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PAPER

Utilizing Facial Emotion Analysis with FaceReader to Evaluate the Effects of Outdoor Activities on Preschoolers' Basic Emotions: A Pilot Study in e-Health

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ABSTRACT

The theory of basic emotions posits that a set of fundamental emotions—happiness, sadness, anger, fear, disgust, and surprise—are associated with universally recognizable facial expressions. One method for studying facial expressions is the Facial Action Coding System (FACS), which allows researchers to measure facial muscles to identify the emotions expressed by participants. Preschool is an important period for the development of kids and their ability to understand emotions. In this stage, children's physical activity (PA) levels tend to decrease significantly, with children spending more time sedentary, such as sitting for six to eight hours a day and engaging in screen-based activities. The present study aimed to assess the basic emotional states and neutral levels of preschoolers (aged 5–6 years) participating in outdoor activities, using FaceReader (FR) as a facial emotion analysis tool. The results indicate that the outdoor activity intervention had a significant impact on the emotional states of the experimental group (EG), with marked reductions in sadness ($p = .002$) and disgust ($p = .01$), as well as significant increases in valence ($p = .01$) and arousal ($p = .004$). These findings showed the importance of outdoor activities in reducing negative emotions among preschool-aged children.

KEYWORDS

basic emotions, outdoor activity, preschoolers, facial analysis, FaceReader (FR)

1 INTRODUCTION

Verbal and nonverbal behaviors are essential to human emotional communication. Nonverbal communication involves physical behaviors such as facial expressions, body language, and vocal expressions [1]. The human face and facial expressions show vital information about people's emotional state [2]. Emotions can be extracted by various factors, including recognizing sudden situations, memory

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recall, and talking about past emotional experiences. Darwin [3] proposed that facial expressions remain in humans because of their evolutionary development and communicative value.

According to basic emotion theory, fundamental emotions—happiness, sadness, anger, scared, disgust, and surprise—have a universally recognized facial expression [4]. These emotional expressions are believed to reflect a human's internal emotional state. Different computer-based technologies have been developed to interpret human emotions more effectively and increase user experience [5]. Machine learning and image-processing research have demonstrated that facial features, for example, eye movements and glazing, can describe mood states [6]. Facial Action Coding System (FACS) can measure facial muscles to identify the emotions expressed by participants [7]. A facial expression is defined as a specific action unit (AU), the smallest anatomical movement of the face that can happen in combination with other movements [8].

Research has shown that separate emotional facial expressions improve with age and development [9]. The study [10] shows that the ability to understand basic emotions peaks during adulthood, and happiness is identified earlier. Environmental factors, such as a child's living environment, significantly affect the progress of emotional recognition abilities. Children who experience strong relationships and are involved in more emotional situations desire to develop better emotional recognition skills [11], [12]. The preschool period is a key for rapidly growing children's emotional detection. During this stage, social-emotional development increases as children try to understand, and communicate with others and regulate their feelings and behaviors [13]. Early social-emotional capacities shown during the preschool years anticipate positive outcomes in the future, including fewer adolescent behavioral problems (teen pregnancy and high school dropout) and increased financial and personal outcomes in adulthood [14]. Physical inactivity is one of the leading risk factors for death worldwide [15]. Only one-third of children are involved in physical activity (PA) levels necessary to prevent health problems, as defined by the WHO [16]. Consequently, researchers emphasize the importance of outdoor activities and sports for improving children's emotional well-being by increasing the neurotransmitters in the brain, mental toughness, and reducing stress levels [17]–[20].

In some countries, outdoor activities are influenced by weather conditions during the coldest period of the year. Although educators generally understand the value of outdoor activities for children's development and learning, different factors prevent the execution of such activities. These include inadequate physical infrastructure, safety concerns in school, overpopulated classrooms, weather conditions, and lack of parental consent [21]. A study found that most 5-year-olds are driven to and from kindergarten (62.5% and 54.0%) by car. Lack of time and distance are the main reasons for not walking. Nearly 20% of children are overweight or obese, and 49% spend over 3 hours on weekends watching screens [22]. During preschool, children's PA levels are reduced because children spend six to eight hours per day in sedentary activities (sitting in front of computers or television screens) related to increased emotional issues [23]–[25]. Living in the city is related to the risk of mental health disorders and increased physiological stress in children. Meanwhile, outdoor activity at school has declined due to structured indoor activities and dual-income families [26]–[29]. Research on preschoolers' emotional states is scarce. Most focus on physical health [30], though recent studies highlight emotional and psychosocial benefits [31]. Negative emotions in children can disturb social communication, cause weak academic performance, and affect well-being [32], [33]. Most emotion recognition studies focus on participants' reactions to controlled stimuli in lab settings [34], leaving real-life emotional states a challenge. Questionnaire-based methods, often used in schools, rely on self-reports, including visual, verbal, or written formats [35]. However, emotions are usually unconscious or hard to express verbally [36]. Traditional psychological scales and text analysis may not fully capture initial emotions [37]. Facial expressions, however, bring rich emotional data, and softwares FaceReader (FR)™ is increasingly valuable. This technology eliminates bias from a subjective judgment [38].

Automated facial emotion analysis systems are designed to interpret and understand human mental states by analyzing facial expressions. As fields linked to computer and artificial intelligence technologies continue to grow, significant social changes and advancements in intelligence are happening [39]. Considering those mentioned above, the study aims to evaluate the basic emotional states (happiness, sadness, anger, fear, disgust, surprise) and neutral level of preschoolers (5–6 years old) participating in outdoor activities using FR™ as a facial emotion analyzer. It is hypothesized that outdoor activities will elicit more positive emotions (happiness, surprise) compared to negative emotions (sadness, anger, fear, disgust) in preschoolers.

2 MATERIALS AND METHODS

2.1 Sample selection

The study sample included 20 children (14 boys and six girls) aged 5 (n = 6) and 6 (n = 14) years from a public preschool (Ziedondarza) in Riga, Latvia. After receiving written consent from the parents about assurances of anonymity and an explanation of the study, demographic and health information of children was provided. The eligibility criteria included a chronological age of 5 or 6 years and good health. The study was approved by the ethical committee of Riga Stradins University Latvian Academy of Sport Education (protocol no. 9/20/47813, 30.06.2023). It was conducted by the Declaration of Helsinki [40].

