

# Title Page

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## Title

A Virtual Psychiatric Ward for Orientating Patients Admitted for the First Time

## A Virtual Psychiatric Ward for Orientating Patients Admitted for the First Time

### ABSTRACT

Misconceptions about psychiatric wards frequently cause newly admitted mental patients to stay away from these wards despite their need for treatment. Although ward orientation is typically conducted by nurses in an attempt to help patients to adapt to the new environment, it is considered time-consuming, and the method of orientation and the explanations given may vary among different nurses. This situation calls for a more effective and standardized approach to orientating mental patients on their first admission. To this end, a computer-based interactive virtual environment was developed based on a real psychiatric ward by using virtual reality (VR) technologies. It enables the patient to navigate around to gain understanding about the ward through a virtual guided tour. The effectiveness of this VR orientation approach was investigated by a randomized controlled trial (RCT) with consecutive sampling. Fifty-four Chinese participants were randomly assigned to undergo ward orientation either by using the VR-based approach, or by reading text-based electronic information sheets about the ward with a computer. Subjective and objective measures were obtained respectively by the Chinese version of the State-Trait Anxiety Inventory Scale (C-STAI) questionnaire and the heart rate variability (HRV) measurement before and after the intervention. In addition, a test on the level of understanding about the ward was administered at the end of the session. The results showed that the VR orientation approach is helpful in reducing patients' anxiety while also improving their level of understanding about the ward.

## INTRODUCTION

Patients with acute or chronic mental illness are usually advised to receive treatment in psychiatric wards to facilitate the recovery process. Misconceptions about these wards, however, are so prevalent that patients, especially those newly admitted to a ward for the first time, are anxious and become reluctant or even refuse to receive in-patient psychiatric management. Ward orientation programmes are thus implemented to introduce the new environment as well as the rules and regulations to *first-time patients*<sup>1</sup>. The orientation is conducted by nurses, who guide patients around the ward. In practice, nurses are so busy with routine work that they cannot afford to take extra care of newly admitted patients. During the orientation, the information delivered and the way of presenting it may also vary among different nurses, resulting in inconsistencies that can confuse the patients. In this paper, virtual reality (VR) technologies are exploited to develop an effective ward orientation method in an attempt to reduce the anxiety of first-time psychiatric patients, making them more willing to stay in the ward to receive the required treatment. Virtual environments (VEs) are developed based on a real psychiatric ward to enable patients to experience the new environment through a quick guided virtual tour. Ward routines and regulations are provided appropriately during the process. Patients can also interact with the virtual scenarios. Several benefits are expected from the proposed VR orientation approach. First, consistency is assured since the virtual ward is computerized and programmed. It can be used repeatedly while providing the same orientation information. Second, the orientation can be conducted by the patients themselves with minimal supervision, e.g. by a healthcare assistant, thus reducing the need for extra human resources to orientate first-time patients. Finally,

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<sup>1</sup> First-time patients refer to patients who are admitted to a psychiatric ward for the first time. This term is used interchangeably with “newly admitted patients” in this paper.

patients can use the system developed for VR orientation as often as they need until they find themselves familiarized and more comfortable with the new environment. The significance of this study is that it is an endeavour to encourage first-time patients to comply with in-patient management, thereby improving the prognosis of their mental illness. It has the potential to reduce the rate of discharge against medical advice (DAMA) on the first day of admission. In addition, the proposed virtual ward is a novel application that adopts VR for the orientation for the first time. In the rest of this paper, the situation of patients newly admitted to psychiatric wards and the application of virtual reality in health care are first reviewed, followed by the development of the proposed VR ward orientation approach and the evaluation of its ability to orientate patients and reduce their anxiety.

## **BACKGROUND**

### *Anxiety of first-time patients*

Studies have shown that patients newly admitted to psychiatric wards usually feel loneliness, fear and lack of security because of their unfamiliarity with the new environment. In particular, psychotic symptoms commonly found in psychiatric wards, e.g. delusion, hallucination and self-muttering, are strange and thus frightening to them. First-time patients are also typically unclear about treatments such as restraints that are applied to fellow patients showing violent behaviour. As a result, they consider themselves vulnerable and incapable of self-protection. The situation is further exacerbated by the lack of readily accessible information about ward routines, rules and regulations.<sup>1-3</sup> Appropriate patient education during hospitalization is therefore crucial

to improve their understanding and to render a feeling of possessing better control of the new environment, which are regarded as key factors contributing to the state of comfort and mental health and well being.<sup>4-6</sup>

### *State and trait anxiety*

While anxiety has been conceptualized from various perspectives and multi-faceted definitions of anxiety exist, the state-trait model proposed by Spielberger is widely recognized in the fields of psychology.<sup>7,8</sup> In this model, state anxiety refers to a *transitory emotional state* of tension determined by individual's trait and present situation, whereas trait anxiety refers to a *stable predisposition* to respond to anxiety.<sup>9</sup> The state-trait anxiety distinction has made significant contribution to the development of the interaction model of personality. Although this distinction approach is well-accepted, whether state anxiety and trait anxiety are multidimensional or unidimensional constructs has been a controversial topic. It has been conceptualized and empirically showed that state and trait anxiety are both multidimensional constructs, with at least two and four facets respectively,<sup>10</sup> while other researchers conceptualized them as being unidimensional.<sup>11,12</sup> Accordingly, different psychometric approaches have been developed to measure state and trait anxiety as being unidimensional (e.g. Spielberger State-Trait Anxiety Inventory) and multidimensional (e.g. Endler Multidimensional Anxiety Scales) respectively. In the present study, a short-form of the state scale of the Spielberger State-Trait Anxiety Inventory was adopted and hence state anxiety was only considered here. Further details about the psychological measurements in the study will be provided in section of Materials and Methods.

