

Virtual Reality Fractal Mindfulness to Support Menopause Symptoms, Sexual Function, Cognitive Mindfulness, and Well-being: A Pilot EEG Study

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Aims

- Looking at the effectiveness of immersive fractal mindfulness for menopause symptoms.
 - Wait-list-controlled RCT
 - VR and EEG outcomes
 - Where the research goes from here





Introduction-Menopause

- Menopause is both a biological and psychological milestone that signifies the end of a woman's reproductive capacity and typically occurs between the ages of 45 and 55 (Nelson, 2008).
- A multitude of physiological, emotional, cognitive, and sexual symptoms often accompany this transition (Avis et al., 2015). During the menopausal transition, or perimenopause, oestrogen levels fluctuate, resulting in vasomotor symptoms such as hot flushes and night sweats, as well as psychological symptoms like anxiety and irritability (Freeman et al., 2006).
- It has profound social and emotional repercussions and can affect women's well-being in various ways, including their sexual function.
- Many women experience sexual difficulties such as decreased desire, vaginal dryness and pain during intercourse (Dennerstein et al., 2005).

What is mindfulness?

- Mindfulness is about paying attention — without judgment.
- The overwhelming consensus suggests mindfulness can mitigate negative self-thoughts and shame and increase well-being and efficacy, supporting behavioural change (Bowen & Enkema, 2014).
- Whilst cognitive behaviour therapy is the preferred psychosocial intervention for menopause, mindfulness is slowly gaining momentum in healthcare to support symptoms.



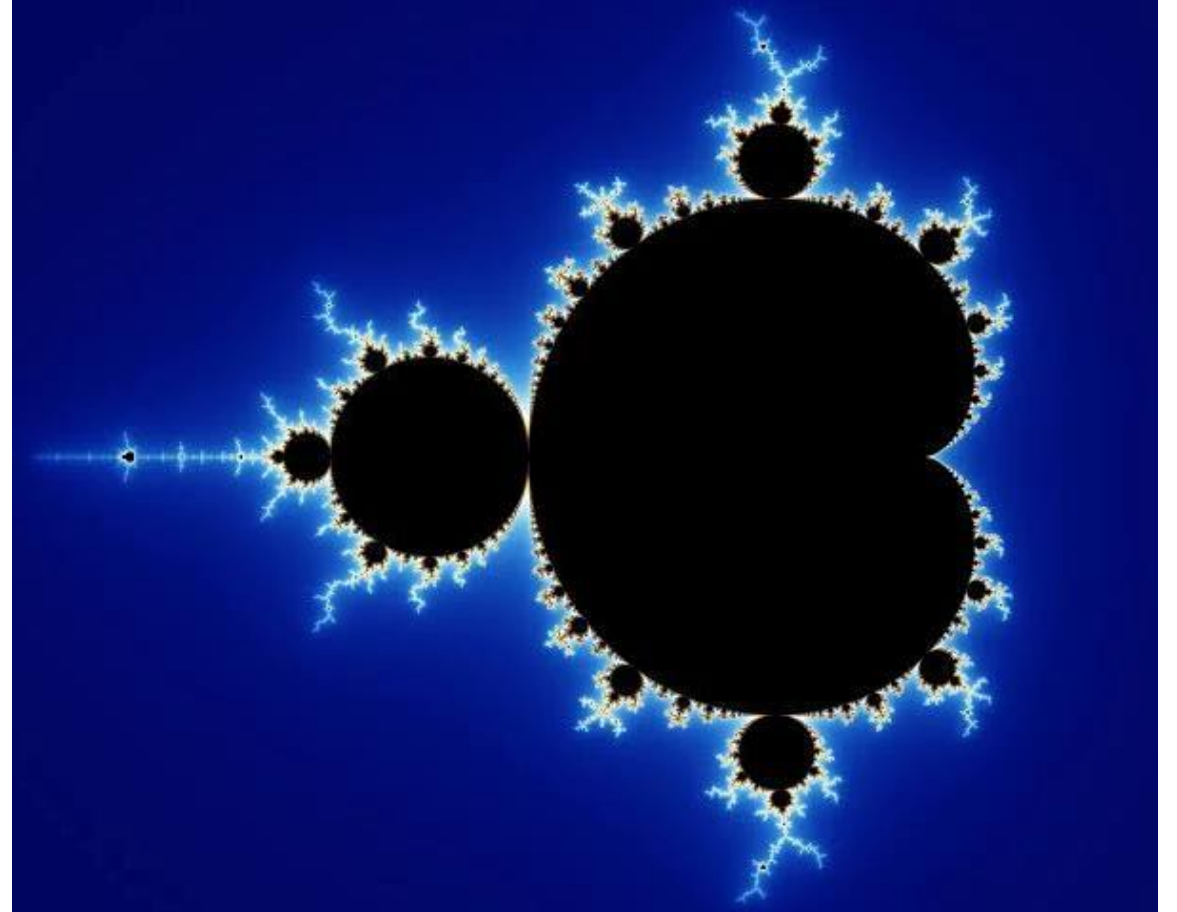
Why immersive mindfulness?