2.2 Variables and measures

FaceReader. This study utilized FR™ version 9.1, developed by Noldus Information Technology, to analyze emotional states [41]. FR automatically evaluates facial expressions across six emotional states. The software's analysis is based on the FACS and AU, specific muscle groups responsible for facial expressions [7]. FR provides the quantitative analysis of facial expressions and applies a facial modeling technique by deep neural networks [42]. This model constructs an artificial face, identifying 500 key points on the face. These key points are based on a database of annotated images. The validity of FR 9 facial expression analysis has been confirmed through comparisons with expressions rated by established databases [43], [44]. Additionally, FR quantifies *expression intensity* for the six basic emotions, presenting each expression as a value between 0 and 1. *Arousal* reflects facial activity, with values from 0 (inactive) to +1 (active), based on the activation of 20 AUs from the FACS. *Valence* defines emotions as positive or negative.

Happiness is the positive emotion, while sadness, anger, fear, and disgust are negative. Surprise is excluded from the valence calculation due to its potential to be either positive or negative. The facial emotion analysis is shown schematically in Figure 1. Open and closed states of eyes and mouth are considered (top part). The expression line chart (bottom part) shows how emotions listed in the chart changed during a 10-second test. Although some of the emotions could not be analyzed from the expression line chart due to small values, they can be analyzed and compared pre- and post-tests.

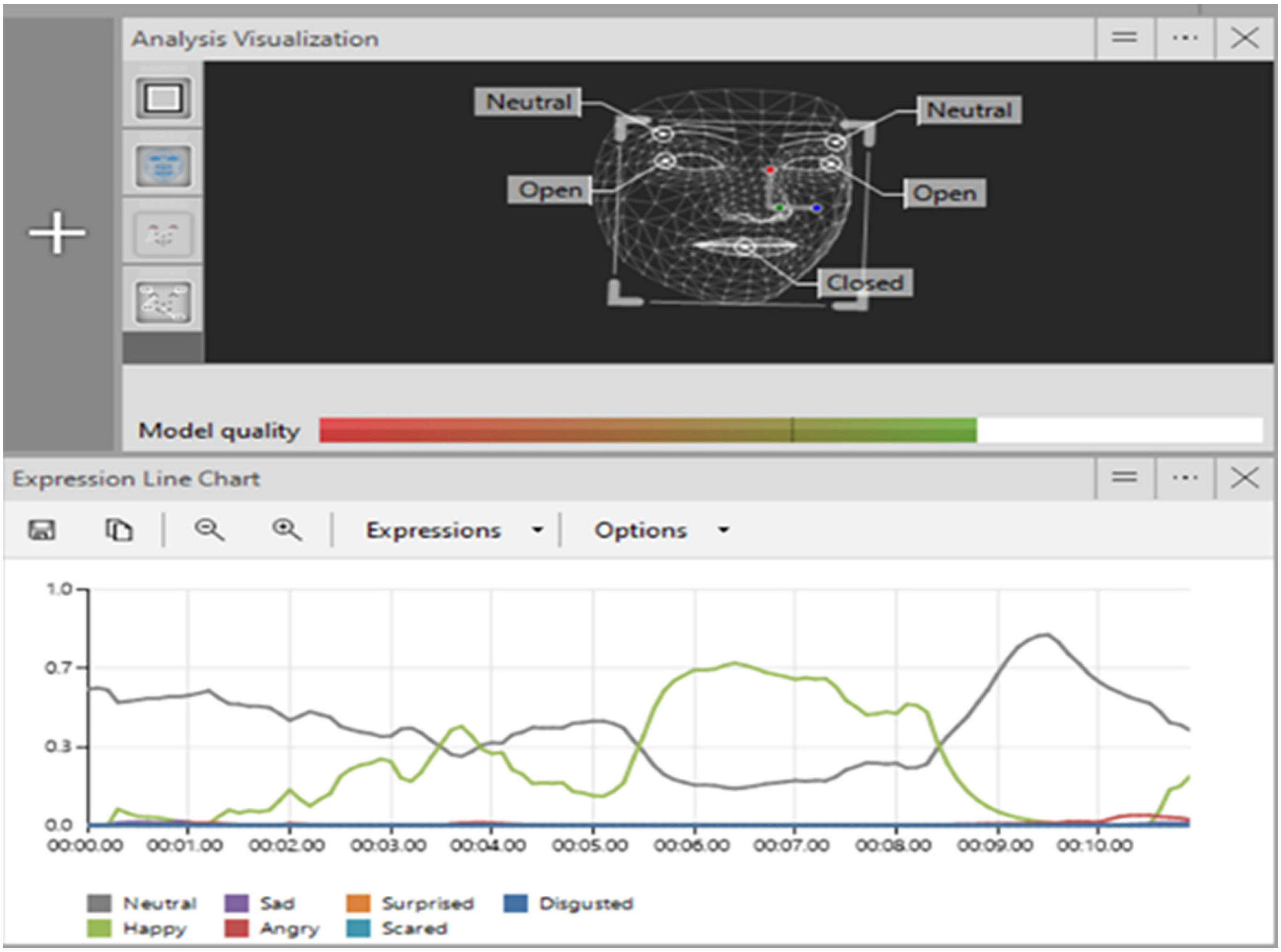

Fig. 1. Schematic example of facial emotion analysis

FaceReader analysis. It is conducted in several stages below.

FaceReader settings. The FR software's default settings were adjusted for the analysis. Continuous automatic calibration was provided, and the general default face model was selected. The optional classification for the contempt expression was excluded. Data export settings were configured to generate constant values, ensuring the comprehensive utilization of all FR outputs.

Video preparation and analysis. Videos were recorded in MP4 format at a frame rate of 25 frames per second and a resolution of 640×480 pixels. Studies suggest that FR requires a minimum (Min) camera resolution of 640×480 pixels for reliable results and sufficient quality [45]–[52]. Forty video clips, each approximately 10 seconds, were used as input data for the analysis. Before conducting the study, videos underwent calibration to minimize the risk of incorrect emotion assignment [41].

Data analysis. All participant video clips were imported for analysis using the FR Project Wizard. The batch analysis feature processed the videos automatically in succession, allowing all clips to be analyzed in one run. The entire analysis process took approximately 20 minutes.

Equipment. Video recordings were made using an integrated USB 2.0 HD UVC webcam with a 640×480 pixel resolution. Each recording session per group lasted approximately 20 minutes and covered pre- and post-tests. Data analysis was performed on an ASUS ExpertBook B9400 laptop, which met the system requirements specified for the FR software.