### *Anxiety reduction using virtual reality*

A major application area of virtual reality in mental health is the treatment of anxiety disorder.<sup>13,14</sup> Research effort has been devoted to the study of virtual reality exposure therapy (VRET) for specific phobias, including flying and driving phobia, social anxiety disorder, and post traumatic stress disorder (PTSD). In these studies, participants are exposed to virtual environment simulating the scenarios that they are afraid of in reality, so as to induce their anxiety and administer treatment. A number of controlled trials on VRET for flying phobia showed that participants received sessions of treatment were able to reduce their anxiety level.<sup>15,16</sup> It was found that visual and acoustic stimuli were already sufficient to immerse the participants while simulating the motion in flight did not further improve the result.<sup>16</sup> Similarly, VRET was reportedly effective in reducing anxiety due to driving and could also be useful in the treatment of post-accident driving phobia.<sup>17</sup> Among various types of social phobias, public speaking is the one that has attracted considerable attention in VRET research. Virtual audience producing neutral, positive and negative feedback were introduced to induce different levels of anxiety.<sup>18</sup> Besides, research was conducted to reduce the anxiety and PTSD symptoms of Vietnam<sup>19</sup> and Iraqi war veterans,<sup>20</sup> as well as survivors of the September 11th terrorist attacks<sup>21</sup> by using VRET. Scenarios involving explosions, flying helicopters, jungle, patrolling soldiers, for example, were simulated in the VRET sessions to immerse the participants in the virtual environments. VRET has also been applied to reduce the anxiety caused by the fear of insects (e.g. spiders or cockroaches), heights (acrophobia) and enclosed spaces (claustrophobia). The participants consider VE to be a more secure and comfortable setting for them to manage their psychiatric problems. It also encouraged them to discuss their feelings openly with therapists, thereby contributing to

improvement in the patient-therapist relationship. Nevertheless, application of VR for psychiatric ward orientation is yet to be seen.

## **RESEARCH FRAMEWORK**

The purpose of this paper is to study whether the application of VR technology can improve the effectiveness of ward orientation programme for patients admitted to psychiatric ward for the first time. The study attempts to examine how effective the VR-based orientation programme is in reducing first-time patients' anxiety and how well it is in raising to their level of understanding about the new environment. The hypotheses in the study are supported by the theories and empirical studies as discussed below.

Orientation programmes are commonly used in the fields of medicine to deliver healthcare information. It is evident from many clinical studies that the programmes are effective in reducing patients' anxiety by providing them with information and knowledge about the situations they are anticipating. For example, orientation programme providing clinic tour, general information about clinic operations, and question-and-answer session was shown to be able to reduce anxiety, distress and depressive symptoms<sup>22</sup>. Reduction of pre-operative anxiety and behavioural disturbance<sup>23</sup> were exhibited by newly diagnosed cancer patients who were provided with informative booklet of disease treatment and coping strategies. Provision of information video before surgical procedures was proven to be a valuable approach to decrease anxiety in patients preparing for colonoscopy<sup>24</sup>. Hence, it is contended in this study that orientation programme dedicated for first-time patients can be helpful in providing them with information about the new ward environments, and thus reducing their anxiety.

Virtual reality has been widely applied for learning and training. Unlike other computer applications, VR systems provide users with the sense of presence in computer-generated replica of real world and the ability to act on it. The objects in virtual environments are programmed with autonomous behaviour to interact with users<sup>25</sup>. These features make VR a promising approach to implement active and experiential learning. While it is commonly assumed that the knowledge and skills acquired in virtual environment will transfer to the real world, evidence from many studies has clearly confirmed the assumption, particularly in the learning of spatial skills. Typical examples demonstrating positive transfer of knowledge from virtual to real environments include the use of VR for training firefighters to navigate through spatial layout of buildings before entering the real structures<sup>26</sup>, preparing children to orientate in a place they have never been<sup>27</sup>, and for teaching students with special learning difficulties shopping skills in virtual supermarket<sup>28</sup>. Transfer of learning has also been investigated and analyzed theoretically with the paradigm of *situated cognition*<sup>25</sup>, which proposes that knowledge must be learned in context and is acquired through learner's *response* to the constraints and affordances of the learning situation. The knowledge acquired can also be transferred to a new situation containing similar constraints and affordances. Here, the use of virtual reality for learning is advantageous in that it is able to simulate scenarios in a way similar to that in real life, immersing learners in various virtual environments while encouraging them to interact with virtual objects as if they were under the real situations. The settings promote transfer of knowledge gained in virtual environment to real world. This is in agreement with the situated cognition paradigm which considers that learning in rich contexts of real scenarios is required to develop learner's attention and intention, thus enhancing the effectiveness of the



learning process<sup>29</sup>. With these arguments, it is further contended here that the use of VR to implement orientation programmes is an effective approach to deliver ward information to first-time patients.

