

ORIGINAL

Characteristics of Transactive Relationship Phenomena among Older adults, Care Workers as Intermediaries, and the Pepper Robot with Care Prevention Gymnastics Exercises

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Abstract : Healthcare for older adults is a significant problem in Japan and in other developed countries. To address this problem, healthcare robots, now realized, can assist and meet healthcare and welfare practice demands. The aim of this study was to clarify characteristics of Transactive Relationships (TR) in older adults, in care workers as intermediaries, and Pepper (Softbank Robotics Corporation) a robot equipped with the application program of Care Prevention Gymnastics Exercises for Pepper (Pepper-CPGE) made by Xing Company, Japan. Data were collected by observing TRs between Pepper and older patients in Kagawa Prefecture, Japan between from May 8 to August 1 2018. The Transactive Relationship Theory of Nursing (TRETON) was used to explain how Pepper-CPGE led the exercises with older adults as physical exercises. The role of Pepper-CPGE was to provide instructions for the older adults in performing gymnastic exercises. During the exercising activity, care workers were present to prevent falls of the older adults, and to operate and observe the video presentations by supporting and caring for the participants. In using Pepper-CPGE, it was possible to change the role of the healthcare providers, originally thought to contribute to increasing the quality of older adult care and their rehabilitation. *J. Med. Invest.* 66 :46-49, February, 2019

Keywords : Transactive phenomenon, Older adults, Humanoid robots, Long-term care, Intermediaries

INTRODUCTION

The aging population in Japan has increased and is increasing at a phenomenal rate that is unequaled in any other country, and the declining birth rate associated with the aging society have caused a dominant aging population demographic structure. Moreover, along with societal changes such as the increase in unmarried people and single-person households, and separated parent-child households, the number of older adults living alone has also increased (1). Healthcare for the older adults is a significant problem in Japan and in other developed countries more so as healthcare providers in Japan are getting older. To address solutions to this problem, using healthcare robots, now realized, is starting to assist and meet healthcare and welfare practice needs.

Research on robot-based rehabilitation is increasing (2, 3), especially assistive robots, to perform function training. Their practical application is increasing. It was reported that exercise training on older adults with cognitive impairment and dementia (4,5) is effective for physical function, cognitive function, and positive behavior. In recent years, research has also begun on virtual reality (VR) for physical and motor rehabilitation (6, 7). Particularly encouraging are the many uses of VR in supporting the recovery of motor skills following accidents or illnesses (8).

However, humanoid robots which play instructive roles for the older adult group, and rehabilitation efforts and gymnastics (exercise) are not enough interventions, besides their evaluation is still not sufficiently conclusive (9).

The aim of this study was to clarify the characteristics of transactive relationship phenomena among older adults, care workers/healthcare providers as intermediaries, and the Pepper (SOFTBANK CORP.) robot equipped with the application program of Care Prevention Gymnastics Exercises (Pepper-CPGE) made by Xing Company, Japan.

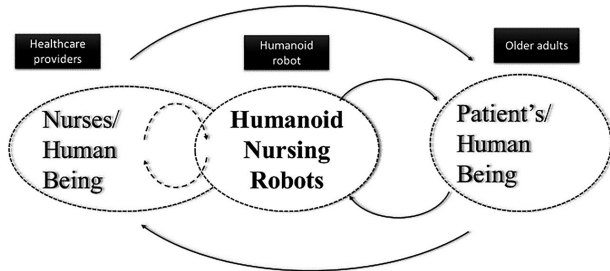
METHODS

Theoretical framework

Figure 1 shows the Transactive Relationship Theory of Nursing (TRETON) (10), in which a nursing encounter is where all nursing occurs encompassing the process of nursing as technological engagement and mutual knowing. The TRETON explains the engagement processes that are characteristic activities among older adults with dementia, the nurse and occupational therapists as mediator, and the Pepper-CPGE. This theory explains the mutual engagement and the technological engagement that transpires among them. Together with video-recorded activities, the indications supporting the characteristic transactive phenomenon among older adults with dementia, nurses, and Pepper-CPGE are made evident.

