Training of professional caregivers in the management of psychological and behavioural symptoms of patients suffering from neurocognitive pathologies through virtual reality: Feasibility study, caregiver satisfaction and training effectiveness

Hermine Lenoir (hermine.lenoir@aphp.fr)
Université Paris Cité
Maribel Pino
Université Paris Cité
Sebastien Dacunha
Université Paris Cité
Anne-Sophie Rigaud
Université Paris Cité

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Abstract

During Alzheimer's disease and related disorders (ADRD), the inability to express one's needs due to cognitive impairments, and loss of self-control abilities, can lead to behavioural disorders which treatment (with medications) can be source of side effects. These issues are avoidable if caregivers are well-trained to verbal and nonverbal (V/NV) communication skills allowing appropriate responds to patients' diminished verbal expressions and non-verbal cues to best meet their needs, avoiding conflictual situations, caregiver burnout and delay in caregiving. However, access to trainings is limited by the constrained financial context, the shortage in health-care professionals, and due to social restrictions imposed by the COVID-19 pandemic. Recent advances in educational technology, particularly virtual reality (VR), may help train caregivers to clinical reasoning in a safe environment with immediate feedback on their achievements. The aim of our study is to develop and assess a VR teaching tool reproducing care scenarios. Immersed in a virtual care environment, 20 professional caregivers will assist to V/NV interactions between a virtual colleague and a patient (played by an actor) through two different scenarios. The trainee will have to identify and criticize inappropriate and more appropriate interactions in each clinical situation. Assessments will be performed to provide learners with personalized and detailed feedback on their achievement, measure their satisfaction with the training tool and feeling of competence. Our hypothesis is that the learner caregiver will acquire skills in non-drug management of disturbing psycho-behavioural symptoms of ADRD, in different care settings, autonomously, safely, without temporal constraints, and at lower cost.

Trial Registration

This study is registered in the French General Data Protection Regulation registry of Assistance Publique – Hôpitaux de Paris the 05/18/2022 under the N° 2022 0518135339

Background

Neurocognitive disorders (dementia) are a major public health problem and a major cause of disability in aging societies. They affect some 55 million people worldwide and each year nearly 10 million new cases [1]. During the clinical course of the disease, are observed impairments in the patients' ability to understand and express themselves verbally as well as memory, judgment, and reasoning impairments [2].

The pathology also impacts the patient's behaviour and mood, and the appearance of behavioural and psychological symptoms of dementia (BPSD) [3], severely worsen the suffering of the patient and the burden of the disease for caregivers [4,5].

The disruptive BPSD such as agitation, disinhibition, aggressiveness, opposition, and often care refusal, are almost always subtended by environmental factors, sleep deprivation [6], or by a confusional syndrome and favoured or maintained by anxiety, depression, delusions and/or hallucinations.

The use of psychotropic drugs to treat such disorders is often source of iatrogenic effects (drowsiness, falls, faecal impaction, acute urine retention, vascular accidents, extrapyramidal symptoms, etc.) in this particularly frail population [7], or sometimes ineffective [8,9]. Therefore, the use of a first line non-pharmacologic approach is highly recommended by health authorities and guidelines.

Insufficient skills of professionals to manage difficult situations (such as opposition to care, aggressiveness, agitation, severe anxiety, and wandering), increase the risk of negative interactions, exhaustion, absenteeism, inappropriate practices (i.e. physical restraint) [10], and even abuse [11,12]. This is also a cause of the exhaustion of family caregivers, the use of emergency services [13], of increase in the length of hospital stays and consequently in the costs associated with care [14,15].

Despite their cognitive impairment, nonverbal communication skills are often preserved among individuals suffering from major neurocognitive impairments, allowing the patient to communicate through gestures, facial expressions, postures, etc [16] …

These are signs that caregivers must know how to interpret correctly in order to best respond to the patient's needs.

Know-how to do and know-how to be (prosody, body language, facial expression) with such patients, calling on techniques such as validation therapy, empathy, active listening, relational touch, very often make it possible to resolve complex situations while ensuring a better quality of life for the patient as well as a feeling of competence and a lower risk of caregiver burnout [17].