Based on the above discussions, the hypotheses of the research are stated as follows.

- H1. The anxiety level of first-time patients orientated with the VR-based approach is lower than that of first-time patients orientated with the non-VR approach.
- H2. First-time patients orientated with the VR-based approach have better understanding about the ward environment than first-time patients orientated with the non-VR approach.

To verify these hypotheses, randomized controlled trial with pre-post test design was conducted to investigate the hypotheses. Two groups of patients were involved in the study: one adopted the proposed VR orientation approach and is referred to as the *VR group*, and the other, the *non-VR group*, read the rules and regulations displayed in the form of text on a computer screen. Anxiety level, heart rate variability and level of understanding about the ward of the two groups were measured and analyzed in the trial. The research design is shown schematically in Fig. 1 and will be discussed in detail in next section. The State-Trait Anxiety Inventory Scale questionnaire (Chinese version) and the heart rate variability of the participants were used to verify the first hypothesis. To verify the second hypothesis, a short written test on the ward rules and regulations was administered to evaluate the participants' level of understanding about the ward environment. On the other hand, the IBM Computer System Usability Questionnaire was adopted to investigate the usability of the VR-based orientation system developed.

Insert figure:  
Fig. 1 Research design

## MATERIALS AND METHODS

This was a randomized controlled trial (RCT) study. Details of the research design are described in this section. The major elements include the choice of target samples, the design of virtual environment and the associated software and hardware, as well as the measures employed and the experimental procedures. The flow of the research and the associated activities are shown schematically in Fig. 1.

### *Sampling*

The subjects of the current study were limited to female since one of the co-authors is a staff of a female psychiatric ward in a local hospital and thus eligible to apply for access for clinical research. According to the policy, researchers conducting clinical research should be a staff of the study venue. The application was eventually approved by the ethics review board of that hospital. Gender difference, however, could be investigated in the current study. The female psychiatric ward admits female in-patients from the accident and emergency department, psychiatric out-patient clinic and the general wards of the same hospital. Consecutive sampling method was adopted, where patients were selected according to the inclusion and exclusion criteria shown in Table 1. The participants were randomly allocated into groups.

Insert table:  
Table 1 Inclusion and exclusion criteria

### *Virtual environment*

In this study, a virtual psychiatric ward was reconstructed based on the real ward. The content was designed so that it included the information provided to the participants of the non-VR group, albeit presented in different ways. Essential features and scenarios

were incorporated in the virtual ward to portray the real environment and routines. Some snapshots of the virtual and real psychiatric wards are shown in Fig. 2(a). In particular, content was included in the VE to explain the necessity of the locked door system, seclusion and physical restraint, which are necessary but commonly misunderstood as punishment or coercion. The lock door system is essential in psychiatric admission ward. It protects patients from harming themselves and others. Keeping ward's entrance locked could also prevent abscondence or access of unwanted visitors. In the VE, when the subject moved towards and attempted to get into an area or a room that he or she was not allowed to do so, the prohibited action would be detected to trigger the display of a pop-up message box in the way as illustrated in Fig. 2(b) to explain about the lock door system and why they are not permitted to enter or leave a certain area. Seclusion and physical restraint are commonly used in psychiatric wards to control the behaviour of patients. Similarly, in the VE, when the subject moved towards the seclusion room in the virtual ward, a message box would pop up to provide information to explain why and when seclusion and restraint are carried out. In particular, the information in the pop-up message box stated that patient would be secluded and physically restrained when they are in poor mental states in order to protect them and other patients. In addition, three scenarios were created to remind the first-time patients to behave properly in the ward, e.g. switching off the radio before leave the dormitory, turning off the water tap after use, and properly flushing the toilet.

Insert figure:

Fig. 2. (a) Snapshots of the real (left) and virtual ward (right): interactive scenarios about switching off the wall radio (top), turning off the water tap (middle) and flushing the toilet (bottom). (b) Pop-up message boxes displayed in the virtual environment to explain location-specific rules and regulations.

In the course of the VR orientation, participants were guided to navigate around the virtual ward. A virtual guided tour led them to different rooms and locations in a predefined order. Accordingly, relevant instructions, rules and regulations were shown appropriately with text messages displayed in pop-up windows (see Fig. 2(b)). The participants were guided to each of the three scenarios mentioned above. They interacted with the VEs with keyboard and mouse and were required to take the correct actions before they could move to the next location. These actions included: (1) switching off the overhead wall-mounted radio, (2) turning off the tap of the water dispenser, and (3) pulling the right string to flush the toilet. Visual and audio feedback were provided in response to their actions whether correct or incorrect. In addition, the VEs were programmed so that the lighting conditions changed dynamically from daytime to night during the guided tour.