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Humanoid nursing robots (HNRS)' ability to remember events and experiences is critical in order to share patient's lived experiences; to maintain a conversation; also to feel, illustrate, and convey emotions.

Figure 1. The Relationships Between and Among Nurses, Humanoid Nursing Robots, and Patients (Partially modified) (10)



Figure 2. Positional relation among Pepper-CPGE, older adults and healthcare providers

Study design and procedure of data collection

In this research, participatory action research method was used (11), and researchers continuously discussed and analyzed the recorded data. The transactions were focused/analyzed as to how Pepper-CPGE led the exercises, and how care workers intervened during physical exercise of the older adults.

Analyzed scenes were physical exercises with Pepper-CPGE. Recorded videos were analyzed only during (1) upper limb motor functions exercise, and (2) exercises using Radio Gymnastics the First (Rajio Taiso Dai-ichi), a program that is well-known and well-practiced by most Japanese citizens. Pepper-CPGE instructs the older adults to perform gymnastics activities while viewing the video monitor.

Data collection period

Data collection period was from May 8 to August 1st, 2018.

Ethical considerations

The data collection procedure was approved by the Ethics Committee of the Tokushima University Hospital (Number 3046) and was also approved by Mifune Hospital Clinical Research Ethics Review Committee (Number 201180502).

RESULTS

The results revealed three important themes namely : Positional relation among Pepper-CPGE, older adults and healthcare providers (Figure 2) ; Pepper-CPGE encourages older adults to maintain their physical functions (Figure 3) ; and the increased motivation of older adults to do gymnastics as evoked by Pepper-CPGE (Figure 4). During the exercising activity with Pepper-CPGE, healthcare providers supported and cared for the older adults. Healthcare providers such as nurses, care workers, occupational therapists, and physical therapists need to support the older adults while Pepper-CPGE provided the recreation and/or physical exercise.

Figure 2 shows the positional relation among Pepper-CPGE, the older adults, and the healthcare providers. When doing gymnastics using Pepper-CPGE, it was necessary that healthcare providers guide older adults at the initial part of the introduction, like so : "Let's do gymnastics with Pepper-kun (Mr. Pepper), please". After the initial introduction, older adults accepted the Pepper-CPGE, and mutual relationships were gradually established. However, there was often some silence in the conversations between Pepper-CPGE and the older adults which were observed to be that they were uncomfortable.

Figure 3 is a scene where Pepper-CPGE conducted a range of motion (ROM) exercise for older adults by demonstrating upper limb lifting while explaining the method of gymnastics exercise. In this activity Pepper-CPGE can lead the older adults to do active ROM exercises.



Figure 3. Pepper-CPGE that encourages older adults to maintain their physical functions

Figure 4 shows the increased motivation of the older adults for gymnastics evoked by Pepper-CPGE. In this case, the older adults who is using the wheelchair for usual transfer, standing up with Pepper-CPGE's leads and performs gymnastics.



Figure 4. Increased motivation of the older adults for gymnastics evoked by Pepper-CPGE

DISCUSSION

The transactive relationships were discussed like below as to how Pepper-CPGE led the exercises, how the care workers intervened during the physical exercises of the older adults.

Positional relation among Pepper-CPGE, older adults and health-care providers

There was silence in the conversation between Pepper-CPGE and older adults. It was considered that the older adults looked uncomfortable. From this situation, it is important that intermediaries motivate so that older adults can feel comfortable to participate recreational and physical activity. For that, it is important to understand and motivate the following communication.

Silence is classified as pause, gap, lapse, or significant/attributional silence (12). Interactional events, established by the nature and significance of the occasion is determined by its place in the ongoing conversation. Different types of silence-pauses, gaps, and lapses (13) were identified. Pause, being outside language is differentiated from (eloquent) silence, a means chosen by the speaker for significant verbal communication alongside speech; it is not the listener's silence nor the silencing of the speaker. Linguistic and non-linguistic contributions to the study of eloquent silence are important functions as means of maintaining contact and alliance in the phatic function (14). It is the means by which two or more speakers reassure themselves that not only are they being listened to, but they are also being understood.

