

Verification of the Effects of Snoezelen Treatment on the Behavioral Problems of Children With Developmental Disabilities Using a Quantitative EEG Analysis

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Abstract

Objective: This paper investigates the electroencephalography (EEG) and behavioral changes associated with Snoezelen treatment for children with developmental disabilities.

Methods: A single-subject A-B-A experimental design was used to determine the effects of Snoezelen treatment. Two children with developmental disabilities participated in this study. In the intervention phase after a baseline assessment, participant 1 was given 30-min access to a Snoezelen room for seven sessions, while participant 2 was given access for eight sessions. Following this process, access to the room was withdrawn for both participants. The outcome measurements included an EEG and child behavior checklist (CBCL).

Results: During the Snoezelen treatment phase, both participants showed increases in relative alpha power and decreases in relative theta power. Decreases in relative gamma power appeared for participant 2 only. The total CBCL scores for both participants decreased after the Snoezelen treatment phase.

Conclusion: These findings provide potential neurophysiologic evidence of the clinical effects of Snoezelen treatment identified in previous research.

Key words: Behavior problems, Developmental disabilities, Electroencephalography, Snoezelen

I. Introduction

The term “Snoezelen”, referred to multi-sensory environment, is derived from two Dutch words meaning “to sniff” and “to doze” (Chitsey, Haight, & Joens, 2002). Snoezelen attempts to achieve a relaxed feeling and facilitate sensory stimulation, and a Snoezelen

philosophy has been created that embraces the concept of enabling within a failure-free environment (Hutchinson, 1991). As a non-direct approach, Snoezelen provides stimulation via tactile, visual, auditory, olfactory, and gustatory senses and enables vestibular and proprioceptive stimulation as patients explore their environment (Ashby, Williams, Pitcaithly,

Broxholme, & Geelan, 1995). Snoezelen was originally intended for recreation, but in recent years has been developed for therapeutic or educational uses and shown research to be an effective treatment method (Kewin, 1994). Snoezelen is proposed to improve the quality of life for patients with anxiety and pain as well as individuals with developmental disabilities or brain lesions (Hulsege & Verheul, 1987).

Some evidence suggests that Snoezelen may result in behavioral, social, emotional and physiologic improvements in individuals with severe mental retardation or elderly sufferers of dementia (Ashby et al., 1995; Kewin, 1994; Lotan & Shapiro, 2005; Shapiro, Parush, Green, & Roth, 1997; Spaul, Leach, & Frampton, 1998; Thompson & Thompson, 2003). Although the majority of studies have reported intra-session positive effects of Snoezelen in individuals with developmental disabilities and dementia, in most cases, the effect of Snoezelen in children with developmental disabilities was determined by assessing the treatment effect with subjective and descriptive methods, including observation, interviews, staff reports, and questionnaires, instead of objective methods (Lancioni, Cuvo, & O'Reilly, 2002). A limited amount of research has been conducted regarding the physiologic effects of Snoezelen.

Physiological findings should provide objective evidence in investigating the therapeutic effects on developmental and psychological problems with improved external validity (Davies & Gavin, 2007). Psychophysiological measures such as electroencephalography (EEG) have been employed in investigations of brain function in children with attention deficit hyperactivity disorder (ADHD), one of the most common chronic conditions of childhood, to identify the etiology of this disorder and other childhood behavior problems (Bresnahan & Barry, 2002; Daoust, Limoges, Bolduc, Mottron, & Godbout, 2004). EEG has generally been used to evaluate the effect of therapeutic intervention and investigate EEG changes after sensory

stimulation in children with behavior problems (Thompson & Thompson, 2003).

Methodological issues with the previous Snoezelen studies require the performance of additional clinical research to evaluate the effectiveness of Snoezelen using objective measures. Also, to the best of the author's knowledge, there has been no research conducted that has investigated the effect of Snoezelen as a treatment method for children with ADHD. Therefore, the present study was designed to determine changes in behavior and EEG before and after Snoezelen and to investigate the feasibility of using Snoezelen as a rehabilitation method for treating children with developmental disabilities.

II. Methods

1. Participants and setting

Two children with developmental disabilities were selected for the study. Informed consent for safety of the procedure followed in this study was obtained from their parents. The Snoezelen procedure was described to both the participants and their parents, and assent was sought each time they were invited into the room.