### *Software*

The VE was built based on the floor plan of the real psychiatric ward. The 3D models were constructed using *Maya* (Autodesk, Inc.) with reference to the geometry of the corresponding real objects. The virtual psychiatric ward was primarily developed with *3DVIA Virtools* (Dassault Systèmes), which has been widely used for interactive 3D content creation. The virtual ward was also made available for virtual navigation with a generic web browser, e.g. *Microsoft Internet Explorer* or *Mozilla Firefox*, through the browser plug-in *Virtools 3D Life Player*. The associated text-based messages, including messages, ward rules and regulations, were appropriately displayed on the web browser during the course of virtual navigation.

### *Hardware*

The software system developed for the virtual ward was executed with a 17-inch notebook computer with an Intel Core 2 Duo T7500 2.2GHz CPU, 2G DDR2 RAM and Nvidia Quadro FX 1600 512MB display card. The screen was set to provide a resolution of 1280×800 pixels. Audio clips were also played by the computer. Participants interacted with the VEs using a keyboard and computer mouse. Heart rate variability (HRV) measurement was achieved with the Heart Rhythm Scanner with the Biocom 3000 ECG recorder (Biocom Technologies). The scanner consisted of two sensors attached to the participant's wrists to measure her HRV.

### *Measures*

Four measures were employed in the experiments: the HRV measurement, six-item Chinese State-Trait Anxiety Inventory Scale (C-STAI) questionnaire, the level of understanding test (LUT), and the IBM Computer System Usability Questionnaire (CSUQ).

*Heart Rate Variability.* HRV provides information about modulation of the heart rate by the autonomic nervous system, which is affected by emotional and mental states, and has been used to evaluate anxiety level.<sup>30,31</sup> In this study, besides mean heart rate (HR), data in the frequency domain, including low frequency power (LF), high frequency power (HF), and the ratio of low to high frequency power (LF/HF) were also measured to offer an objective measure of the anxiety level of the first-time patients. HF reflects parasympathetic activities, whereas LF is an index of both sympathetic and HF parasympathetic activities. During mental or emotional stress, it is found that sympathetic activities increase while parasympathetic activities decrease.<sup>31</sup>

*Six-item C-STAI Questionnaire.* The original State-Trait Anxiety Inventory (STAI) questionnaire<sup>32</sup> contains 40 self-reporting questions designed for measuring state and trait anxiety. Participants are asked to choose one of the 4-point Likert scale ratings from 1 (“not at all”) to 4 (“very much so”). The scores are weighted with a scoring key such that the higher the weighted score, the higher the anxiety level. The STAI questionnaire has been translated<sup>33</sup> into Chinese and tested.<sup>34-36</sup> Results showed it to have high internal reliability ( $\alpha=0.9$ ) and to correlate significantly with all other measures of psychological well-being, such as the Chinese General Health Questionnaire (GHQ-30) for non-psychosis disturbances and the Chinese Beck Depression Inventory (BDI) for psychotic disturbances. In addition, the questionnaire was found to be a culturally valid measure for Hong Kong Chinese<sup>37</sup> where the content validity index (CVI) was 0.9, and  $\alpha$  was 0.88 and 0.92 for reliability for state and trait anxiety respectively.

Since the 40-item STAI questionnaire is rather lengthy and not suitable for studies where time constraints are a concern, a simplified version of the questionnaire containing 6 questions only has been developed by Marteau and Bekker.<sup>38</sup> It is a short-form of the *state scale* of the STAI. In their study, the questions were chosen from the original questionnaire by selecting the smallest subset of items from the full length STAI which was highly correlated with scores obtained using the full length STAI. The choice of questions was based on the method of *Item-Remainder Correlations*. The scores of each item were correlated with scores on the remaining items to assess the contribution of each item to the overall state anxiety score. Short forms with 2, 4, 6, 8 and 10 items were then developed using the items of high item-remainder correlations. Next, the correlations between scores from these short-forms and the full-length STAI

were obtained respectively. Eventually, it was found that 6 is the optimal number of items for the short-form questionnaire, where the correlation with the full-length STAI was high ( $r=0.95$ ). The short-form questionnaire was also found to have high internal reliability ( $\alpha=0.82$ ).

In the present study, the original 40-items STAI questionnaire was considered lengthy for the psychiatric patients, whose mental states were not good enough to pay full attention to all the questions in the questionnaire. Besides, patients in the VR group were required to go through the VR orientation approach for about 10-15 minutes, after which their attention would decrease and further requiring them to complete a lengthy questionnaire was not practical. Therefore, the 6-item short-form of the state scale of the STAI was adopted in the study so that the assessment could be completed relatively quickly and easily by the patients without causing excessive disturbance. With this short-form questionnaire, the study *only* measured and considered state anxiety of the patients. The scales of the 6-item questionnaire are listed in Appendix 1.

