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Effects of Aromatherapy on the Archer's Anxiety Responses and Performance

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아로마테라피가 양궁 선수의 불안반응과 수행에 미치는 영향

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Abstract The purpose of this study was to confirm the effects of inhaling aroma on anxiety responses and performance in high school girl archers. Specifically, the study aimed to identify the changes in anxiety responses such as brainwaves, competitive state anxiety, and heart rate, as well as performance during the inhalation of oil and aroma, including conducting no intervention. The subjects were currently active high school girl archers, and 21 participants who understood and agreed to the research purpose after the researcher directly introduced the study and the inhalation of aroma were selected. The data obtained in this study were processed using the SPSS program for Windows, and all measurements were calculated as mean and standard deviation (mean ± SD). To confirm the effects of aroma, the differences in measurements between no intervention, after inhaling oil, and after inhaling aroma were identified through the Friedman rank test. Post-hoc comparisons between no intervention and oil, and between no intervention and aroma, were analyzed using the Wilcoxon test. The analysis results are as follows. In summary, the aroma of neroli and lemon appears to increase psychological stability and reduce tension, potentially improving archery performance.

Key Words : Aromatherapy, Archer's, Anxiety responses, Performance, Brainwaves, Heart rate, Competitive state anxiety

요 약 본 연구의 목적은 아로마 향기 흡입이 여자 고등학교 양궁선수들의 불안 반응 및 수행력에 미치는 영향을 확인하는 데 있다. 구체적으로 무중재를 포함하여 오일 향을 맡았을 때와 아로마 향을 맡았을 때 불안 반응인 뇌파, 경쟁상태불안, 심박수, 그리고 경기 수행력의 변화를 확인하고자 하였다. 대상자는 현재 활동 중인 고등학교 여학생 양궁 선수이며, 모든 대상자는 연구자가 직접 방문하여 본 연구 목적과 아로마 향기 흡입에 대해 소개한 후 연구 목적을 이해하고 동의한 21명을 선정하였다. 본 연구에서 획득한 자료는 Windows용 SPSS 프로그램을 이용하여 처리하였으며, 모든 측정값은 평균과 표준편차(mean ± SD)를 산출하였다. 아로마 향의 효과를 확인하기 위하여 무중재, 오일 향 흡입 후, 아로마 향 흡입 후 간 차이를 Friedman 순위검정을 통해 확인하였다. 사후 비교는 무중재와 오일, 그리고 무중재와 아로마 간 차이를 Wilcoxon 검정을 통하여 분석하였다. 분석한 결과는 다음과 같다. 종합하여 보면, 네롤리와 레몬의 아로마 향은 심리적 안정감을 증가시키고 긴장감을 감소시키는 효과를 가져 양궁 기록을 향상시킬 수 있는 것으로 사료된다.

주제어 : 아로마테라피, 양궁선수, 불안반응, 수행, 뇌파, 심박수, 경쟁상태불안

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1. Introduction

1.1 Necessity of the study

Archery is a typical closed sport in which participants aim at a target set at a specific distance and score points by hitting it with arrows. The outcome is influenced by a high level of precision and concentration, stability of the lower body, steady movements of the upper body, and the ability to focus on the target without being affected by external factors. Systematically learning how to handle distractions encountered during competitions can lead to desired results.

Many previous studies on archery[1-3]suggest that during competitions, archers should overcome state anxiety and regain confidence to focus on the game and maintain a steady psychological pace without wavering. Eom[4] stated that concentration strategies of excellent archers vary depending on the competition situation. It requires systematic strategies suitable for each situation, such as maintaining posture at the shooting line, maintaining confidence during shooting, focusing on the target, maintaining the current situation when winning, and reflecting on oneself and renewing the atmosphere when losing. High-intensity concentration is required because the psychological state and concentration during shooting affect the outcome. Therefore, elite archers seek various training methods to continuously improve their focus from the shooting line to the point of release during actual competitions.

However, due to the characteristics of archery as a closed sport, it requires precise techniques and a sense of physical rhythm without shaking, and it tends to induce a high level of state anxiety. In particular, since 2006, the federation has adopted the 'Olympic FITA Round', a one-on-one tournament format, to make the archery events more interesting. In domestic and international tournament archery competitions, archers pay excessive attention to their opponents' performance (scores), and the pressure from mistakes, competition results, and environments that induce tension inside and outside the stadium is further exacerbated. Tournament competitions induce more severe psychological tension and various pressures than before[5]. Therefore, methods to cultivate the ability to maintain a stable psychological state suitable for the characteristics of each individual archer have become urgently needed[6].

