Scientific Research Publishing

Open Journal of Therapy and Rehabilitation, 2024, 12, 236-244
https://www.scirp.org/journal/ojtr
ISSN Online: 2332-1830
ISSN Print: 2332-1822

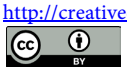
Verification of the Physiological Therapeutic Effects of Harvesting Activities in a Patient with Moderate Alzheimer's Disease with Long-Term Agricultural Experience

Kikuo Eguchi[1], Seigo Koura[2], Nao Eguchi[3], Akihiko Kondo[1]

[1]Faculty of Occupational Therapy, School of Rehabilitation, Reiwa Health Sciences University, Fukuoka City, Japan
[2]Faculty of Rehabilitation, Nishikyusyu University, Kanzaki City, Japan
[3]Clinical Art Class Studio, Takanabe City, Japan
Email: k.eguchi@rhs-u.ac.jp

How to cite this paper: Eguchi, K., Koura, S., Eguchi, N. and Kondo, A. (2024) Verification of the Physiological Therapeutic Effects of Harvesting Activities in a Patient with Moderate Alzheimer's Disease with Long-Term Agricultural Experience. *Open Journal of Therapy and Rehabilitation*, **12**, 236-244.
https://doi.org/10.4236/ojtr.2024.123018

Received: June 3, 2024
Accepted: July 7, 2024
Published: July 10, 2024



Abstract

Background: Harvesting activities have proven effective in reducing stress in patients with dementia. At a psychiatric hospital, occupational therapists (OT) made patients with dementia perform vegetable harvesting activities as a part of their treatment. The patients became calmer and began to smile not only after but also before and during harvesting activity. Therefore, this study aimed to measure autonomic nervous system (ANS) responses over time in a female patient in her 80s with moderate Alzheimer's disease (AD) who had experience in farming when performing harvesting activities. Additionally, this study aimed to consider factors associated with changes in ANS responses over time and to verify the physiological therapeutic effects of harvesting activities. **Methods**: An OT with more than 10 years of experience and a good relationship with the patient conducted one-on-one sessions with the patient. Harvesting activity was performed in a courtyard with trees. The patient harvested lettuce (three lettuce plants) grown in a planter while sitting on a chair. Additionally, the planter was set up on a desk. ANS responses were measured over time from before to after the activity for different events at six time periods. Changes in the patient's ANS responses were assessed during each period. **Results**: With the involvement of environmental factors and OT during harvesting activities, parasympathetic nervous system (PNS) activity significantly increased. This may lead to improved mental stability. **Conclusion**: The findings of this study indicate that implementing harvesting activities may have a positive effect on the PNS in patients with AD with long-term agricultural experience. However, further studies with a larger sample size and multidimensional evaluations are needed.

Keywords

Alzheimer's Disease, Autonomic Nervous Response, Harvesting Activity, Therapeutic Effects

1. Introduction

Dementia is a syndrome that has different causes [1]. It is a devastating condition that is most commonly seen in older adults and places a significant burden on individuals, their families, and the healthcare system [2]. With the increasing number of older adults, the prevalence of dementia has also increased [3]. Dementia symptoms, such as memory loss, lack of attention, and impaired visual perception, can make patients with dementia psychologically stressed and experience confusion, anxiety, or anger. Therefore, emotional stability and social interaction play an important role in improving the lives of patients with dementia [4]. Additionally, engaging patients with dementia in meaningful activities can enhance their well-being [5].

Providing meaningful activities for patients with dementia in institutional care settings can be challenging for many activity staff. However, horticultural therapy (HT) is an approach to addressing this challenge [6]. The American Horticultural Therapy Association defines HT as "the process of using plants and gardening to improve the social, educational, psychological, and physical conditioning of people in need of improvement of body, mind, and spirit."HT has been widely used to promote the well-being and emotional stability of patients with dementia [4]. Blake *et al.* [7] reported that HT is a cost-effective way by which patients with dementia can be supported to sustain their well-being, behavioral and psychological symptoms can be redressed, the need for prescription of certain anxiolytic, sedative, or antipsychotic medications can be reduced, and mental health and engagement can be improved. Furthermore, Abigail *et al.* [8] reported the benefits of gardening for patients with dementia, including physical benefits, improvement in mood, reinforcement of memories related to gardening, improved sense of purpose, and pride in accomplishment. In short, HT is associated with biopsychosocial well-being in patients with dementia.