Participant 1 was 7 years 10 months old and had been diagnosed as ADHD. He had a history of inattentive and hyperactive behavior and delayed language development. He was put on medication for attention deficit disorder after being diagnosed, but the medication was stopped for the duration of the study. A social maturity test revealed that his social quotient was 105.6 and social age was 7.5. Participant 2 was 10 years 3 months old and had been diagnosed as Asperger's syndrome. He had a history of inattentive behavior, oversensitivity to auditory stimulation, and anxiety. Additionally, he received a social quotient of 64.37 and a social age of 6.6 in a social maturity test.

The Snoezelen room was a quiet, windowless room (18 ft×12 ft) with padded floor and white walls, and

contained an array of multisensory equipment that provided stimuli in olfactory, tactile, auditory, visual, and vestibular modes. The stimuli consisted of a colored fiber-optic light spray projector with a spotlight and color wheel, a mirror ball, a lit bubble tube, a bird mobile suspended from the ceiling, a living picture panel, a mirrored limelight panel, a white beanbag chair, a leaf chair, a tactile panel, a vibration pillow, bar chimes, a musical water bed, a musical hopscotch pad, a CD player with nature sounds, and an interactive aroma box.

2. Measurements

Electroencephalography (EEG). An 8-channel digital signal-processing hardware and software package from QEEG-8 system: CANS 3000 (Laxtha Inc., Daejeon, Korea) was used in the acquisition and storage of EEG data. The EEG was recorded from eight electrode sites (Fp1, Fp2, F3, F4, T3, T4, P3 and P4) according to the International 10-20 System (Jasper, 1958). An electro-cap reference was connected to the earlobe (A1), and a ground electrode was located on the forehead. The impedance was kept below 5 k Ω for impedance equilibrium. The filter settings were as follows: a low-frequency filter was set at 0.5 Hz and a high-frequency filter was set at 50 Hz. The EEG recordings were digitized at a sampling rate of 256 Hz with a 12-bit analog-to-digital converter. Participants were first familiarized with the testing equipment and procedure, and then fitted with electrodes. Testing was performed in a quiet, air-conditioned room.

Child Behavior Checklist (CBCL). The CBCL is a standardized parental questionnaire in which a child is rated on various behavioral and emotional problems (Achenbach, 1991). In the present study, a Korean modified version of the CBCL was used to determine behavioral changes before and after the Snoezelen phase. The reliability of this Korean adaptation has been confirmed (Jung, 2001). Behavioral problems in

CBCL were given five classifications (hyperactive, anxious, withdrawn, aggressive, and immature behaviors), and each of these was composed of eight questions, with a score range of 0 to 5 for each question. A high score indicates that a patient has more severe behavioral problems.

3. Design and procedures

A single-subject A-B-A experimental design was used to evaluate changes before and after Snoezelen and at the follow-up after the intervention. This included a baseline (A), intervention phase (B), and follow-up (A') phases. A total of 11 and 12 measurement sessions were taken for participants 1 and 2, respectively. The entire duration for these sessions was 6 weeks, implemented as follows: 1 week baseline phase; 4 weeks Snoezelen phase; and, 1 week follow-up phase.

First, an EEG baseline was recorded for two sessions in the EEG Recording Room for 1 week. During the intervention phase, after the baseline assessment, participant 1 was given access to the Snoezelen Room for seven sessions, and participant 2 was given access to the same room for eight sessions. Finally, access to the room was withdrawn during the follow-up phase. The follow-up phase was taken two sessions after the Snoezelen phase. During each of these sessions, the EEG was recorded for each child.

Each Snoezelen intervention was carried out for an average of 30 minutes, twice per week. Each participant went into the Snoezelen Room with the main investigator, who had completed a special course on the Snoezelen application. In the Snoezelen Room, the main investigator followed the participant's lead, without specific instructions on how to explore the environment, and engaged with each participant in whatever was of interest. After the Snoezelen session, each participant took the EEG measurement in a quiet and air conditioned examination room while sitting in an armchair with eyes closed. Each participant was instructed not to move

during the 5 minute EEG measurement.

The CBCL evaluation, assessing the type and level of behavioral problems, was made before and after the Snoezelen phase by interviewing the participants' parents.

4. Data analysis

The EEG data were quantitatively analyzed with Complexity 2.0 (Laxtha Inc.). Spectral analysis using fast Fourier transformation was performed at the frequency bands delta (0–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (30–50 Hz). The relative power is represented by the percentage of the power in a given frequency band relative to the total power across all frequency bands. For example, relative delta power is measured to $(\text{absolute alpha power} / \text{absolute theta power} + \text{absolute alpha power} + \text{absolute beta power} + \text{absolute gamma power}) \times 100$. The delta power was not included in the relative power analysis because of contamination by artifacts due to body movement and electrode line confusion.