*Level of Understanding Test.* The LUT contained questions commonly raised by most first-time patients after they were admitted to the ward. The aim of the test was to evaluate how well a participant could understand and remember the content provided in the two orientation approaches. There were totally 8 questions in the LUT, 3 fill-in-the-blank questions followed by 5 true-or-false questions. The fill-in-the-blank questions concerned ward routine, involving the daily visiting hours, the age of visitors and the time for lunch. The true-or-false questions pertained to issues about smoking, keeping sharp objects, absconding, and the use of camera, video recorder and mobile phone. The questions of the LUT are provided in Appendix 2. In the VE, pop-up message boxes were displayed to explain location-specific rules and regulations when the subject

navigated to different parts of the ward. The information provided in the message boxes was sufficient for answering all the questions in the LUT. Therefore, if the subjects paid enough attention to the VE during the VR orientation programme, they would be able to answer the LUT questions correctly. Content validation was performed by a psychiatric physician and an experienced nursing officer, and the CVI was 0.93. The test was administered for both the VR-group and the non-VR group.

*IBM CSUQ.* The IBM Computer System Usability Questionnaire<sup>39</sup> is a self-reporting questionnaire with a 7-point Likert scale to measure how usable a computer system is, from 1 (“strongly agree”) to 7 (“strongly disagree”) for each question. The questionnaire has high reliability ( $\alpha=0.93$ ) and validity. The original English version was translated into Chinese, with CVI=0.94 and  $\rho=0.97$ . The first 7 questions in CSUQ, which concern system usefulness, were considered relevant to the present study and thus adopted to evaluate the usability of the system developed for VR ward orientation.

### *Procedures*

All patients admitted to the ward for the first time were invited to participate in this RCT study. They provided informed consent and were interviewed to determine whether they met the inclusion criteria and agreed to use computers for this study. Participants were then randomly assigned into either the VR group or the non-VR group, each with a size of 27 participants. In both groups, the sensors of the Biocom 3000 ECG recorder were bilaterally attached to participants’ wrists. They were also asked to complete the six-item C-STAI questionnaire, and their HRV were recorded for 2 minutes as the baseline before orientation.

For the non-VR group, a ward orientation was conducted by allowing participants to read on the computer screen Chinese text-based electronic information sheets about the



ward rules and regulations. For the VR group, participants were orientated by using the software system developed for the proposed VR orientation approach. These orientation methods were carried out in the same consultation room with the same computer for a duration of 10-15 minutes.

After finishing the orientation, participants were asked to complete the six-item C-STAI questionnaire again and their HRV were also recorded for 2 minutes as the post-test measurement. They were further asked to take the LUT. For the VR group, participants were required to evaluate the usability of the VR orientation approach by completing the IBM CSUQ. On the day after the ward orientation, the participants of both groups were re-tested by asking them to complete the C-STAI questionnaire and the LUT.

A pilot test was performed with 3 psychiatric patients who fulfilled the requirements stated above. They demonstrated understanding of the purpose of the study and the procedures, as well as the ability of using computers to navigate around the virtual ward with the VR orientation system. They all completed the study and showed patience during the whole process.

## **RESULTS**

### *Demographic data*

Fifty-four female Chinese between 14 and 65 years of age, with an average age of 35.7, took part in the study. Seven of them were educated up to primary level, 42 had reached secondary level and the rest had tertiary level education. Demographic data of the non-VR group and the VR group are shown in Table 2. Statistical results indicated that there was no significant difference in age ( $\chi^2 = 3.754$ ,  $p = 0.585$ ) and education

level ( $\chi^2 = 3.943$ ,  $p = 0.139$ ). All participants came to the study venue for the first time and voluntarily. That is, they were admitted without any kind of legal status. They were suffering from different types of mental disorders such as depression, schizophrenia, anxiety disorders and adjustment disorders.

Insert table:

Table 2 Demographic Data

### *HRV*

The results for the HRV measurements are presented in Table 3. They show that for the non-VR group, there were no significant differences in HRV before and after the orientation, whereas the differences were found to be significant for the VR group (except for LF, with  $p = 0.84$ ). It is noteworthy that the difference in HRV between the two groups, after conducting the respective orientation approach, was found to be insignificant. This is evident from the  $p$ -values of the between-group t-tests on the mean post-test HRV measurements, as listed in the last column of the table.

Insert table:

Table 3 Statistical Analysis for HRV Measurements

### *C-STAI*

The results of the C-STAI questionnaire in Table 4 show that the mean scores of both groups decreased right after conducting the respective orientation approach. A considerable decrease of 4.71 from 16.93 to 12.22 was observed from the VR group ( $p=0.00$ ), while the decrease was 0.82 for the non-VR group ( $p=0.008$ ). The C-STAI scores continued to decrease further on the following day, although, for the VR group, the decrease was not statistically significant ( $p=0.15$ ). Paired t-tests on the post-test data

and that recorded one day later indicated that there were significant differences in the C-STAI results between the two groups, with  $p=0.02$  and  $p=0.01$  respectively.

Insert table:

Table 4 Statistical Analysis for C-STAI Questionnaire

### *LUT*

The results of the LUT after orientation indicated that the VR group scored higher than the non-VR group by 1.22, a statistically significant difference ( $p=0.00$ ). On the day after orientation, the LUT scores for both the VR and non-VR group increased ( $p=0.00$  for both groups), but the VR group still out-performed the non-VR group (not significant,  $p=0.82$ ). The results are shown in Table 5.