Regarding the objective effects of gardening activities, Teraoka *et al.* [9] reported that harvesting summer vegetables significantly reduced stress in older people with dementia who had gardening experience. Additionally, Hayashi *et al.* [10] reported that vegetable harvesting relieved stress in older people with dementia. Harvesting summer vegetables reduces stress in older people with dementia who have long-term agricultural experience.

At a psychiatric hospital, occupational therapists (OTs) made patients with dementia perform vegetable harvesting activities as a part of their treatment. The patients became calmer; moreover, patients were observed to smile not only after but also before and during harvesting activity. Therefore, a literature search was

performed to investigate the physiological effects before, during, and after performing vegetable harvesting activities as a treatment for patients with dementia. However, no study has investigated changes in physiological responses before, during, and after harvesting.

Therefore, this study aimed to measure autonomic nervous system (ANS) responses before, during, and after harvesting in a patient with moderate Alzheimer's disease (AD) with long-term agricultural experience. Additionally, this study aimed to consider factors associated with changes in ANS responses over time and to verify the physiological therapeutic effects of harvesting activities.

2. Methods

2.1. Patient's Characteristics

This study included a woman in her 80s with long-term farming experience who was diagnosed with AD by a doctor using the ICD-10 diagnostic criteria. Moreover, the severity of dementia was judged as moderate by the physician in charge based on Clinical Dementia Rating and Mini Mental State Examination [11]. The doctor had prescribed her donepezil hydrochloride, and no side effects were noted from the medication. Table 1 presents the patient characteristics.

Table 1. Characteristic information of the patient.

Diagnosis	AD
Age	80s
Sex	Female
Various evaluation results	Clinical Dementia Rating: 2
	Mini-Mental State Examination: 11
	Behavioral Rating Scale for the Mental States: 17
	New Clinical Scale for Rating Activities of Daily Living in Older People: 29
	Dementia Behavior Disturbance Scale: 36

2.2. Environment and the Measurement Method

An OT with more than 10 years of experience and a good rapport with the patient conducted one-on-one sessions with the patient. Harvesting activity was performed in a courtyard with trees. The weather was sunny with a temperature of 25.5˚C and humidity of 58%. The patient harvested lettuce (three lettuce plants) grown in a planter while sitting on a chair. Additionally, the planter was set up on a desk.

ANS responses were measured over time from before to after the activity. ANS responses were measured for the following events at six time periods: (I) when taking a break on the indoor sofa (60 s), (II) when going out to the courtyard and moving to the desk (30 s), (III) when the OT encouraged the patient to perform harvesting activities, and the patient said, "I can't harvest the vegetables

because I didn't grow them" (30 s), (IV) when the OT asked the patient, "Could you please harvest it so we can all have it for lunch?", and the patient was convinced and started harvesting (120 s), (V) after harvesting and returning from the desk to the indoor sofa (40 s), and (VI) when resting on the original sofa (60 s).

Moreover, when the patient spoke to the OT, the OT empathized and quickly responded. The ward staff were asked to cooperate during the assessment and to set the environment in such a way that other patients would not talk to the patient. Additionally, noise and visual distractions in the ward that could affect ANS responses were eliminated.