- VR creates a sense of presence with visual and auditory cues (under their control). This minimises spectating (Seabrook et al., 2020), which helps users focus attention on the present moment.
- Further, incorporating VR as an adjunct counselling intervention has increased the ease and acceptability of treatment compared to a non-VR intervention in supporting well-being (e.g. Boeldt et al., 2019).



And fractals? – broken...

- John Briggs.
- The Mandelbrot set has become the most famous object in modern mathematics- fractals.
- While fractals are quite complex, they're formed by simple equations that repeat endlessly

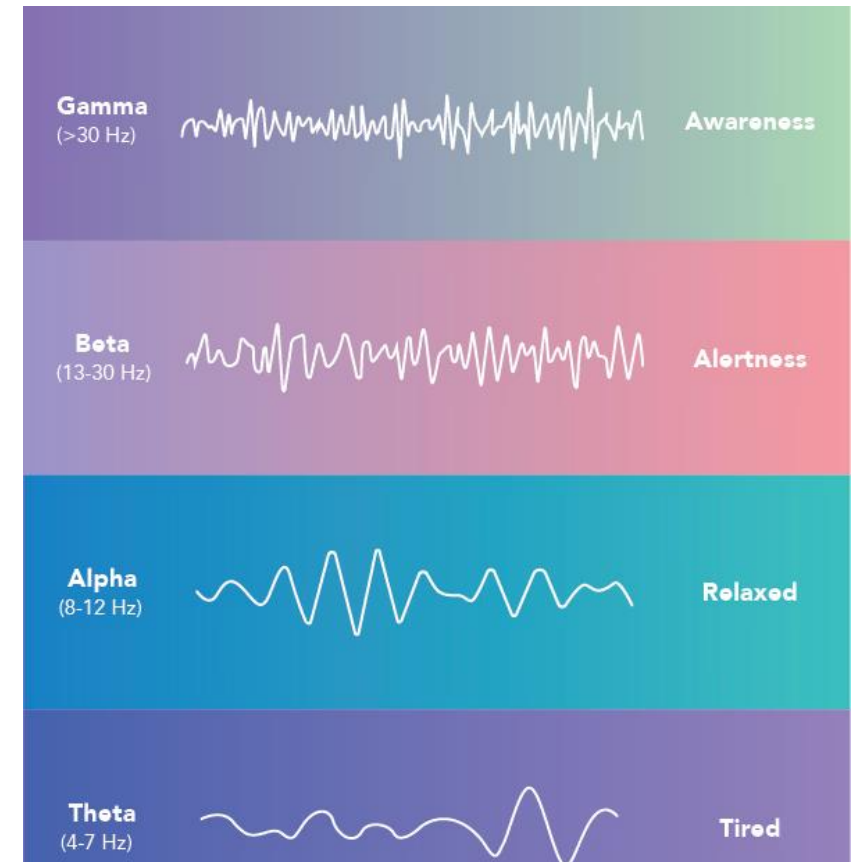


Fractals in nature



Using fractals in nature to support stress

- Taylor (2006; 2011) examined the impact of fractals on art and science, as well as their relationship to stress levels.
- Three intentionally stress-inducing tasks were presented to 24 participants using various fractal stimuli.
- The results suggested that stress levels decreased with fractal exposure, revealing a significant difference in alpha response activity in the frontal region of the brain.
- Another study found that the highest levels of alpha waves occurred in the frontal and occipital areas of the brain after exposure to fractal patterns, as observed using an EEG (Hagerhall et al., 2008).