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Table 5 Statistical Analysis for LUT Scores

### *IBM CSUQ*

Finally, the results of the first 7 questions in the IBM CSUQ concerning the system usefulness of the VR orientation approach are presented in Table 6. For each question, the mean score was below 2, and 75% of the participants chose item 2 on the 7-point Likert scale. The results showed that the participants were satisfied with the VR system and considered it effective to use the developed VE for ward orientation. They agreed that the system was comfortable and easy to use.

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Table 6 Descriptive Analysis for IBM CSUQ of the VR Group

## **DISCUSSION**

### *Result analysis*

In this study, it was hypothesized that the proposed VR orientation approach would be able to reduce the anxiety level of patients admitted to psychiatric wards for the first time. From the objective measurements of anxiety level obtained with HRV, it was found that the anxiety level of the VR group was indeed similar to that of the non-VR group, suggesting that the VR orientation approach was not able to appease the newly-admitted patients in a way considerably better than that achieved by the text-based non-VR orientation method. On the other hand, the results of the C-STAI questionnaire indicated the reverse. The C-STAI score of the VR group decreased significantly after orientation, indicating that they were much less anxious than their counterparts in the non-VR group. This conflicting observation could be explained by the argument that, subjectively, the patients in the VR group perceived the novel VR orientation approach as a helpful tool to orientate them in the new environment even though, physiologically, their level of anxiety as measured with HRV did not reflect their appreciation of the VR approach. This argument is supported by the fact that the LUT scores of the VR group were much higher. The VR group demonstrated a better understanding of the ward routines and regulations when the information was presented in a lively and interactive manner via the 3D virtual environment developed for the study. The positive response in the IBM CSUQ also confirmed that the participants regarded the VR system as a useful tool to introduce them to the new environment.

While the LUT scores of the VR group, both right after the orientation and on the following day, surpassed those of the non-VR group, the observed out-performance was only statistically significant for the scores right after the orientation (i.e. post-test data).

On the day after the orientation, both groups had already had some opportunities to experience the new environment physically. Increases in the LUT scores of both groups were thus observed, but the experience gained from the real environment became a confounder, which makes it difficult to judge the out-performance of the VR group. The VR orientation approach is applicable to educate newly admitted patients before they can actually experience the real psychiatric ward. The outstanding performance in the LUT by the VR group right after the orientation suggests that presenting information in the interactive 3D virtual ward is an efficient way to familiarize patients with the new environment.

Several steps had been taken to ensure the subjects selected had the intention and ability to use the virtual ward orientation system. First, the patients had to be admitted voluntarily, and agreed to stay in the ward for psychiatric treatment. Next, floridly psychotic patients were excluded from this study. Information sheet was provided to explain and give details about the study. The patients were required to sign on the consent form to indicate that they understood the study and agreed to participate. Their ability to use computer for the study was confirmed by asking them whether they found using computer uncomfortable or had computer phobia. Besides, the user interface employed in the study, i.e. a computer monitor, mouse and keyboard, was very common. Using the VR orientation system was the same as operating an ordinary computer.

It was observed that the VR-based approach was able to attract patients' interest because they were admitted to the study venue for the first time and were curious about the new environment. The novelty of applying VR for psychiatric ward orientation as compared to the boredom of reading plain text in the non-VR group was probably another factor that attracted the patients. The subjective feeling due to patients' curiosity

and novelty of the VR-based system may also contribute to the great decrease in the C-STAI scores of the VR group. Nevertheless, two participants of the VR groups were found to partially lose attention during the moments when they were being automatically guided toward some rooms in the virtual ward. One participant developed paranoid ideation on the day after the VR orientation, but was relieved after receiving further explanation and counselling.

### *Limitations*

The research is limited in several aspects. While the study employed an RCT design, it was not double blinded. However, the experimental setting required the researcher to take part in both the VR based and the non-VR based orientation approaches. The researcher was fully aware of the grouping of the participants. Similarly, the participants were also aware of the group they were assigned. Thus, the use of double-blind method is not feasible in this study. Besides, the sample size was relatively small, involving only 54 participants. While the study was carried out within a period of 4.5 months, because of the admission policy and the unpredictability of the admission rate at the study venue, it was difficult to recruit more subjects to further demonstrate the significance of the research result. The study was also limited by the fact that the study venue was a female psychiatric ward. Variability due to gender difference was therefore not investigated. Furthermore, it did not take into account of ethnic difference as the study was conducted with patients who are ethnic Chinese and Chinese literate, and the information was provided in Chinese as well. In HRV measurement, sensor attachment to participants' wrists should be firm and stable in order to obtain high-quality signals. In reality, some participants were not able to maintain the same posture during the whole

period of HRV measurement. The resulted perturbation in sensor-wrist contacts could degrade signal quality and the accuracy of the results.

On the other hand, the computer software developed for the VR orientation approach was tailor-made for the study venue. It is not generic enough to be directly used in other psychiatric wards or hospitals where the settings are different, e.g. structures, furniture arrangements and decorations. The platform on which the VR orientation was developed was simply a common notebook computer with keyboard and mouse as the user interface. A more immersive virtual environment could be built with 3D user interfaces, such as stereoscopic visual display and haptic gloves, but the enhanced immersion is considered inappropriate for acute psychiatric patients, who may have difficulty in discerning the virtual environment from the real ward, so that delusions could develop to aggravate their psychotic status. In addition, discomfort created by devices attached to the body may become agitation.

