International Journal of Enhanced Research in Educational Development (IJERED) ISSN: 2320-8708, Vol. 11 Issue 1, Jan-Feb, 2023, Impact Factor: 7.326

The Efficiency of Horticulture Therapy with Flowers

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INTRODUCTION

In the movie *Mulan* it was said, "The flowers that blooms in adversity is the most rare and beautiful of all" (Cook & Bancroft, 1998). Horticulture, the cultivation of a garden, and horticulture therapy are methods of stress reduction. Stress has become a prevalent issue worldwide in the past few years with about 33% of the world experiencing extreme stress (Patterson et al., 2022). In the scientific community, there is a limited amount of data involving the influence of flowers in horticulture on stress relief.

This study assesses the difference in stress response of horticulture involving plants with and without flowers. Researchers have studied whether horticulture therapy improves human well-being: Is there a relationship between stress and the presence of flowers?

When someone perceives a threat, the stress response activates. However, over-exposure to stress is very harmful to one's health. The Mayo Clinic (2019) asserts that chronic stress puts people at risk for anxiety, depression, headaches, digestive issues, sleep problems, heart disease, memory impairment, and weight gain. Thus, it is important to regulate stress levels. Stress invokes the release of cortisol, elevates blood pressure, and raises heart rate (Mayo Clinic, 2019). Heart Rate Variability (HRV) is also associated with the stress response, and it measures the fluctuations in heartbeat interval times. The Yeungnam University, Daegu, Republic of Korea conducted a study about the validity of the stress and HRV connection. The study examined 37 publications on HRV and stress to conclude that stress impacts HRV (Kim et al., 2018). Therefore, HRV can objectively assess psychological health and stress. A more variable heart rate indicates higher levels of stress while a more stable heart rate suggests low levels of stress. Professionals utilize horticultural therapy to relieve stress and improve patient health. The benefits of interaction with plants on stress are a promising field of study because of the current and potential research. One study in the Journal of Physiological Anthropology (2015) compared the effects of transplanting plants with performing computer tasks through HRV measurement and a psychological assessment of 24 test subjects. The experiment, led by Min-sun Lee, concluded that indoor plants are beneficial in reducing stress compared with computer work. Moreover, a different study by Jane DyrhaugeThomsen (2011) concluded that plants in workplaces reduce discomfort and boost mood after analyzing 24 employees' questionnaires. This study's experiment evaluated the nuances of horticulture, the cultivation of gardening, for stress relief. There is a lack of information in the scientific community regarding the differences in types of plants for stress relief. Consequently, this study aims to provide preliminary data on the differences in stress response to flowering and non-flowering plants in horticulture. Six test subjects practised horticulture on plants with flowers and the same type of plants but with the flowers removed. Eight Catharanthus roseus plants were used for this experiment. The subject's stress response was measured through HRV, heart rate, and blood pressure along with a survey after each interaction with plants.

METHODS

Before the subjects interacted with any plants their heart rate, HRV, and blood pressure were recorded while they were in a seated position. The test subjects were four females and two males at the age of 30.16, mean. Each subject participated in the study over two days. The subjects were randomly divided so that some interacted with flowers on the first day of testing and no flowers on the second day, while the other subjects interacted in the opposite order. Each day of testing had similar weather conditions (sunny and temperatures in the mid-eighties), and the experiment was conducted at the same time of day. The subjects spent five minutes interacting with the four plants with flowers or the four plants without flowers. The 5 plants were 11 cm to 20 cm in height and 9 cm to 14 cm in width. There were six blooms among the four flowering plants.

Figure 1: ***Experimental Setup***

Note: This was the experimental set-up and materials for the flowering plant trial. The subjects were presented with a shovel, soil, rocks, the plants in a larger pot, and four smaller pots. The subjects were instructed beforehand on how to transplant and water the plants; each subject moved the four plants from one larger pot into four smaller pots and then watered them. The tasks of transplanting and watering were chosen because they are representative of common horticulture. Additionally, these actions were also used by Min-sun Lee, Juyoung Lee, Bum-Jin Park, and Yoshifumi Miyazaki in their study of interactions with indoor plants on stress reduction (2015).

