shown that people can maximize their decision quality through accepting experts' advices (Schrah et al., 2006). Besides, the level of expertise can influence the users' decision quality (Xiao & Benbasat, 2007). Moreover, knowledge that are systematically elaborated by authoritative source can satisfy patients and promote actual understanding of the knowledge more in-depth (Bickmore et al., 2009). Thus we infer that:

H2: In contrast to VPA, emergency rescuers' actual understanding of the psychological knowledge provided by the mental-health advisory system is better with VEA.

Social presence refers feelings that "an artifact is perceived as sociable, warm, personal, or intimate when interacting with it" (Gefen & Straub, 2003). The similarity-attraction theory indicates that individuals enjoy communicating with people who are similar to themselves. Therefore, humanoid virtual advisors make individuals having the perception that they are coexisting with other social beings (Fontaine, 1992). Prior study also showed that users perceive stronger social presence when interacting with people with similar ethnicity (Qiu & Benbasat, 2010) or similar decision process (Al-Natour et al., 2011). Likewise, we expect that VPA will trigger user's self-resonance better than VEA and can therefore positively impact users' feelings of social presence.

H3: In contrast to VEA, VPA can enhance emergency rescuers' sense of social presence while using the system.

Perceived interpersonal resonance refers to people's perception that the advisory system is able to share similar interpersonal traits which result in the formation of a relationship of mutual understanding or trust and agreement. People who shared similar preferences have similar interpersonal traits (Boer et al., 2011). People are often more easily attracted to those

who are similar to themselves. Li and Chignell empirically demonstrated that interpersonal attraction will increase with greater perceived personality similarity (Li & Chignell, 2010). Further, goal similarity also positively influence interpersonal attraction (Lin et al., 2012). Therefore if rescuers consult VPA who exhibit similar goals, they are more likely to feel more self-resonance interpersonally during the consultation. Hence, we expect VPA can positively influence perceived interpersonal resonance compared with VEA .

H4: In contrast to VEA, emergency rescuers perceive VPA as more capable in triggering their interpersonal resonance while using the system.

Sense of control refers to emergency rescuer's believes that his/her voluntary activity can have positive influence on their inner mental status. Sense of control is said to be able to influence people's thought patterns, emotional arousal and changes in behaviour (Koufaris, 2002). It is found that transparency enables users to enjoy a high level of sense of control (Koufaris, 2002). Additionally, informativeness of a system significantly impact user's sense of control (Li & Gregor, 2011). Furthermore, empowerment theory proposes that acquiring psychological skills or information can enhance patients' sense of autonomy, self-efficacy and self-awareness (Aujoulat et al., 2007). Studies also show that social presence is a significant antecedent to users' behaviour and attitudes in the context of virtual worlds (Jung, 2011) and individuals perceive more self-control in social presence (Uziel, 2010). Moreover, shared languages and codes in social networks are also positively associated with sense of control (De Carolis & Saporito, 2006), so we expect an increased level of interpersonal resonance can also affect sense of control.

H5: Improvement of perceived understanding will increase emergency rescuer's sense of control.

H6: Improvement of actual understanding will increase emergency rescuer's sense of control.

H7: A better sense of social presence will increase emergency rescuer's sense of control.

H8: Perceived interpersonal resonance will increase emergency rescuer's sense of control.

Perceived power refers to people's sense of having the power and confidence to deal with external difficulties and challenges. Informativeness is a key element during the empowerment process, which can enhance people's perceptions of power and self-efficacy (Zimmerman, 2000). Another research also demonstrated that message with high transparency are more persuasive, which are expected to be more effective in increasing rescuer's perceived power after using the system (Littlejohn & Foss, 2007). Similarly, patients feel empowered through acquiring knowledge from experts, which encourages patients to actively involve in self-care (Bickmore et al., 2009). Besides, high-quality advice, which enhances the extent of actual understanding, makes users feel more confident and comfortable (Wang & Benbasat, 2009). Prior studies indicated that stronger social presence can increase positive emotions, in particular confidence (Argo et al., 2005). As pointed out by Cummins, social presence of an online learning community can empower student learning (Cummins, 2013). Hence, we expect that social presence can enhance emergency rescuers' perceived capability to overcome dilemma and handle challenging situations. Furthermore, studies surrounding people's perceived power indicate that individuals can gain more confidence from similar others (McLaughlin et al., 2008). We hypothesize systems that can trigger a user's interpersonal resonance will also enhance the rescuer's perceived power in dealing with challenging



situations. To sum up, these above variables are expected to positively influence users' perceived power:

H9: Feelings of enhanced understanding will increase emergency rescuer's perceived power.

H10: Improvement of actual understanding will increase emergency rescuer's perceived power.

H11: A better sense of social presence will increase emergency rescuer's perceived power after using the system.

H12: Perceived interpersonal resonance will increase emergency rescuer's perceived power after using the system.

### Modulating Variables

Individual difference plays an important role in people's perceptions and behaviours in using information systems (Qureshi et al., 2009; Bansal et al., 2010; Al-Natour et al., 2011). Goldberg classifies personality in five aspects, including: agreeableness, conscientiousness, openness, extraversion and neuroticism (Goldberg, 1990). Agreeableness is most concerned with orientations of interpersonal relationship (Graziano & Eisenberg, 1997), moreover, this dimension tests persons' traits of trusting, generous, sympathetic, cooperative, aggressive, and cold (Gosling et al., 2003). Therefore, we consider individual character, in particular, agreeableness as a modulating variable that impacts on the dependent variables in our research model.

Based on the above discussions, we propose our research model for the virtual MHAS (see Figure 1).

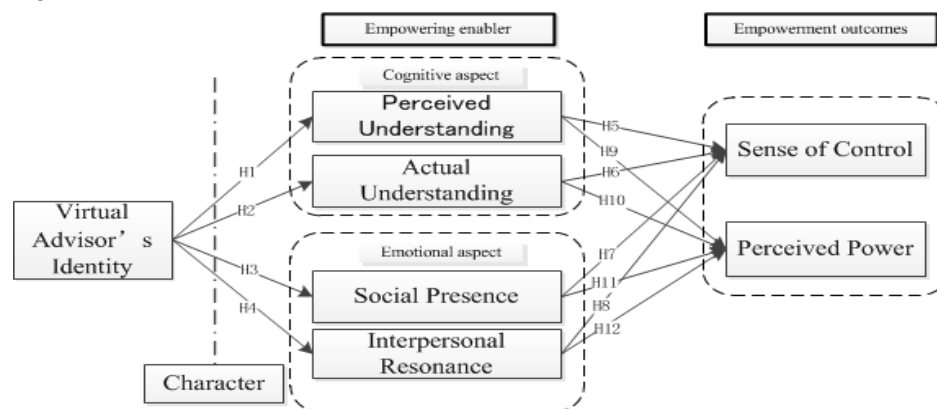


Figure 1 Research Model

## 3 METHOD

### 3.1 Participants

The subjects were 120 emergency rescuers serving in Inner Mongolia, including police officers and soldiers. The experiment was conducted in meeting rooms. Of the 120 subjects, 83.6% had performed a rescue mission and all of them were males, the average age was about 20 years, 99.2% had not got married, and 60.5% of the participants' education levels are senior high school. 22.8% of the subjects had installed healthcare applications on their mobile phones, and 29.8% of the subjects reported that they had mental health dilemmas to consult. We have

sampled our respondents from Inner Mongolia because this region has just experienced serious flood in Aug 2013 and these officers and soldiers had just returned from their emergency tasks while we arrived on the site.