2.3. Measurements

Heart rate variability, an indicator of ANS activity, was measured based on a previously reported method [12] [13]. An electrocardiogram (ECG) monitor (BSM-0805, Nihon Kohden Corporation, Tokyo, Japan) was used, and ECG analog signals were analyzed using MemCalc/Tarawa software (GMS Co., Ltd., Tokyo, Japan), which is PC software that can measure ECG fluctuations. An installed wireless transmitter was used to send ECG data to the PC, and only a three-point sensor was attached to the patient to reduce the load on the patient during harvesting as much as possible. The three-point sensors were attached to the patient, by an occupational therapist of the same sex who was not involved in this study and had a good rapport with the patient, 3 minutes before the start of the measurement of "(I) when taking a break on the indoor sofa (60 s)". The sensors were removed after "(VI) when resting on the original sofa (60 s)" was measured.

The measurement items were heart rate, entropy (every eight beats), and heart rate variability (coefficient of variation of the R-R intervals) averaged every 10 s. The MemCalc/Tarawa software was used to analyze the frequency of heart rate variability based on the R-R interval from the ECG heart rate waveform and the fluctuation component of the ECG R-R interval using a power spectrum analysis [14]. The low-frequency (LF: 0.04 - 0.15 Hz) component of heart rate variability reflected sympathetic nervous system (SNS) function and some parasympathetic nervous system (PNS) function, whereas the high-frequency (HF: 0.15 - 0.4 Hz) component, which is related to respiratory heart rate variability, mostly reflected PNS function [15]. Therefore, the LF/HF ratio was used as an index of SNS.

No direct method was used to assess changes in calmness in this study to reduce patient anxiety before and after the study. However, HF heart rate variability when PNS activity was predominant indicated a relaxed state [16]. Therefore, an increase in the patient's PNS activity indicated decreased anxiety and increased calmness.

2.4. Ethical Consideration

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Additionally, the study protocol was approved by the Ethics Review Board of our university (Approval No. 22-016). Informed consent was

obtained from the patient and her family before participation in this study.

3. Results

Figure 1 illustrates the changes in the patient's PNS and SNS activities. Additionally, Table 2 presents the average values and standard deviation for each period of patients' PNS and SNS activities. The patient's facial expressions, conversation with the OT, and PNS and SNS activities at each period were as follows:

During period I, the patient and OT were sitting on the sofa. The patient looked down. At that time, the SNS activity increased.

During period II, the patient and OT got up from the sofa and walked to the desk with the planter in the courtyard. When the patient and OT went out into the courtyard, the patient smiled and talked to the OT, saying things like, "It's nice weather today", and "The sunlight filtering through the trees is beautiful". At that time, the OT agreed, "That's right." The OT made a quick response to the patient. A slight increase in the patient's PNS activity was observed during this period.

During period III, the OT encouraged the patient to perform harvesting activities. However, the patient said, "I can't harvest the vegetables because I didn't grow them." A decrease in the PNS activity was observed.

During period IV, the OT asked the patient, "Could you please harvest it so we can all have it for lunch?" The patient was satisfied with the OT's explanation and began harvesting. The patient said, "The lettuce is growing beautifully," and "It looks delicious." At that time, the OT agreed, "That's right." The OT made a quick response to the patient. Then, the patient smiled. At that time, the PNS activity significantly increased.

During period V, after harvesting, the patient was exposed to sunlight filtering through the trees while moving indoors. The patient then said, "It feels good." At that time, the OT agreed, "That's right." The OT made a quick response to the patient. At that time, the PNS activity significantly increased.

During period VI, the patient and OT were seated on the original sofa. At that time, the patient's expression was calm. A slight increase in the patient's PNS activity was observed.

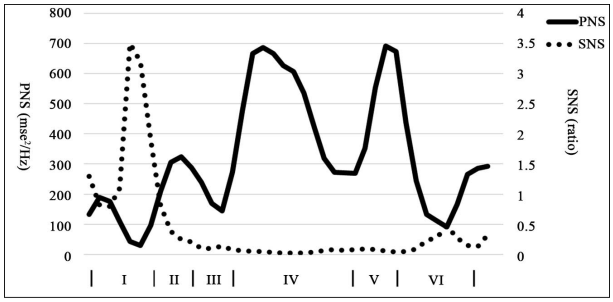


Figure 1. Changes in the patient's PNS and SNS activities during each period. PNS, parasympathetic nervous system; SNS, sympathetic nervous.

