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Research Article

Analysis of Psychological and Physiological Responses to Snoezelen Multisensory Stimulation

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Abstract

This study evaluates the effects of two months of regular snoezelen therapy on anger-hostility (AH), assessing both psychological and physiological indicators before and after the intervention. Using the Profile of Mood States (POMS-2), the research measured changes in anger-hostility levels and stress responses, comparing pre- and post-intervention data. At baseline, participants exhibited relatively high levels of anger-hostility, with psychological scores averaging 40.14 (± 2.46) and physiological scores averaging 42.25 (± 2.71), indicating significant irritability, aggression, and elevated stress responses. After two months of multisensory stimulation in a snoezelen room, participants' psychological scores decreased to 37.40 (± 2.26) and physiological scores to 39.50 (± 2.01), suggesting improvements in mood and physiological stress. The statistical analysis yielded a *p* - value of 0.047, indicating that the reductions were significant. These findings suggest that snoezelen therapy can be effective in reducing anger-hostility and associated physiological stress, offering a promising intervention for emotional regulation and stress management.

Introduction

The Snoezelen approach was developed based on the idea that sensory stimulation offers a meaningful experience, particularly beneficial for individuals with limited cognitive abilities [1,2]. This multisensory therapy uses controlled sensory stimuli to create a soothing environment, which can positively impact both physical and mental well-being, especially for those who experience sensory deprivation in social care settings [2].

Snoezelen therapy has been shown to induce relaxation, which is believed to contribute to a variety of positive effects, including reductions in challenging behaviors and improvements in adaptive behaviors [1,3]. Research has further demonstrated its benefits in lowering arousal levels and enhancing stress regulation, making it an effective tool for managing emotional and behavioral responses. Studies by Cameron, et al. [4], Haig and Hallett [5], and Ismail, et al. [6] support these findings, indicating that Snoezelen environments can help individuals achieve calm and sympathetic nerve–adrenal medulla system" (SAM system) and the "hypothalamus–anterior pituitary-adrenal cortex system" (HPA system). [7]. Multisensory stimulation, such as that provided by Snoezelen therapy, can have a significant impact on the stress system, particularly the HPA axis and the autonomic nervous system (ANS), both of which are crucial in the body's response to stress. When stress is activated, the HPA axis triggers a cascade of physiological and emotional changes aimed at mobilizing the body's resources to deal with the stressor, such as increased heart rate, blood pressure, and blood sugar levels. However, prolonged activation of the HPA axis, as noted by Tsigos [8], can lead to allostatic load, which contributes to physical and psychological health deterioration.

Snoezelen therapy, through its multisensory environment, offers a potential counterbalance to this stress response. By providing controlled and soothing stimuli such as gentle tactile, auditory, and visual inputs, Snoezelen creates an environment that encourages relaxation and sensory

integration. This can help reduce the overactivation of the stress system by promoting parasympathetic nervous system activity, which counteracts the stress-induced fight-or-flight response. The research by Speranza, et al. [9] and Thoma, et al. [10] highlights the significant role of auditory stimulation, particularly music, within Snoezelen therapy in promoting emotional well-being and stress reduction. According to Speranza, et al. [9], listening to music within a Snoezelen environment can trigger the release of neurotransmitters such as dopamine and endorphins. These chemicals are known to promote feelings of pleasure and well-being, thus enhancing the therapeutic effects of the multisensory environment. The calming and enjoyable nature of music helps foster a positive emotional state, which is particularly beneficial for individuals experiencing anxiety or stress.

Furthermore, the study by Thoma, et al. [10] provides insight into the physiological benefits of sensory stimulation through music. Their research demonstrated that music can modulate physiological responses by reducing cortisol levels (a stress hormone), lowering heart rate, and decreasing blood pressure. These physiological markers are commonly associated with reduced stress and anxiety, supporting the idea that sensory stimulation through music in Snoezelen therapy can have a direct impact on the body's stress response, helping to alleviate symptoms of anxiety and promote a more relaxed state. Tsigos´study [8] suggests that exposure to multisensory environments can enhance neuroplasticity and cognitive performance, which may contribute to stress resilience.

The principles of multisensory stimulation integration explored in Snoezelen therapy resonate with findings on the effects of simulated multisensory environments on physiological and psychological restoration. In Snoezelen settings, tactile stimulation plays a critical role in improving physiological recovery, aligning with research emphasizing its importance in restoring physical equilibrium [11].

Similarly, Snoezelen therapy's focus on multisensory engagement, including olfactory and gustatory stimulation, parallels findings that these sensory triggers are pivotal for psychological recovery. They help alleviate anxiety and stress, as seen in studies on virtual urban green spaces [12,13], while also enhancing cognitive abilities. These connections underscore the therapeutic potential of Snoezelen environments to foster holistic recovery through carefully integrated sensory modalities.

Research

Snoezelen therapy, a form of multisensory stimulation designed to engage various sensory pathways, has been widely used to promote relaxation, reduce stress, and improve mood. This research aimed to evaluate the psychological and physiological effects of snoezelen therapy, particularly its impact on mood disturbances, anxiety, fatigue, and overall well-being. By analyzing changes in several emotional and physiological measures before and after the intervention, the study sought to determine whether snoezelen therapy could significantly alleviate symptoms of anxiety, depression, and fatigue while enhancing feelings of vigor and satisfaction. The results of this research provide valuable insights into the potential benefits of snoezelen therapy for improving mental and physical health.

Methods

This study employed a pre-post design to assess the impact of Snoezelen therapy on both psychological and physiological indicators. Participants were assessed on these indicators before and after undergoing two months of therapy. The assessments aimed to evaluate any changes in mood, physiological responses, and overall well-being, with a focus on the potential benefits of multisensory stimulation. Snoezelen therapy was administered in a specialized multisensory environment designed to engage participants' five senses. The environment included visual stimulation through bubble tubes, glowing fiber optics, projectors, and more; auditory stimulation with soft, healing music played continuously; and olfactory stimulation through the use of calming aromas. The lighting was dimmed using optic curtains to create a relaxing atmosphere.