The subjects were aware that they would only be transplanting and watering for five minutes, but they were instructed to take a leisurely pace. The timer was not visible to test 6 subjects and there were no auditory alarms to signal the completion of five minutes. Five minutes was adequate time for subjects to transplant and water four plants and for this activity to affect vital signs. Some previous studies have tracked HRV and heart rate in response to plants over incremental check-ins throughout the day, 15-minute intervals, or even three-minute intervals (Toyoda et al., 2019; Lee et al., 2015; Ikei et al., 2014). Blood pressure and heart rate were measured with an Omron automatic blood pressure machine while HRV was measured with the app Welltory. Welltory uses photoplethysmography with the phone flashlight and camera to analyze the fluctuations in heart rate intervals. In fact, Welltory conducted a study on the accuracy of the app compared to the Polar chest strap; it found that the deviation range did not exceed about 5–8ms. The overall deviations did not exceed one per cent (Welltory, 2017). Welltory measures heart rate in lnRMSSD; so, the higher the lnRMSSD, the healthier the HRV (see Table 1).

All subjects interacted with both the flowering and non-flowering plant groups and wore gloves. After each interaction, they completed a questionnaire rating their comfort, relaxation, and positivity. The questionnaire assessed perceived stress and consisted of a seven-point scale for each category: comfort, relaxation, and positivity. The outline questionnaire for the experiment was reproduced from the Min-sun Lee study (2015) about plant interaction and computer activity on psychological and physiological stress; it used the semantic differential method of psychological evaluation.

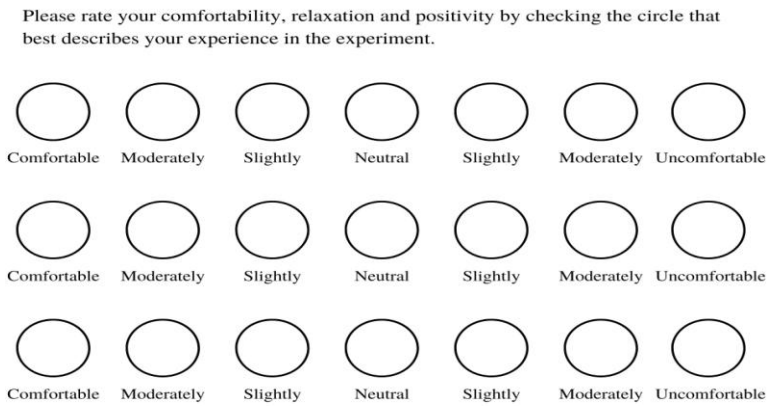


Figure 2: Self-Survey Form

Note: This is the survey that each subject completed after interaction with a group of plants. The subjects marked one circle in each row. For the interpretation of data, the survey was adapted into numerical quantities with neutral representing 'zero,' the far-left column representing 'three' for the emotion, and the far right column representing 'negative three' for the emotion.

RESULTS

The differences in readings before and after horticulture were calculated from a baseline for each measurement. The baseline was the average of two measurements taken before any plant interaction that day. The two values were similar and provided a more holistic view of how horticulture affected vital signs.

