

Full-Length Article

Can Rhythmic Sensory Stimulation Decrease Cognitive Decline in Alzheimer's Disease? A Clinical Case Study

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Abstract

Background/Objectives: To present Rhythmic Sensory Stimulation (RSS) as a potential new treatment of Alzheimer's disease (AD).

Design: Longitudinal case study over a 3-year period.

Setting: RSS was provided both in a long-term care/research facility and in-home.

Participant: A 92 year old female with AD.

Intervention: Treatments consisted of RSS resulting in gamma frequency entrainment, provided with two different treatment devices over 3 years.

Measurements: Quantitative and qualitative measures were used including: MMSE, SLUMS, interviews, observation notes and a participant question sheet.

Results: MMSE scores since diagnosis 3 years earlier, as well as cognition, clarity, and awareness were reported by the subject's husband, to have remained unchanged.

Conclusion: Although further research is warranted, this case suggests that RSS has potential to help maintain cognition in AD.

Keywords: *alzheimer's disease, cognition, clarity, gamma frequency entrainment* multilingual abstract | mmd.iammonline.com

Introduction

A 92 year-old woman diagnosed with Alzheimer's disease (AD) was treated with sound-driven vibrotactile and auditory stimulation referred to as Rhythmic Sensory Stimulation (RSS). Mini Mental State Examination (MMSE) [1] remained stable over the following 3 years. This case demonstrates the potential of RSS treatments to maintain cognition in patients with AD.

Background/ client information

The patient (89 years) was diagnosed with an MMSE score of 22/30 indicating probable AD with mild impairment. MMSE subscores were: 6/10 on orientation, 3/5 on world backwards, and 1/3 on delayed recall. Visuospatial skills on clock drawing and intersecting pentagons were intact. However, drawing of the Necker Cube was impaired. On CERAD learning and recall, she learned 2, 4, and 5 words on the first 3 trials. After a delay, she recalled 1 word and recognized 17/20 words. She scored 18/30 on the Boston Naming Test. Verbal fluency was average for the letters C (n=14), F (n=8), and L (n=11). Semantic fluency for animals was impaired at 10. Digit span was 6 forwards and 4 backwards. She completed Trails A in 94 seconds. She could not complete the Trails B sample. She demonstrated some preservative behaviour issues on drawing alternating Ms and Ns, as well as ramparts. She was on a stable dose of Donepezil.

She was treated with gamma entraining RSS with 12 sessions at a long-term care facility. Subsequently, she acquired a consumer device that provided RSS embedded within relaxing music and she continued to use daily. The

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Amy Clements-Cortés, PhD, RP, MTA, MT-BC, FAMI. 56 Destino Crescent, Woodbridge, Ontario, L4H 3E1, Canada; Email: notesbyamy2@yahoo.ca | COI statement: Bartel receives royalties for the VTS1000 –Somerset Group for sound and Headwaters Corporation for design consulting. Freedman received honoraria from Eli Lilly Canada Inc. for participating in consultancy and advisory board meetings. He is also listed on a provisional patent related to methods and kits for differential diagnosis of AD vs. frontotemporal dementia using blood biomarkers and may be listed on the planned patent application.

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International Association for Music & Medicine (IAMM).

study was approved by the Research Ethics Board at Baycrest Health Sciences.

Foundational concept of sound as brain stimulation

RSS uses rhythmic pulsation to stimulate the brain through the tactile, auditory, or visual system [2] at regular intervals. In this study RSS was only tactile and auditory. RSS can function as a specific singular frequency (as was used in the first part of the intervention), or it can be embedded with conventional music, or it can be embedded with conventional music (second part of the intervention-at-home). RSS is premised on the following: (1) Oscillatory brain circuits can become dysregulated,[3] Dysregulation and connectivity problems result in medical conditions.[4] (2) Intra-brain connectivity is associated with 40Hz gamma oscillation. [5] (3) External rhythmic stimulus can regulate dysregulated circuits and connectivity. The central premise for the role of RSS in AD is the observed decrease in 40Hz gamma activity [2, 6] and that auditory and vibrotactile stimulation can increase 40Hz activity and brain connectivity.

METHODS

Intervention

During initial treatment, the patient received 12 RSS sessions in four weeks on a Next Wave Physioacoustic Chair [7] that delivers full-body vibrotactile stimulation with computer-generated, sinusoidal sound waves transmitted through the chair’s six low-frequency speakers. It is classified as a low-risk device approved by the Canadian Standards Association, The United States’ Food and Drug Administration, and British Standards Institution.

Treatment consisted of a sinusoidal 40 Hz tone (although we call it RSS because of our theoretical frame, it is also known as vibroacoustic therapy), amplitude modulated on a 4 second cycle, with sound moving progressively through the six speakers from legs to head and back again with a peak amplitude in the range of 104 – 109 dBc (Decibels relative to carrier). This RSS treatment was applied for 45 minutes per session. Because the patient was experiencing some boredom, during sessions 7–12, relaxing music was played in the treatment room as ambient sound in addition to the 40Hz RSS.

The patient was administered the Saint Louis University Mental Status (SLUMS)[8] cognitive assessment before and after treatment, plus a short (25 point) set of 11 questions about her family (e.g., her children’s and grandchildren’s names and birthdates) to assess her long-term memory (See Table 1). Observations and reflective notes recorded by the music therapist during and after the session documented patient’s alertness, ability to focus, drowsiness, confusion, distraction, inattention and preoccupation, in addition to any

direct words the patient stated. The patient’s husband was interviewed 4 times - at the end of each week of treatments. (See Table 2 for open-ended interview questions). The SLUMS was administered by the music therapist who conducted the treatment, however, the husband’s interviews were conducted by another researcher.