2.3 Procedure

The study engaged two FR measurements to assess basic emotional states. Preschoolers were assigned to either an experimental group (EG) ($n = 10$) or a control group (CG) ($n = 10$). Before the intervention, all participants participated in an introductory session to familiarize themselves with the FR and certify correct facial expressions by the software. The intervention involved outdoor activities, conducted three times per week for 40 minutes per session (totaling nine sessions), as utilized in a study [53]. The pre-test was led in the second week of January 2024, while the post-test was carried out at the end of January 2024, following three weeks of outdoor activities. The EG conducted the activities under the supervision of their teacher.

Meanwhile, the CG continues the standard preschool routine without outdoor activities. To ensure correct analysis with software, video recordings were made with participants positioned frontally in close-up, ensuring clear facial visibility and adequate lighting. For the CG, one participant was recorded at a time (pre- and post-test) in a separate room. The researcher posed a simple question regarding the participant's emotional state, and their facial expressions were filmed. For the EG, video recordings were made in the kindergarten yard before and after the intervention.

2.4 Statistical analyses

The Min, maximum (Max), and mean (M) scores were calculated. The M intensity for each of the six emotions and neutral, arousal, and valence was determined to extract emotional data from FR. The normality of the data was calculated by the Shapiro-Wilk test. Effect sizes (Cohen's *d*), rank-biserial correlation (rb), and confidence intervals (CIs) were reported. A paired t-test (t) and the Wilcoxon signed-rank test (w) were applied for data analyses. The significance level was $p < 0.05$. All statistical analyses were conducted using Jeffreys's Amazing Statistics Program (JASP) version 0.18.3.

3 RESULTS

This section presents the results of the emotional responses observed in both the CG and the experimental group.

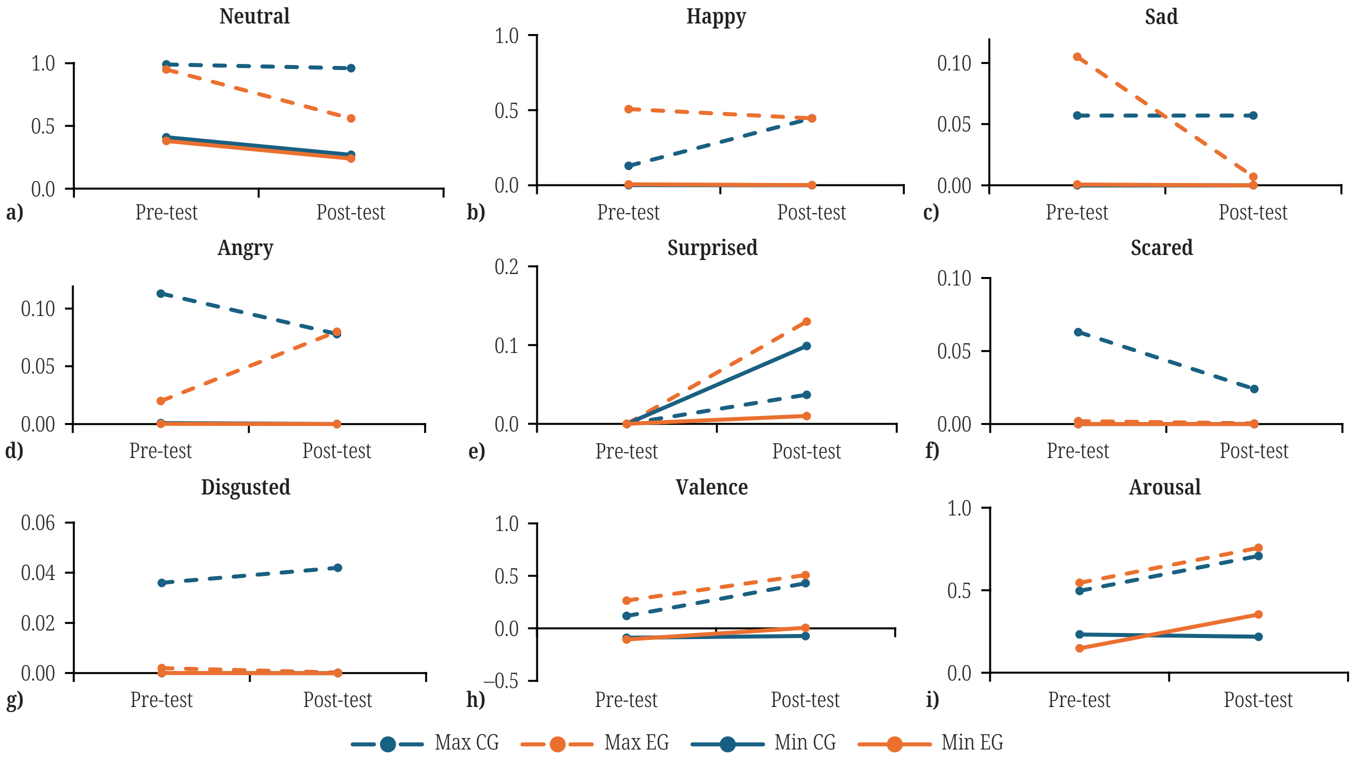

Fig. 2. Results of Min and Max scores for CG and EG (pre- and post-test)

Neutral level. A small reduction was observed in the CG from the pre-test to the post-test. The Min score decreased from .41 to .27, and the Max score dropped slightly from .99 to .96 (see Figure 2a). The CG's M score increased from M = .72 to .75, but it was not statistically significant (p = .69, *d* = –.13, 95% CI [–.74, .49]). Conversely, the EG showed a noticeable decrease. The Min score declined from .38 to .24. The Max score decreased from .95 to .56. The M score for the EG decreased from M = .70 to .42. This reduction was statistically significant (p = .001, *d* = 1.73, 95% CI [.71, 2.72]), demonstrating that the outdoor activity intervention led to a significant decrease in the neutral level (refer to Table 1).

Happy emotion. Happiness is the only positive emotion on the basic emotions list. CG exhibited an increase in scores (see Figure 2b). The Max score increased from .12 to .44, and the Min score slightly decreased from .00041 to .00021. The M score increased from M = .05 to .10. Conversely, the EG experienced a small decline in happiness, with the Min score falling from .006 to .000556 and the Max score decreasing from .50 to .44. The M score of the EG decreased slightly from M = .20 to .15 (refer to Table 1). The intervention did not significantly change happiness levels in either group (CG: p = .33, *d* = –.32, 95% CI [–.95, .32]; EG: p = .45, *d* = .24, 95% CI [–.38, .87]).