### 3.2 Measurement Scales

The questionnaire used to collect participant feedback consisted of seven parameters: Perceived Understanding (PU) was adapted from (Li et al., 2012); Social Presence (SP) used the measurement given in (Gefen & Straub, 2003); Interpersonal Resonance (IR) was adapted from (Leach et al., 2008); Sense of Control (SC) was based on (Koufaris, 2002); Perceived Power (PP) used the measurement scale in (Chen et al., 2001) and Agreeableness (AG) adopted the scale used in (Soto & John, 2009). Except for AU, the measures for the constructs utilized in the questionnaires were all derived from existing scales that exhibited good psychometric properties. For AU, questions were tested on the dialogue content that the video depicted, with the purpose to study the subjects' actual understanding towards the mental health knowledge provided by the system and the full mark is 7. All psychometric questions used a seven-point Likert scale.

### 3.3 Artifact Description

Our virtual MHAS is based on the mobile platform, which can provide timely and effective mental advisory services for emergency rescuers to relieve their psychological pressure. The MHAS contains several important functions: (1) consultation with virtual advisors, the interactive process can enhance social presence, engagement and transparency; (2) self-learning, which can promote users to learn psychological knowledge to gain sense of support and control over their situations; (3) self-testing, through which users can understand their own psychological status; (4) physiological monitoring: using medical device to monitor users' physiological indices at anywhere and anytime so as to understand their own mental health conditions. Some representative screenshots are displayed in Figure 2.

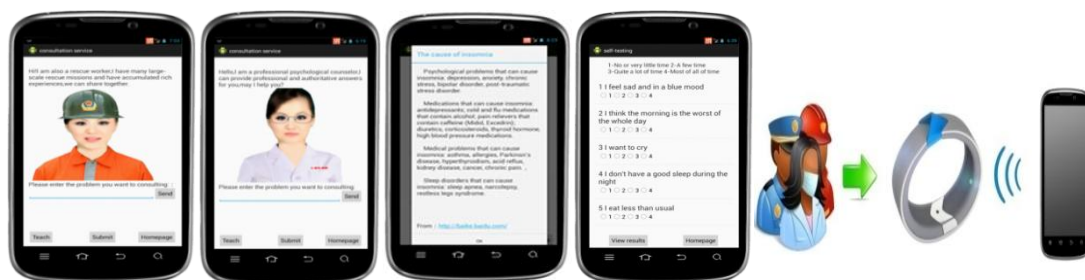


Figure 2 Exemplar screen shots of MHAS (under patent application)

### 3.4 Pilot

Before conducting the experiment, we performed a pre-test with 10 subjects to check the questionnaires and fine-tune the experiment procedures. Most of the subjects were able to complete the whole process in 30 minutes. Feedback from the subjects in the pre-test indicated that the experiment design and questionnaires were appropriate.

### **3.5 Experiment Procedures**

The experiment consisted of three phases: (1) watching a 5-minute video that described the virtual MHAS, (2) demonstrating to rescuers how to use the virtual advisory system through exemplar use cases and (3) filling in a questionnaire. First we divided these emergency rescuers into two groups, one group having 64 persons and the other having 56 persons, all subjects were randomly assigned to the two groups. The two groups were randomly assigned to two different conference rooms, where MHAS was available with different virtual advisors. We then gave the subjects a brief introduction to the research. Next, we played the video which described the system comprehensively and demonstrated to them different interactions with the systems. For one group (n=64), we played the video in which the advisor was an emergency rescue worker (i.e., virtual peer advisor); for the other group (n=56), the advisor was a professional psychologist (i.e., virtual expert advisor). Afterwards, we issued paper-based survey questionnaires and ask them to answer it based on their own feelings. The whole experiment process lasted for about 40 minutes. Finally every participant received a thank-you gift for their time.

The subjects' perceptions of virtual advisor's identity were used to verify that the advisors' identity was effective. As a manipulation check, subjects were asked to answer a question: was the virtual advisor you consulted with a rescuer worker or a psychological expert? Up to 80% of the subjects distinguished the virtual advisor's identity correctly, which verified that most users had taken notice of the virtual advisors' identity.