Pepper-CPGE's gymnastics and recreational programs are not designed on the premise of transaction/interaction with a large number of patients at the present time. Therefore, it was considered important that healthcare providers' roles as intermediaries be in order to smoothly carry out conversations with Pepper-CPGE (15).

Pepper-CPGE that encourages older adults to maintain their physical functions

Pepper-CPGE leads older adults to perform active ROM exercises. ROM exercises can increase flexibility in the major joints of healthy older adults (16). For example, a simple nurse-led ROM exercise program can generate positive effects in enhancing physical and psychological functions of bedridden older people with stroke (17). Passive and active motion exercises were found to be similarly effective for improving the functional fitness of older adult nursing home residents (18). In a study evaluating activation of the cerebral cortex using functional MRI (19), active training led to more prominent increases in fMRI activation of the contralateral primary motor cortex than passive training. Therefore, it was considered that such voluntarily motor training is more effective than passive motor training.

Increased motivation of the older adults for gymnastics evoked by Pepper-CPGE

Pepper-CPGE provided increased motivation for the older adults to perform activities following the Radio Gymnastics First.

The role of Pepper-CPGE is providing instructions for the older adults performing gymnastics. During the exercise activity, care workers were present to prevent falls and physical harm to the older adults, and to operate and observe the video program while supporting and caring for the participants.

Healthcare providers like nurses, care workers, and occupational and physical therapists require leadership skills to moderate physical activities necessary to provide the recreation and/or physical exercise of the older adults (20). They can practice this role to provide motivation for exercising, preventing falls, and supporting joint ROM training for older adults.

Depending on the cognitive function and degree of physical

function of the older adults, support by medical staff as intermediaries to prevent fall and provide supplementary explanation for gymnastics by Pepper-CPGE instruction were necessary.

Radio Gymnastics First demonstrated by Pepper-CPGE is familiar to older adults, and to most Japanese citizens who have experience of exercising. Its advantage is also because of ease to implement.

This exercise can also contribute to the prevention of waste syndrome (or locomotive syndrome), and enhances maintenance of physical functions (21). However, if the older adults only sees Pepper-CPGE's instructions, there is a possibility that Pepper's upper limb movements cannot be carried out sufficiently by them, unlike the original Radio Gymnastics First exercise routine. Depending on the cognitive function level of the older adults, there are some patients who cannot exercise with the instructions by Pepper-CPGE. From these observations, healthcare providers need to support patients according to their degree of cognitive functioning, especially the older adults. In addition, healthcare providers should supplement any information given by Pepper and do further explanations which are difficult to reproduce with the Pepper-CPGE's movement functions of upper limbs and lower limb.

CONCLUSION

During the exercise activity with Pepper-CPGE, care workers were present whose roles included preventing falls among the older adults, and to operate and observe, support and care for the participants. Healthcare providers, such as nurses, care workers, and occupational or physical therapists require leadership skills to moderate activities necessary to provide the recreation and/or physical exercise of the older adults. They can practice this role to provide motivation for exercise, prevention of falls, support joint motion and range training for the older adults. In using Pepper-CPGE, it was possible to change the roles of the healthcare providers, which was thought to contribute to increasing the quality of care of older adults and their rehabilitation. The role of Pepper-CPGE using the video was as the instructor for the older adults in performing gymnastics.

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CONFLICT OF INTEREST

There is no actual or potential conflict of interest that exist in this manuscript.

REFERENCES

1. Tanioka T, Osaka K, Locsin R, Yasuhara Y, Ito H : Recommended Design and Direction of Development for Humanoid Nursing Robots Perspective from Nursing Researchers. *Intelligent Control and Automation* 8 : 96-110, 2017
2. Swinnen E, Beckwee D, Meeusen R, Baeyens JP, Kerckhofs E : Does robot-assisted gait rehabilitation improve balance in stroke patients? A systematic review. *Topics in Stroke Rehabilitation* 21(2) : 87-100, 2014
3. Hu XL, Tong RK, Ho NS, Xue JJ, Rong W, Li LS : Wrist Rehabilitation Assisted by an Electromyography-Driven Neuromuscular Electrical Stimulation Robot After Stroke.