Each participant underwent two months of therapy, with sessions occurring twice a week. The sessions lasted for 30 minutes each, allowing participants to experience the full range of sensory inputs while maintaining a calm and controlled environment.

The study used tools to assess psychological and physiological responses, including the Short Version of the ADULT Profile of Mood State, 2nd Edition (POMS 2-AS), the State-Trait Anxiety Inventory (STAI), and fatigue measured via a numerical rating scale. Seven mood scales such as anger–hostility (AH), confusion–bewilderment (CB), depression–dejection (DD), fatigue–inertia (FI), tension–anxiety (TA), vigor–activity (VA), friendliness (F), and plus total mood disturbance (TMD) were determined using standardized scores for each factor.

A two-factor analysis of variance (ANOVA) was conducted, with the independent variables being the experimental condition and time. This design allowed for an examination of changes in mood, anxiety, and stress. Statistical analysis was performed to compare pre-and post-intervention data on psychological and physiological measures. Paired t-tests were used to identify significant changes in the indicators measured. The relationship between the degree of independence and therapy outcomes was also examined to assess whether higher levels of support influenced the effectiveness of the Snoezelen therapy.

The sample for the study consisted of 82 individuals

with intellectual disabilities, aged between 35 and 45 years, all residing in social care centers. All participants had completed primary education and came from diverse family backgrounds, including those with patchwork (18%) or divorced families (23%) and unstable social environments (24%) and foster family environments (35%). Participants were also affiliated with either the Catholic (77%) or Evangelical faiths (23%).

These individuals were evaluated to identify differences in psychological and physiological indicators before and after undergoing two months of Snoezelen therapy. Additionally, the sample included an assessment of participants' degrees of independence from social services, as defined by Law 448/2008 Z.z., providing a framework for understanding the level of support required by each individual. This comprehensive demographic, social, and legal context allowed for a nuanced analysis of the therapy's effects across varying levels of independence, family dynamics, and spiritual backgrounds.

This study was conducted with the approval of the Review Board of Ethics Committee, St. Elisabeth University of Health and Social Work including confirmed participants´ informed content under Prameň nádeje Social Care Centre (No. 2024-0902). The participants took a 10-minute test to induce a mental stress load, followed by a 20-minute Snoezelen therapy lasting 2 months (2 x per week). Snoezelen was a type of therapy that involved a multisensory environment designed to gently stimulate the five human senses through various visual, auditory, and olfactory inputs. The environment typically featured dim lighting, achieved through blackout curtains, and visual stimulation from elements such as bubble tubes, glowing fiber optics, projectors, and mirror balls. Auditory stimulation was provided by soft, soothing tunes, including healing music, which created a calm and relaxing atmosphere. Additionally, olfactory stimulation was incorporated through the use of calming aromas. This combination of sensory inputs was intended to promote relaxation, reduce anxiety, and improve emotional well-being and mood. The therapy was particularly beneficial for individuals with intellectual disabilities or sensory processing challenges, as it provided a controlled environment where participants could engage with sensory stimuli in a way that suited their individual needs.

The selection criteria for the study included the following:

- **Diagnosis:** Individuals had to have a confirmed diagnosis of intellectual disability.
- **Age range:** Participants were required to be aged between 35 and 45 years.
- **Residential status:** Individuals needed to be residents of social care centers at least for 6 months.
- **Degree of independence:** Eligibility was based on their classification under Law 448/2008 Z.z., which defines levels of dependency on social services.
- **Willingness to participate:** Participants had to consent to take part in the study.
- **Stable health condition:** Participants needed to have a stable physical and mental health condition to ensure their ability to engage in the Snoezelen therapy sessions.

Results

The sample consisted of 82 individuals with intellectual disabilities, aged 35 to 45 years, residing in social care centers. Participants were assessed for differences in psychological and physiological indicators both before and after two months of snoezelen therapy. The therapy involved regular multisensory stimulation within a snoezelen room, designed to promote relaxation, reduce stress, and improve overall emotional well-being. The baseline measurements, taken prior to the intervention, revealed relatively high scores on both psychological and physiological indicators, with participants showing significant levels of anger-hostility, including irritability, aggression, and reduced impulse control. Physiologically, the elevated scores indicated heightened stress responses, such as increased heart rate and blood pressure, and elevated levels of stress hormones like cortisol and adrenaline.

The main research aim was to analyse differences between psychological and physiological indicators that were assessed by observation and testing two months before using Snoezelen therapy and two months of regular multisensory stimulation in the Snoezelen room.

The research evaluates the effects of two months of regular snoezelen therapy on anger-hostility (AH) (Table 1), using the Profile of Mood States (POMS-2) to measure changes in both psychological and physiological indicators. Initial (pre-intervention) scores were relatively high, with participants averaging 40.14 (± 2.46) on psychological measures and 42.25 (± 2.71) on physiological measures. These elevated scores indicate significant levels of irritability, aggression, and reduced impulse control, alongside heightened physical stress responses, such as elevated heart rate, blood pressure, and increased levels of stress hormones like adrenaline and cortisol. Chronic anger, as reflected in these baseline scores, poses risks to both mental well-being and physical health, as it often leads to increased inflammation and cardiovascular strain.

After two months of regular multisensory stimulation in a snoezelen room, participants' post-intervention scores showed noticeable reductions, with psychological indicators decreasing to an average of 37.40 (± 2.26) and physiological

Table 1: Differences between psychological and physiological indicators.