Artificial fractals – Immersive alternatives

- Fractals have become more accessible and scalable through digital platforms, enabling their integration into mainstream healthcare (Loucks et al., 2022).
- Through immersive, multisensory environments designed to support emotional regulation, attentional focus, and cognitive restoration, VR has shown promise in enhancing mindfulness (Ma et al., 2025).
- In these psychologically safe spaces, users can explore bodily awareness, process emotions, and reflect on their identity in dynamic and personalised ways (Bell et al., 2020).



The background is a complex, symmetrical digital environment. It features a central perspective view down a long, glowing corridor. The walls and ceiling are composed of intricate, fractal-like patterns in shades of blue, purple, and white. Numerous small, glowing cubes and spheres are scattered throughout the scene, some appearing to float in the air. In the foreground, a white VR headset is visible, suggesting the viewer is experiencing this virtual world. The overall atmosphere is one of high-tech, digital artistry.

Methodology- Julius Horsthuis fractal artist

<https://www.julius-horsthuis.com/recombination>

Methodology

- A mixed methods approach
 - waitlist control RCT
- A content analysis was conducted on participants' feedback on the VR intervention.
- Recombination – 3D Mandlebrot
- EEG – Spiker box

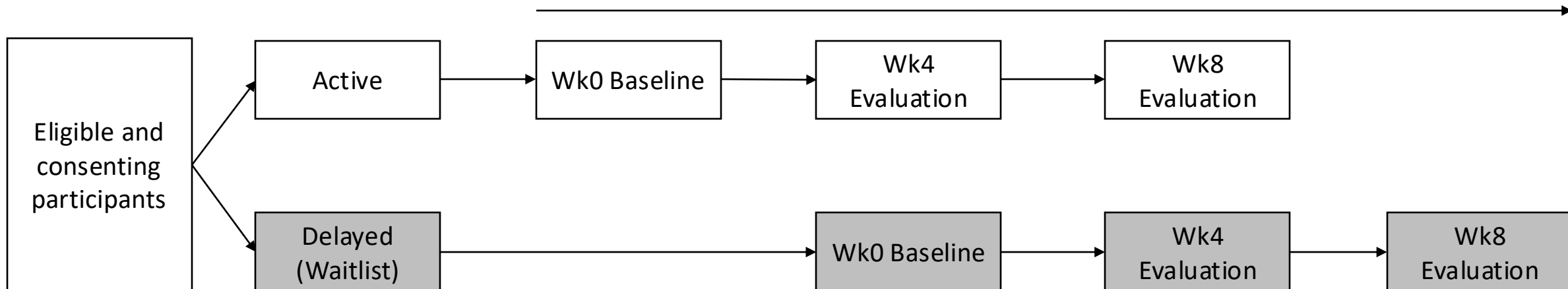
Measures

Menopause Symptom Questionnaire (NHS, 2017)

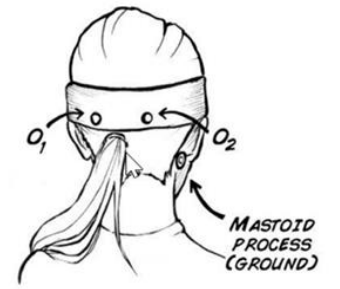
Female Sexual Function Index (FSFI) (Rosen et al., 2000)

Cognitive and Affective Mindfulness Scale – Revised (CAMS-R) (Feldman et al., 2007)

Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS) (Tennant et al., 2007)