Aromatherapy utilizes the properties of essential oils, which are volatile aromatic oils extracted from flowers, fruits, stems, leaves, and roots of plants, and essential oils are classified into stimulant oils and sedative oils based on their properties. Stimulant oils simultaneously induce stress reduction and arousal, which can be confirmed through the increase in alpha waves in brainwaves. Sedative oils, on the other hand, have been shown to stabilize the mind and body by reducing blood pressure and stress[7]. Aromatherapy is a relatively safe and effective method because it does not accumulate in the body compared to general chemical drugs and is excreted from the body through the respiratory, liver, and kidney systems[8,9]. Occasionally, athletes are tempted to use drugs to enhance performance despite being aware of their negative impact on the body. Such drug use for performance enhancement can lead to side effects that affect bodily functions. Therefore, there is growing interest in aromatherapy, which helps improve performance without negatively impacting the body.

Park & Park[10] confirmed through a meta-analysis study that aromatherapy helps reduce psychological stress, physical stress, and state anxiety. The effect of aromatherapy on reducing anxiety has also been confirmed

through physiological responses. Ju[11] found in his study that after applying aromatherapy to archers, significant changes were observed in alpha waves of brainwaves, blood pressure, and heart rate, and cortisol secretion increased, affecting psychological and physiological changes. Numerous studies have confirmed that these changes in psychological and physiological anxiety responses can affect performance records.

Kim[12] analyzed competitive state anxiety and performance records, finding that higher anxiety levels were associated with poorer performance records, whereas higher levels of state confidence were associated with better performance records. Therefore this study aims to identify the effects of aromatherapy on anxiety responses and performance of high school girl archers before a match. Specifically, it sought to identify the differences in anxiety responses such as brainwaves, competitive state anxiety, and heart rate, as well as performance during the inhalation of oil and aroma, including conducting without specific intervention(hereinafter referred to as no intervention).

1.2 Research hypotheses

The research hypotheses established to achieve the purpose of this study are as follows:

1) There will be differences in anxiety responses between intervention types.

① There will be differences in brain waves between no intervention and oil and aroma inhalation.

② There will be differences in competitive state anxiety between no intervention and oil and aroma inhalation.

③ There will be differences in heart rate between no intervention and oil and aroma inhalation.

2) There will be differences in archery scores between intervention types.

① There will be differences in archery performance between no intervention and oil and aroma inhalation.

2. Methods

2.1 Research subject

The subjects of this study are currently active high school girl archers, and 21 participants who understood and agreed to the research purpose after the researcher directly introduced the study and the inhalation of aroma were selected. Their average career length and age are presented in Table 1.

2.2 Measurement items and methods

All measurements were taken after the subjects arrived at the laboratory and rested for 30 minutes. Before measuring brainwaves for each group, gauze soaked in oil and aroma was attached to the chest guard and inhaled for 30 minutes. The detailed measurement methods for each item are as follows.

2.2.1 Brainwaves

Brainwaves were collected using the neuroNicle E2 (a metal 2-channel electrode band-type Bluetooth wireless brainwave measuring device) from Laxtha Inc., Korea. During brainwave measurement, the metal electrode parts were cleaned with alcohol swabs, and the electrodes were fixed with Velcro to ensure proper attachment to both sides of the forehead (prefrontal cortex), with the main body positioned to the right. Care was taken to ensure no hair interfered. After wearing the brainwave measurement band on the head, the reference ground electrode sensor (clip electrode) was attached to the right earlobe.

Table 1. Characteristics of the study subjects

Object	Number (n)	Average career(years)	Average age(years)	Average height(cm)	Average weight(kg)
girls' high school archers	21	5.90	17.90	163.33	61.14

Table 2. Items questions by sub-factors of competition status anxiety

	Lower factor	Number of questions	Question number
Competitive state anxiety CSAI-2	Cognitive state anxiety	9	1, 4, 7, 10, 13, 16, 19, 22, 25
	Physical state anxiety	9	2, 5, 8, 11, 14, 17, 20, 23, 26
	Status Confidence	9	3, 6, 9, 12, 15, 18, 21, 24, 27

Brainwaves were measured for 1 minute with eyes closed and wearing an eye patch, and analyzed using the TeleScan software (Laxtha), with the results categorized by frequency. Noise and other factors affecting measurement accuracy, such as talking and movement, were minimized. The brainwave frequency bands used in this analysis were alpha (8-12 Hz), SMR (sensory motor rhythm: 13-15 Hz), low beta (16-20 Hz), and high beta (21-30 Hz) waves.