Sad emotion. For sadness, CG exhibited a few changes. The Min score increased slightly from .0000025 to .000021, and the Max score remained unchanged at .05 (see Figure 2c). The M score increased from M = .012 to .015, but the difference was insignificant (p = .79, *d* = –.08, 95% CI [–.70, .54]). The EG showed reduced sadness. The Min score dropped from .000625 to 0, and the Max score reduced from .1 to .007. The M score for the EG decreased significantly from M = .02 to M = .00084 (p = .002, rb = 1.0) (refer to Table 1), indicating that the intervention effectively reduced sadness in this group.

Angry emotion. There was a slight decrease in CG. The Min score decreased from .000876 to .0000905, and the Max score fell from .1 to .07 (see Figure 2d). The M score dropped from M = .017 to .013. In the EG, there was a small decrease in the

Min score (from .00019 to .00000085), but the Max score increased slightly from .02 to .08. The M score for the EG increased slightly from M = .007 to .009. However, these changes were not statistically significant (CG: p = .33, *d* = .32, 95% CI [–.32, .95]; EG: p = .08, rb = .63, 95% CI [.05, .89]), suggesting that the intervention had no substantial effect on anger (refer to Table 1).

Surprised emotion. When people see something unexpected, they feel surprised. Therefore, the surprise could be either positive or negative. Regarding surprise, the CG demonstrated a decrease, with the Max score falling from .09 to .03. Conversely, the EG increased, with the Max score rising from .01 to .13 (see Figure 2e). However, no significant differences were found between the groups (CG: p = .23, rb = .45, 95% CI [–.20, .83]; EG: p = 1.0, rb = –1). The M score for CG decreased slightly from M = .024 to .008, while the M score for EG increased from M = .001 to .013 (refer to Table 1). These findings show no significant effect of the outdoor activity.

Scared emotion. The levels decreased in both the CG and EG. In CG, the Max score declined from .06 to .02, while the EG experienced a decrease from .002 to .000439 (see Figure 2f). Despite these reductions, no statistically significant changes were observed in either group (CG: p = .19, rb = .49, 95% CI [–.16, .84]; EG: p = .37, rb = .34, 95% CI [–.32, .78]). The M score for the CG decreased from M = .007 to .003. At the same time, the EG exhibited a slight increase from M = .00043 to .00058 (refer to refer to Table 1), indicating no significant effect of the intervention on scared.

Disgusted emotion. CG showed an increase in disgust, with the Max score rising from .03 to .04. In contrast, the EG exhibited a significant reduction in disgust (see Figure 2g). The Min score dropped from .000031 to .000000021, and the Max score reduced from .002 to .000203. The M score for the EG decreased from M = .00064 to .00051. A Wilcoxon signed-rank test revealed a significant reduction in disgust for the EG (p = .012, *d* = .9, 95% CI [.21, 1.7]), indicating that the outdoor activity intervention effectively reduced disgust. CG showed no significant change (p = .62, rb = –.20, 95% CI [–.71, .45]), with a slight increase in the M from M = .004 to .006 (refer to Table 1).

Valence. It reflects the emotional tone of the responses (positive or negative), which increased in both groups post-test. The Max score for CG rose from .11 to .43, and the Max score for EG increased from .26 to .50 (see Figure 2h). EG showed more improvement in valence, with the M score increasing from M = .06 to .19, which was statistically significant (p = .01, *d* = –.91, 95% CI [–1.63, –.14]), suggesting a shift toward more positive emotional states. CG's M score increased slightly from M = .03 to .07 (refer to Table 1), but this change was insignificant (p = .42, *d* = –.26, 95% CI [–.88, .37]).

Table 1. Summary of FaceReader results for CG and EG group

Group		t	df	w	z	*p*
Neutral	CG	–.41	9	–	–	.69
	EG	5.48	9	–	–	.001*
Happy	CG	–1.01	9	–	–	.33
	EG	.78	9	–	–	.45
Sad	CG	–.26	9	–	–	.79
	EG	–	–	55.0	2.80	.002*#
Angry	CG	1.03	9	–	–	.33
	EG	–	–	45.0	1.78	.08#

(Continued)

Table 1. Summary of FaceReader results for CG and EG group *(Continued)*

Group		t	df	w	z	*p*
Surprised	CG	–	–	40.0	1.27	.23#
	EG	–	–	0.0	–1.0	1.0#
Scared	CG	–	–	41.0	1.37	.19#
	EG	–	–	37.0	0.96	.37#
Disgusted	CG	–	–	22.0	–0.56	.62#
	EG	3.14	9	–	–	.01*
Valence	CG	–.83	9	–	–	.42
	EG	–2.87	9	–	–	.01*
Arousal	CG	–	–	40.0	1.27	.23#
	EG	–3.75	9	–	–	.004*

Notes: t-t statistics, df-degrees of freedom, p-p-value, *Significant ($p < 0.05$), w-Wilcoxon signed-rank test, #Nonparametric test.

Arousal indicates information about the subject's emotional activation or excitement and can be assessed as calming or exciting. Arousal levels showed an increase in both groups post-test. CG's Max score rose from .4 to .7, while the EG's increased from .5 to .7 (see Figure 2i). EG exhibited a more substantial rise in arousal, with the M score increasing from M = .39 to .48, and this change was statistically significant (p = .004, *d* = –1.18, 95% CI [–1.9, –.34]), indicating heightened arousal following the intervention. In contrast, CG showed a slight decrease in M arousal from M = .35 to .32 (refer to Table 1), with no significant difference (p = .23, rb = .45 (95% CI [–.20, .83]).

4 DISCUSSION

This study aims to evaluate the basic emotional states (happiness, sadness, anger, fear, disgust, surprise) and neutral level of preschoolers (5–6 years old) participating in outdoor activities, using FR™ as a facial emotion analyzer. The findings show significant differences between the EG and the CG. Specifically, the EG showed a significant reduction in negative emotions, sadness (p = .002), disgust (p = .01), and neutral level (p = .001). Additionally, the EG exhibited a notable increase in valence (p = .01), reflecting a shift toward more positive emotional states and arousal (p = .004), suggesting enhanced emotional activation. In contrast, the CG did not demonstrate any significant changes in sadness, disgust, or other emotional states (p > .05). Facial expressions serve as a key mode of emotional communication, reflecting an individual's current emotional state and conveying that information to others. Based on the research hypothesis, we expected that outdoor activities would elicit more positive emotions compared to negative emotions in preschoolers. Our results are not conclusive, and there are both expected and unexpected results, which are discussed below.