Table 2. Average values and standard deviation in the patient's PNS and SNS activities during each period.

Time periods	I	II	III	IV	V	VI
Seconds	60	30	30	120	40	60
PNS ($msec^2/Hz$)	111.1 ± 61.2	280.0 ± 61.3	210.0 ± 65.7	485.3 ± 168.3	496.3 ± 172.5	198.5 ± 82.3
SNS (ratio)	1.8 ± 1.1	0.5 ± 0.3	0.1 ± 0.1	0.04 ± 0.02	0.1 ± 0.02	0.2 ± 0.1

Average value ± standard deviation.

4. Discussion

In this study, we measured the ANS responses over time in patient with moderate AD who have long-term agricultural experience before, during, and after harvesting. Therefore, we could observe patients' behavior and ANS responses that could not be understood only by comparing them before and after harvesting.

During periods II and V, an increase in HF was observed when the patient walked for a short time while basking in the sunlight filtering through the trees. Karibe *et al.* showed that the PNS values in simulated space using sunlight filtering through trees tend to be higher than those in unassimilated space [17]. Although this study involved actual sunlight filtering through trees, the PNS might be activated by a similar effect. Additionally, pupil contraction occurs when PNS activity becomes dominant over SNS activity [18]. Thus, it is possible that the difference in light intensity between sunlight filtering through trees and indoor lighting caused the patient's pupils to contract, leading to a PNS response.

Furthermore, when the patient was exposed to sunlight filtering through the trees in periods II and V, the PNS activity increased more in period V than in period II. We thought that it would take some time for the patient to feel the sunlight filtering through the trees. Additionally, the increase in the patient's PNS activity due to harvesting may have also influenced the subsequent increase in HF due to sunlight filtering through the trees.

During period III, the patient said, "I can't harvest the vegetables because I didn't grow them." A decrease in PNS activity was observed. The patient was concerned about whether it was okay to harvest something she did not grow. Therefore, we thought that this led to a decrease in HF.

During period IV, the OT asked the patient, "Could you please harvest it so we can all have it for lunch?" The patient was satisfied with the OT's explanation and began harvesting. Then, when the patient started harvesting, the HF began to increase. Social roles are linked to people's motivation. Additionally, if they are motivated, they will seek out a role. Their sense of satisfaction increases once their role is established [19]. The OT asked the patient to harvest crops as part of their social role. As a result, we thought that the patient felt relieved, and their motivation, role, and sense of satisfaction increased. Additionally, patients with AD have residual procedural learning, and it is possible that they can improve their quality of life by using retained procedural memory [20] [21]. Therefore,

even patient with moderate AD can effectively use procedural memory naturally, effortlessly, and safely. We also thought that the patient felt safe and had an increased sense of motivation, role, and satisfaction. Therefore, we considered that this may have led to an increase in HF at harvest time.

When the patient spoke to the OT, the OT responded with empathy and nodding. Ono *et al.* reported that empathetic reactions from the listener (a state of "accompanying empathy") are an important factor in reducing stress [22]. Therefore, the OT's empathetic response to the patient's speech may have led to PNS activation. These results showed that the complex elements over time before, during, and after the harvesting task in this study had a positive effect on the activation of the patient's PNS.

On the other hand, further studies with a large sample size are needed, and it is necessary to perform more detailed settings to verify whether the evaluation results are consistent.

We believe that in the future, it will be necessary to investigate not only the short-term intervention of HT with dementia patients but also the long-term effects, it will also be crucial to clarify the optimal frequency and duration of harvesting activities. It is also necessary to verify the objective and subjective effects of each HT technique, and to use HT to realize a richer life for people with dementia.