- Neurorehabil Neural Repair 29(8) : 767-76, 2015
4. Vina J, Borrás C, Sanchis-Gomar F, Martínez-Bello VE, Olayo-González G, Gambini J, Ingles M, Gómez-Cabrera MC : Pharmacological Properties of Physical Exercise in The Elderly. *Current Pharmaceutical Design* 20(18) : 3019-29, 2014
 5. Heyn P, Abreu BC, Ottenbacher KJ : The effects of exercise training on elderly persons with cognitive impairment and dementia : A meta-analysis. *Archives of Physical Medicine and Rehabilitation* 85 : 1694-1704, 2004
 6. Sveistrup H : Motor rehabilitation using virtual reality. *Journal of NeuroEngineering and Rehabilitation* 1 : 10, 2004
 7. Sveistrup H, McComas J, Thornton M, Marshall S, Finestone H, McCormick A, Babulic K, Mayhew A (2003), *Experimental Studies of Virtual Reality-Delivered Compared to Conventional Exercise Programs for Rehabilitation*. *Cyberpsychol Behav* 6 (3) : 245-9, 2003
 8. Weiss PL, Keshner EA, Levin MF (Eds.) : *Virtual Reality for Physical and Motor Rehabilitation*. Springer, New York, NY, 2014
 9. Tanioka R : Potential Legal Issues and Care Implications during Care-Prevention Gymnastic Exercises for the Elderly Using Pepper in Long Term Health Care Facilities. *Intelligent Control and Automation* 9(3) : 85-93, 2018
 10. Tanioka T : The Development of the Transactive Relationship Theory of Nursing (TRETON) : A Nursing Engagement Model for Persons and Humanoid Nursing Robots. *International Journal of Nursing and Clinical Practices* 4 : 223, 2017
 11. Hegney DG, Francis K : Action research : changing nursing practice. *Nurs Stand* 29(40) : 36-41, 2015
 12. Sacks H, Schegloff EA, Jefferson G : A Simplest for the Organization of Turn-Taking for Conversation. *Language* 50(4) : 696-735, 1974
 13. Elouakili S : A Conversation Analysis Approach to Attributable Silence in Moroccan Conversation. *International Research in Education* 5(2) : ISSN 2327-5499, 2017
 14. Ephratt M : The functions of silence, *Journal of Pragmatics* 40 : 1909-1938, 2008
 15. Osaka K, Sugimoto H, Tanioka T, Yasuhara Y, Locsin R, Zhao Y, Okuda K, Saito K : (2017) Characteristics of a Transactive Phenomenon in Relationships among Older Adults with Dementia, Nurses as Intermediaries, and Communication Robot. *Intelligent Control and Automation* 8 : 111-125, 2017
 16. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, Salem GJ, Skinner JS : Exercise and physical activity for older adults. *Medicine & Science in Sports & Exercise* 41(7) : 1510-1530, 2009
 17. Tseng CN, Chen CC, Wu SC, Lin LC : Effects of a range-of-motion exercise programme. *J Adv Nurs* 57(2) : 181-91, 2007
 18. Takahashi T, Takeshima N, Rogers NL, Rogers ME, Islam MM : Passive and active exercises are similarly effective in elderly nursing home residents. *J Phys Ther Sci* 27(9) : 2895-900, 2015
 19. Lotze M, Braun C, Birbaumer N, Anders S, Cohen LG : Motor learning elicited by voluntary drive. *A Journal of Neurology* 126 : 866-872, 2003
 20. King AC : Interventions to Promote Physical Activity by Older Adults, *The Journals of Gerontology. Series A* 56(1-2) : 36-46, 2001
 21. Nakamura K : A "super-aged" society and the "locomotive syndrome". *Journal of Orthopaedic Science* 13(1) : 1-2, 2008