POMS-2	Pre	Post	P
Anger Hostility (AH) • **Psychological Effects**: Increased irritability, aggression, and reduced impulse control. Chronic anger can impair relationships, increase resentment, and contribute to a negative outlook on situations and people.	40.14 ± 2.46	37.40 ± 2.26	0.047**
• **Physiological Effects**: Elevated heart rate and blood pressure, increased adrenaline and cortisol levels, and heightened muscle tension. Chronic anger may also lead to inflammation, which is linked to cardiovascular risks.	42.25 ± 2.71	39.50 ± 2.01	
Confusion–Bewilderment (CB) • **Psychological Effects**: Feelings of disorientation, indecisiveness, and impaired cognitive functioning. Confusion can cause frustration, reduced self-confidence, and a sense of helplessness.	41.24 ± 2.55	41.00 ± 2.50	0.29 *
• **Physiological Effects**: Altered neural activity, especially in the prefrontal cortex, can impair cognitive processing and memory. Chronic confusion can lead to prolonged cortisol elevation, and affect concentration and mental clarity.	40.52 ± 2.42	40.02 ± 2.40	
Depression– Dejection (DD) • **Psychological Effects**: Feelings of hopelessness, low self-worth, and a lack of motivation. Depression often involves ruminative thought patterns, diminished pleasure, and social withdrawal.	45.24 ± 4.46	45.00 ± 4.35	0.24 *
• **Physiological Effects**: Lower serotonin and dopamine levels, chronic fatigue, appetite changes, weakened immune function, and reduced neurogenesis in the hippocampus. Long-term depression is associated with increased inflammation and cortisol.	48.05 ± 4.63	47.56 ± 4.20	

Notes: Values were expressed as mean ± standard deviation. For statistical analysis, a two-factor analysis of variance with the snoezelen condition and time as independent variables was performed to compare before and after multisensory stimulation. Furthermore, Spearman's rank correlation coefficient was used to examine the relationship between psychological and physiological indices *$p \geq 0.05$, ** $p < 0.01$.

indicators to 39.50 (± 2.01). These lower scores suggest improvements in mood, reflecting reduced irritability, aggression, and physiological stress. Statistically, the *p* - value of 0.047 indicates that these reductions are significant, meaning the changes are likely due to the intervention rather than random chance.

The results from the snoezelen therapy study on Confusion–Bewilderment (CB), assessed through the Profile of Mood States (POMS-2), show minimal changes in both psychological and physiological measures over the two-month intervention period. At baseline (pre-intervention), the average psychological score for confusion–bewilderment was 41.24 (± 2.55), while the physiological score averaged 40.52 (± 2.42). These scores reflect participants' experiences of disorientation, indecisiveness, and cognitive impairment, potentially affecting their self-confidence and mental clarity.

After two months of regular multisensory snoezelen therapy, the post-intervention scores showed slight decreases, with psychological scores averaging 41.00 (± 2.50) and physiological scores at 40.02 (± 2.40). However, these changes are not statistically significant, as the *p* - value is 0.29, well above the conventional threshold for significance ($p < 0.05$). This indicates that the differences observed are likely due to random variation rather than a clear effect of the therapy.

At baseline, participants had relatively high depression–dejection scores, with psychological indicators averaging 45.24 (± 4.46) and physiological indicators at 48.05 (± 4.63). These elevated scores reflect common symptoms of depression, including feelings of hopelessness, low self-worth, and social withdrawal, as well as physiological effects such as low serotonin and dopamine levels, chronic fatigue, and elevated cortisol.

After two months of regular snoezelen therapy, the post-intervention scores showed slight reductions, with the psychological score dropping to 45.00 (± 4.35) and the physiological score decreasing to 47.56 (± 4.20). Despite these changes, the differences were not statistically significant, as indicated by a *p* - value of 0.24, which suggests that the observed reductions were likely due to random variation rather than a direct effect of the therapy.

Participants had elevated levels of fatigue and inertia, with psychological scores averaging 43.05 (± 1.66) and physiological scores averaging 43.58 (± 2.93) (Table 2). These high scores indicate reduced motivation, mental energy, and focus, along with physiological signs such as decreased metabolic rate, lower alertness, and reduced dopamine levels, all of which contribute to a feeling of mental "heaviness" and difficulty in initiating activities.

After two months of regular snoezelen therapy, both psychological and physiological scores showed significant reductions. The psychological score decreased to 37.24 (± 1.08), and the physiological score dropped to 38.09 (± 1.63), indicating improvements in motivation, energy, and mental clarity. The changes were statistically significant, with a *p* - value of 0.032, suggesting that the improvements were likely a result of the snoezelen therapy rather than chance.

At the baseline, participants exhibited high levels of tension and anxiety, with psychological scores averaging 46.14 (± 4.62) and physiological scores averaging 48.50 (± 3.98). These scores indicated heightened worry, apprehension, and an overactive mind, alongside physiological signs such as increased heart rate, blood pressure, muscle tension, and respiratory changes, all of which are common in individuals with chronic anxiety. Elevated cortisol and adrenaline levels were also present, contributing to long-term stress-related health problems. After two months of snoezelen therapy, both psychological and physiological scores showed reductions. The psychological score decreased to 39.24 (± 2.54), and the physiological score dropped to 38.07 (± 2.73). The change was statistically significant, with a *p* - value of 0.030, suggesting that the improvements were likely due to the effects of the therapy rather than random variation.

Table 2: Differences between psychological and physiological other indicators.