However, institutional contingencies, in particular the rising trends toward decrease in financial resources (especially the financing of continuing education, but also the lack of didactic material) and scarce human resources (limited number of trainers, time-consuming requirements of student supervision) in medico-social structures or geriatric hospitals, make it difficult for caregivers to have general access to this training [18].

The COVID-19 pandemic context has increased these difficulties by the obligation to maintain barrier gestures, including the safety distance between learners, limiting the clinical exposure and expert supervision necessary for the acquisition of these skills, which are essential for an adequate care. Furthermore, theoretical training can be a source of weariness for learners and is generally less favoured by caregivers in their practice over time than training in real situations. Interactive training, such as role-playing, can improve these aspects but is subject to the constraints indicated in the previous paragraph.

Recent advances in educational technologies offer a growing number of innovative learning opportunities thanks to new tools. Among these, virtual reality represents a promising area with great potential for improving the training of health professionals [19, 20]. VR training provides a rich, interactive and engaging educational context, thus promoting experiential learning; it contributes to the interest and motivation of learners and effectively supports the acquisition and transfer of skills, since the learning process can be regulated in an experiential setting [20].

Current applications of virtual training in healthcare are diverse depending on their technological/multimedia sophistication, types of skills being trained (telesurgical applications, interactive simulations of the human body or brain, virtual worlds for emergency training) [21,22]. Other interesting applications include the development of immersive 3D environments for training psychiatrists and psychologists in the treatment of mental disorders [23].

The scientific literature on the contribution of VR to learning techniques (clinical reasoning and self-assessment) is increasingly rich [24]. As Bonk points out, recent technological developments have converged to radically alter the conception of teaching and the learning process [25].

Learning in VR requires interaction, which encourages active participation rather than passivity. The learner assimilates knowledge more effectively when given the freedom to circulate within their learning context.

Therefore, it seems useful to design educational programs based on virtual reality in this field because they would allow repeated practice of clinical gestures through interactions with a virtual agent, with several advantages: (a) Providing the learner with a safe environment for learning a clinical practice. (b) Representing a wide range of symptoms and diseases. (c) Providing the learner with immediate feedback on performance.

The virtual patient (virtual agent) would also allow exposure to a variety of clinical scenarios, compensating for lack of training and facilitating the acquisition of operational skills in the patient-caregiver relations.

A few studies exist assessing simulation as a learning method for training clinicians to communicate with elderly people and those on communication with demented elderly are still scarce [26].

Orton et al. from the University of Iowa's showed that a web-based platform called *GeriaSims* virtual patient program offered clinicians the opportunity of interacting with a virtual patient embodied as an elderly person and was effective for geriatric education. Indeed, more than 85% of the responses to an evaluation survey of *GeriaSims* users indicated favourable perceptions of instructional effectiveness, efficiency, and ease of use [27].

In another study, Robinson et al. focused on training communication skills of 82 speech pathology students with a virtual elderly resident of a nursing home with behavioural symptoms of dementia [28]. The two successive 15-minute interactions were based on predetermined scenarios of verbal (e.g., comprehension difficulties, word search, confusion) and non-verbal (e.g., crying, shrugging, chuckling) responses of the virtual elderly that were representative of dementia. The analysis of the trainee's verbal and non-verbal (V/NV) behaviour coupled with a self-rating by the trainees of their communication skills revealed an improvement in students' communication skills in the second interaction. However, it was not possible to distinguish the benefit of the simulation on the verbal versus non-verbal level.

Despite these results and as mentioned above the development of virtual reality for training professional caregivers to communicate adequately with people with cognitive impairment and suffering from psychological or behavioural symptoms of dementia is still limited.

In addition, most experiments have used avatars as virtual patients. Although these avatars mimic the body language of real subjects, they still lack realism. Using real actors in an immersive environment would provide the professional caregiver trainee a greater sense of reality and facilitate meaningful interactions.