5. Conclusions

This study identified complex factors associated with changes in ANS responses before, during, and after harvesting, such as the amount of sunlight, the OT's voice to relieve the patient's anxiety, the use of procedural memory, and the empathic response of the OT. Thus, harvesting activities may have a positive effect on PNS activation.

When using harvesting activities for patients with moderate AD who have long-term agricultural experience, it is crucial to take appropriate approaches before, during, and after harvesting. Additionally, it is necessary to value the use of environmental factors.

6. Limitations

This study has some limitations. This study was conducted with consideration for the stress that the patient may experience during examination and was completed in a single verification. Additionally, the OT who participated in this study had more than 10 years of experience and was the one who normally provided occupational therapy to the patient. Thus, confirming whether the evaluation results would be consistent when OTs with different years of experience were involved was not possible. Further studies are needed to verify whether the same results can be obtained even when OTs with different years of experience provide vegetable harvesting activity to patients. Additionally, the patient had moderate AD. Thus, investigating whether the same results can be obtained even

when the severity of the patients' conditions varies is necessary. And we also need to compare the results with control groups, such as patients who are engaged in activities other than long-term agricultural experience, patients who are not engaged in activities, or settings with different environmental conditions.

Acknowledgements

The authors would like to thank the psychiatric facility, the patient, and her family for their cooperation in this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Fazio, S., Pace, D., Maslow, K., Zimmerman, S. and Kallmyer, B. (2018) Alzheimer's Association Dementia Care Practice Recommendations. *The Gerontologist*, **58**, S1-S9. https://doi.org/10.1093/geront/gnx182

[2] Welmer, A.K., Rizzuto, D., Qiu, C., Caracciolo, B. and Laukka, E.J. (2014) Walking Speed, Processing Speed, and Dementia: A Population-Based Longitudinal Study. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, **69**, 1503-1510. https://doi.org/10.1093/gerona/glu047

[3] Zhao, Y., Liu, Y. and Wang, Z. (2022) Effectiveness of Horticultural Therapy in People with Dementia: A Quantitative Systematic Review. *Journal of Clinical Nursing*, **31**, 1983-1997. https://doi.org/10.1111/jocn.15204

[4] Lu, L.C., Lan, S.H., Hsieh, Y.P., Yen, Y.Y., Chen, J.C. and Lan, S.J. (2019) Horticultural Therapy in Patients with Dementia: A Systematic Review and Meta-Analysis. *American Journal of Alzheimer's Disease & Other Dementias*, **35**, 1-11. https://doi.org/10.1177/1533317519883498

[5] Jarrott, S.E. and Gigliotti, C.M. (2010) Comparing Responses to Horticultural-Based and Traditional Activities in Dementia Care Programs. *American Journal of Alzheimer's Disease & Other Dementias*, **25**, 657-665. https://doi.org/10.1177/1533317510385810

[6] Gigliotti, C.M. and Jarrott, S.E. (2004) Harvesting Health: Effects of Three Types of Horticultural Therapy Activities for Persons with Dementia. *Dementia*, **3**, 161-180. https://doi.org/10.1177/1471301204042335

[7] Blake, M. and Mitchell, G. (2016) Horticultural Therapy in Dementia Care: A Literature Review. *Nursing Standard*, **30**, 41-47. https://doi.org/10.7748/ns.30.21.41.s44

[8] Styck, A.C. and George, D.R. (2022) Evaluating the Impact of Community Gardening on Sense of Purpose for Persons Living with Dementia: A Cluster-Randomized Pilot Study. *Journal of Alzheimer's Disease Reports*, **6**, 359-367. https://doi.org/10.3233/ADR-220018

[9] Teraoka, S. and Konishi, M. (2018) Effects of Different Horticultural Activities on the Mental Stress of Older People with Dementia in Japan. *Journal of Gerontological Nursing and Caring Research*, **8**, 34-43.

[10] Hayashi, N., Matsuura, Y., Shimizu, N., Murase, H., Murakami, K. and Ozawa, K. (2009) The Effects of Horticultural Activity for Elderly with Senile Dementia. *The*

Japanese Institute of Landscape Architecture, **5**, 178-181.