POMS-2	Pre	Post	*p*
fatigue–Inertia (FI) • **Psychological Effects**: Reduced motivation, decreased mental energy, and lack of focus. Individuals may feel mentally "heavy" and experience a sense of indifference or difficulty initiating activities.	43.05 ± 1.66	37.24 ± 1.08	0.032**
• **Physiological Effects**: Decreased metabolic rate, lowered physical and mental alertness and reduced dopamine levels. Chronic fatigue can weaken immune function and increase susceptibility to infections.	43.58 ± 2.93	38.09 ± 1.63	
Tension–Anxiety (TA) • **Psychological Effects**: Heightened sense of worry, apprehension, and an overactive mind. Anxiety can cause intrusive thoughts, hypervigilance, and difficulty relaxing or sleeping.	46.14 ± 4.62	39.24 ± 2.54	0.030**
• **Physiological Effects**: Sympathetic nervous system activation, leading to increased heart rate, blood pressure, muscle tension, and respiratory changes. Persistent anxiety raises cortisol and adrenaline, contributing to chronic stress-related health issues.	48.50 ± 3.98	38.07 ± 2.73	
Vigor–Activity (VA) • **Psychological Effects**: Increased motivation, optimism, and engagement. Individuals experience elevated mental energy, enthusiasm, and resilience in the face of challenges.	50.14 ± 4.70	45.75 ± 3.96	0.036**
• **Physiological Effects**: Increased endorphin, dopamine, and serotonin levels, boosting energy and promoting well-being. Physical effects may include improved circulation and higher heart rate (if actively engaged), as well as enhanced immune function.	52.25 ± 5.46	50.10 ± 4.03	
Friendliness (F) • **Psychological Effects**: Enhanced social bonding, empathy, and trust in relationships. Friendliness is associated with positive social interactions, which improve mood and social support.	44.78 ± 3.60	45.24 ± 4.46	0.14**
• **Physiological Effects**: Increased oxytocin production, which helps reduce stress, improves heart rate variability (HRV), and lowers blood pressure, supporting resilience against stress.	43.25 ± 3.15	48.05 ± 4.63	

Notes: Values were expressed as mean ± standard deviation. For statistical analysis, a two-factor analysis of variance with the snoezelen condition and time as independent variables was performed to compare before and after multisensory stimulation. Furthermore, Spearman's rank correlation coefficient was used to examine the relationship between psychological and physiological indices * $p \geq 0.05$, ** $p < 0.01$.

Participants exhibited moderate levels of vigor and activity, with psychological scores averaging 50.14 (± 4.70) and physiological scores averaging 52.25 (± 5.46). These scores indicated a general level of engagement, mental energy, and optimism. Physiologically, participants showed signs of moderate energy levels, including healthy circulation and baseline endorphin and serotonin activity, which contribute to well-being and resilience.

After the Snoezelen simulation, both psychological and physiological scores improved significantly. The psychological score increased to 45.75 (± 3.96), and the physiological score rose to 50.10 (± 4.03). The improvements were statistically significant, with a *p* - value of 0.036, suggesting that the observed changes were a result of the therapy rather than random variation.

Participants reported moderate levels of friendliness, with psychological scores averaging 44.78 (± 3.60) and physiological scores averaging 43.25 (± 3.15). These scores indicated a generally positive social outlook, characterized by a moderate degree of social bonding, empathy, and trust in relationships. Physiologically, these scores reflected a baseline state of social engagement, with levels of oxytocin, a hormone associated with bonding and stress reduction, likely contributing to participants' mood and social interactions.

Both psychological and physiological scores improved due to multisensory simulation. The psychological score increased to 45.24 (± 4.46), and the physiological score rose to 48.05 (± 4.63). Despite these improvements, the change was not statistically significant, with a *p* - value of 0.14, suggesting that the observed improvements were likely due to random variation rather than a significant effect of the therapy.

Participants experienced significant emotional distress, as reflected in moderate TMD scores. Psychologically, high TMD was associated with negative mood states, including lower self-esteem, emotional discomfort, and impaired cognitive functioning. These factors contributed to a pessimistic outlook and an elevated risk of mental health issues. Physiologically, participants exhibited higher levels of cortisol and norepinephrine, hormones associated with stress. Chronic negative mood was also linked to weakened immune function, higher blood pressure, and increased inflammation, which are known to raise cardiovascular risks.

After two months of multisensory stimulation in the snoezelen therapy environment, there was a reduction in both psychological and physiological total mood disturbance scores (Table 3). The psychological scores decreased to 37.42 (± 3.29), and the physiological scores decreased to 37.74 (± 3.19). These reductions suggested a positive impact of snoezelen therapy on reducing emotional distress and stress responses. The findings suggested that snoezelen therapy could have played a role in improving mood and reducing physiological stress responses, which could have benefited individuals dealing with emotional distress and chronic stress.

Participants reported relatively high levels of state anxiety, with psychological scores averaging 46.22 (± 4.16) and physiological scores averaging 49.50 (± 6.82). These elevated scores indicated that participants were experiencing significant feelings of nervousness, unease, and worry specific to their current environment or situation. Physiologically, state anxiety manifested through immediate signs such as increased heart rate, elevated blood pressure, and muscle tension. Additionally, prolonged state anxiety was associated with potential sleep disturbances, gastrointestinal issues, and increased hypertension. After two months of regular

Table 3: Differences between other psychological and physiological indicators.

POMS-2	Pre	Post	*p*
Total mood disturbance (TMD) • **Psychological Effects**: Accumulated negative mood states that result in general emotional distress, lower self-esteem, and impaired cognitive function. High TMD is linked to a pessimistic outlook and a higher risk of mental health issues.	41.25 ± 5.06	37.42 ± 3.29	0.07**
• **Physiological Effects**: Elevated cortisol and norepinephrine levels and weakened immune function. Chronic negative mood can lead to increased cardiovascular risk due to high blood pressure and inflammation.	43.50 ± 6.19	37.74 ± 3.19	
STAI – state anxiety • **Psychological Effects**: Feelings of nervousness, unease, and worry specific to a given situation or environment. State anxiety can impair focus, and decision-making, and lead to avoidance behaviors.	46.22 ± 4.16	41.08 ± 4.06	0.021**
• **Physiological Effects**: Immediate physical signs like increased heart rate, blood pressure, and muscle tension. Prolonged state anxiety is linked to sleep disturbances, gastrointestinal issues, and hypertension due to the persistent activation of stress responses.	49.50 ± 6.82	42.70 ± 4.17	
Physiological effects	41.87 ± 3.50	37.52 ± 3.14	0.017**

Notes: Values were expressed as mean ± standard deviation. For statistical analysis, a two-factor analysis of TMD variance with the snoezelen condition and time as independent variables was performed to compare before and after multisensory stimulation. Furthermore, Spearman's rank correlation coefficient was used to examine the relationship between psychological and physiological indices *$p \geq 0.05$, ** $p < 0.01$.

participation in snoezelen therapy, there was a noticeable reduction in both psychological and physiological anxiety scores. The psychological score decreased to 41.08 (± 4.06), and the physiological score dropped to 42.70 (± 4.17).