Aims

The aim of our research is to develop and evaluate a virtual reality educational tool that allows the realisation of care scenarios in a 3D virtual environment. The caregiver learner, immersed in a virtual care environment, will witness V/NV interactions between a virtual colleague and a virtual patient (played by an actor) during two different scenarios. The goal for the trainee is to identify and criticize inappropriate interactions and differentiate them from more appropriate attitudes and words in each clinical situation. At the end of each module, an assessment will provide learners with personalized and detailed feedback on the answers given. An evaluation of their satisfaction with the training tool and their feeling of competence will also be carried out.

Our hypothesis is that the learner caregiver will eventually acquire skills in the non-pharmacological management of psycho-behavioural symptoms of patients suffering from Alzheimer's disease or related disorders, autonomously, without spatial or temporal constraints, in a secure manner, without feeling judged, and at a lower cost. This training will also ensure quality training, adaptable for caregivers in different care settings (nursing home, hospital, home).

Methods, Participants

Participants will be 40 geriatric health-care professionals (nurses, aid-nurses, physicians, nursing students) working at Broca Geriatric Hospital (Paris) regardless of day-time or night-time shift, recruited on a voluntary basis, using posters posted in the geriatric wards of the Hospital, or by informing them during team meetings in the hospitalization units. If they are willing to participate, health professionals will be invited to contact the researchers in charge of the project.

There will be no age or gender criteria for inclusion. Participants must have given their written consent to participate after having read the information letter and been given, at their request, any additional information they may need. Professionals will be informed that their data will always be anonymized and that the results of their participation in the study (opinions, results of questionnaires, test scores) will have no impact on their professional evaluation. The evaluating researchers (psychologists) will have no professional relationship with the potential participants.

Health-care professionals with a history of epilepsy, pregnant women, and people suffering from motion sickness, balance problems or prone to migraines will not be included in the study (information provided in the letter of information given before the experimentation).

No financial compensation will be provided to participants. Arrangements will be made for the participant to be free to attend the focus group and/or evaluations as appropriate. The maximum duration of participation in the study will be one hour and thirty minutes (90 minutes).

Protocol (description of tasks and materials)

a. Task description

Step One:

Prior to the evaluation of the virtual reality tool, 10 participants (healthcare professionals), after giving their written consent to participate in the study (after reading Information Sheet and Consent Form), will be questioned during a focus group and with the help of a questionnaire ("Verbal and Non-Verbal Communication Training Needs Questionnaire" designed for the study), about their V/NV communication training needs with patients suffering from BPSD.

We will then propose to the participants to read two scenarios written by the researchers (see example of scenario in Appendix), each describing a clinical context (in the hospital or in a nursing home) confronting a virtual patient (played by an actor) suffering from disturbing BPSD (aggression, opposition, agitation, and/or anxiety) and a virtual professional caregiver.

Each scenario, in a precise but concise way, describes situations where a conflict is likely to be generated because of the virtual patient's non-cooperative behaviour when asked by the virtual caregiver (e.g., grooming or blood test to be performed, medication to be administered but the patient is opposed/aggressive or agitated). The participants, based on their own professional experience/knowledge, will be able to give their opinions, make clarifications or corrections to this working document. In addition, participants will be asked to modify or complete, if necessary, the dialogues and gestures described by the fictional characters, so as to implement in the text the attitudes/speeches of the virtual caregiver likely to aggravate the conflict or, on the contrary, to soothe the patient in order to accede to his requests (if they are relevant) while providing him with the care he needs.

Finally, participants will contribute to the design of a total score based on the percentage of good and bad attitudes/speeches of the virtual caregiver towards the virtual patient identified by the learner among the totality of these attitudes described in each scenario (See detailed description in step two).

Step two:

It will first consist of 30 participants (different from the 10 previous ones) after giving their written consent to participate (specific Information Sheet and Consent Form) to successively view the final

scenarios 1 and 2 resulting from the work of the focus group (See step 1 above) and produced in virtual reality (VR) movies using a video headset. The participant is represented in this VR film as a professional caregiver (Nurse/Doctor/Assistant Caregiver) moving through the virtual environment predefined by the scenario (e.g., patient room/unit corridors/care station). In this environment, the learner witnesses the interactions of a virtual caregiver (as if he/she were a colleague or a team member) and the virtual patient.

