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An analysis of Psychophysiological Responses in the Prefrontal Cortex Depending on the Use of Universal Tools and Traditional Methods During Agricultural Activities by Individuals With Physical Disabilities Using Mobility Aids

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ABSTRACT

Background and objective: Physical disabilities are significant and permanent limitations in physical capabilities, which make routine tasks and participation in various activities increasingly difficult. This study aimed to investigate the effect of different agricultural activities on prefrontal cortex (PFC) activation in individuals with physical disabilities (IWPDs) using mobility aids, by comparing activities with and without the use of universal tools.
Methods: The study involved 26 participants aged between the age of 20 and 65 years, with physical disabilities and utilizing mobility aids. It was conducted at a laboratory within the campus of Konkuk University. Participants engaged in six different agricultural activities: soaking (with/without universal tool), sowing (with/without universal tool), and planting (with/without universal tool), performed in a random order for 180 seconds each. Functional Near-Infrared Spectroscopy (fNIRS) was used to measure changes in oxyhemoglobin (oxy-HB) concentration in the PFC during each activity.
Results: The results indicated that oxy-HB concentration in the overall PFC was significantly lower during planting performed without the use of universal tools ($p < .001$). During the soaking activity, the use of a universal soaking tool led to lower oxy-HB concentration across the entire PFC ($p < .05$). During sowing activity performed without universal tools, a lower oxy-HB concentration was observed across the entire PFC ($p < .01$). Similarly, during planting activity performed without universal tools, a lower concentration of oxy-HB was observed across the entire PFC ($p < .01$).
Conclusion: Overall, engaging in planting without the use of universal tools and utilizing a universal soaking tool can lead to stability through a decrease in oxy-HB concentration. The study concluded that the use of universal tools in agricultural activities affects PFC activation in IWPDs using mobility aids. Specifically, planting without universal tools and soaking with a universal tool led to significantly lower oxy-HB concentrations, indicating potential stability and reduced cognitive load.

Keywords: individuals with physical disabilities (IWPDs), oxyhemoglobin, prefrontal cortex (PFC) activation, universal tool, vocational rehabilitation

Introduction

The term “physical disability” is defined as a significant and permanent limitation in an individual’s ability to move, perform physical tasks, remain active, or be agile (Mann and Lance, 1995). This implies that activities such as lifting or dressing, which would otherwise be performed with ease, become more challenging and time-consuming (Clute,

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2013; Smith and Mitchell, 2017). Individuals with physical disabilities (IWPDs) may encounter challenges in accessing environments that require the use of their bodies (Young and Edwards, 2015), safely using equipment and facilities, participating in learning tasks and assessments, and performing practical activities (Ascondo et al., 2023). It has been repeatedly reported that IWPDs experience high levels of social exclusion, which presents a considerable barrier to their participation in education and social activities. This suggests that they are exposed to stereotypes, social stigma, and prejudices that are perpetuated by society (Anaunt Bravo et al., 2017). This situation creates economic and educational barriers for IWPDs, which impede their general well-being and equal opportunities (Cabra, 2017). Furthermore, social barriers resulting from indifference or negative attitudes toward them play an important role in their self-perception and motivation in professional, social, and cultural spaces (Tomczyszyn et al., 2022).

IWPDs are more likely to experience chronic diseases or disabilities with age (Jepsson Grassman and Whitaker, 2013; Giesbrecht et al., 2015), which consequently leads to an increase in their use of mobility aids. The use of mobility aids may be either transient or sustained. Reduced mobility is closely associated with decreased social engagement and leisure activities, social isolation, diminished well-being, and unfavorable health outcomes (Ormerod et al., 2015; Musselwhite, 2018). Research suggests that the use of mobility aids increases function and participation in activities (May and Rugg, 2010), which in turn leads to new activities (Pettersson et al., 2006) and ultimately greater life satisfaction (Sutherland and Braun, 2020).