The expected results. A neutral facial expression displays the absence of significant emotion. In this study, the neutral level score for participants in the EG decreased after three weeks of outdoor activities, suggesting an increased expression of other emotions. These results are consistent with the findings of a study that show a reduction in neutral expression scores among participants engaged in outdoor activities in a forest setting compared to a control group [54].

In contrast, the study [55] showed an insignificant effect on neutral emotions and discussed that a neutral level could be misinterpreted as sadness. Another research has noted that identifying emotions can be difficult [56]. Analyzing the neutral level in our study reflects the emotional dynamics in real-world social interactions, where facial expressions with minimal emotions may be discovered as neutral. Researchers need to calibrate facial expressions and ask participants to show a neutral face at the start of the test because some participants could interpret expressions as anger or sadness. A significant difference was in the negative emotions of sadness and disgust, with a reduction in the EG. Outdoor exercise effectively evokes more emotional responses, reducing sadness and disgust. Active participation in outdoor activities likely helps reduce sadness and disgust, enhancing emotional well-being. This finding aligns with research about the impact of PA on children's emotions [57]. One explanation is that outdoor activities distract children from negative stimuli and improve emotions during and after the activity [58]. Another factor could be self-efficacy, where outdoor activities are perceived as challenging experiences that increase positive emotions and confidence [59]. Additionally, social interactions and relationships in outdoor activities affect emotional responses [60]. The valence and arousal levels results were significant. Gender may be one of the reasons. Females may show their emotional states more intensely with facial expressions [61]. Emotional responses are influenced by physiological factors (reward mechanisms), psychological indicators (age and expectations based on prior experiences), and sociological factors (economic status) [62].

The unexpected results. In this study, happiness, the only positive emotion among basic emotions [63], did not show significant changes in either group. Although there were no significant differences between surprise and scared, outdoor activities heightened responses for surprise and reduced scared in the EG. Research on gender differences and emotional expressions shows that men are less expressive [64], show less happiness [65], and smile less than women [66]. The high number of boys (14 boys, six girls) in our study may explain the unchanged happy emotion. We used FR to analyze facial expressions, but young children often express happiness through body movements, laughter, or verbal cues instead of consistent facial expressions. Preschoolers pick up on various subtle emotional cues in social interactions, with some being recognized more easily than others. Emotional detection software may not fully capture children's emotional complexity, especially in dynamic, playful contexts [67]. FR identified female facial expressions more accurately than males [68]. However, surprised and scared emotions are better in males [69]. As FR cannot differentiate between acted or genuine expressions, if a face is realized as happy, FR will detect it as such, although the expression is acted [70]. Small effect sizes are generally reported for this sex difference, and more research is needed [71]–[73].

Some studies suggest that brief exercise sessions may not provide sufficient emotional support [74]. Therefore, exercise duration for children should be from 30 to 60 minutes. In our study, the outdoor activities were 40 minutes, consistent with other studies [75]. The weather has a significant role in the mood [76]. The average temperature for the EG during outdoor activities was –3.1°C, while the temperature in the CG's indoor environment was 22.3°C. It is possible that cold temperatures can be a discomfort-inducing environmental stressor and decrease children's wishes about activities [77].

The practical implications and limitations. While FR allows researchers to compare findings with reported emotional responses from surveys and interviews, several considerations must be noted when using this method. This study focuses on one kindergarten in Latvia with a small sample, limiting generalizability. The sample size was determined based on participant availability rather than sample size calculations. Future research should aim to involve larger sample sizes and conduct rigorous sample size calculations to increase the statistical robustness. Another limitation is related to the duration of three weeks of outdoor activities. Although this period was adequate for a significant reduction in neutral level and negative emotions (sadness and disgust), a longer period would provide more insight into the effects of different interventions. Educators can incorporate more outdoor interventions to support the emotional state of preschoolers. Future research and practical applications should consider facial analysis with additional indicators such as heart rate variability and voice tone measurements. While FR enabled basic emotion analysis, complex emotions such as excitement and social bonding were not assessed. FR is sensitive to lighting conditions. It is important to note that positive and negative emotions are not necessarily opposite poles but separate constructs [78]. FR is an effective tool for measuring emotions by analyzing participants' facial expressions.

5 CONCLUSION

The findings indicate that the outdoor activity intervention significantly impacted the emotional states of the EG, with significant reductions in sadness and disgust, as well as increases in valence and arousal. These results show the potential of outdoor activities to improve basic emotions by reducing negative feelings. Future studies could incorporate advanced motion sensors, such as eye tracking and electrodermal response registration, for more accurate measurements of relevant indicators.

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7 REFERENCES

[1] G. M. Reevy, *Encyclopedia of Emotion*. Santa Barbara, CA: Greenwood, 2010. https://doi.org/10.5040/9798400645242

[2] H. S. Asthana, *Facial Asymmetry in Expression of Emotion: A Neurocultural Perspective*. New Delhi: Concept Publishing Company, 2012.

[3] A. J. Fridlund, *Human Facial Expression: An Evolutionary View*. London: Academic Press, 2014.

[4] P. Ekman, "Universal facial expressions of emotion," *California Mental Health Research Digest*, vol. 8, no. 4, pp. 151–158, 1970. https://psycnet.apa.org/record/1972-06605-001

[5] M. Batty and M. J. Taylor, "Early processing of the six basic facial emotional expressions," *Cognit. Brain Res.,* vol. 17, no. 3, pp. 613–620, 2003. https://doi.org/10.1016/S0926-6410(03)00174-5

[6] D. Leony *et al.*, "Provision of awareness of learners' emotions through visualizations in a computer interaction-based environment," *Expert Syst. Appl.,* vol. 40, no. 13, pp. 5093–5100, 2013. https://doi.org/10.1016/j.eswa.2013.03.030

[7] P. Ekman and W. V. Friesen, *Facial Action Coding System*. APA PsycTests, 1978. https://doi.org/10.1037/t27734-000

[8] P. Ekman, W. V. Friesen, and J. C. Hager, *Facial Action Coding System – The Manual*. Salt Lake City: Research Nexus, 2002.