The learner must identify during the film the appropriate or inappropriate attitudes/speeches of the virtual caregiver (colleague) in response to the behaviours or requests of the virtual patient. A joystick will allow the healthcare professional to categorize the "right attitude" and "wrong attitude" of the virtual caregiver (different button/beep system for each case).

At the end of the two scenarios, a debriefing is carried out between the evaluating psychologists and the participant to analyze the choices made during the viewing by the latter. The participant's scores (percentage of correct answers for the adequate detection of the good and bad attitudes/speech of the virtual caregiver) obtained in scenario 1 and scenario 2 will be returned to him/her in order to allow him/her to note his/her possible progress in the learning process and his/her acquisition of knowledge on V/NV communication with patients suffering from BPSD.

b. Materials used

The virtual reality software: An interactive computer software will be developed within the framework of the project. It will make it possible to display on a screen of virtual reality helmet, virtual agents taking the shape of virtual caregiver and a patient played by an actor, in a 3D institutional environment of a hospital or nursing home (ex. room, common room, corridor, room of care).

c. Assessment tools

- The assessment of the training needs of healthcare professionals in verbal and non-verbal (V/NV) communication prior to the use of the training tool will be conducted using a V/NV communication training needs questionnaire designed for this research (See Appendix_1, online resource 1). "This questionnaire consists of 7 questions on the participants' basic knowledge of the particularities of patients suffering from BPSD, and the different training courses that the participants have taken in communication and relational care with regard to behavioural disorders. This evaluation based on the guidelines of the French High Authority of Health (Haute Autorité de Santé) of December 2019, will also allow us to see if the participants are comfortable with digital technology and if they have already followed a training based on digital technology and/or virtual reality simulation in particular [29].

Educational evaluation will be carried out by:

- The evolution of the learner's scores between scenario 1 and scenario 2 of VR movies: These scores will be automatically calculated, by a software program that records the number of times the learner correctly identifies the "appropriate" and "inappropriate" V/NV responses of the virtual caregiver to the behaviours

or words of the virtual patient (see example of scenario in Appendix_2, Online Resource 2) and their ratio to the total number of these predefined responses for each scenario (total number identical for scenario 1 and scenario 2). The difference in the average score of the 30 participants at the end of scenario 2 (Score 2) and scenario 1 (Score 1) will give an idea of the pedagogical value of the training tool (Score 2 < Score 1 meaning no progress for the caregiver, Score 2 > Score 1 meaning progress in knowledge acquisition).

- The assessment of the satisfaction of the learners and the usability of the modules and of the virtual reality headset training method: these assessments will be performed thanks to a satisfaction questionnaire designed by the researchers as well as the "*System Usability Scale*" (SUS) make it possible which collects the subjective point of view of the user on a system as well as on the ease of its use. The results are given on a 5-point Likert-type scale, ranging from 0 to 4. The total is calculated according to the method given by the SUS questionnaire and ranges from 0 to 100. The higher the score, the more satisfactory the usability of the device [30].

- The quantitative analysis of the subjective feeling of competence of the learners will be performed through a questionnaire designed by the researchers and on basis of the perceived competence subsection of the *Intrinsec Motivation Inventory* which evaluates motivation and competence in a multidimensional way [31]. The results are given on a 4-point Likert-type scale, ranging from 0 to 4. The higher the total score, the higher the sense of acquired competence.

Discussion

For this study, potential risks for participants have been anticipated.

Exposure to virtual reality can, according to data from the 2019 French National Health Security Agency (ANSES) survey, disrupt the sensory system and lead to symptoms such as nausea, dizziness, sweating, paleness, loss of balance, etc., grouped together under the term "cyber kinetosis" [32]. In people who are sensitive to it, these symptoms can appear as early as the first minutes of use. Following a session, virtual reality can also induce a temporary modification of sensory, motor and perceptive capacities and thus alter manual dexterity or the ability to orientate one's body. Finally, exposure to the temporal modulation of the light emitted by these LED screens - flashing light sometimes imperceptible to the eye - can trigger epileptic seizures in people with a favourable background [32].

To avoid the occurrence of these effects, following the recommendations of ANSES [32] :

- The tests during the use of the virtual reality visor will be stopped in the event of the appearance of symptoms such as nausea, dizziness, sweating, pallor...