Recently, as the national interest in stress, depression, and lifestyle management has expanded to rural settings and environmentally friendly farming activities, there has been a growing interest in care farming, also known as social farming or farming for health, which focuses on the therapeutic use of agricultural practices (RDA, 2022). Care farming offers social, economic, public health promotion and environmental benefits, and public interest and participation in care farming is growing rapidly every year. These activities include urban farming for leisure or educational purposes (Jang et al., 2010). Care farming activities are divided into three levels of exercise intensity, which can be adjusted to suit individual participants (Park et al., 2015). Additionally, various occupational potentials can be developed within the activities on the basis of work elements (Tandler and Gollner, 2018). A comparative study of greenhouse gardening by individuals with disabilities (IWDs) found that common gardening activities require awkward postures and repetitive tasks that can cause serious damage to joints and muscles, such as the back, shoulders and knees, both in people with and without disabilities (Park and Kim, 2013). However, training in greenhouse gardening reduced stress and improved the ability to work (Norris and Rimmer, 2013). The importance of physical activity in promoting social inclusion and self-esteem for IWPDs has been highlighted (Hardee and Fetters, 2017; Zahra et al., 2022), and the development of smart farming technology presents new opportunities for vocational rehabilitation and social inclusion by facilitating their participation in farming. Domestic and international research has consistently shown that farming for health has a positive effect on the physical and mental health of the chronically ill, as well as individuals with and without disabilities (Kim et al., 2020; RDA, 2020). While these activities have positive physical effects on their health and farming skills, they also have positive psychological effects on their self-esteem and confidence, quality of life, emotional stability, interpersonal relationships, and trust in others (Hine et al., 2008). However, there is a lack of research on the analysis of therapeutic mechanisms underlying care farming activities, which are the core of farming for health for IWPDs using mobility aids. Although there have been previous studies that measured electroencephalogram changes in the cerebral cortex during farming activities using agricultural machinery (Hwang and Nam, 2023), research on farming activities using conventional methods and assistive tools is insufficient in terms of the need for research on assistive tools to help IWPDs work and increase efficiency (NIHH, 2018).

Therefore, in this study, a total of six care farming activities were performed, including three activities using conventional methods (soaking, sowing, and planting) and three activities using universal tools (e.g., hydroponic sponge soaking tool, seeder, and transplanter) manufactured by companies P and D. To investigate the psychophysiological responses to the use of these tools, functional near-infrared spectroscopy (fNIRS) was used to analyze the differences in oxyhemoglobin (oxy-HB) concentration based on hemoglobin measurements in the prefrontal cortex during care farming activities.

Research Methods

Participants

Participants in this study were IWPDs aged 20 or more to less than 65 years who used mobility aids (wheelchairs, canes, and crutches). Welfare groups for the disabled in Seoul were sent the study's recruitment notice, which included the study's content. With their cooperation, participants were recruited from March 6 to 27, 2023. Individuals whose dominant hand was the right hand (Tarkka and Hallett, 1990) and who had no allergies to plants were selected as participants. Individuals who currently had certain diseases (Choi et al., 2016) or sensory problems were excluded from the selection. In addition, participants were asked to fast for 3 hours before the experiment to minimize the effects of caffeine (Heckman et al., 2010). The purpose and procedures of the study were explained to adults who were interested in participating in the study, and those who volunteered and provided written consent to participate in the study were selected. This study was approved by the Institution Review Board of Konkuk University (7001355-202303-HR-640).

Experimental Environment

This experiment was conducted in a laboratory on the campus of the Konkuk University. The laboratory space was set at 2.0 x 2.0 m according to the workspace standards of the International Facility Management Association (IFMA) in the United States, and the indoor environment was maintained at a temperature of 23–26 ○C, a relative humidity of 30 ± 10% (O-257; DRETEC Co. Ltd, Saitama, Japan) and an illuminance of 700 lx or less (ST-126; SINCON, Bucheon, Korea) according to the recommendations of the American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE, 2009). Ivory blackout curtains were installed to block out visual elements inside and create an enclosed workspace. Participants who used wheelchairs performed the activities while seated in their own wheelchairs, and those who used crutches or canes were provided with chairs with an adjustable backrest so that they could lean back comfortably by adjusting the angle of recline.