The EEG data were visually analyzed using graphs to determine the stability and trends in A, B, and A', and values in each session were provided with descriptive methods. The CBCL data were provided in graph format to compare changes before and after the Snoezelen phase.

III. Results

1. Changes in EEG

Changes in EEG during the baseline, Snoezelen, and follow-up phases

The EEG data with changes during the Snoezelen phase are exhibited in Table 1 and 2. Figure 1 and 2 represent the visual changes of the relative alpha power at the baseline, Snoezelen, and follow-up phases.

For participant 1, who had ADHD, the average relative powers of theta and alpha of all channels showed small changes (See Table 1). The average theta power showed the greatest decreases in Fp1 and Fp2 of all channels. The average alpha power showed increases in Fp1, Fp2, F3, and F4, with greater increases in Fp1 and Fp2 placed at the prefrontal area (See Figure 1). Almost no changes in beta and gamma powers were observed during the Snoezelen phase.

Participant 2, who had Asperger's syndrome, showed changes in theta, alpha, and gamma powers. A decrease in the average relative power appeared in Fp2 and Fp4 for theta and in Fp1, Fp2, and T3 for gamma (See Table 2). The relative alpha power showed the most noticeable increase in Fp1, Fp2, and T3 during the Snoezelen phase, and the average value of all channels was maintained at the follow-up phase (See Figure 2). The beta power did not change during the Snoezelen phase.

Table 1. Average relative power (%) of theta and alpha of Participant 1 measured at the baseline (A), Snoezelen (B), and follow up phases (A')

	A	B	C
Theta			
Average power of all channels	34	33	33
Average power in Fp1	39	33	33
Average power in Fp2	41	32	32
Alpha			
Average power of all channels	40	44	41

Table 2. Average relative power (%) of theta, alpha and gamma of Participant 2 measured at the baseline (A), Snoezelen (B), and follow up phases (A')

	A	B	C
Theta			
Average power of all channels	30	28	29
Average power in Fp2	36	30	28
Average power in F4	39	34	32
Alpha			
Average power of all channels	24	33	34
Gamma			
Average power of all channels	21	14	14
Average power in Fp1	48	22	26
Average power in Fp2	30	19	19
Average power in T3	25	13	12

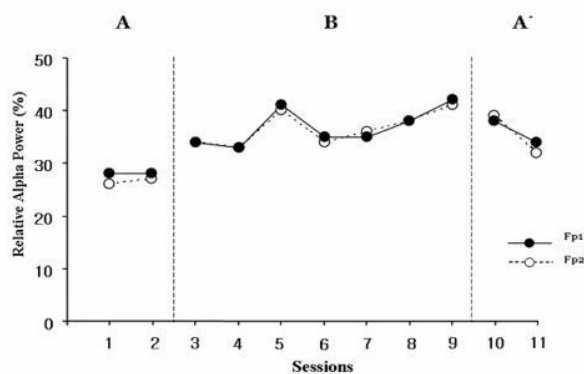


Figure 1. Changes in the alpha power of Participant 1 in the baseline (A), Snoezelen (B), and follow up phases (A')

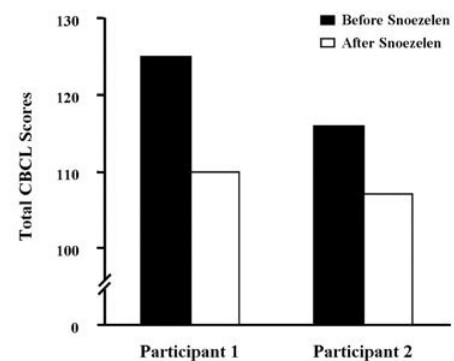


Figure 3. Comparison of Child Behavior Checklist (CBCL) total score before and after Snoezelen in each participant

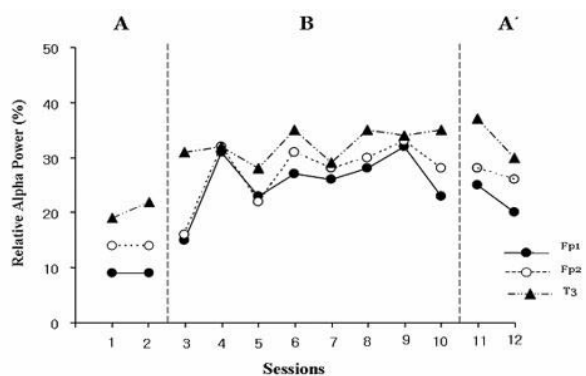


Figure 2. Changes in the alpha power of Participant 2 in the baseline (A), Snoezelen (B), and follow up phases (A')