Spiker Box

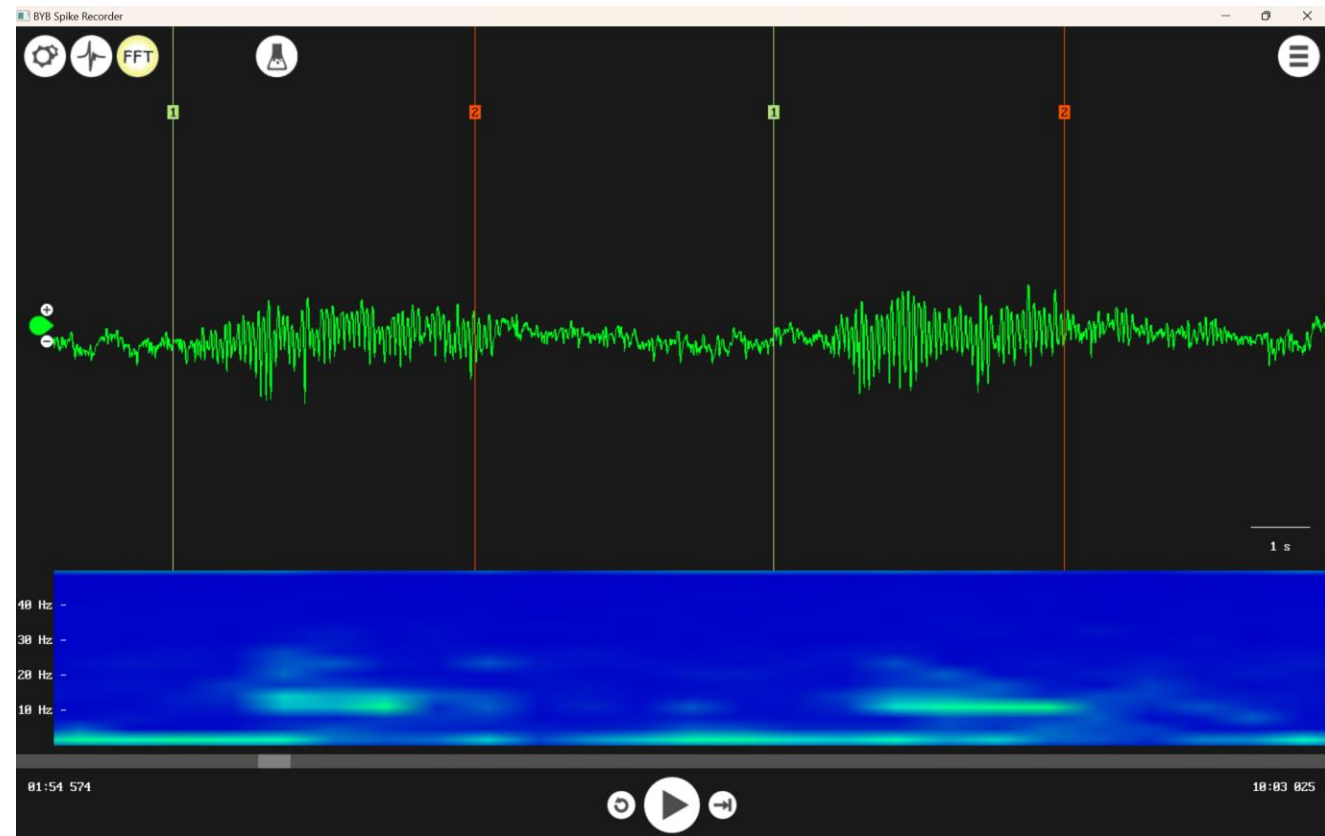


- EEG data were recorded continuously during each fractal VR session.
- EEG data were also recorded during a rest session (alternating eyes open and eyes closed).

How do we know our EEG is working?

- Because we see alpha waves when the participant closes his eyes (
- 1> Eyes closed= high amplitude and low frequency 10 Hz brain waves called **alpha waves**.
- 2> Eyes opened= alpha waves disappear

In our experiment, we compare the EEG patterns from participants with their eyes open to those recorded while they are immersed in VR fractals