#### *Future directions*

While the proposed approach was tested in a psychiatric ward, it would also be beneficial to deploy the service at psychiatric out-patient clinics or even the accident and emergency department, which are major sources of admission. If orientation is performed at this early stage to provide correct information about psychiatric wards, patients will be better prepared before admission, which could potentially reduce DAMA cases or premature discharge.

The user interface of the current system is conventional and matches the level of computer literacy of the participants. For this study, specific text information was only displayed on the screen selectively, depending on the location in the virtual ward. These

location-specific messages could be synchronized with audio clips narrating the routines and regulations to facilitate information delivery.

The novel VR-based approach attempts to provide an effective and time-saving way to orientate first-time psychiatric patients with appealing interactive 3D content and consistent information, so as to reduce their mental stress related to the new environment. In the present study, the first-time patients of the non-VR group browsed text-based electronic information sheets to gain understanding about the new environment. To make a more significant comparison between the VR and non-VR group, it is suggested to expose non-VR group's subjects to actual real-life stimuli that was presented in the VR based approach. This can be done in several ways. Ideally, a nurse can orientate the subjects of the non-VR group by escorting them to tour around the newly admitted ward, providing them with the same information presented to the VR group. Other possibilities are to present the non-VR group's subjects with pamphlets containing both text-based explanations and ward photos, or to use a ward orientation video to provide the real-life stimuli presented in the VR based approach. If the outcome is positive, it will provide strong evidence to justify the development of VR ward orientation software for first-time patients. The present study could also be further elaborated to study whether there are any gender differences in the results, and also the effect of the VR orientation approach on psychiatric patients with different types of mental disorders. A qualitative research design could be adopted, through structured interviews for example, to understand more specifically their feelings toward the VR orientation approach and their feedback.



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**AUTHOR DISCLOSURE STATEMENT**

No competing financial interests exist.

**APPENDIX***Appendix 1 Scales of the Six-item Short-form of the State Scale of the STAI.*

Statement	Answer			
	Not at all	Somewhat	Moderately	Very much
1. I feel calm	1	2	3	4
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	1	2	3	4
5. I feel content	1	2	3	4
6. I am worried	1	2	3	4

Statement	Score			
	Not at all	Somewhat	Moderately	Very much
1. I feel calm	4	3	2	1
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	4	3	2	1
5. I feel content	4	3	2	1
6. I am worried	1	2	3	4

*Appendix 2 The level of Understanding Test (LUT).*

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Fill in the blank

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1. The visiting hours of the ward are daily from \_\_\_\_\_ p.m. to \_\_\_\_\_ p.m.
  2. The lunch time of the patients starts from \_\_\_\_\_ p.m.
  3. The age of visitors visiting the ward should not less than \_\_\_\_\_ years.
- 

True or false

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4. Smoking is prohibited in the ward.
  5. Patients can keep scissors in the ward.
  6. Patients should neither leave the ward nor walk around in the hospital at will.
  7. Taking photos and video recording are not allowed in the ward.
  8. Patients are free to use mobile phones.
-

## REFERENCES

1. Haigh R. Acute wards: problems and solutions: Modern milieux: therapeutic community solutions to acute ward problems. *Psychiatric Bulletin* 2002;26(10):380-382.
2. Sun F-K, Long A, Boore J, Tsao L-I. Patients and nurses' perceptions of ward environmental factors and support systems in the care of suicidal patients. *Journal of Clinical Nursing* 2006;15(1):83-92.
3. Wood D, Pistrang N. A safe place? Service users' experiences of an acute mental health ward. *Journal of Community & Applied Social Psychology* 2004;14(1):16-28.
4. Bandura A. (1997). *Self-efficacy: the exercise of control*. New York: W.H. Freeman.
5. Evans GW. The Built Environment and Mental Health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine* 2003;80(4):536-555.
6. Shapiro DH, Astin J. (1998). *Control therapy: an integrated approach to psychotherapy, health, and healing*. New York, N.Y.: J. Wiley.
7. Spielberger CD. (1972). *Anxiety: Current trends in theory and research on anxiety*. New York: Academic Press.
8. Endler NS, Kocovski NL. State and trait anxiety revisited. *Journal of Anxiety Disorders* 2001;15(3):231-245.
9. Zeidner M. (1998). *Test anxiety : the state of the art*. New York ; London: Plenum Press.
10. Endler NS. Stress, anxiety and coping: the multidimensional interaction model. *Canadian Psychology* 1997;38:136-153.
11. Taylor JA. A personality scale of manifest anxiety. *Journal of Abnormal and Social Psychology* 1953;48:285-290.
12. Spielberger CD. (1985). *Anxiety, cognition and effect: a state-trait perspective*. Hillsdale, NJ: Lawrence Erlbaum Associates.
13. Pull CB. Current status of virtual reality exposure therapy in anxiety disorders. *Curr Opin Psychiatry* 2005;18:7-14.
14. Gregg L, Tarrier N. Virtual reality in mental health : a review of the literature. *Social psychiatry and psychiatric epidemiology* 2007;42(5):343-54.
15. Wiederhold BK, Wiederhold MD. Three-Year Follow-Up for Virtual Reality Exposure for Fear of Flying. *CyberPsychology & Behavior* 2004;6(4):441-445.
16. Mühlberger A, Wiedemann G, Pauli P. Efficacy of a one-session virtual reality exposure treatment for fear of flying. *Psychotherapy Research* 2003;13:323-336.
17. Walshe DG, Lewis EJ, Kim SI, O'Sullivan K, Wiederhold BK. Exploring the Use of Computer Games and Virtual Reality in Exposure Therapy for Fear of Driving Following a Motor Vehicle Accident. *CyberPsychology & Behavior* 2003;6(3):329-334.
18. Pertaub D-P, Slater M, Barker C. An Experiment on Public Speaking Anxiety in Response to Three Different Types of Virtual Audience. *Presence: Teleoperators & Virtual Environments* 2002;11(1):68-78.
19. Rothbaum BO, Hodges L, Alarcon R, Ready D, Shahar F, Graap K, Pair J, Hebert P, Gotz D, Wills B, Baltzell D. Virtual Reality Exposure Therapy for PTSD Vietnam Veterans: A Case Study. *Journal of Traumatic Stress* 1999;12(2):263-271.