[11] Perneczky, R., Wagenpfeil, S., Komossa, K., Grimmer, T., Diehl, J. and Kurz A. (2006) Mapping Scores onto Stages: Mini-Mental State Examination and Clinical Dementia Rating. *The American Journal of Geriatric Psychiatry*, **14**, 139-144. https://doi.org/10.1097/01.JGP.0000192478.82189.a8

[12] Middleton, H.C. and Ashby, M. (1995) Clinical Recovery from Panic Disorder Is Associated with Evidence of Changes in Cardiovascular Regulation. *Acta Psychiatrica Scandinavica*, **91**, 108-113. https://doi.org/10.1111/j.1600-0447.1995.tb09749.x

[13] Kikuo, E., Seigo, K., Noriyuki, O., Nao, E. and Akihiko, K. (2023) Verification of Therapeutic Effects When an Occupational Therapist Walks with a Patient with Moderate Alzheimer's-Type Dementia: A Case Report—Validity of Clinical Observational Perspective Verified by Changes in Autonomic Nervous System Responses: A Preliminary Study. *Open Journal of Therapy and Rehabilitation*, **11**, 54-61. https://doi.org/10.4236/ojtr.2023.112005

[14] Pagani, M., Lombardi, F., Guzzetti, S., Rimoldi, O., Furlan, R., Pizzinelli, P., Sandrone, G., Malfatto, G., Dell'Orto, S. and Piccaluga, E. (1986) Power Spectral Analysis of Heart Rate and Arterial Pressure Variabilities as a Marker of Sympatho-Vagal Interaction in Man and Conscious Dog. *Circulation Research*, **59**, 178-193. https://doi.org/10.1161/01.RES.59.2.178

[15] Akselrod, S., Gordon, D., Ubel, F.A., Shannon, D.C., Berger, A.C. and Cohen, R.J. (1981) Power Spectrum Analysis of Heart Rate Fluctuation: A Quantitative Probe of Beat-to-Beat Cardiovascular Control. *Science*, **213**, 220-222. https://doi.org/10.1126/science.6166045

[16] Benson, H. and Klipper, M.Z. (2000) The Relaxation Response. Haper Collins.

[17] Karibe, Y., Urushitani, A., Ikeda, T. and Hosono, T. (2019) Effects of Indoor Greening on Physiological and Psychological Function with Simulated "Komorebi" (Sunlight through the Leaves). *Journal of Japanese Society of People-Plant Relationships*, **18**, 37-46.

[18] Loewenfeld, I.E. (1993) The Pupil: Anatomy, Physiology, and Clinical Applications. Iowa State University Press.

[19] Takehara, A. (2017) Approach to Help People with Dementia Live Go Smoothly Based on the Occupational Therapy Model. *Medical Rehabilitation*, **206**, 1-8.

[20] Kawai, H., Kawamura, M., Mochizuki, S., Yamanaka, K., Arakaki, H., Tanaka, K. and Kawachi, J. (2002) Longitudinal Study of Procedural Memory in Patients with Alzheimer-Type Dementia. *Brain and Nerve*, **54**, 307-311.

[21] De Wit, L., Marsiske, M., O'Shea, D., Kessels, R.P.C., Kurasz, A.M., DeFeis, B., Schaefer, N. and Smith, G.E. (2021) Procedural Learning in Individuals with Amnestic Mild Cognitive Impairment and Alzheimer's Dementia: A Systematic Review and Meta-Analysis. *Neuropsycholgy Review*, **31**, 103-114. https://doi.org/10.1007/s11065-020-09449-1

[22] Ono, M., Fujita, M. and Yamada, S. (2009) Physiological and Psychological Responses to Expressions of Emotion and Empathy in Post-Stress Communication. *Journal of Physiological Anthropology*, **28**, 29-35. https://doi.org/10.2114/jpa2.28.29