### **3.6 Control variables**

To investigate other potential effects, we performed ANOVA and T-tests to examine whether demographics data had effects on these dependent variables. The results show that gender, age, marital status, education levels, rescue experience and mobile application experience had no significant effect on the dependent variables. Further, to test the impact of characters as proposed by (Soto & John, 2009), we analyzed it with PLS and the outcome indicated that only the agreeableness construct shed significant influence on the dependent variables, while conscientiousness, openness, extraversion and neuroticism were found to have no effect on dependent variables. Consequently, 'agreeableness' aspect of the character was used as a modulating variable in further investigations.

## **4 EXPERIMENT RESULTS**

Six questionnaires were removed from 120 cases on account of initial data screening and checking for incompleteness. Hence, a sample of 114 subjects was used in the following analysis. After preliminary data screening, we conducted an analysis of covariance (ANCOVA) with the 'character' (i.e., Agreeableness) variable as the covariate to examine the impact of virtual advisor's identity on rescuers' perceptions of PU, AU, SP, and IR. ANCOVA results show that the interaction effect of virtual advisor's identity and subjects' character on these dependent variables is not significant. Controlling for the impact of character variable named Agreeableness, virtual advisor identity has significant effects on following variables: PU ( $F(1,111) = 12.523, p < 0.05$ ), SP ( $F(1,111) = 5.278, p < 0.05$ ) and IR ( $F(1,111) = 9.171, p < 0.05$ ).

As an exception, virtual advisor's identity directly affects AU ( $F(1,111) = 9.194, p < 0.05$ ), without Agreeableness acting as the modulating variable ( $F(1,111) = 2.773, p > 0.05$ ). In addition, in contrast to the peer group, the expert group has stronger influence on PU (mean difference (expert versus peer) = 0.579,  $p < 0.05$ ) and AU (mean difference (expert versus peer) = 0.876,  $p < 0.05$ ), however, the peer group has stronger effect on SP (mean difference (expert versus peer) = -0.447,  $p < 0.05$ ) and IR (mean difference (expert versus peer) = -0.520,  $p < 0.05$ ) relative to the expert group.

Next, we analyzed the model using the Partial Least Squares (PLS) method. We mainly accessed the model from two aspects: measurement model and structural model. The measurement model was examined for internal consistency, convergent validity and discriminant validity (Barclay et al., 1995). The internal consistency was evaluated with Cronbach's  $\alpha$ . From Table 2, we can see that Cronbach's  $\alpha$  for every construct exceeded 0.7, which can reflect high internal consistency of the constructs. Then we used the average variance extracted (AVE) to evaluate the convergent validity of these constructs. All constructs' AVE exceeded 0.5, demonstrating that at least 50% of the construct variance was due to its indicators. A rule for assessing discriminant validity requires that the square root of AVE is larger than the correlations between constructs (i.e., off-diagonal elements) (Barclay, Thompson, & Higgins, 1995). It can be seen that all constructs met the discriminant validity requirement.

Construct	R <sup>2</sup>	CR	Cronbach's $\alpha$	AVE	Inter-construct correlations					
					AU	PP	PU	IR	SC	SP
AU	0.1039	1.0000	1.0000	1.0000	1.0000					
PP	0.5041	0.9178	0.8972	0.5846	0.0970	0.7646				
PU	0.2117	0.9257	0.9064	0.6407	0.2707	0.5425	0.8004			
IR	0.2322	0.9610	0.9190	0.9249	-0.2824	0.3954	0.0828	0.9617		
SC	0.5791	0.9074	0.8645	0.7103	0.0415	0.5951	0.3802	0.5704	0.8428	
SP	0.1824	0.9012	0.8621	0.6470	-0.1284	0.5877	0.3044	0.6341	0.7057	0.8044

Table 2. R square, composite reliability, cronbach's  $\alpha$ , AVE and Inter-construct correlations