Table 1: HRV Change After Interaction with Flowers and No Flowers

Effect of Horticulture with Flowers on Heart Rate Variability	
Subject	Difference (lnRMSSD)
1	55.5
2	12.5
3	37
4	68.5
5	29
6	-7
Mean (SD)	32.58 (27.63)

Effect of Horticulture without Flowers on Heart Rate Variability	
Subject	Difference (lnRMSSD)
1	43.5
2	12.5
3	-32
4	10.5
5	-29
6	16
Mean (SD)	3.583 (28.99)

Note: The HRV units were lnRMSSD, the natural log of the root mean square of successive RR interval differences. RR intervals are the time in milliseconds between successive R-waves, the highest 'spike' in an electrocardiogram (EKG) reading. If there are very few variations between heart-beat interval times, then the mean of differences will be small, and the natural log of the root mean square of successive RR interval differences (lnRMSSD) will be a high value. Higher lnRMSSD indicates more stability and therefore, less stress. In this table, a high, positive difference of lnRMSSD from before to after horticulture indicates that the subject's stress level decreased because their HRV became more stable. The differences in the charts are obtained from the baseline value. Also, the standard deviation is represented as 'mean (SD).'

The changes in HRV by each subject show there was a greater increase in stability after interaction with flowering plants than with plants with the flowers removed. A higher ln RMSSDHRV score indicates a healthier autonomic

nervous system (EliteHRV, 2020). The same trend of more stable vital signs with flower horticulture applies to heart rate.

Table 2: Heart Rate Change After Interaction with Flowers and No Flowers

Effect of Horticulture with Flowers on Heart Rate	
Subject	Difference (bpm)
1	-4
2	2.5
3	-3.5
4	6
5	-5.5
6	-4
Mean (SD)	-1.42 (4.58)

Effect of Horticulture without Flowers on Heart Rate	
Subject	Difference (bpm)
1	-4
2	6.5
3	3.5
4	3
5	2.5
6	4
Mean (SD)	2.58 (3.51)

Note: Heart rate was measured in beats per minute (bpm) and these measurements were calculated from each subject's baseline value. The subjects' heart rate was measured separately from HRV, and the subjects' interactions with flowers produced a greater decrease in heart rate than interactions with no flowers. The average change in heart rate after interacting with flowers was about a 1.41 bpm decrease compared to the baseline. Yet, the average change in heart rate after interacting with no flowers was about a 2.58 bpm increase.

Table 3: Blood Pressure Changes After Horticulture with and without Flowers

Effect of Horticulture with Flowers on Diastolic Blood Pressure	
Subject	Difference (mmHg)
1	5
2	-4.5
3	2
4	-1.5
5	8
6	-3.5
Mean (SD)	0.92 (4.95)

Effect of Horticulture without Flowers on Diastolic Blood Pressure	
Subject	Difference (mmHg)
1	4
2	-2.5
3	3
4	2.5
5	4
6	-4.5
Mean (SD)	1.08 (3.65)

Note: Blood pressure was measured in millimetres of mercury (mmHg) and this data was calculated from baseline values.

There were no consistent trends in data for blood pressure when the two groups of plant interactions were compared. The average change in diastolic blood pressure from the baseline compared to after flower interaction was a 0.92 mmHg increase. On the contrary, there was an average increase of 1.08 mmHg in diastolic blood pressure from the