Study demographics



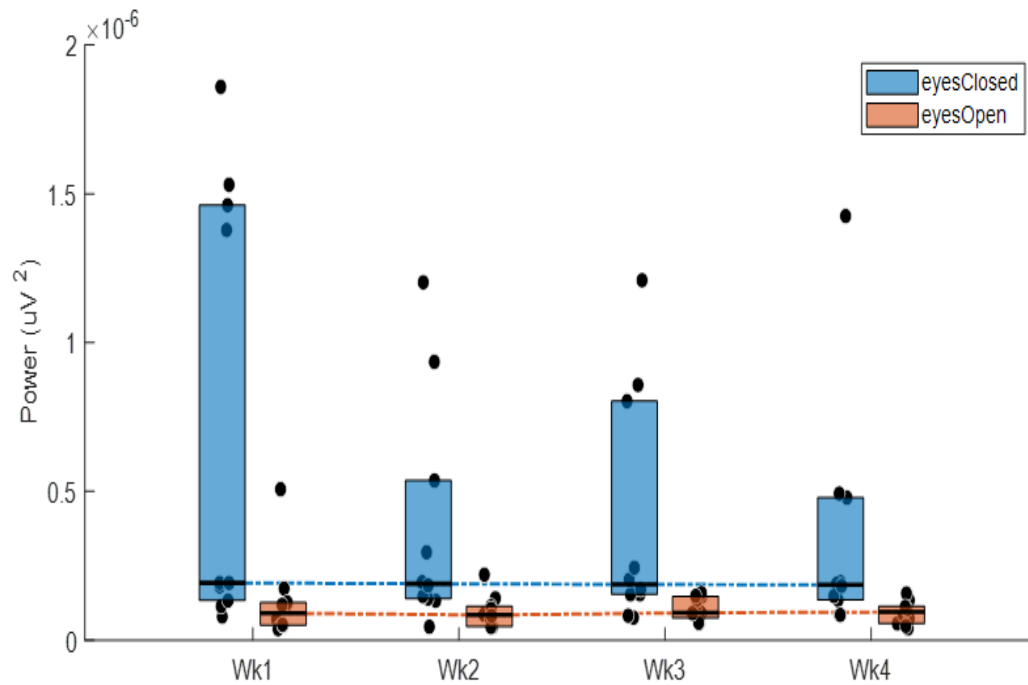
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- The majority of participants were aged between 46–55 (n = 9, 50.0%), followed by those aged 36–45 (n = 7, 38.9%) and 56–65 (n = 2, 11.1%).
 - Ethnically, two-thirds of the sample identified as White (n = 12, 66.7%), while the remaining participants identified as Asian or Asian British (n = 3, 16.7%) or as Mixed or multiple ethnic groups (n = 2, 11.1%).
 - The nationalities were diverse, with participants identifying as British (n = 7, 38.9%), Polish (n = 3, 16.7%), Hungarian (n = 3, 16.7%), Brazilian (n = 3, 16.7%), Lithuanian (n = 1, 5.6%), and Australian (n = 1, 5.6%).
 - Participants also reported various durations for experiencing menopausal symptoms. Half of the sample (n = 9, 50.0%) had experienced symptoms for three or more years or were unsure, while 27.8% (n = 5) reported two years, and 22.2% (n = 4) reported having symptoms for one year or less.
 - N = 9 (50.0%) were using MHT or bioidentical hormones. None of the participants were engaged in any psychosocial or psychosexual intervention at the time of this intervention.