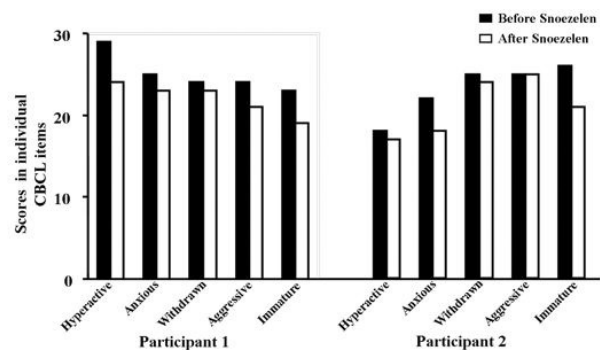


Figure 4. Comparison of individual Child Behavior Checklist (CBCL) scores before and after Snoezelen in each participant

2. Changes in the CBCL scores

The CBCL scores assessed before and after the Snoezelen phase are shown in Figure 3 and 4. The CBCL total score decreased from 125 to 110 for participant 1 and from 116 to 107 for participant 2 after the Snoezelen phase (See Figure 3). In individual CBCL scores, participant 1 showed improvements in hyperactive (from 29 to 24), anxious (from 25 to 23), withdrawn (from 24 to 23), aggressive (from 24 to 21), and immature (from 23 to 19) behaviors after the Snoezelen phase (See Figure 4). In participant 2, the scores showed decreases in hyperactive (from 18 to 17), anxious (from 22 to 18), withdrawn (from 25 to 24), and immature (from 26 to 21) behaviors.

IV. Discussion

Snoezelen is used increasingly in the management of children with developmental disabilities, especially in those associated with behavioral and emotional problems. Many studies on the effectiveness of Snoezelen have been conducted using various methods. The present study demonstrated a behavioral and neurophysiologic correlation indicating that Snoezelen has a positive effect on children with developmental disabilities.

The main outcome of this study was a positive EEG changes obtained from participants during the Snoezelen phase. The EEG analysis revealed increased alpha power and decreased theta power after the Snoezelen phase. The alpha power reflects a calm and relaxed state of the brain, leading to emotional harmony associated with a positive emotional state (Banquet, 1973), which is necessary for enhancing attention, learning, and cognition and maintaining a proper state of awareness (Anna, 1995). The theta power corresponds to the hypnagogic state before sleep onset (Thompson & Thompson, 2003). Therefore, increased alpha power and decreased

theta power indicate that Snoezelen improves alertness. In addition, increased alpha should be considered neurophysiologic evidence related to the relaxing effect of Snoezelen as supported by previous research (Schofield & Davis, 2000).

Disparity in the EEG associated with increased theta power and decreased alpha and beta powers, especially in the prefrontal lobe, are present in 30 to 60% of children with ADHD (Mann, Lubar, Zimmerman, Miller, & Muenchen, 1992; Satterfield, Cantwell, Lesser, & Podosin, 1972). Participant 1 with ADHD showed positive changes in EEG in Fp1 and Fp2 (prefrontal lobe) during the Snoezelen phase. The findings are similar to the effect of neuro-feedback used for ADHD treatment (Pop-Jordanova, Markovska-Simoska, & Zorcec, 2005). The EEG findings of the present study support the use of the Snoezelen as beneficial therapeutic method of ADHD.

Participant 2 with Asperger's syndrome showed changes in gamma power as well as alpha and theta powers. During the Snoezelen phase, decreases in the theta power in Fp2 and F4 (frontal lobe), an increase of alpha power, and decreases in the gamma power in Fp1, Fp2, and T3 (temporal lobe) occurred. Gamma is a fast wave and is produced during highly cognitive activities and at high conscious levels by complex information processing (Thompson & Thompson, 2003). Fast waves such as gamma are associated with increased energy consumption in neural tissues, fatigue due to an excessively high alert level, anxiety, and a decreased ability to maintain attention. As the study result shows, the decreased gamma power might be associated with the resolution of excessive arousal level, anxiety, and emotional tension. In autistic spectrum disorders such as Asperger's syndrome and autism, neurophysiologic signs in the frontal and temporal lobes have been reported with theta power increase on the whole (Daoust et al., 2004). Positive changes in EEG may be regarded as neurophysiologic evidence to support the therapeutic effect of Snoezelen related to maintaining an

optimal level of awareness, while inhibiting a high arousal level and facilitating a low arousal level.