[9] C. M. Herba *et al.*, "The development of emotion-processing in children: Effects of age, emotion, and intensity," *J. Child Psychol. Psychiatry*, vol. 47, no. 11, pp. 1098–1106, 2006. https://doi.org/10.1111/j.1469-7610.2006.01652.x

[10] A. R. Richoz *et al.*, "Tracking the recognition of static and dynamic facial expressions of emotion across the life span," *J. Vis.,* vol. 18, no. 9, pp. 1–27, 2018. https://doi.org/10.1167/18.9.5

[11] H. A. Raikes and R. A. Thompson, "Family emotional climate, attachment security and young children's emotion knowledge in a high-risk sample," *Br. J. Dev. Psychol.*, vol. 24, no. 1, pp. 89–104, 2006. https://doi.org/10.1348/026151005X70427

[12] T. R. Goldsmith and L. A. LeBlanc, "Use of technology in interventions for children with autism," *J Early Intensive Behav Interv*, vol. 1, no. 2, pp. 166–178, 2004. https://doi.org/10.1037/h0100287

[13] J. P. Shonkoff and A. D. Phillips, *From Neurons to Neighborhoods: The Science of Early* Childhood *Development*. Washington DC: National Academies Press, 2000. https://doi.org/10.17226/9824

[14] T. E. Moffit, R. Poulton, and A. Caspi, "Lifelong impact of early self-control," *Am. Sci.*, vol. 101, no. 5, p. 352, 2013. https://doi.org/10.1511/2013.104.352

[15] WHO, "Global strategy on a diet, physical activity, and health," https://www.who.int/dietphysicalactivity/pa/en/. [Accessed: 2024].

[16] P. C. Hallal *et al.*, "Global physical activity levels: Surveillance progress, pitfalls, and prospects," *Lancet*, vol. 380, no. 9838, pp. 247–257, 2012. https://doi.org/10.1016/S0140-6736(12)60646-1

[17] M. W. Voss *et al.*, "Exercise, brain, and cognition across the lifespan," *J. Appl. Physiol. of Physical Inactivity*, vol. 111, pp. 1505–1513, 2011. https://doi.org/10.1152/japplphysiol.00210.2011

[18] B. Boobani *et al.*, "Effect of walking in nature on stress levels and performance of taekwondo athletes in the competition period," *Journal of Kinesiology and Exercise Sciences*, vol. 34, no. 106, pp. 17–27, 2024. https://doi.org/10.5604/01.3001.0054.4456

[19] B. Boobani *et al.*, "Effect of outdoor recreation activity on the mental toughness of taekwondo athletes in competition period," *Arch Budo Sci Martial Art Extreme Sport*, vol. 19, pp. 113–121, 2023.

[20] B. Boobani *et al.*, "Effect of green exercise on stress level, mental toughness, and performance of taekwondo athletes," *Arch Budo*, vol. 20, pp. 29–40, 2024.

[21] Y. Simge, "Outdoor environment and outdoor activities in early childhoods education," *Mersin University Journal of the Faculty of Education*, vol. 12, no. 1, pp. 423–437, 2016.

[22] Report "Study on physical activity, nutrition habits and the body mass index for 5-6-year-old pre-school children in Latvia," of the research project ESF Nr.9.2.4.1/16/I/001 (in Latvian). Online: https://ppdb.mk.gov.lv/wp-content/uploads/2021/12/5_6_gadi_NODEVUMS_NR_4_PETIJUMS.pdf. [Accessed: 2025].

[23] W. Rusek *et al.*, "The influence of body mass composition on the postural characterization of school-age children and adolescents," *BioMed Res. Int*, vol. 2018, no. 1, p. 9459014, 2018. https://doi.org/10.1155/2018/9459014

[24] G. Lissak, "Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study," *Environmental Research*, vol. 164, pp. 149–157, 2018. https://doi.org/10.1016/j.envres.2018.01.015
[25] J. M. Twenge, G. N. Martin, and W. K. Campbell, "Decreases in psychological well-being among american adolescents after 2012 and links to screen time during the rise of smartphone technology," *Emotion*, vol. 18, no. 6, pp. 765–780, 2018. https://doi.org/10.1037/emo0000403
[26] J. Peen, R. A. Schoevers, A. T. Beekman, and J. Dekker, "The current status of urban-rural differences in psychiatric disorders," *Acta Psychiatrica Scandinavica*, vol. 121, no. 2, pp. 84–93, 2010. https://doi.org/10.1111/j.1600-0447.2009.01438.x
[27] S. V. Wass, C. G. Smith, L. Stubbs, K. Clackson, and F. U. Mirza, "Physiological stress, sustained attention and cognitive engagement in 12-month-old infants from urban environments," *Dev. Psychol.*, vol. 57, no. 8, pp. 1179–1194, 2021. https://doi.org/10.1037/dev0001200
[28] E. Baines and P. Blatchford, "Full report-school break and lunch times and young people's social lives: A follow-up national study," *Nuffield Foundation*, 2019. http://www.nuffieldfoundation.org/
[29] E. Y. Lee *et al.*, "Systematic review of the correlates of outdoor play and time among children aged 3–12 years," *International Journal of Behavioral Nutrition and Physical Activity*, vol. 18. no. 41, 2021. https://doi.org/10.1186/s12966-021-01097-9
[30] K. Bjørgen, "Physical activity in light of affordances in outdoor environments: Qualitative observation studies of 3–5 years olds in kindergarten," *SpringerPlus*, vol. 5, no. 950, 2016. https://doi.org/10.1186/s40064-016-2565-y
[31] J. McNeill, S. J. Howard, S. A. Vella, R. Santos, and D. P. Cliff, "Physical activity and modified organized sport among preschool children: Associations with cognitive and psychosocial health," *Mental Health and Physical Activity*, vol. 15, pp. 45–52, 2018. https://doi.org/10.1016/j.mhpa.2018.07.001
[32] R. Zapata-Lamana *et al.*, "Anxiety, low self-esteem, and a low happiness index are associated with poor school performance in chilean adolescents: A cross-sectional analysis," *Int. J. Environ. Res. Public Health*, vol. 18, no. 21, p. 11685, 2021. https://doi.org/10.3390/ijerph182111685
[33] A. Drigas and L. Bakola, "The 8×8 layer model consciousness-intelligence-knowledge pyramid, and the platonic perspectives," *Int. J. Recent Contrib. from Eng. Sci. IT (iJES)*, vol. 9, no. 2, pp. 57–72, 2021. https://doi.org/10.3991/ijes.v9i2.22497
[34] S. Saganowski, B. Perz, A. G. Polak, and P. Kazienko, "Emotion recognition for everyday life using physiological signals from wearables: A systematic literature review," *IEEE Transactions on Affective Computing*, vol. 14, no. 3, pp. 1876–1897, 2023. https://doi.org/10.1109/TAFFC.2022.3176135
[35] V. Terzis, C. N. Moridis, and A. A. Economides, "Measuring instant emotions based on facial expressions during computer-based assessment," *Pers. Ubiquit. Comput.*, vol. 17, pp. 43–52, 2013. https://doi.org/10.1007/s00779-011-0477-y
[36] D. Maison and B. Pawłowska, "Using the facereader method to detect emotional reaction to controversial advertising referring to sexuality and homosexuality," in *Neuroeconomic and Behavioral Aspects of Decision Making*, *Springer Proceedings in Business and Economics*, K. Nermenr and M. Latuszynska, Eds., Springer, Charm, 2017, pp. 309–327. https://doi.org/10.1007/978-3-319-62938-4_20
[37] C. Crolic, F. Thomaz, R. Hadi, and A. T. Stephen, "Blame the bot: Anthropomorphism and anger in customer–Chatbot interactions," *J. Mark.*, vol. 86, no. 1, pp. 132–148, 2022. https://doi.org/10.1177/00222429211045687
[38] T. Skiendziel, A. G. Rosch, and O. C. Schultheiss, "Assessing the convergent validity between the automated emotion recognition software Noldus FaceReader 7 and facial action coding system scoring," *PLoS ONE*, vol. 14, no. 10, p. e0223905, 2019. https://doi.org/10.1371/journal.pone.0223905