Questions	Possible Points
What is the name of your husband?	1
What year did you get married?	1
How many children do you have?	1
What are their names?	8
Who is the eldest?	1
Who is the youngest?	1
How many grandchildren do you have?	1
What are their names?	8
Who is your youngest grandchild?	1
How old is he/she?	1
Who is your first grandchild?	1

Table 1: 11 Questions for Patient about Family

Since the patient’s treatment started, have you noticed any changes in...	
1.	How she sleeps?
2.	Short-term memory function.
3.	Mood?
4.	Mental clarity during conversations?
5.	Interest in going places?
6.	Appetite?
7.	How she looks after herself?
8.	Interest in recreation?
9.	Social Relationships?
10.	Ability to solve problems?
11.	Level of worry or contentment? Anxiety?
12.	How safe she feels?
13.	Anything else?

Table 2: Interview Questions with Husband

Following 12 treatments, the patient was advised to use an in-home consumer device (Sound Oasis VTS1000 [9]) for 30 to 60 minutes a day, five days a week with the “Energize” program. The Energize program features pleasant instrumental music with a sine-wave bass line that activates vibrotactile gamma stimulation with 40Hz as the most prominent frequency. Using the device for 60 minutes resulted in 20 minutes of 40Hz stimulation. She used the

device almost daily for 30 to 60 minutes for the three years prior to current reassessment.

RESULTS

Initial RSS Treatments

The SLUMS scores ranged between 13 and 22 pre- RSS treatment, and between 13 and 23 post-treatment (mean scores 17.67 and 18.17). Scores for the 11 questions post-test ranged between 11 and 16, with an average of 13.2. For both the post-test SLUMS scores and the post-test 11 questions, data were analyzed to determine the effect of treatment using a linear regression analysis. In both cases, the scores were modeled as linear functions of number of treatments. The estimated slopes and standard errors are given by 0.476(0.197) and 0.567(0.122), respectively. The p-values, for testing that the slopes are zero; (and thus there is no effect due to number of treatments), are 0.036 and 0.002, respectively. There is an effect of approximately 0.5 of a scale point per treatment. It is evident from the RSS post-test scores that there is an upward linear trend in the SLUMS scores.

The following are qualitative observations from the first 12 RSS sessions. The patient typically reported she was comfortable and described the treatment as: “*Very gentle, hardly noticeable, very comfortable.*” She tended to close her eyes, rest, and sometimes fall asleep for the first 15-18 minutes of the treatment but then opened her eyes, looked around the room, and commented on items in the room and sometimes began conversation.

In the weekly interview, her husband reported he noticed little change during initial sessions in short-term memory, and stated her mental clarity fluctuated. She continued to try to complete crossword puzzles, but this was becoming more challenging, however her math skills remained strong. Prior to session 9, her husband noted that during the previous week she had wandered off, went to three stores, and called home, remembering her phone number, which she had not been able to remember in the past few months prior. After the last session, her husband reported a slight improvement in her short term memory and sleep. Generally she was content, but had some moments of irritability.

Three years post diagnosis

Three years after the initial RSS treatment sessions, the patient was re-assessed. In the initial 12 RSS treatment sessions she scored an average of 17.7 on SLUMS tests administered at the start of each treatment. On the 11 questions, she scored an average of 13.2. Three years later she scored 13 on the SLUMS test, and 10 on the set of 11 questions test. MMSE score at 3 years post-onset was the same as when she was diagnosed, i.e. 22/30 vs 22/30. This score is noteworthy since the typical

annual decline in the MMSE score is about 3.3 (95% CI 2.9 – 3.7) [9,10].

The patient’s husband was interviewed approximately 3 years after the initial 12 RSS treatments. He reported that after she was diagnosed with AD he noted an increase in frustration and “having tantrums”. But, two years after initial RSS treatment sessions this behavior had subsided without medications. She was still able to name her 8 children, but not her grandchildren or great grandchildren. She also exhibited a few other new behaviors such as hiding her purse and worrying that she does not have any money in her wallet. She no longer reads and does not do crossword puzzles. When she wakes up she is typically disoriented as to where she is, and sometimes asks her husband who he is.

DISCUSSION

The increase in SLUMS scores during the first 12 RSS scores is consistent with the findings of a recent RSS and AD pilot study showing an increase in SLUMS scores with an effect size close to 3.5 (.58 for each session) in just 6 sessions of RSS treatment.[10] Three years after continued RSS treatments with the use of the home device, [11] there was little change from the patient’s initial SLUMS scores. Furthermore, the MMSE scores and comments in her medical record indicated that her cognitive function remained fairly consistent. Although music used with the RSS may be a contributor to the results observed, the consistency of these results with the RSS only study [12] points to the conclusion that it is the frequency specific RSS that contributed the primary effect.

As a single case study, limitations include the reliability of the statistical conclusions and potential subjectivity of the therapists and their observations and assessments of the patient’s condition pre-, during, and post-treatment. Furthermore, the set of 11 questions and the interview questions were not standardized and therefore did not provide validated measures.

This case supports the use of RSS as a potential new treatment that may help reduce cognitive decline in AD. Research is being planned to include neuroimaging of AD patients at the mild and moderate levels to determine whether the mechanism involved is possibly the power of the gamma frequency oscillation and whether this may serve as a biomarker for AD.

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