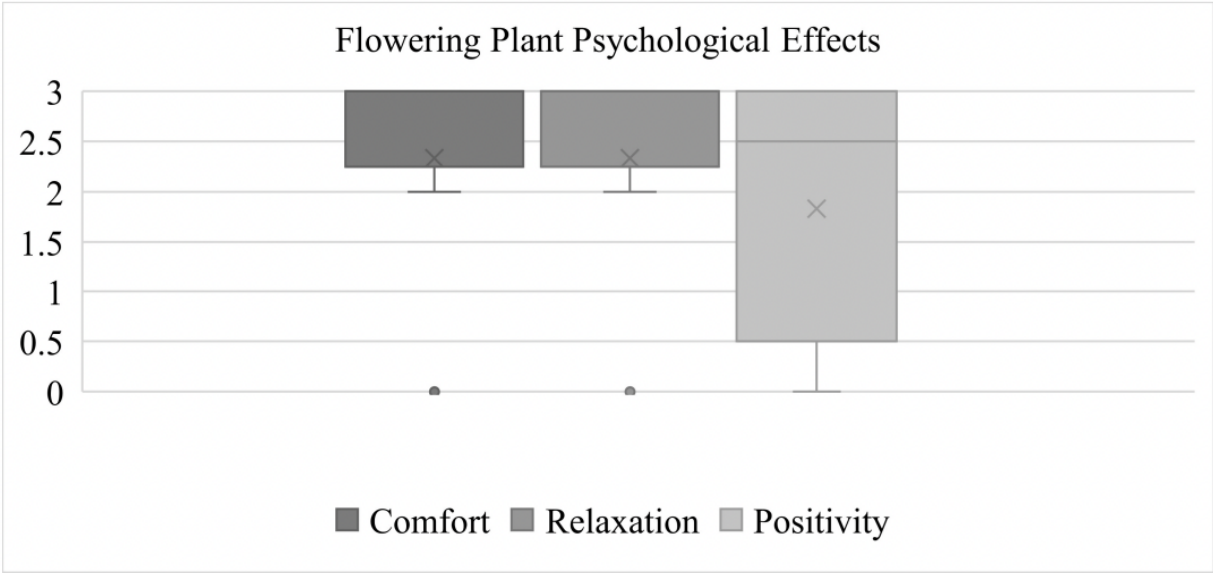
baseline to non-flower interaction. An increase in the number of subjects could help to clarify differences in flowering horticulture and non-flowering horticulture on blood pressure.

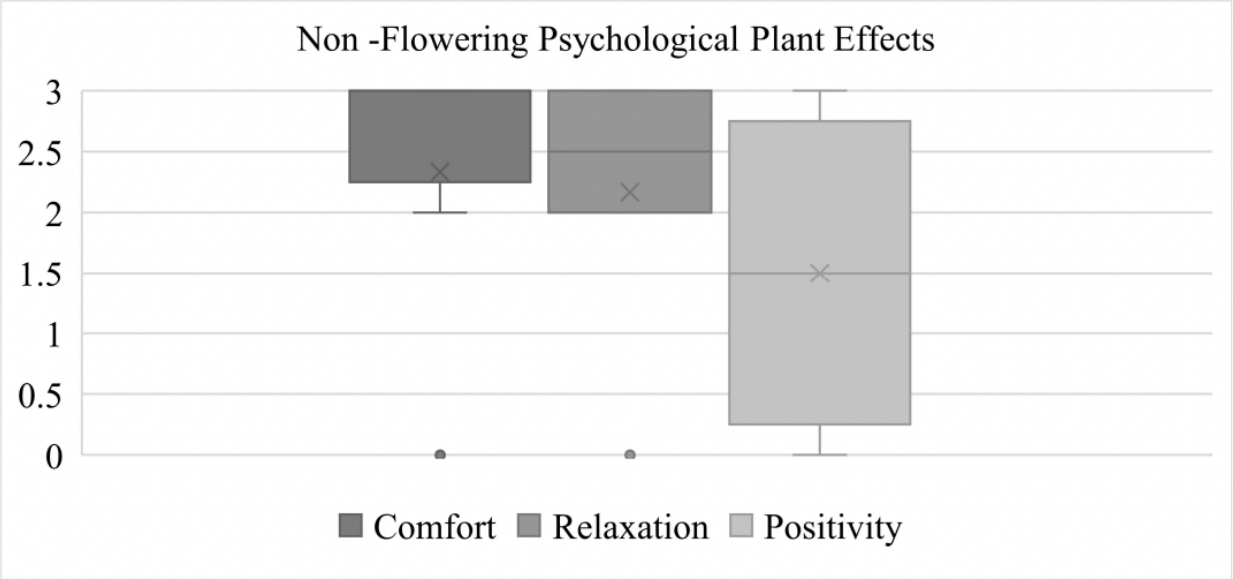
In addition, there was a slight difference in psychological stress response when comparing the reaction to plants with and without flowers. The survey totals for comfort, relaxation, and positivity were slightly higher after plant interaction with flowers.