2.2.2 Competitive state anxiety

In this study, the CSAI-2 developed by Martens et al[13] was used to assess the level of competitive state anxiety. The CSAI-2 questionnaire consists of 27 items, including 9 items for cognitive state anxiety, 9 items for somatic state anxiety, and 9 items for confidence. Each item is scored on a scale from 1 to 4 (1: not at all, 2: somewhat, 3: mostly, 4: very much), with scores ranging from 9 to 36 for each factor. Higher scores indicate higher levels of anxiety and confidence. The total score of the questionnaire is not used; instead, scores for each subdomain are calculated. To prevent learning effects from repeated use of the questionnaire, different items were added, or the order of items was changed, and the competitive state anxiety questionnaire was completed after a 5-minute rest following the brainwave test. The items composing each subdomain of competitive state anxiety are presented in Table 2.

2.2.3 Heart rate

Heart rate was measured using the Polar-H10 heart rate monitor. The program was installed on an iPad, and the participant's name, date of birth, gender, weight, and height were entered into the program. The Polar heart rate measuring band was moistened with alcohol and directly attached to the skin, and heart rate was measured from the preparation at the shooting line until the release of the arrow.

2.2.4 Performance score

At each school's archery range, 36 arrows were shot in total under each condition (no intervention, oil intervention, and aroma intervention), with 6 arrows shot 6 times at a distance of 50m. The total score of these 36 arrows was recorded as the final score.

2.3 Research process

In this study, all 21 subjects repeated the same interventions and tests. There were three types of interventions: no intervention, oil intervention, and aroma intervention, with tests conducted in the order of brainwave, competitive state anxiety, heart rate, and

archery performance. To minimize the 'repeated test' effect, an internal validity threat, the subjects were divided into two groups (10 in group 1, 11 in group 2). Group 1 underwent the interventions and tests in the order of 'no intervention-oil-aroma', while group 2 underwent them in the order of 'no intervention-aroma-oil'.

2.4 Statistical Analysis Method

The data obtained in this study were processed using the SPSS program for Windows (ver 23.0, SPSS Inc., IBM, USA), and all measurements were calculated as mean and standard deviation (mean ± SD). To confirm the effects of aroma, the differences in measurements before intervention, after inhaling oil, and after inhaling aroma were identified through the Friedman rank test. Post-hoc comparisons between no intervention and oil, and between no intervention and aroma, were analyzed using the Wilcoxon test.

3. Results

3.1 Relationship between aroma and anxiety response

3.1.1 Brainwaves

The results of the test for the difference between the types of brain waves measured after smelling oil and aroma scents, including no intervention, and the types of intervention for each measurement are presented in Table 3. The measurement values in this study were often not normally distributed. Therefore, the differences in brain waves between no intervention, oil, and aroma were analyzed using the Friedman rank test, and individual comparisons were made between no intervention and oil, and no intervention and aroma using the Wilcoxon test.

As shown in Table 3, the alpha wave was higher in the order of aroma, oil, and no intervention on both the left and right sides, and the Friedman rank test results showed significant differences between the types of intervention. As shown in the Wilcoxon test results, there was no significant difference between oil and no intervention, but the ratio of alpha waves was
significantly higher after the aroma intervention than after the no intervention. These results indicate that
aroma can provide a sense of stability. There was no significant difference in the SMR wave between the treatments. In the case of β waves, there was a difference in the results of the Friedman rank test in the low frequency β waves, but there was no significant difference between the treatments in the Wilcoxon test. In the high frequency β waves, it was significantly lower after the aroma treatment compared to the no treatment or oil. These results imply that aroma can relieve tension. In summary, based on the results of the EEG test, it seems that the aroma neroli and lemon scents have the effect of increasing stability and relieving tension.