Experimental protocol

Prior to the experiment, participants sat comfortably in a chair for 5 minutes to measure their stability status. They then performed six care-farming activities in a random order, including soaking, sowing, and planting (each using both conventional methods and universal tools) for 3 minutes (Fig. 1).

Agricultural Activity classification

There were six different activities of care farming performed by IWPDs using mobility aids; three activities (soaking, sowing, and planting) performed using conventional methods, and the same three activities performed using universal tools. The six activities and their detailed procedures are shown in Table 1. Universal tools are designed to help IWPDs perform these activities more efficiently and

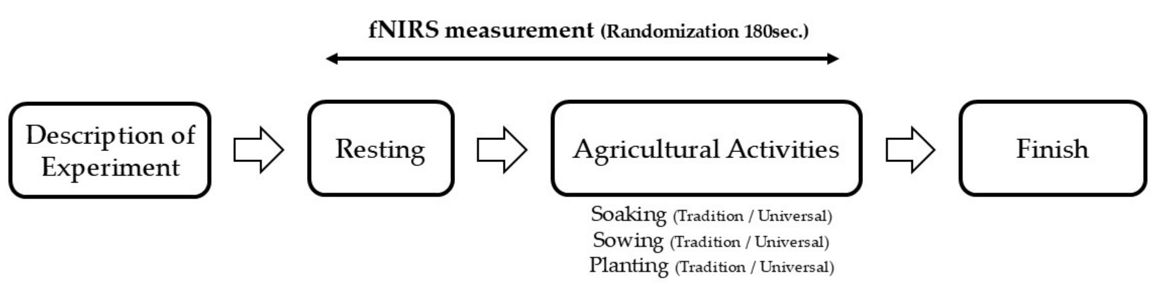


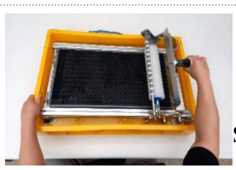
Fig. 1. Experiment procedure.

safely, with several advantages in terms of work efficiency. The hydroponic sponge soaking tool is designed in the form of a roller handle, allowing users to easily wet a hydroponic sponge with less effort. This reduces hand fatigue and makes the water absorption process more consistent compared to conventional methods. The seeder is designed to place seeds more accurately and efficiently using a seed tray and button system. This reduces the process of placing seeds one at a time, shortening labor time and minimizing seed loss. The transplanter consists of a seed drill and a spacing tool that helps plant seedlings at the correct depth and spacing. This increases the accuracy of the seedling planting process, improves the survival rate and reduces worker fatigue.

Measurements

For fNIRS in this study, a brain imaging system, NIRSIT Lite (OBELAB Inc., Seoul, Republic of Korea), was used, which allowed us to monitor brain activity, including in the anterior prefrontal cortex (aPFC; CH 2–14), the dorsal prefrontal cortex (dPFC; CH 1), and the orbital part of the inferior frontal gyrus (IFG; CH 15), which fall under Brodmann's areas. Participants' oxy-HB concentrations in the entire, left, and right prefrontal cortex (PFC) were measured for 3 mi-