Table 4: Self-Survey Responses

Questionnaire Responses to Flowering Plants			
Subject	Comfort	Relaxation	Positivity
1	2	3	3
2	3	3	0
3	3	2	2
4	3	3	3
5	0	0	0
6	3	3	3
Totals	14	14	11

Questionnaire Responses to Non-Flowering Plants			
Subject	Comfort	Relaxation	Positivity
1	3	3	3
2	3	3	0
3	3	2	2
4	3	3	3
5	0	0	0
6	2	2	1
Totals	14	13	9





Figures 3: Comparison of Psychological Assessments

Note: The integers (0, 1, 2, 3) represent the scale for neutral, slightly, moderately, and extremely respectively for each emotion. There were no negative responses after interaction with either group of plants. These box and whisker plots were calculated with an inclusive median. The difference in perceived stress relief was minimal throughout the survey. The numeric totals (representing the slightly, moderately, and extremely scale) of comfort, relaxation, and positivity for the flowering plants were within two points of the non-flowering plants in every category. The vital signs of heart rate and HRV showed a more noticeable difference than the self-surveys.

DISCUSSION

This study evaluated the stress-reducing effects of horticulture with flowers and horticulture without flowers. The flowering plants elicited greater physiological stress relief as reflected in more stable HRV and lower heart rate. The psychological stress reduction was much more subtle; however, the questionnaire indicated that the flowering plants still had greater stress relief. After only five minutes, the flowering plants made subjects feel more positive, relaxed, and comfortable while also lowering heart rate and increasing the stability of heart Rhythms.

Although many studies reported the positive effects of horticulture, most of them do not examine the difference in benefits based on the presence of flowers on plants (Lee et al., 2015; Ikei et al., 2014). Flowering plants in horticultural practices may have a greater benefit in stress reduction due to their appeal to the senses. Plants with flowers generally have more colours, symmetrical shapes, and sometimes a more pleasing aroma than their non-flowering counterparts. In this study, the flowers added more symmetry and colours to the plants. These sensory-appealing factors may have contributed to the effectiveness of flowers in horticultural stress reduction.

The excellent effects of flowering horticulture invite a further analysis regarding the workings of flowering plants for stress reduction. Future studies should increase the time of plant interaction to assess whether non-flowering plants can eventually accomplish the same level of stress reduction as flowering plants or if flowering plants bring a new level of stress reduction. In this study, after five minutes, the plants with flowers provided slightly more stress relief than those without. This could be because plants with flowers simply work faster at relieving stress through horticulture. Another theory is that plants with flowers may provide more stress relief than non-flowering plants ever can. Ultimately, whether flowering plants expedite stress relief or increase the amount of stress relief obtainable in horticultural practices, flowering plants are an important tool to include in horticulture and horticulture therapy.

Continuous measurements of HRV and heart rate during plant interaction can reveal more about the processes of stress reduction. Future studies should expand upon this research by increasing the subject group size because this study was limited due to COVID-19 precautions. This data comparing horticulture with and without flowers is preliminary.

CONCLUSION

In the scientific community, there is a limited amount of data involving the influence of flowers in horticulture on stress relief. This study assesses the difference in stress response of horticulture involving plants with and without flowers. The experiment consisted of six test subjects who interacted with groups of plants with and without flowers. According to the data, there was an increased benefit of using flowers in horticulture as they more effectively reduced heart rate and stabilized heart rhythms. In short, the presence of flowers led to more stress relief for the six test subjects. Since this experiment is a preliminary step for analyzing the nuances of horticulture on stress relief, future studies should be conducted to confirm and expand upon these results. Another expansion of this research would be the addition of plants with strong aromas. A comparison of the visual and olfactory qualities of flowers and plants would provide further insight into the nuances of horticultural stress relief.

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