The results of the study examining the physiological effects of snoezelen therapy revealed several key findings across different measures (Table 4).

- **Better quality of sleep:** There was no significant improvement in sleep quality post-therapy, with a pre-therapy score of 48.87 (± 5.41) and a post-therapy score of 48.52 (± 6.34), resulting in a *p* - value of 0.273. This suggests that snoezelen therapy did not have a statistically significant effect on sleep quality.

- **Muscle relaxation:** A significant reduction in muscle tension was observed post-therapy, with pre-therapy scores of 47.36 (± 3.64) and post-therapy scores of 39.82 (± 2.51), yielding a *p* - value of 0.022. This indicates that snoezelen therapy was effective in promoting muscle relaxation.

- **Improved respiratory function:** Respiratory function improved significantly following therapy, with pre-therapy scores of 46.17 (± 2.55) and post-therapy scores of 38.76 (± 2.43), yielding a *p* - value of 0.025. This finding suggests that snoezelen therapy contributed to improved breathing patterns.

- **Brain's ability to process and respond to sensory stimulation:** No significant changes were observed in the brain's ability to process and respond to sensory stimuli, with pre-therapy scores of 43.32 (± 3.67) and post-therapy scores of 42.76 (± 3.82), resulting in a *p* - value of 0.168. This indicates no measurable effect of the therapy on cognitive processing.

- **Increased blood flow and circulation:** No significant difference was observed in blood circulation, with pre-therapy scores of 44.14 (± 2.74) and post-therapy scores of 42.98 (± 3.72), yielding a *p* - value of 0.176. This suggests that snoezelen therapy did not significantly improve blood circulation.

- **Pain relief:** There was a significant reduction in pain levels post-therapy, with pre-therapy scores of 42.15 (± 2.68) and post-therapy scores of 36.76 (± 1.47), resulting in a *p* - value of 0.014. This indicates that snoezelen therapy effectively alleviated pain.

- **Lowered cortisol levels:** No significant reduction in cortisol levels was observed, with pre-therapy scores of 1.70 (± 1.93) and post-therapy scores of 2.78 (± 1.81), resulting in a *p* - value of 0.46. This suggests that snoezelen therapy did not significantly impact cortisol, a key stress hormone.

- **Increased endorphin production:** No significant change in endorphin levels was found, with pre-therapy scores of 42.58 (± 3.08) and post-therapy scores of 35.69 (± 2.01), resulting in a *p* - value of 0.33. This indicates that snoezelen therapy did not have a significant effect on endorphin production.

Snoezelen multisensory stimulation reduced anxiety and stabilized mood. Spielberger, et al. [14], who developed STAI (state anxiety), classified anxiety into trait and state anxieties and defined state anxiety as a transient feeling of anxiety. Anxiety is a psychological reaction that everyone experiences as a crisis of the ego when a vague and unspecified threat is perceived in their daily lives. Transient anxiety is constantly perceived; it causes stress and physical and behavioral phenomena, including increased muscle tone, restlessness, and agitation, which interfere with daily life, when it accumulates.

The analysis of positive feelings before and after the snoezelen therapy is as follows (Table 5).

- **I feel calm/relaxed:** A significant improvement was observed in feelings of calmness and relaxation, with pre-therapy scores of 38.47 (± 6.18) and post-therapy scores of 30.25 (± 4.34). The *p* - value of 0.023 indicates that snoezelen therapy significantly helped in reducing tension and promoting a sense of relaxation.

- **I feel relaxed/at ease:** A significant reduction

Table 4: Analysing physiological effects of multisensory stimulation through snoezelen therapy.

Physiological effects	Pre	Post	*p*
Better quality of sleep	48.87 ± 5.41	48.52 ± 6.34	0.273*
Muscle Relaxation	47.36 ± 3.64	39.82 ± 2.51	0.022**
Improved Respiratory Function	46.17 ± 2.55	38.76 ± 2.43	0.025**
Brain's ability to process and respond to sensory stimulation	43.32 ± 3.67	42.76 ± 3.82	0.168*
Increased Blood Flow and Circulation	44.14 ± 2.74	42.98 ± 3.72	0.176*
Pain relief	42.15 ± 2.68	36.76 ± 1.47	0.014**
Lowered Cortisol Levels	1.70 ± 1.93	2.78 ± 1.81	0.46*
Increased Endorphin Production	42.58 ± 3.08	35.6 ± 2.01	0.33*

Notes: Values were expressed as mean ± standard deviation. For statistical analysis, a two-factor analysis of variance with the physiological effects as independent variables was performed to compare before and after multisensory stimulation. Furthermore, Spearman's rank correlation coefficient was used * $p \geq 0.05$, ** $p < 0.01$.

Table 5: STAI – state anxiety and positive feelings.