Table 1. Agricultural activities classification and detailed procedure

	Agricultural activity		Detailed procedure
W/O[x]		Soaking	1. Forward your arms over the hydroponic seeding sponge. 2. Press the hydroponic seeding sponge with your hand to absorb water. 3. Move your hands to the side and press the sponge. 4. Repeat steps 2 and 3 for 3 minutes.
		Sowing	1. Lift the bowl containing the Lettuce seeds with your left hand. 2. Pick up the one Lettuce seed with your right hand. 3. Insert one lettuce seed into the hole of the hydroponic seeding sponge. 4. Repeat steps 2 and 3 for 3 minutes
		Planting	1. Hold the trowel with your right hand. 2. Dig 5 holes for seedling cores. 3. Plant the Lettuce seedlings. 4. Repeat steps 2 and 3 for 3 minutes
W[Y]		Soaking	1. Hold the square tray with your left hand. 2. Hold the handle of the sponge dampening tool with your right hand. 3. Press the roller handle and slide it to the left, dampening the sponge. 4. Raise the roller handle and pull it to the right 5. Repeat steps 3 and 4 for 3 minutes.
		Sowing	1. Hold the bowl containing the Lettuce seeds with your right hand. 2. Take a spoonful of seeds and put them into the top of seed storage box. 3. Hold the seed storage box with both hands and shake it left and right to place the seeds in the holes of the storage box. 4. Press the botton located on left side with your left hand. 5. Repeat steps 2 to 4 for 3 minutes.
		Planting	1. Pick up the spacing adjustment tool and place it on the tray. 2. Hold the rotary drill tool with right hand. 3. Dig a hole with a rotary drill tool. 4. Remove the spacing adjustment tool. 5. Plant lettuce seedlings. 6. Repeat steps 1 to 5 for 3 minutes.

[x]W/O means working in a conventional way without using universal tools
[Y]W means working with universal tools

nutes while performing six care-farming activities. fNIRS is a technique that uses near-infrared light to non-invasively measure changes in blood flow in the brain. It emits near-infrared light in the range of 700–1000 nm into the cerebral cortex, and detects oxy-HB and deoxyhemoglobin (deoxy-HB) in the cerebral blood flow of the cerebral cortex to measure blood oxygen concentration (Fox, 2007). This technique is much simpler and less burdensome than real-time brain measurement methods such as functional magnetic resonance imaging (fMRI) or EEG, and is only minimally affected by movement, environment or space limitations. Since it is also easy to measure brain activity in real time at relatively fast measurement speeds (Ferrari and Quaresima, 2012), we used fNIRS to collect baseline data on participants' oxy-HB concentrations in the PFC and analyzed changes in oxy-HB concentrations among hemoglobin measurements in the PFC to determine differences in psychophysiological responses with the performance of care-farming activities.

Data analysis

The analysis procedure using fNIRS to identify brain activity characteristics that occur during six activities is as follows. To process the experimental results, a low-pass filter (LPF) of discrete cosine transform (DCT) 0.1 and a high-pass filter (HPF) of DCT 0.0005 were applied to the raw data. The signal-to-noise ratio (SNR) of 10–15 seconds of data was then estimated, and channels with values lower than 30 dB were excluded from the analysis. Then, the oxy-HB concentration was calculated using the Beer-Lambert law (MBLL) calculation method. In measuring CBF, the baseline change in hemoglobin is greater than the change in deoxy-HB. Considering this, the change in oxy-HB was used for analysis in this study (Hoshi et al. 2001; Strangman et al. 2002). The baseline was based on previous studies using fNIRS and EEG, with the average of three minutes before the commencement of the task employed as the baseline. The task time was set to the average of three minutes for analysis. A one-way ANOVA was then performed to test the difference between the six activities, and Duncan's multiple rank test was performed as a post-hoc test for the rank test between the activities. A paired t-test was performed to confirm the difference in oxy-HB concentration between the activities using the conventional method and universal tools. The statistical significance level of all analyses was set at 0.05 to test the differences between the six activities. The statistical software program used was SPSS 26.0 (IBM SPSS Statistics 26.0; IBM Inc., NY, USA).

Results and Discussions

Demographic information

This study was conducted on 26 individuals with physical disabilities who use mobility aids, consisting of 6 males (23%) and 20 females (76.9%; Table 2).