[39] H. Wu *et al*., "Learn to sense: A meta-learning-based sensing and fusion framework for wireless sensor networks," *IEEE Internet of Things Journal*, vol. 6, no. 5, pp. 8215–8227, 2019. https://doi.org/10.1109/JIOT.2019.2919225
[40] World Medical Association, "World medical association declaration of Helsinki: Ethical principles for medical research involving human subjects," *JAMA*, vol. 310, no. 20, pp. 2191–2194, 2013. https://doi.org/10.1001/jama.2013.281053
[41] Noldus, "FaceReader." 2024. https://www.noldus.com/facereader [Accessed: Dec. 27, 2024].
[42] A. Bulat and G. Tzimiropoulos, "How far are we from solving the 2D & 3D face alignment problem? (and a dataset of 230,000 3D facial landmarks)," in *Proceedings of the IEEE International Conference on Computer Vision*, 2017, pp. 1021–1030. https://doi.org/10.1109/ICCV.2017.116
[43] M. Olszanowski *et al*., "Warsaw set of emotional facial expression pictures: A validation study of facial display photographs," *Frontiers in Psychology*, vol. 5, 2014. https://doi.org/10.3389/fpsyg.2014.01516
[44] J. Schalk *et al*., "Moving faces, looking places: The Amsterdam Dynamic Facial Expressions Set (ADFES)," *Emotion*, vol. 11, no. 4, pp. 907–920, 2011. https://doi.org/10.1037/a0023853
[45] L. Fiala and C. N. Noussair, "Charitable giving, emotions, and the default effect," *Econ. Inq.*, vol. 55, no. 4, pp. 1792–1812, 2017. https://doi.org/10.1111/ecin.12459
[46] E. Bartkiene *et al*., "Factors affecting consumer food preferences: Food taste and depression-based evoked emotional expressions with the use of face reading technology," *Biomed. Res. Int.*, vol. 2019, no. 1, pp. 1–10, 2019. https://doi.org/10.1155/2019/2097415
[47] A. Hadinejad, B. D. Moyle, A. Kralj, and N. Scott, "Physiological and self-report methods to the measurement of emotion in tourism," *Tour. Recreat. Res*., vol. 44, no. 4, pp. 466–478, 2019. https://doi.org/10.1080/02508281.2019.1604937
[48] K. Ploom, K. Pentus, A. Kuusik, and U. Varblane, "The effect of culture on the perception of product packaging: A multimethod cross-cultural study," *J. Int. Consum. Mark*., vol. 32, no. 3, p. 163–177, 2020. https://doi.org/10.1080/08961530.2019.1660752
[49] D. J. Moulds, J. Meyer, J. F. McLean, and V. Kempe, "Exploring effects of response biases in affect induction procedures," *PLoS ONE*, vol. 18, no. 5, p. E0285706, 2023. https://doi.org/10.1371/journal.pone.0285706
[50] A. Lavallee *et al*., "Monitoring the emotional facial reactions of individuals with antisocial personality disorder during the retrieval of self-defining memories," *PloS ONE*, vol. 17, no. 6, p. e0268818, 2022. https://doi.org/10.1371/journal.pone.0268818
[51] A. Ling, N. George, B. Shiv, and H. Plassmann," Altering experienced utility by incidental affect: The interplay of valence and arousal in incidental affect infusion processes," *Emotion*, vol. 23, no. 8, pp. 2179–2193, 2023. https://doi.org/10.1037/emo0001241
[52] M. Tsikandilakis, P. Bali, J. Derrfuss, and P. Chapman, "Anger and hostility: Are they different? An analytical exploration of facial-expressive differences, and physiological and facial-emotional responses," *Cognit. Emot.*, vol. 34, no. 3, pp. 581–595, 2020. https://doi.org/10.1080/02699931.2019.1664415
[53] M. Tersi and O. Matsuoka, "Improving social skills through structured playfulness program in preschool children," *Int. J. Instr.*, vol. 13, no. 3, pp. 259–274, 2020. https://doi.org/10.29333/iji.2020.13318a
[54] H. Weia *et al*., "Relationship between environmental factors and facial expressions of visitors during the urban forest experience," *Urban Forestry & Urban Greening*, vol. 53, p. 126699, 2020. https://doi.org/10.1016/j.ufug.2020.126699
[55] C. Y. Yua and C. H. Kob, "Applying facereader to recognize consumer emotions in graphic styles," *Procedia CIRP*, vol. 60, pp. 104–109, 2017. https://doi.org/10.1016/j.procir.2017.01.014