Next, we analyzed the structural model using the bootstrapping technique (with 700 samples). Congruent with the ANCOVA results, controlling for subjects' character, virtual advisor's identity had negative significant effects on PU ( $\beta = -0.308, p < 0.05$ ) and AU ( $\beta = -0.272, p < 0.05$ ). Besides, they positively affected SP ( $\beta = 0.196, p < 0.05$ ) and IR ( $\beta = 0.429, p < 0.05$ ). In addition, PU, SP and IR positively affected participants' SC ( $\beta = 0.179, p < 0.05$ ;  $\beta = 0.498, p < 0.05$ ;  $\beta = 0.283, p < 0.05$ , respectively). PU, SP and IR were shown to be significantly impacting PP ( $\beta = 0.399, p < 0.05$ ;  $\beta = 0.392, p < 0.05$ ;  $\beta = 0.157, p < 0.05$ , respectively). Yet, AU had no significant effect on SC and PP ( $\beta = 0.085, p > 0.05$ ;  $\beta = 0.080, p > 0.05$ , respectively). Consequently, the above results indicated that while Hypotheses 1, 2, 3, 4, 5, 7, 8, 9, 11 and 12 were supported, Hypotheses 6 and 10 were not supported by the data.

For the overall model, most R-square values show that the model exhibits moderate to substantial strength in explaining the dependent variables (Garson, 2012). Actual understanding has a weak R-square value of 10%, and this exception happens due to actual understanding being a single-value without indicator variables (as calculated via user's quiz score out of 7) (Garson, 2012). We have initially included user demographics and all five factors of personal character conscientiousness, openness, extraversion and neuroticism (Goldberg, 1990) in the research model as control variables. Except for Agreeableness, none of these user demographics or personal character aspects significantly impact on the dependent

variables of interest. Therefore the model was reanalyzed excluding the insignificant control relationships, using Agreeableness as the modulating variable. The results of the model are shown in Figure 3.

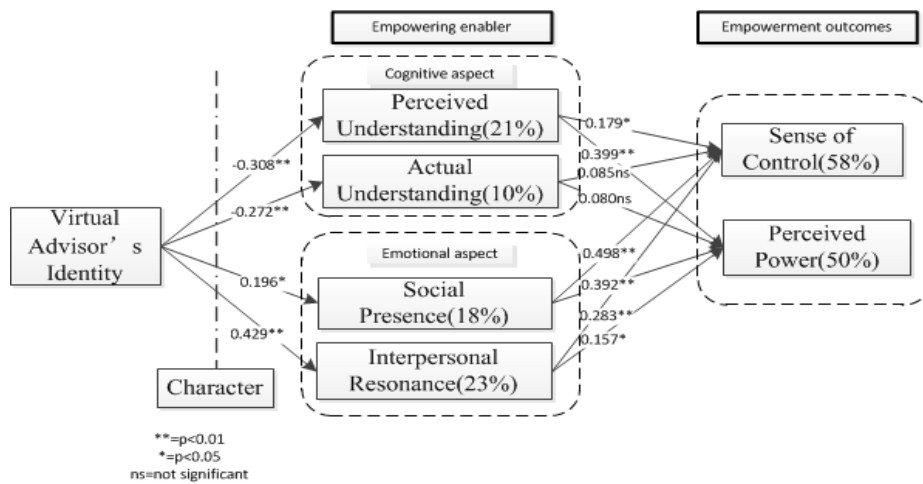


Figure 3 Structural Model Results

## 5 DISCUSSION AND CONCLUSION

The results of the study suggest that advisor's identity significantly influence emergency rescuers' cognitive and emotional aspects after using the system. Further, emergency rescuers consider virtual expert advisor to be better in transferring knowledge relative to virtual peer advisors. Actually, the extent of the actual understanding of the knowledge exactly conforms to emergency rescuers' perceptions. Simply put, virtual expert advisors have stronger empowerment effect in imparting knowledge to emergency rescuers than virtual peer advisors. On the other hand, the positive significant effects on emotional aspects, measured in terms of social presence and interpersonal resonance, imply that virtual peer advisor can bring emergency rescuers a stronger sense of social presence and a better feeling of inner resonance. Overall, bootstrapping result highlights that cognition and emotion as important empowering enablers have substantial influence on empowerment outcomes measured by sense of control and perceived power. In contrast to perceived understanding, actual understanding does not significantly contribute to variations in the empowerment outcomes. This shows that perceived understanding or transparency is the one that actually matters for the empowerment outcomes after using the system, overruling how much actual knowledge has been obtained in a user's mind. In other words, enhancing the transparency of a MHAS, for example through reducing a user's cognitive load in the system design, is an effective way to boost the value of such a system.