3.1.2 Competitive state anxiety

The mean and standard deviation of the sub-factors of competitive state anxiety, including cognitive state anxiety, physical state anxiety, and physical self-confidence, measured after smelling oil and aroma scents, including unmediated conditions, and the results of the test of differences between the types of intervention for each measurement are presented in Table 4. As shown in Table 4, cognitive state anxiety and physical state anxiety were highest in unmediated conditions, and state self-confidence was highest after smelling aroma scents, but there was no statistically significant difference. In other words, oil and aroma scents were found to have no effect on competitive state anxiety.

Table 3. Group comparison of brain waves

item	region	M± SD(unit: uV²)			x^2 value	SP	Wilcoxon test results
		NI	Oil	Aroma			
α wave	left	0.07±0.07	0.08±0.08	0.16±0.11	12.286	0.002	NI〈Aroma
	right	0.07±0.07	0.10±0.10	0.16±0.12	9.238	0.010	NI〈Aroma
SMR wave	left	0.01±0.02	0.01±0.01	0.01±0.01	3.524	.172	-
	right	0.01±0.02	0.01±0.03	0.01±0.01	2.571	.276	-
Lβ wave	left	0.02±0.02	0.01±0.02	0.02±0.01	3.524	.172	-
	right	0.01±0.01	0.02±0.02	0.02±0.01	6.381	0.041	-
Hβ wave	left	0.02±0.02	0.02±0.01	0.01±0.01	6.952	.031	NI〉Aroma
	right	0.02±0.02	0.02±0.02	0.01±0.01	9.524	.009	NI〉Aroma

NI: No intervention, SP: Significance probability

Table 4. Comparison between groups of competitive state anxiety

Item	NI(M±SD)	Oil(M±SD)	Aroma(M±SD)	x^2 value	SP
Cognitive state anxiety	20.29±5.27	17.91±3.97	19.71±5.23	.701	.704
Physical state anxiety	17.10±3.78	16.91±4.22	16.71±3.30	.521	.771
Status Confidence	19.14±4.57	19.43±5.61	20.95±5.67	3.747	.154

NI: No intervention, SP: Significance probability

Table 5. Between-group comparison of heart rate

Item	NI(M±SD)	Oil(M±SD)	Aroma(M±SD)	x^2 value	SP
Heart rate	102.24±10.99	100.57±15.29	104.65±14.19	0.381	0.827

NI: No intervention, SP: Significance probability

Table 6. Comparison between groups of performance (scores)

Item	NI(M±SD)	Oil(M±SD)	Aroma(M±SD)	x^2 value	SP	Wilcoxon test results
Score	314.38±17.39	314.00±19.57	323.14±12.42	14.381	.001	NI 〈Aroma

NI: No intervention, SP: Significance probability

3.1.3 Heart rate

The results of the test for the mean and standard deviation of heart rate after smelling oil and aroma scents, including non-intervention, and the difference between the intervention types for each measurement are presented in Table 5. As shown in Table 5, there was no significant difference in heart rate between non-intervention, oil, and aroma. In other words, oil and aroma scents were found to have no effect on heart rate.

3.2 Relationship between aroma and archery performance

The mean and standard deviation of the archery scores measured after smelling oil and aroma scents, including no intervention, and the results of the test for differences between intervention types are presented in Table 6. As shown in Table 6, the performance (score) was higher in the order of aroma, no intervention, and oil, and the Friedman rank test showed a significant difference between the intervention types. As for the Wilcoxon test results, there was no significant difference between oil and no intervention, but after the aroma intervention, it was significantly higher than the no intervention.

4. Discussion

4.1 Relationship between aroma and anxiety response

In Kim[14] study, neroli oil was diluted in

stages from 0.1% to 100% to investigate brain activation and emotional responses based on concentration changes. At low concentrations of 0.1% neroli oil, brainwave responses in both males and females were more aroused compared to no scent. However, as the concentration of neroli increased, beta and gamma waves, indicators of arousal and concentration, decreased, while alpha waves, an indicator of relaxation, increased. This result is similar to the findings of this study using neroli and lemon essential oils.

Kim et al[15] found that blending bergamot, lavender, and peppermint in a 2:2:1 ratio and inhaling this aroma reduced academic stress and increased alpha waves in adolescents compared to a no-scent control group. Although their study used different scents, it partially aligns with this study in terms of reducing stress and increasing the proportion of alpha waves in brainwaves through aroma inhalation.