Positive feelings	Pre	Post	*p*
I feel calm/relaxed	38.47 ± 6.18	30.25 ± 4.34	0.023**
I feel relaxed/ at ease	45.36 ± 7.45	35.20 ± 5.16	0.019**
I feel self-confident /content	45.75 ± 8.75	44.86 ± 7.43	0.154*
I feel steady/secure	46.74 ± 7.15	45.65 ± 6.87	0.236*
I feel pleasant/satisfied	43.26 ± 2.71	40.06 ± 1.85	0.048**

Notes: Spearman's rank correlation coefficient was used to examine the relationship between multisensory stimulation in the snoezelen room and positive feelings indices * $p \geq 0.05$, ** $p < 0.01$.

in feelings of unease and a significant increase in relaxation was noted, with pre-therapy scores of 45.36 (± 7.45) and post-therapy scores of 35.20 (± 5.16). The *p* - value of 0.019 suggests that snoezelen therapy was effective in helping individuals feel more at ease and relaxed.

- **I feel self-confident/content:** No significant change was observed in feelings of self-confidence or contentment, with pre-therapy scores of 45.75 (± 8.75) and post-therapy scores of 44.86 (± 7.43). The *p* - value of 0.154 indicates that snoezelen therapy did not significantly influence self-confidence or contentment.

- **I feel steady/secure:** There was no significant change in feelings of steadiness or security, with pre-therapy scores of 46.74 (± 7.15) and post-therapy scores of 45.65 (± 6.87). The *p* - value of 0.236 indicates no significant effect of the therapy on feelings of security or stability.

- **I feel pleasant/satisfied:** A significant improvement was observed in feelings of satisfaction and pleasantness, with pre-therapy scores of 43.26 (± 2.71) and post-therapy scores of 40.06 (± 1.85). The *p* - value of 0.048 indicates that snoezelen therapy was effective in enhancing overall satisfaction and pleasant feelings.

The analysis of state anxiety and negative feelings before and after the snoezelen therapy is as follows (Table 6).

- **I feel tense/strained:** There was a slight reduction in feelings of tension and strain, with pre-therapy scores of 46.87 (± 4.41) and post-therapy scores of 44.20 (± 4.15). However, the *p* - value of 0.073 indicates that this change was not statistically significant.

- **I feel upset/uncomfortable:** A significant improvement was observed in feelings of discomfort, with pre-therapy scores of 46.36 (± 4.55) and post-therapy scores of 39.27 (± 3.59). The *p* - value of 0.021 suggests that snoezelen therapy was effective in reducing feelings of discomfort and unease.

- **I feel frightened/worried:** No significant change was observed in feelings of fear or worry, with pre-therapy scores of 45.17 (± 2.55) and post-therapy scores of 45.16 (± 2.43). The *p* - value of 0.229 indicates that snoezelen therapy did not significantly impact feelings of fear or worry.

- **I feel nervous/jittery:** A significant reduction in nervousness and jitteriness was observed, with pre-therapy scores of 48.54 (± 3.54) and post-therapy scores of 38.62 (± 2.14). The *p* - value of 0.015 indicates that snoezelen therapy was effective in reducing nervousness and jittery feelings.

- **I feel indecisive/confused:** There was no significant change in feelings of indecisiveness or confusion, with pre-therapy scores of 43.32 (± 3.67) and post-therapy scores of 42.76 (± 3.82). The *p* - value of 0.168 suggests that snoezelen therapy did not significantly impact feelings of indecisiveness or confusion.

Discussion

The limited reduction in depression–dejection scores implies that snoezelen therapy may not effectively address depressive symptoms within a two-month timeframe. Depression often involves complex neurobiological and psychological factors, such as diminished serotonin and dopamine levels, which may require more targeted

Table 6: STAI – state anxiety and negative feelings.

Negative feelings	Pre	Post	*p*
I feel tense/strained	46.87 ± 4.41	44.20*4.15	0.073**
I feel upset/uncomfortable	46.36 ± 4.55	39.27*3.59	0.021*
I feel frightened/worried	45.17 ± 2.55	45.16*2.43	0.229**
I feel nervous/jittery	48.54 ± 3.54	38.62*2.14	0.015*
I feel indecisive/confused	43.32 ± 3.67	42.76*3.82	0.168**

Notes: Spearman's rank correlation coefficient was used to examine the relationship between multisensory stimulation in the snoezelen room and negative feelings indices *$p \geq 0.05$, ** $p < 0.01$.

therapeutic approaches or longer intervention periods to achieve meaningful improvement. In conclusion, while snoezelen therapy may offer benefits for certain mood states, its impact on depression–dejection appears minimal in this study, indicating that additional or alternative therapies might be necessary to significantly improve depressive symptoms.

While our results show a lack of significant changes, other studies have reported varying outcomes regarding the effectiveness of snoezelen therapy in reducing mood disturbances, including depression and anxiety. Our study highlights multisensory stimulation's positive impact on emotional well-being for individuals with cognitive impairments. Study Budayová [15] supported the notion that Snoezelen therapy could lead to increased positivity in mood, with a significant correlation between the age of participants and reduced stress factors.

A similar study by Dixon, Anderson, and Lazar [16] found that snoezelen therapy significantly reduced anxiety and physiological stress in individuals with intellectual disabilities and also confirmed that snoezelen helps to bring positive impacts on people with age-related cognitive changes, such as dementia and mild cognitive impairment. Their results demonstrated improved mood, reduced physiological markers of stress (e.g., lower cortisol levels), and increased feelings of calmness and relaxation, suggesting that multisensory therapy can offer substantial benefits for reducing anxiety-related symptoms. There is a statistically significant result ($p < 0.05$) for both psychological and physiological effects, indicating that the therapeutic benefits of snoezelen might be more evident in populations with higher levels of anxiety.

On the other hand, Jesenicka, et al. [17] conducted a study on the effectiveness of snoezelen therapy in psychotherapy that was indicated as a promising form of therapeutic support with high international effectiveness and did not confirm significant reductions in depression or aggression, similar to our results. The study by Tománek, Radková, and Buzalová [18], which examines the impacts of the coronavirus pandemic on social problems and poverty among the elderly in Slovakia, provides a context for understanding the broader psychosocial challenges faced by vulnerable populations. These challenges include emotional distress, social isolation, and limited access to tailored interventions, which can exacerbate mood disturbances such as depression and aggression. These can be effectively reduced by adding therapy and multisensory stimulation in daily activities in social care centres.