Theoretically, this study extends existing theories in virtual advisory system design. Little empirical work has been done systematically to investigate the influence of different design strategies for mental-health advisory services on the mobile platform, and it is especially scarce for emergency rescuers. Further, this study has implications for the use of empowerment theory and similarity theory in the field of information systems. Cognitive and emotional aspects can be significant empowering enablers, which can generate stronger sense of control and perceived power for advisory system users. Third, we have taken an iterative

approach in our system artefact (i.e., MHAS) design and development. Through the refinement of a concrete system artifact based on experimentation, this methodology ensures both rigor and relevance of our study (Gregor & Hevner, 2013).

Practically, the result of this study also provides numerous useful insights for practitioners. First, our study results reveal that virtual expert advisors, who appear as authoritative figures, are suitable when the emphasis of the system's design is on knowledge acquisition. In other situations where the focus of the system is on establishing rapport and sense of support for the depressed users, virtual peer advisors should be used as they appear to exhibit more human warmth and interpersonal resonance. As an interesting implication, different virtual advisor identities can be used for different scenarios or sections of the system, with innovative design themes to cater for different purposes. Further, to our knowledge existing mobile mental-health advisory system for emergency rescuers is sparse. More interestingly, this project combines mobile technologies with a medical device to monitor emergency rescuers' physiological indices on the go. While part of this project is under patent application, more details of the system hardware and software design are available upon request.

There are a few limitations to note while interpreting the findings. First, this study is part of a large-scale project, focusing on emergency rescuers. Due to the nature of the rescue work in emergency settings, the scope of the study is limited to emergency rescuers (i.e., rescue soldiers) serving in the army. Future study could examine or extend the research model to other research settings. Second, we have travelled to and sampled our respondents from Inner Mongolia because this region has just experienced natural disaster (i.e., Aug 2013) and these soldiers have just returned from their emergency rescue tasks while we arrived on their site. While we believe these soldiers are usually recruited from different provinces of China, it will also be helpful to investigate the feedback from more sites in different provinces after natural disaster happens. Third, we played videos and demonstrated the functions of the system in a comprehensive and systematic way instead of installing the mobile application on participants' mobile phones. The former approach guarantees more control in the experiment design; the later approach could be taken when richer user experiences are needed in the field setting. Given the time and resource limitations, while we tried our best to eliminate confounding factors in our research study, one should interpret our findings with these limitations in mind.

Future research could be directed towards the following aspects. First, we could design and examine a variety of different identities for virtual advisors in different settings so as to investigate its potential impact in a more well-rounded way. Second, we expect to improve the voice function, enabling users to converse in voice, which can bring users stronger sense of humanoid interaction and social presence. Third, we plan to integrate context-aware features into our mobile mental-health advisory system, which adds more value and enhances its usability tremendously. Finally, there are only scarce studies exploring ways to present 3D scenes on mobile devices. We are in the process of realizing 3D visualization, which can enhance users' presence in the setting and improve their satisfaction towards the virtual advisory service.

In summary, drawing on existing literature related to mobile healthcare applications and psychological services, we designed and developed our MHAS system for emergency rescuers. Inspired by similarity theory and empowerment theory, we explored key values of MHAS for rescuers and investigated the impact of virtual advisor's identity on emergency rescuers'

cognitive and emotional aspects, controlling for their character differences. The result of the study reveals that the virtual expert advisors are more effective in imparting knowledge to emergency rescuers; while virtual peer advisor can bring stronger sense of emotional support, such as feelings of social presence and interpersonal resonance to empower emergency rescuers. These empower emergency rescuers, leading to a higher sense of control and more perceived power towards upcoming challenges. To conclude, this study promotes innovation in the design of mobile virtual advisory services providing significant contributions to both research and practice.

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