Previous studies on the relationship between aroma and state anxiety show mixed results. Yi[16] found no statistically significant difference between an experimental group inhaling lavender, chamomile, and orange oils in a 4:1:2 ratio and a control group in preoperative patients. However, a study by Kim[17] found that inhaling a mixture of bergamot, lavender, and ylang-ylang oils in a 3:3:1 ratio reduced anxiety in coronary angiography patients. Although this study used neroli and lemon, which differs from the previous studies, the results are similar to Yi[16] study in terms of the lack of significant differences in anxiety reduction effects between the experimental and control groups.

Previous studies on the relationship between aroma and heart rate show that aromatherapy during the recovery period after maximum exercise resulted in a rapid decrease in heart rate at 5, 10, and 15 minutes into the recovery period compared to no treatment, with statistically significant differences observed at 15 minutes, indicating a positive effect of aromatherapy on heart rate recovery[18]. Additionally, lavender aromatherapy significantly reduced heart rate in women with good sleep quality, and marjoram aromatherapy significantly reduced heart rate in both men and women with good sleep quality[19]. Marjoram aroma significantly reduced heart rate within the normal range in groups with good sleep quality[20]. In this study, there were no significant differences in heart rate between intervention types, including no intervention, which differs from the results of these studies. In summary, the results showed that brainwave responses to anxiety improved, with increased stability and reduced tension after inhaling aroma.

4.2 Relationship between aroma and archery performance

As a result, archery performance scores improved after inhaling aroma. Previous studies on the relationship between aroma and athletic performance indicate that aromatherapy improved anaerobic power[21] and positively influenced aerobic capacity in taekwondo athletes[22]. Although these studies differ from this study in terms of sports and the types of athletic abilities investigated, they demonstrate the potential for aroma to positively impact physical fitness.

In this study, aroma was found to improve archery performance, showing partially similar results to those of previous studies. Overall, this study demonstrated that aroma intervention partially improved anxiety responses and enhanced archery performance. However,

different results were observed depending on the type of anxiety response, indicating the need for further detailed research on this topic.

5. Conclusion & Suggestion

The purpose of this study was to confirm the effects of inhaling aroma on anxiety responses and performance in high school girl archers. Specifically, the study aimed to identify the changes in anxiety responses such as brainwaves, competitive state anxiety, and heart rate, as well as performance during the inhalation of oil and aroma, including conducting no intervention. The subjects were currently active high school girl archers, and 21 participants who understood and agreed to the research purpose after the researcher directly introduced the study and the inhalation of aroma were selected.

The data obtained in this study were processed using the SPSS program for Windows, and all measurements were calculated as mean and standard deviation (mean ± SD). To confirm the effects of aroma, the differences in measurements between no intervention, after inhaling oil, and after inhaling aroma were identified through the Friedman rank test. Post-hoc comparisons between no intervention and oil, and between no intervention and aroma, were analyzed using the Wilcoxon test. The analysis results are as follows.

First, in terms of anxiety responses, there were no significant differences in competitive state anxiety levels and heart rate between intervention types, but positive changes were observed in brainwaves. Specifically, after inhaling aroma, alpha waves increased and high-frequency beta waves decreased, indicating increased psychological stability and reduced tension.

Second, in terms of archery scores, there were no significant differences between oil and no intervention, but scores significantly increased after inhaling aroma.

In summary, the aroma of neroli and lemon appears to increase psychological stability and reduce tension, potentially improving archery performance.

Regarding the results of this study, the following directions for future research are suggested:

First, since physiological responses to inhaling essential oils can vary based on sensory factors related to the scent, gender, preference, the characteristics of the aroma, subjective emotions, and individual differences, it is suggested that future studies consider these factors.

Second, while many studies on aromatherapy have already been conducted in the field of nursing, research in the field of sports science is still lacking and limited to a few sports. Aromatherapy is a field of alternative medicine with few side effects and ease of use. Therefore, athletes can identify their weaknesses and apply appropriate aromatherapy for psychological aspects such as relaxation, anxiety reduction, anti-depression, and physical aspects such as muscle relaxation to address these weaknesses and enhance their strengths, ultimately improving their performance and records. Thus, research related to these aspects is suggested.

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