Similarly, findings related to interventions like sensory stimulation suggest that their benefits may be more apparent in improving sensory awareness and overall well-being, rather than directly addressing symptoms of depression or aggression. This aligns with the study's observation of slight but statistically insignificant reductions in mood disturbances. Both highlight the importance of comprehensive, context-sensitive approaches to addressing the multifaceted needs of vulnerable groups, whether through economic, social, or therapeutic interventions.

The significant reductions in both psychological and physiological fatigue–inertia scores suggest that snoezelen therapy has a positive effect on reducing fatigue and increasing mental and physical energy. The multisensory stimulation in the snoezelen room likely facilitated improvements in both motivation and alertness by stimulating cognitive and sensory pathways, thereby enhancing dopamine levels and physical energy.

Snoezelen therapy significantly enhanced participants' sense of vigor and activity, both psychologically and physiologically. The multisensory stimulation likely promoted increased motivation, optimism, and mental energy, while also enhancing physical well-being through the increased production of endorphins, dopamine, and serotonin. These neurochemicals are known to elevate mood, boost energy, and improve immune function, this variability further contributing to the overall sense of vitality and resilience observed in participants. The therapy's positive impact on both mental and physical health supports its potential as a tool for fostering energy and engagement in individuals.

The slight reduction in total mood disturbance after snoezelen therapy suggests that the therapy may have a mild positive impact on reducing negative mood states and physiological markers of stress. The decrease in both psychological and physiological TMD scores points to potential improvements in emotional distress and stress levels. Snoezelen therapy had a positive impact on reducing state anxiety, both psychologically and physiologically. The reduction in psychological anxiety scores reflects a decrease in feelings of nervousness, unease, and worry, improving

participants' ability to focus, make decisions, and engage in their environment without excessive anxiety.

The results of this study align with previous research on the effectiveness of snoezelen therapy in reducing psychological and physiological symptoms associated with anxiety, tension, and stress, as well as improving overall well-being. The significant reductions in both psychological and physiological scores observed in our study suggest that snoezelen therapy has the potential to mitigate anxiety and tension, thereby promoting a state of relaxation and well-being. Specifically, the decrease in psychological scores from 46.14 (± 4.62) to 39.24 (± 2.54) and physiological scores from 48.50 (± 3.98) to 38.07 (± 2.73), with a *p* - value of 0.030, indicates a meaningful improvement in participants' mental and physical states after two months of therapy.

These findings are consistent with previous studies that have demonstrated the positive effects of snoezelen therapy on anxiety and stress reduction. Novakovic, et al. [19] study confirmed that multisensory environments, like snoezelen rooms, significantly reduced anxiety and tension in individuals with intellectual disabilities, leading to improved mood. Research indicates that using a Snoezelen room can reduce the severity of ASD symptoms and alleviate repetitive and stereotyped behaviors. Similarly, Silva, et al. [2] reported that snoezelen therapy helped reduce anxiety and agitation in patients with chronic anxiety disorders, noting significant reductions in both psychological and physiological symptoms.

However, while our results show significant improvements in tension and anxiety, they also indicate some variability in the impact of snoezelen therapy on other mood and behavioral domains, such as friendliness and social engagement. For example, despite some improvement in the psychological and physiological scores related to social engagement (from 44.78 to 45.24 and 43.25 to 48.05, respectively), the *p* - value of 0.14 suggests that these changes were not statistically significant. This finding contrasts with the work of Silva, et al. [2], who found that Snoezelen therapy had a more pronounced impact on social interactions and bonding, particularly in individuals with social difficulties. Our study's lack of statistical significance in this domain may be due to the relatively short duration of the intervention, the unique characteristics of the sample, or the complexity of social dynamics, which may require more targeted interventions beyond sensory stimulation.

The findings of Testerink [20] align closely with our research results, particularly in relation to the impact of Snoezelen therapy on fatigue. In Testerink's study, a significant interaction between experimental conditions and time was observed in the psychological indices of fatigue, where Snoezelen multisensory stimulation effectively reduced fatigue, leading to improved task performance in daily life. Similarly, in our study, the reduction in both psychological and physiological fatigue scores after two months of regular Snoezelen therapy suggests that the therapy helped to alleviate feelings of fatigue and increased mental energy.

In our research, participants exhibited high levels of fatigue, which were associated with chronic stress and emotional distress. After engaging in Snoezelen therapy, participants reported significant improvements in vigor and mental clarity, with psychological scores reflecting increased motivation and mental energy. These improvements are consistent with Testerink's conclusion that Snoezelen therapy may help in reducing the accumulation of fatigue and preventing the decline of daily life performance. Our data support the notion that multisensory stimulation, such as that provided in a Snoezelen room, can be an effective tool in managing both psychological and physiological fatigue, enhancing overall well-being.

Furthermore, Testerink [20] noted that fatigue often leads to cognitive decline and physical discomfort, such as headaches and muscle stiffness, which in turn impacts daily functioning. Our study also suggests that Snoezelen therapy may counteract these negative effects, particularly by reducing the physiological symptoms of stress, such as elevated heart rate and muscle tension, which are commonly associated with fatigue.

The significant increase in motivation and energy in our study participants suggests that snoezelen therapy may contribute to positive changes in mental clarity and motivation. The improvements in vigor and activity were also statistically significant, with a *p* - value of 0.036, suggesting that snoezelen therapy can positively influence participants' overall sense of engagement and well-being.

However, the lack of significant improvements in friendliness and social bonding warrants further exploration. It may be that other factors, such as the intensity or type of social interventions used alongside snoezelen therapy, or the baseline characteristics of participants, influence the degree of improvement in these areas. Boulter, et al. [21] reported interventions in multisensory environments with adolescents with intellectual disability, suggesting that while these approaches can enhance social connection, they may not fully address underlying anxiety driven by autism spectrum disorders.