20. Rizzo A PJ, McNERNEY PJ, Eastlund E, Manson B, Gratch J., Hill R SB. Development of a VR therapy application for Iraq war military personnel. . *Stud Health Technol Inform* 2005;111:407-413.
21. Difede J, Hoffman H. Virtual reality exposure therapy for World Trade Center Post-traumatic Stress Disorder: a case report. . *Cyberpsychol Behav* 2002(5):529-535.
22. McQuellon RP, Wells M, Hoffman S, Craven B, Russell G, Cruz J, Hurt G, DeChatelet P, Andrykowski MA, Savage P. Reducing distress in cancer patients with an orientation program. *Psycho-Oncology* 1998;7(3):207-217.
23. Katz MR, Irish JC, Devins GM. Development and pilot testing of a psychoeducational intervention for oral cancer patients. *Psycho-Oncology* 2004;13(9):642-653.
24. Luck A, Pearson S, Maddem G, Hewett P. Effects of video information on precolonoscopy anxiety and knowledge: a randomised trial. *The Lancet* 1999;354(9195):2032-2035.
25. Bossard C, Kermarrec G, Buche C, Tisseau J. Transfer of learning in virtual environments: a new challenge? *Virtual Reality* 2008;12(3):151-161.
26. Bliss JP, Tidwell PD, Guest MA. The effectiveness of virtual relity for administering spatial navigation training to firefighters. *Presence: Teleoperators and Virtual Environments* 1997;6:73-86.
27. Volbracht S, Domik G, Backe-Neuwald D, Rinkens H-D. The 'City Game' An Example of a Virtual Environment for Teaching Spatial Orientation. *Journal of Universal Computer Science* 1998;4(4):461-465.
28. Cromby J, Standen P, Newman J, Tasker H. Successful transfer to the real world of skills practised in a virtual environment by students with severe learning difficulties. 1996; Maidenhead, Berkshire, UK. p 93-101.
29. Young M. An ecological psychology of instructional design: Learning and thinking by perceiving-acting systems. In: Jonassen DH, editor. *Handbook of Research for Educational Communications and Technology*. 2nd ed. Mahwah, NJ: Erlbaum; 2004. pp 169-178.
30. Malik M, Camm AJ, editors. *Heart rate variability*. Armonk, NY: Futura Pub. Co.; 1995.
31. Appelhans BM, Luecken LJ. Heart Rate Variability as an Index of Regulated Emotional Responding. *Review of General Psychology* 2006;10(3):229-240.
32. Spielberger CD, Gorsuch RL. (1983). *State-trait anxiety inventory for adults: Sampler set, manual, test, scoring key*. Palo Alto, Calif.: Mind Garden.
33. Tsoi MM, Ho E, Mak KC, editors. *Becoming Pregnant Again After Stillbirth or the Birth of a Handicapped Child*. Amsterdam: Elsevier Science Publishers; 1986.
34. Shek DTL. Reliability and factorial structure of the Chinese version of the State-Trait Anxiety Inventory. *Journal of Psychopathology and Behavioral Assessment* 1988;10(4):303-317.
35. Shek DTL. The Factorial Structure of the Chinese Version of the State-Trait Anxiety Inventory: A Confirmatory Factor Analysis. *Educational and Psychological Measurement* 1991;51(4):985-997.
36. Shek DTL. The Chinese version of the State-Trait Anxiety Inventory: Its relationship to different measures of psychological well-being. *Journal of Clinical Psychology* 1993;49(3):349-358.

37. Soetanto AL, Chung JW, Wong TK. Gender Differences in Pain Perception: A Signal Detection Theory Approach. *Acta Anaesthesiologica Taiwanica* 2004;42(1):15-22.
38. Marteau TM, Bekker H. The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology* 1992;32(3):301-306.
39. Lewis JR. IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. *International Journal of Human Computer Interaction* 1995;7(1):57-78.

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