Results- self report measures

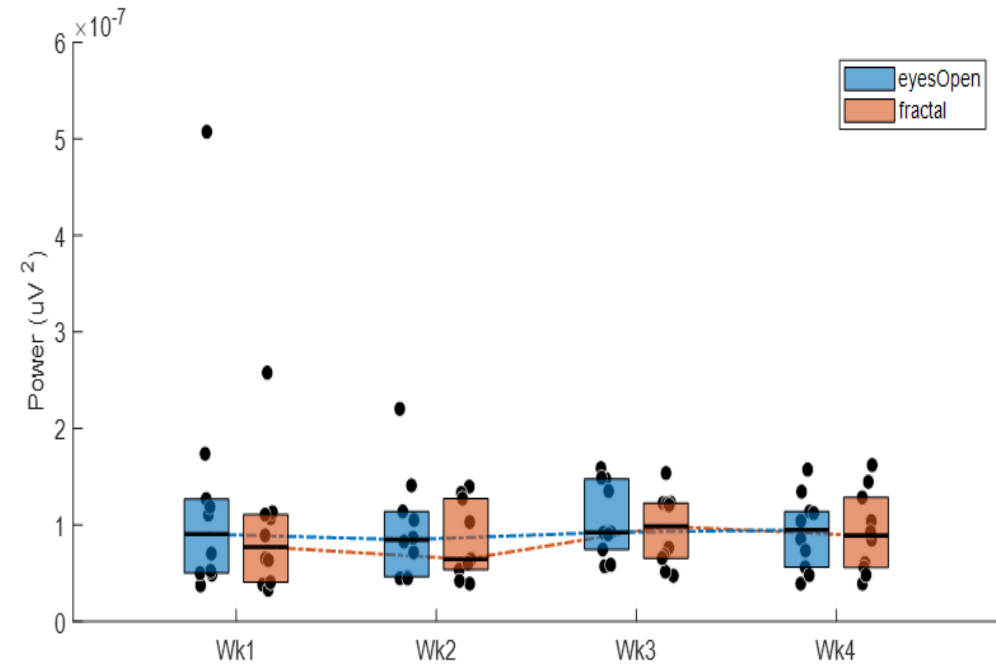
	Active Group		Delayed Group	
Week	M	SD	M	SD
Cognitive mindfulness				
0	29.333	4.549	25.632	4.152
4	29.667	6.595	28.611	4.612
8	40.222*	2.817	43.257**	3.266
Menopause – emotional symptoms				
0	14.444	3.575	14.233	2.922
4	10.332	3.775	9.572	3.101
8	10.889	3.100	8.571*	3.101
Menopause – local and sexual symptoms				
0	10.778	2.728	10.333	2.925
4	6.778	1.481	8.571	2.101
8	7.777*	2.333	7.571*	3.101
Menopause – other/aches and pains				
0	9.889	1.616	9.720	2.928
4	6.778	2.333	6.571	2.100
8	6.888**	2.204	6.671*	2.101
Sexual arousal				
0	5.223	2.814	5.285	2.924
4	6.333	2.291	6.211	2.102
8	8.000*	1.322	8.835**	1.100
Sexual desire				
0	6.625	0.915	6.663	1.825
4	11.875	1.457	11.714	1.604
8	11.750*	1.580	11.710*	1.703
Well-being				
0	23.556	5.812	24.426	5.122
4	28.667	4.555	25.143	4.645
8	31.222**	3.598	31.286**	3.162
* $p < 0.05$				
** $p < 0.001$				