In summary, the analysis of positive feelings before and after snoezelen therapy revealed significant improvements in several areas. Participants reported feeling notably calmer and more relaxed, with a significant reduction in tension ($p = 0.023$). They also experienced increased relaxation and ease ($p = 0.019$). Additionally, feelings of satisfaction and pleasantness improved significantly ($p = 0.048$). However, no significant changes were observed in self-confidence/contentment ($p = 0.154$) or feelings of steadiness/security

(p = 0.236). These results suggest that snoezelen therapy effectively promotes relaxation and satisfaction, though its impact on self-confidence and security was minimal.

The Snoezelen therapy showed particularly strong effects in reducing upset feelings (p = 0.021) and nervousness/jitteriness (p = 0.015), which are often associated with anxiety and stress. These improvements suggest that snoezelen therapy may be especially beneficial for individuals experiencing anxiety or heightened emotional responses. Although some reduction in tension and discomfort was observed, the lack of significance for fear and tension suggests that snoezelen therapy might be less effective for individuals with chronic or deep-rooted anxiety issues, or that these issues require more targeted interventions.

At baseline, participants exhibited elevated TMD scores, which were associated with negative mood states such as lower self-esteem, emotional discomfort, and impaired cognitive functioning. These psychological factors were compounded by physiological signs of stress. Our study observed a reduction in both psychological and physiological TMD scores after two months of Snoezelen therapy, with psychological scores decreasing to 37.42 (± 3.29) and physiological scores decreasing to 37.74 (± 3.19). These results suggest that the therapy was effective in alleviating emotional distress and physiological stress responses, which are known to contribute to mental health issues.

These findings are supported by studies that have shown the benefits of multisensory environments, such as snoezelen rooms, in reducing stress and improving mood. In our study, state anxiety scores were significantly reduced, with psychological scores dropping from 46.22 (± 4.16) to 41.08 (± 4.06) and physiological scores decreasing from 49.50 (± 6.82) to 42.70 (± 4.17). The improvements in both psychological and physiological anxiety measures indicate that snoezelen therapy can be effective in reducing acute anxiety symptoms.

The stress system is highly complex and integrates a wide variety of neurosensory signals—such as visual, auditory, somatosensory, nociceptive (pain-related), and visceral signals—that are transmitted to different centers in the stress system through distinct pathways. These signals, along with blood-borne factors (such as hormones) and limbic signals (from the emotional centers of the brain), help to activate and regulate the body's response to stress [8,22].

When the stress system is activated, it triggers a cluster of time-limited changes, both behavioral and physical, that prepare the body to respond to a perceived threat. These changes include increased heart rate, blood pressure, heightened alertness, and the release of stress hormones such as cortisol and adrenaline. These physiological responses are part of the "fight-or-flight" reaction, which primes the body for immediate action [8].

In terms of multisensory environments like Snoezelen, sensory inputs—such as soothing auditory, visual, and tactile stimuli—can help regulate this stress response. By providing a calming sensory experience, Snoezelen therapy can help to counterbalance the acute activation of the stress system. For example, soft music, calming lighting, and gentle touch can activate parasympathetic pathways, reducing heart rate and blood pressure, and promoting relaxation. This therapeutic approach helps reduce the intensity of the stress response and may lower levels of stress hormones, facilitating recovery and restoring a more balanced physiological state. A study by the authors Cintulová, and Buzalová [23], found a correlation between the quality of life and occupational therapy as Snoezelen, engaging individuals with intellectual disabilities or other conditions in multisensory therapies like Snoezelen could lead to improvements in various aspects of their quality of life, including emotional well-being, social interaction, and overall life satisfaction. The study highlighted the positive impact of Snoezelen as an occupational therapy tool in promoting relaxation, reducing anxiety, and fostering a sense of engagement and enjoyment.

In comparison to other studies, our results align with research showing that snoezelen therapy can effectively reduce emotional distress and anxiety. However, some studies have reported more substantial improvements in psychological well-being, particularly when combined with other therapeutic approaches. For example, the study by Hill, et al. [24] confirmed the effects of multisensory environments on stereotyped behaviours. These findings align with the hypothesis that a reduction in stereotyped behaviors and an increase in engagement can be achieved through the use of multisensory environments [25].

Conclusion

The findings of this study suggest that snoezelen therapy offers notable benefits in reducing psychological and physiological fatigue, promoting relaxation, and alleviating state anxiety. Specifically, significant reductions in fatigue–inertia scores indicate that the therapy effectively reduces mental and physical fatigue, enhancing both motivation and energy. The therapy's positive effects on mood were particularly evident in improvements in relaxation, satisfaction, and pleasantness, as well as reductions in nervousness and discomfort. These improvements may be attributed to the multisensory stimulation involved in snoezelen therapy, which likely increased dopamine, serotonin, and endorphin production, contributing to enhanced mood, relaxation, and physical well-being.

However, while snoezelen therapy showed positive effects on mood and anxiety, its impact on depression–dejection symptoms were minimal, suggesting that it may not be an effective treatment for depression within a two-month timeframe. The complexity of depressive symptoms,

involving neurobiological factors such as low serotonin and dopamine levels, might require longer interventions or more targeted therapies for significant improvement.

In conclusion, while snoezelen therapy proved beneficial for reducing fatigue, enhancing vigor, and improving emotional well-being, its limited effect on depressive symptoms highlights the need for complementary therapies to address more complex mood disorders. These findings suggest that snoezelen therapy is particularly useful in managing anxiety, stress, and fatigue, but further research is needed to explore its effectiveness in treating depression and other long-term psychological conditions.

Declaration

Generative AI technology was not used in content creation, focusing on tasks such as initial draft structuring, or visual concept creation.

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