Physiological Responses – fNIRS

Comparing the oxy-HB concentration in the entire PFC during the activities of soaking, sowing and planting (using conventional methods and universal tools, respectively), it was found that oxy-HB concentration was lowest when plant-

Table 2. General characteristics of participants

Variance	Male (n = 6)	Female (n = 20)	Total (N = 26)
	Mean ± SD		
Age	58.28 ± 3.4	60.52 ± 4.58	60 ± 4.38
Height (cm) [1]	161.9 ± 5.83	149.38 ± 13.68	152.31 ± 13.35
Weight (kg) [2]	55.14 ± 5.64	53.8 ± 10.44	54.11 ± 9.46
BMI (kg/m^2) [3]	20.96 ± 0.83	24.25 ± 4.26	23.48 ± 3.99 [4]

[1]Height was measured using an anthropometer without shoes. (Ok7979; Samhwa, Seoul, South Korea).
[2]Weight was measured using a body fat analyzer (ioi 353; Jawon Medical, South Korea).
[3]Body mass index was calculated using the formula, [weight (kg)] / [height (cm)]. [4] Falls within the normal range proposed by the World Health Organization.

ing was performed using conventional methods and highest when sowing was performed using seeders (universal tool) ($p < .001$). Comparing the oxy-HB concentration in the right PFC, it was lowest when planting was performed using conventional methods and highest when sowing was performed using seeders ($p < .01$). Comparing the oxy-HB concentration in the left PFC, it was lowest when planting was done with conventional methods and highest when sowing was done with seeders ($p < .01$; Table 3).

Comparing soaking activities performed with conventional methods and universal tools, oxy-HB concentration was found to be significantly lower in the entire PFC when hydroponic sponge soaking tools were used ($p < .05$). When soaking tools were used, oxy-HB concentration was lower in the left PFC, but the difference was not significant ($p > .05$). When soaking tools were used, the oxy-HB concentration in the right PFC was significantly lower ($p < .05$).

Comparing sowing activities performed with conventional methods and universal tools, the oxy-HB concentration was significantly lower in the entire PFC when sowing was performed with conventional methods ($p < .01$). The oxy-HB concentration was significantly lower in the left PRC when sowing was performed with conventional methods ($p < .05$). The oxy-HB concentration was lower in the right PFC when sowing was performed using conventional methods, but the difference was not significant ($p > .05$).

Comparing planting activities performed using conventional methods and universal tools, the oxy-HB concentration was significantly lower in the entire PFC when planting was performed with conventional methods ($p < .01$). The oxy-HB concentration was significantly lower in the left PFC when planting was performed using conventional methods ($p < .01$). The oxy-HB concentration was lower in the right PFC when planting was performed using conventional methods, but the difference was not significant ($p > .05$; Table 4).

This study analyzed oxy-HB concentrations in the PFC to evaluate the psychophysiological effects of six activities of care farming (soaking, seeding, and planting using conventional methods, and the same activities using universal tools) on IWPDs aged 20 or more to less than 65 years who use mobility aids.

The PFC is functionally divided according to the characteristics of the information processing performed. Of the Brodmann's areas (BA) of the cerebral cortex, BA10 and BA46 mainly control executive functions, cognition, working memory, planning and reasoning, while BA47 mainly controls communication, social interaction, emotional regulation and emotional recognition (Petrides, 1996). In general, the left hemisphere controls the right side of the body, language, categorization, and typical behavior, while the right hemisphere specializes in emergency response, spatial organization, face recognition, and emotional processing

Table 3. Comparison of oxyhemoglobin concentrations in prefrontal cortex by agricultural activities

Agricultural activities	Universal tool	Entire PFC [V]	Left PFC [W]	Right PFC [X]
		Mean ± SD (mM)		
Soaking	W/O [Y]	$(-0.28 \pm 2.38) \times 10^{-4}$ cd	$(-0.28 \pm 2.5) \times 10^{-4}$ bc	$(0.26 \pm 2.03) \times 10^{-4}$ cd
	W. [Z]	$(-2.6 \pm 2.92) \times 10^{-4}$ b	$(-2.08 \pm 2.38) \times 10^{-4}$ bc	$(-2.96 \pm 3.68) \times 10^{-4}$ ab
Sowing	W/O [Y]	$(-1.8 \pm 2.55) \times 10^{-4}$ bc	$(-2.98 \pm 2.57) \times 10^{-4}$ ab	$(-0.49 \pm 2.21) \times 10^{-4}$ bc
	W. [Z]	$(1.11 \pm 2.3) \times 10^{-4}$ d	$(0.55 \pm 2.9) \times 10^{-4}$ c	$(1.63 \pm 1.81) \times 10^{-4}$ d
Planting	W/O [Y]	$(-4.97 \pm 2.31) \times 10^{-4}$ a	$(-5.18 \pm 3.03) \times 10^{-4}$ a	$(-4.22 \pm 3.17) \times 10^{-4}$ a
	W. [Z]	$(-1.74 \pm 3.15) \times 10^{-4}$ bc	$(-1.4 \pm 1.79) \times 10^{-4}$ bc	$(-1.76 \pm 2.88) \times 10^{-4}$ abc
F		8.396	3.973	5.057
p- value		0.000***	0.003**	0.001**