[56] B. McDaniel *et al.*, "Facial features for affective state detection in learning environments," in *Proceedings of the Annual Meeting of the Cognitive Science Society*, vol. 29, 2007. Retrieved from https://escholarship.org/uc/item/9w00945d

[57] J. S. Y. Chan *et al.*, "Therapeutic benefits of physical activity for mood: A systematic review on the effects of exercise intensity, duration, and modality," *J. Psychol*, vol. 153, no. 1, pp. 102–125, 2019. https://doi.org/10.1080/00223980.2018.1470487

[58] M. Bourke, T. A. Hilland, and M. Craike, "Domain-specific association between physical activity and affect in adolescents' daily lives: An ecological momentary assessment study," *Psychol. Health*, vol. 38, no. 3, pp. 369–388, 2021. https://doi.org/10.1080/08870446.2021.1965603

[59] A. Bandura, "Self-efficacy: Toward a unifying theory of behavioral change," *Psychol. Rev.*, vol. 84, no. 2, pp. 191–215, 1977. https://doi.org/10.1037/0033-295X.84.2.191

[60] C. P. Ransford, "A role for amines in the antidepressant effect of exercise: A review," *Med. Sci. Sport. Exerc*, vol. 14, no. 1, pp. 1–10, 1982. https://doi.org/10.1249/00005768-198201000-00001

[61] T. S. H. Wingenbach, C. Ashwin, and M. Brosnan, "Sex differences in facial emotion recognition across varying expression intensity levels from videos," *PLoS ONE*, vol. 13, no. 1, p. e0190634, 2018. https://doi.org/10.1371/journal.pone.0190634

[62] E. P. Koster and J. Mojet, "From mood to food and from food to mood: A psychological perspective on the measurement of food-related emotions in consumer research," *Food Res. Int*, vol. 76, pp. 180–191, 2015. https://doi.org/10.1016/j.foodres.2015.04.006

[63] D. Sauter, "More than happy: The need for disentangling positive emotions," *Current Directions in Psychological Science*, vol. 19, no. 1, pp. 36–40, 2010. https://doi.org/10.1177/0963721409359290

[64] B. Campos *et al.*, "Positive and negative emotion in the daily life of dual-earner couples with children," *J. Fam. Psychol.*, vol. 27, no. 1, pp. 76–85, 2013. https://doi.org/10.1037/a0031413

[65] C. Oveis, J. Gruber, D. Keltner, J. L. Stamper, W. T. Boyce, and L. Feldman Barrett, "Smile intensity and warm touch as thin slices of child and family affective style," *Emotion*, vol. 9, no. 4, pp. 544–548, 2009. https://doi.org/10.1037/a0016300

[66] M. LaFrance, M. A. Hecht, and E. L. Paluck, "The contingent smile: A meta-analysis of sex differences in smiling," *Psychol. Bull.*, vol. 129, no. 2, pp. 305–334, 2003. https://doi.org/10.1037/0033-2909.129.2.305

[67] W. Zheng, Y. Wu, and L. Chen, "Business intelligence for patientcenteredness: A systematic review," *Telemat. and Inform.*, vol. 35, no. 4, pp. 665–676, 2018. https://doi.org/10.1016/j.tele.2017.06.015

[68] P. Lewinski, T. M. Den Uyl, and C. Butler, "Automated facial coding: Validation of basic emotions and FACS AUs in FaceReader," *J. Neurosci. Psychol. Econ.*, vol. 7, no. 4, pp. 227–236, 2014. https://doi.org/10.1037/npe0000028

[69] V. Terzis, C. N. Moridis, and A. A. Economides, "Measuring instant emotions during a self-assessment test: The use of facereader," in *Proceedings of the 7th International Conference on Methods and Techniques in Behavioral Research*, 2010, pp. 1–4. https://doi.org/10.1145/1931344.1931362

[70] J. van der Schalk, S. T. Hawk, A. H. Fischer, and B. J. Doosje, "Moving faces, looking places: The Amsterdam Dynamic Facial Expressions Set (ADFES)," *Emotion*, vol. 11, no. 4, pp. 907–920, 2011. https://doi.org/10.1037/a0023853

[71] R. Hegestedt, J. Nouri, and U. Fors, "Factors influencing the implementation of data-driven techniques for students' mental health," *Int. J. Emerg. Technol. Learn.*, vol. 19, no. 8, pp. 48–60, 2024. https://doi.org/10.3991/ijet.v19i08.51941

[72] M. Gottlieb and M. C. Utesch, "Publish or perish: A scientific blueprint for a journal article," *Int. J. Eng. Ped.*, vol. 12, no. 3, pp. 171–177, 2022. https://doi.org/10.3991/ijep.v12i3.28253

[73] L. Lu, "A Comprehensive study on the relationship between user experience of mobile learning platforms and academic anxiety among college students," *Int. J. Interact. Mob. Technol.*, vol. 19, no. 3, pp. 41–55, 2025. https://doi.org/10.3991/ijim.v19i03.53951

[74] P. Salmon, "Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory," *Clin. Psychol. Rev.*, vol. 21, no. 1, pp. 33–61, 2001. https://doi.org/10.1016/S0272-7358(99)00032-X

[75] M. A. M. Peluso and L. H. S. G. de Andrade, "Physical activity and mental health: The association between exercise and mood," *Clinics*, vol. 60, no. 1, pp. 61–70, 2005. https://doi.org/10.1590/S1807-59322005000100012

[76] M. C. Keller *et al.*, "A warm heart and a clear head. The contingent effects of weather on mood and cognition," *Psychol. Sci*, vol. 16, no. 9, pp. 724–731, 2005. https://doi.org/10.1111/j.1467-9280.2005.01602.x

[77] F. W. Schneider, W. A. Lesko, and W. A. Garrett, "Helping behavior in hot, comfortable and cold temperature: A field study," *Environ. Behav.*, vol. 12, no. 2, pp. 231–241, 1980. https://doi.org/10.1177/0013916580122007

[78] Y. Zhao, L. Yan, and H. T. Keh, "The effects of employee behaviors on customer participation in the service encounter: The mediating role of customer emotions," *Eur. J. Mark.* vol. 52, nos. 5/6, pp. 1203–1222, 2018. https://doi.org/10.1108/EJM-10-2016-0559

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