EEG Outcomes

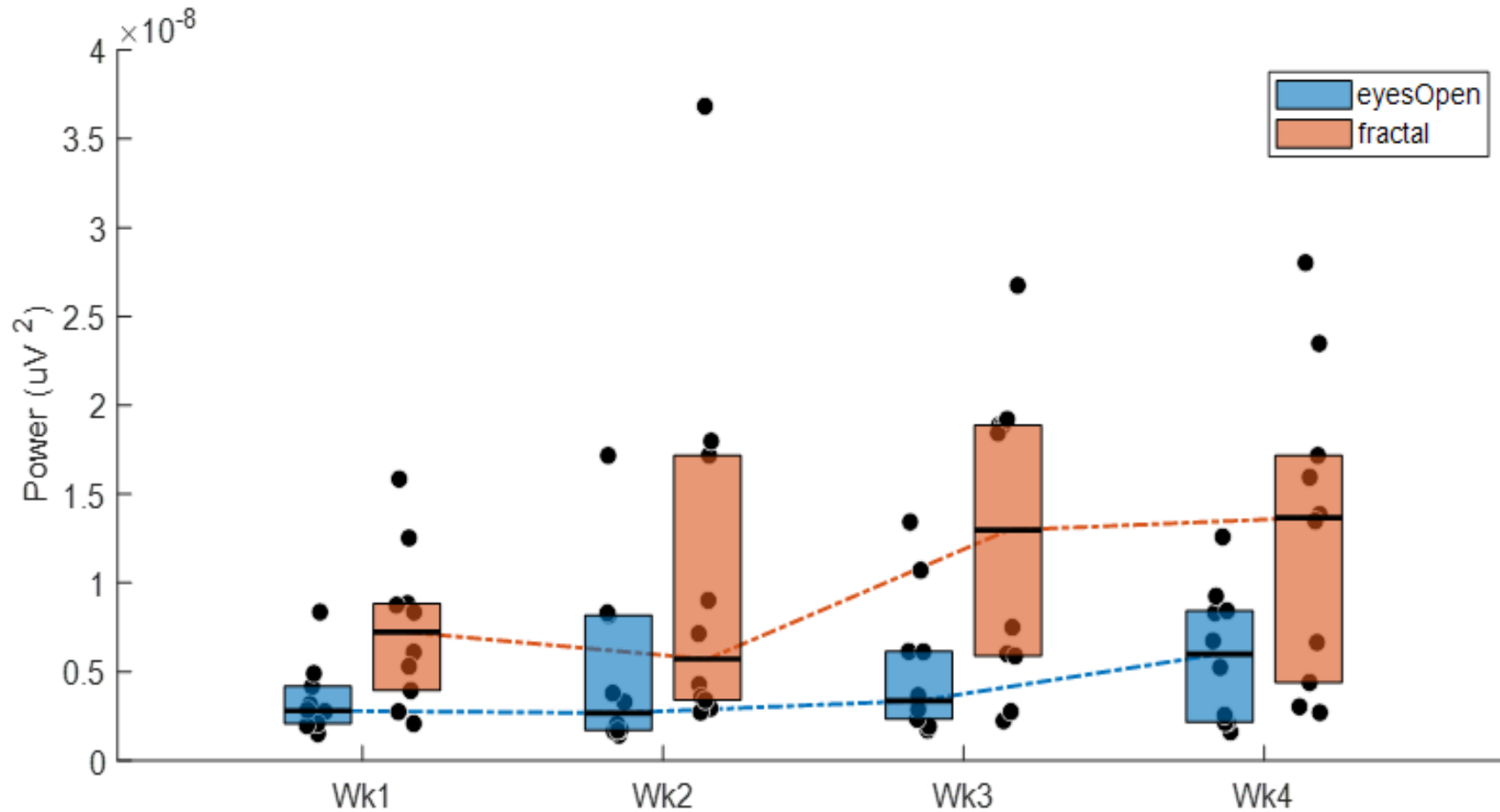
Alpha waves: Eyes Closed vs Eyes Open



Alpha waves: Eyes Open vs VR mindful fractals



Gamma Eyes Open vs VR mindful fractals



Qualitative- feedback week 8

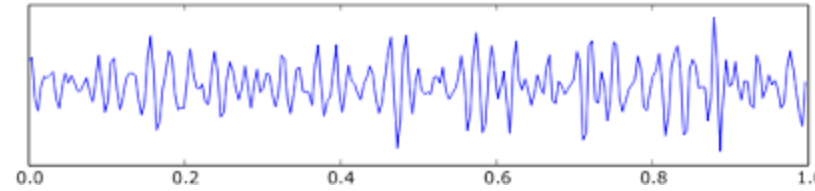
- Question 1: What aspects of the intervention did you find most helpful, and why?
- At week 4, the majority of respondents, $n = 6$ (35.3%), found the intervention helpful for relaxation. Additionally, $n=5$ participants (29.4%) reported that it improved their mental well-being and positivity, while $n=5$ participants (29.4%) noted increased awareness and enhanced symptom management. According to $n = 3$ (17.6%), the intervention also supported improved sleep quality. By week 8, relaxation and stress reduction were cited as the most beneficial aspects by $n=10$ participants (58.8%).
- Question 2: What changes or additions would you suggest to improve this intervention?
- Several feedback reports indicated that the duration of the intervention requires improvement. At weeks 4 and 8, with $n = 14$ (82.4%), participants suggested a longer duration with extended sessions.
- Question 3: Do you have any further comments or reflections?
- $N = 7$ (41.2%) participants described the VR experience as immersive and highly engaging in Week 4. A total of $n=5$ respondents (29.5%) reported that VR assisted them in relaxing and focusing, while $n=3$ participants (17.6%) indicated that it enhanced their sense of connection and presence. In Week 8, 62.7% of participants ($n = 11$) characterised their experience as very positive and enjoyable, with $n = 5$ (29.4%) noting relaxation, spiritual uplift, and increased awareness. The intervention was also described as life-changing or deeply meaningful by $n=4$ participants (23.5%), and stress management, along with emotional support, was mentioned by $n=5$ participants (29.4%).