, * significant at $p < .01$, and .001, respectively, by one-way analysis of variance. The statistical method used Duncan's post hoc analysis (a > b > c > d). The lowercase letters indicate the group to which the activities belong when performing analysis using Duncan. [V] Entire PFC refers to CH1-15 on NIRSIT LITE. [W] Left PFC refers to CH 8-15 on NIRSIT LITE. [X] Right PFC refers to CH 1-7 on NIRSIT LITE. [Y] W/O means working in a conventional way without using universal tools. [Z] W. means working with universal tools.

Table 4. Comparison of oxyhemoglobin concentrations in the prefrontal cortex during activities performed with and without universal tools

Agricultural Activities	Universal tool	Entire PFC [V]	Left PFC [W]	Right PFC [X]
		Mean ± SD (mM)		
Soaking	W/O [Y]	$(-0.28 \pm 2.38) \times 10^{-4}$	$(-0.28 \pm 2.5) \times 10^{-4}$	$(0.26 \pm 2.03) \times 10^{-4}$
	W. [Z]	$(-2.6 \pm 2.92) \times 10^{-4}$	$(-2.08 \pm 2.38) \times 10^{-4}$	$(1.63 \pm 1.81) \times 10^{-4}$
	t	2.984	1.516	2.89
	p-value	0.01*	0.18 NS	0.028*
Sowing	W/O [Y]	$(-1.8 \pm 2.55) \times 10^{-4}$	$(-2.98 \pm 2.57) \times 10^{-4}$	$(-0.49 \pm 2.21) \times 10^{-4}$
	W. [Z]	$(1.11 \pm 2.3) \times 10^{-4}$	$(0.55 \pm 2.9) \times 10^{-4}$	$(1.63 \pm 1.81) \times 10^{-4}$
	t	-4.484	-3.539	-2.228
	p-value	0.001**	0.012*	0.067 NS
Planting	W/O [Y]	$(-4.97 \pm 3.09) \times 10^{-4}$	$(-5.18 \pm 3.03) \times 10^{-4}$	$(-4.22 \pm 3.17) \times 10^{-4}$
	W. [Z]	$(-1.74 \pm 2.31) \times 10^{-4}$	$(-1.4 \pm 1.79) \times 10^{-4}$	$(-1.76 \pm 2.88) \times 10^{-4}$
	t	-3.681	-4.454	-1.439
	p-value	0.002**	0.004**	0.2 NS

NS, *, ** nonsignificant or significant at P<0.05, and 0.01, respectively, by Paired t-test. [V] Entire PFC refers to CH1-15 on NIRSIT LITE, [W] Left PFC refers to CH 8-15 on NIRSIT LITE. [X] Right PFC refers to CH 1-7 on NIRSIT LITE. [Y] W/O means working in a conventional way without using universal tools. [Z] W. means working with universal tools.

(MacNeilage et al., 2009). Studies using positron emission tomography (PET) have reported that activation of the cerebral cortex occurs with increasing task level (Larson et al., 1995). The frontal lobe receives information and processes it through connections with other brain regions, and is responsible for response execution, memory retrieval, and emotional evaluation, etc. (Miller and Cohen, 2001).

The results of this study showed that the oxy-HB concentration in the entire PFC was lowest during planting using conventional methods but highest during sowing with seeders (p<0.001). A similar trend was observed in the right and left PFC. The oxy-HB concentration was lowest during planting using conventional methods but highest during sowing with seeders ($p < .01$).