In this study, a CBCL modified for Korean patients was used to identify behavioral patterns of participants before and after the Snoezelen phase. The CBCL is one of the best-studied empirically derived checklists to measure general psychopathology. It has excellent psychometric properties, and previous research has demonstrated its reliability and validity in both clinical and nonclinical populations (Achenbach, 1991). Both of the participants in this study showed positive changes in the CBCL. In the case of participant 1, hyperactive and immature behaviors decreased considerably, and participant 2 showed the greatest change in anxiety and immature behavior. These findings may be directly associated with the positive changes in EEG. The positive behavioral changes presented in this study are in agreement with previous reports (Shapiro et al., 1997; Withers & Ensum, 1995).

The most common symptoms of ADHD are impulsiveness, hyperactivity, and inattention. Although ADHD is most prevalent in mid-childhood, and the symptoms diminish over time, the chronic nature of ADHD and the transition to adulthood have been reported in previous studies (Brown et al., 2001). Methods of treatment usually involve some combination of various medications, behavior modifications, life style changes, and counseling. However, there is no consensus in the literature for an overall effective ADHD treatment, as each approach has methodological weaknesses with relevant to its outcomes (Doggett, 2004). To evaluate the efficacy of Snoezelen this study employed the EEG, which can be regarded as an objective outcome measurement. Based on the findings of this study, Snoezelen has great adaptability as an effective intervention for children with ADHD.

The single-subject design provides a practical yet controlled experimental approach to study a subject's response to an intervention with limited resources (Portney & Watkins, 2000). However, as only two

participants were recruited with limited sessions, generalization of the results to other children with developmental disabilities is limited. Therefore, further studies with greater sample sizes and longer interventions are required to determine the clinical benefits of Snoezelen as a rehabilitative method for children with ADHD.

V. Conclusion

EEG analysis demonstrated physiological effects of Snoezelen therapy. The findings provide some potentials of the neurophysiologic evidence for earlier findings that maladaptive or challenging behaviors of individuals with ADHD are reduced and emotional relaxation is facilitated in a Snoezelen room. This study provides information that will inform future research on how the Snoezelen intervention affects the behaviors of children with ADHD.

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스노즐렌을 적용한 발달장애 아동의 문제행동 치료효과 검증 - 뇌파의 정량적 분석을 중심으로 -

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목적 : 본 연구의 목적은 스노즐렌 치료 적용이 발달장애 아동의 문제행동 변화에 미치는 영향을 알아보고, 이들 결과를 신경 생리적으로 검증하기 위해 뇌파의 변화를 알아보고자 하였다.

연구방법 : 연구의 대상은 2명의 발달장애 아동이었고, 연구 설계에는 개별사례 실험 연구 중 ABA 설계를 사용하였다. 실험의 절차는 기초선(A1)에서의 2회기, 치료과정(B)에서의 8회기, 치료추적(A2)조사에서의 2회기로 모두 12회기로 이루어졌다. 치료는 스노즐렌 치료실에서 30분 동안 비지시적인 아동중심치료접근법으로 각 아동에게 제공했다. 종속변수인 문제행동검사(CBCL)는 치료전과 후에 각 1씩 실시하였고, 뇌파 측정은 연구의 전 과정 동안 매 회기마다 이루어졌다. 뇌파 자료는 파워 스펙트럼 분석을 통해 정량적으로 분석하였는데, 결과의 분석을 위해 상대뇌파(췌타파, 알파파, 베타파, 감마파) 값을 선택하였다.

결과 : 연구 결과, 문제행동검사의 전체 점수는 스노즐렌 치료 후 두 아동 모두 감소함을 보여 스노즐렌 치료의 긍정적인 행동변화 효과를 알 수 있었다. 뇌파 변화의 결과에서는 상대뇌파 분석에서 대상자들 모두가 췌타파의 감소와 알파파의 증가를 보였고, 대상자2는 이와 함께 감마파의 큰 감소를 보였다.

결론 : 본 연구를 통하여 스노즐렌 치료 적용이 발달장애 아동의 문제행동과 뇌파 변화에 영향을 미친다는 것을 알 수 있었다. 본 연구는 발달장애 아동의 문제행동 완화와 이에 관련된 뇌파 변화를 검증함으로써 스노즐렌 치료의 임상적 유용성을 확인하였다.

주제어 : 뇌파, 문제행동, 발달장애, 스노즐렌