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- Question 4: How effective was the intervention in managing or alleviating symptoms?
 - N = 6 (35.3%) reported increased body awareness and comfort in week 4; n = 5 (29.4%) noted enhanced emotional intimacy; and n = 4 (23.5%) reported reduced sexual discomfort. The majority of participants (100%) indicated that they would recommend the intervention to others, citing relaxation support, improved mental well-being, and the overall enjoyable nature of the intervention.
 - Question 5: Did you notice any changes in your peri/menopausal symptoms throughout the intervention?
 - The participants reported improved sleep patterns in week 4, a decrease in emotional symptoms in n=7 (41.2%), fewer physical symptoms, and increased energy levels in n=5 (29.4%), along with improved memory and concentration in n=2 (11.8%). By week 8, participants reported increased relaxation and calmness, along with improved sleep quality and a decrease in anxiety and stress. A total of n=11 (64.7%) reported improved relaxation and calmness, n=7 (41.2%) reported greater mindfulness, n=6 (33.5%) reported increased energy and motivation, and n=5 (29.4%) reported fewer menopausal symptoms.



Discussion



- This study aimed to assess the effectiveness of the immersive VR fractal intervention in reducing peri/menopausal symptoms and improving sexual function, cognitive mindfulness, and overall well-being.
- The hypotheses received partial support, as not all areas of peri/menopausal symptoms or sexual functioning showed positive results with fractal patterns. However, peri/menopausal symptoms can be complex, and further research is necessary to clarify the role of fractal mindfulness in this context.
- Both the active and delayed groups showed significant improvements in local and sexual symptoms of menopause, as well as other symptoms such as aches and pains. Additionally, levels of cognitive mindfulness, well-being, sexual arousal, and sexual desire increased in both groups. An interaction effect was observed between these variables in the active and delayed groups.
- In the EEG data, interestingly, participants exhibited elevated gamma activity while engaged with the VR fractals.

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- The visual cortex stimulated during a psychedelic experience produces fractal patterns, which influence the interpretation of these visual fractals, making them more “familiar to us” as they form part of “our innate” biopsychological understanding (e.g. Bressloff et al., 2002).
 - These patterns, symbols, and fractals resonate with Jung's theories on archetypes embedded within the human psyche. This can evoke a deep sense of self-awareness or enlightenment in various contexts, including self-exploration and introspection.
 - Jung viewed meditation as a means of developing self-understanding and recognising one's projections, exploring the mind and archetypes that may surface during meditation (cited Smalley, 2007).



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- Consistent with prior research, the baseline analysis confirmed an apparent increase in alpha power (8–12 Hz) during the ‘eyes closed’ condition compared to ‘eyes open’, indicating the expected occipital alpha rhythm associated with relaxed wakefulness (Hohaia et al., 2022).
 - This effect validates both the protocol and the signal quality of the Backyard Brains headband. In contrast, alpha power did not differ significantly between the eyes-open and VR fractals conditions, suggesting that the VR fractals experience did not disrupt the baseline alpha rhythm beyond the level of normal visual engagement.
 - However, gamma band power (25–45 Hz) showed a significant condition effect, with VR fractals producing reliably higher gamma activity compared to eyes-open rest.
 - This modulation of gamma activity may reflect enhanced sensory processing and cognitive integration during immersive VR exposure.



Conclusion



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- Overall, the outcomes favoured the intervention, particularly concerning local and sexual peri/menopausal symptoms, as well as other complaints such as aches and pains.
 - Levels of cognitive mindfulness and well-being also increased, highlighting interaction effects among these variables. Importantly, various adjunct treatments and alternative interventions that utilise the growing use of technology, including VR, are vital for promoting healthcare engagement.
 - Peri/menopause requires attention, as it often receives limited support aside from standard biological treatments that are readily available. MHT remains the gold standard for peri/menopause symptoms but perhaps emphasises the need for alternative therapies or options that may offer a holistic approach to supporting women during this transition.
 - Furthermore, this intervention could complement standard counselling practices in assisting women with different aspects of their peri/menopause journey or serve as part of relational therapy. Indeed, the use of fractal mindfulness in therapeutic settings is gaining popularity, whether derived naturally or artificially.
 - The key is providing a diverse range of healthcare options to cater to a broad spectrum of individuals, thereby enhancing their well-being and quality of life. There remains much to learn about the application of fractals and mindfulness in promoting well-being.
 - We hope this research will encourage further studies into supporting fractal mindfulness pattern research and evaluating and advancing potential healthcare interventions.

Sample References

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Collaboration welcome

Thank you

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