Comparing soaking activities performed using hydroponic sponge soaking tools (universal tool) and using conventional methods, oxy-HB concentration was significantly lower in the entire and right PFC when soaking tools were used ($p < 05$). The tools can be used by simply moving the handle left and right, which seems to have decreased cerebral blood flow and thus lowered oxy-HB concentration (Esposito et al., 1996; Saito and Watanabe, 2016). Meanwhile, pushing a sponge by hand using conventional methods resulted in higher oxy-HB concentrations due to the increased motor activity, suggesting that the PFC was activated by the cognitive demands of the motor task (Suzuki et al., 2004).

Comparing sowing activities performed using seeders (universal tool) and using conventional methods, the oxy-HB concentration was lower in the entire PFC when conventional methods were used ($p < .01$). It was lower in the left PFC when conventional methods were used ($p < .05$); it was higher when seeders were used, which involved transferring seeds to the seeders' storage box with a spoon and placing them on the sponge by pressing the left button. This is consistent with research showing that brain activity, such as working memory, directly affects the increase in oxy-HB concentration (Patel and Rodriquez, 2021). It appears that the use of unfamiliar tools and complex task processes increased the activity of the PFC (Techayusukcharoen, 2019).

Comparing planting activities performed using planters (universal tool) with those performed using conventional methods, oxy-HB concentrations were lower in the entire and left PFC when conventional methods were used ($p < .01$). Of the six activities, oxy-HB concentrations were lowest when planting was done using conventional methods, which involved holding lettuce by hand, making holes with a trowel or by hand, and then planting. This is in line with research that indicates having plants indoors stimulates the autonomic nervous system and provides psychophysiological stability, that soil-mixing activities stabilize the autonomic nervous system, and that people's unconscious calming responses are triggered when they touch plant foliage (Koga and Iwasaki, 2013; Choi et al., 2016; Kim et al., 2022). Moreover, in the emotional rating according to the presence of plants, the Total Mood Disturbance (TMD) score on the Profile of Mood States (POMS) significantly decreased, and the score on the calming and stabilizing items of the Semantic Differential Method (SDM) significantly increased (Park et al., 2016). This supports the findings of various previous studies that plants, nature, and substances derived from nature provide stability to humans. Therefore, the oxy-HB concentration during planting activities is lower than during other activities due to the tactile, visual, and olfactory stimulation provided by plants, indicating that the PFC is stabilized.

Limitations

In this study, we focused on analyzing brain activity in the PFC based on activities, but future studies need to measure and analyze different parts of the brain. Notably, an experimental design that considers the effects of the details and difficulty of each activity on the PFC as well as other parts of the brain is required, which will allow for more advanced research results. Furthermore, by analyzing the differences in responses by age and gender, and by expanding the scope of the study to compare groups with and without agricultural experience, we will be able to more comprehensively understand the effects of care farming activities on brain function.

Conclusion

This study analyzed the oxy-HB concentration in the PFC of the brain to evaluate the psychophysiological response to care farming activities for IWPDs using mobility aids. Our findings showed that the oxy-HB concentration in the PFC during the activities differed depending on the type of activity. Planting activities using conventional methods resulted in the lowest oxy-HB concentration in the PFC, suggesting that the tactile, visual, and olfactory stimulation provided by plants contributes to mental stability. The highest oxy-HB concentration was observed when seeders (universal tool) were used, indicating that the complex task process stimulated PFC activity. For soaking and planting activities, oxy-HB concentrations differed depending on whether universal tools were used, suggesting that tool use may alter the cognitive demands of the tasks. This study contributes to the understanding of brain functional effects of care farming activities by measuring changes in the PFC, and suggests the potential of application in programs for emotional stability and in terms of vocational rehabilitation. Future research should conduct more comprehensive analyses that take into account the complexity of different brain regions and activities, as well as participants' prior gardening experience. Such research could evaluate the effectiveness of care farming under different conditions, and contribute to the development of tailored programs.

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