- A rest period of half an hour during and half an hour after the use of the virtual reality device will also be respected for each participant.

- People with epilepsy or people identified as sensitive: pregnant women, people suffering from motion sickness, balance problems or prone to migraines will not be included in the study (information appearing

in the information letter and the exclusion criteria).

In order to avoid risks related to Covid-19, all equipment (visiocasks, furniture) will be disinfected before and after use by each participant by the evaluators. A physical distance of 2 meters will also be respected by the evaluators and the participants, while respecting all the other barrier gestures (wearing a mask, hydro-alcoholic hand disinfection, use of pens dedicated to each participant).

We believe that, compared to other training programs, the interest and originality of our study protocol consists in the fact that the trainee does not interact directly with the patient but must analyze and criticize the attitudes and words of a virtual caregiver colleague with the patient. This, we believe, prevents the caregiver from censoring him/herself in the way he/she interacts with the patient, for fear of being judged by the examiner. We believe that in this way, the trainee caregiver will learn from the interaction mistakes made by their peers.

Furthermore, we believe that the use of a real actor instead of an avatar, however realistic it may have been designed, will allow the trainee to get closer to the reality of his daily work.

Expected results and conclusion

By participating in this research project, the health professional will contribute to the development of technological and digital means for the training of professionals in the health and medico-social sectors in geriatrics, regardless of their profession. The results of this study will make it possible to create an interactive tool adapted to the training of professionals working with patients suffering from neurodegenerative diseases with disruptive behavioural and psychological symptoms. This training will present the advantage of improving relational skills of professional caregivers with this kind of patients, not in a theoretical way but close to the real situations of daily care and management, in a secure way, with a controlled cost.

In addition to good gestures and good practices, immersion in a potentially anxiety-provoking environment will allow working on the management of emotions and stress, thus reducing the risk of exhaustion, while integrating good care practices.

The modules will be developed to be used in individual training sessions (in autonomous e-learning mode) or in group sessions, if necessary supervised by a psychologist or other trainer.

Through the co-construction of virtual environment scenarios, the project will promote the transfer of skills from healthcare professionals to industry and startups.

Abbreviations

ADRD: Alzheimer's disease and related disorders

V/NV: verbal and non-verbal

VR : Virtual Reality

BPSD: behavioural and psychological symptoms of dementia

ANSES: Agence Nationale de Sécurité Sanitaire (French National Health Security Agency)

Statements And Declarations

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Ethics approval and consent to participate

All of the research meets the ethics guidelines, including adherence to the legal requirements of Ethics committee approval of the University of Paris Cité.

Lettre of informations and Consent forms have been designed for all paticipants and approved by the Comité d'Ethique pour la Recherche (Ethics Commitee for the Resaerch) of University of Paris Cité.

Consent for publication

All authors have given their consent for the present publication.

Availability of data and materials

The materials and data that will support the findings of this study will be available from the corresponding author upon reasonable request.

Competing interests

All authors of this study state that they have no financial or non-financial conflicts of interest to that are directly or indirectly related to the work submitted for publication to disclose.

Authors' contributions

All authors read and approved the final version of the manuscript. – Conceptualization and material preparation : [Hermine Lenoir, Anne-Sophie Rigaud], Methodology: [Hermine Lenoir, Anne-Sophie Rigaud, Sébastien Dacunha]; Writing - original draft preparation: [Hermine Lenoir]; Writing ; [Hermine Lenoir] - review and editing: [Hermine Lenoir, Anne-Sophie Rigaud, Sébastien Dacunha, Maribel Pino]; Funding acquisition: [Hermine Lenoir, Sébastien Dacunha, Maribel Pino, Anne-Sophie Rigaud]; Resources: [Hermine Lenoir, Sébastien Dacunha]; Supervision: [Anne-Sophie Rigaud].

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Research involving human/Animal participants

This study research will not involve human participants (patients).

Informed consent

To be included in the study, all participants will be asked to give their written informed consent to participate in the study and having their data published in a journal article.

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Supplementary Files

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- AppendixarticleHermineLenoirJMedSystem05062022.docx