Verification of Effect of Music and Animal Therapy on Psychiatric Care by using a Nonlinear Analysis of Pulse Waves

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Abstract. This study examines the psychiatric effectiveness of music therapy and animal therapy. Unlike previous research into these modalities, the present study relies on scientifically valid measurements of actual somatic reaction rather than on subjective reports. Earlier work by the current authors defined fluctuation in plethysmogram readings in terms of a Lyapunov exponent derived from activity in the sympathetic nervous system related to the preservation of mental health. Drawing on the previous findings, this study measured changes in the Lyapunov exponent as a function of therapy. Results demonstrated that the Lyapunov exponent reflected the therapeutic effect of these treatments. Specifically, an increase in the lyapunov exponent indicated nerve activation within the sympathetic nervous system. On this basis, the authors recommend that traditional formulation regarding a "healing effect" (i.e., therapeutic benefit) be reconsidered.

1 Introduction

This study examines the psychiatric effectiveness of music therapy and animal therapy. Unlike previous research into these modalities, the present study relies on scientifically valid measurements of actual somatic reaction rather than on subjective reports. Earlier work by the current authors defined fluctuation in plethysmogram readings in terms of a Lyapunov exponent derived from activity in the sympathetic nervous system related to the preservation of mental health. Drawing on the previous findings, this study measured changes in the Lyapunov exponent as a function of therapy. Results demonstrated that the Lyapunov exponent reflected the therapeutic effect of these treatments. Specifically, an increase in the lyapunov exponent indicated nerve activation within the sympathetic nervous system. On this basis, the authors recommend that traditional formulation regarding a "healing effect" (i.e., therapeutic benefit) be reconsidered.

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2 What is Therapy?

Music therapy is a type of therapy that uses music for the purpose of psychiatric treatment. It is very different from simple recreation. Indeed, it begins with an assessment process that includes goal-setting, treatment program design, an initial session, a documented evaluation, and a treatment conference [3], [4].
Potential participants include psychiatric patients, children, senior citizens, and those with terminal illnesses. Target diagnoses include physical handicaps, autism, developmental disabilities, symptoms of ageing, and responses to imminent death. Group music therapy may also be indicated.
There are two subtypes of music therapy: passive music therapy, and active music therapy. Passive music therapy involves having patients listen to, sing with, and perform body movements in response to music that has been selected by the therapist on the basis of individual needs and goals. Active music therapy entails the application of treatment techniques to the aforementioned situation; these techniques are employed for the purpose of achieving mental health goals.
Brain activation accompanies the behaviors involved in active music therapy. In addition, the deep breathing that enables singing has a positive effect on the respiratory state of singers. Moreover, the experience of rhythm in music helps to stabilize the behavioral rhythms of daily living. Adequate sleep, tasty food, good defluxion, and balanced bodily cycles promote health.
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Yet, claims regarding the efficacy of music therapy must be qualified until studies using methods that meet the standards of evidence-based-medicine (EBM) demonstrate such efficacy. It is not enough to recommend music therapy on the basis of qualitative research alone. The availability of research that validates the efficacy of music therapy using methodologies accepted by EBM will be of great importance to individuals who are involved in this treatment and who may benefit from this modality in the future [5].
Therapy (i.e., psychotherapy) is a treatment method that is employed to achieve a healing/curative goal for individuals suffering from psychiatric conditions. It should be possible to determine the effect of a treatment by the degree to which the goal is achieved.

2.1 Music Therapy

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2.2 Animal Therapy

Animal therapy uses the positive impact of the physical affection that attends contact with a specially trained animal in the service of the treatment of psychiatric disorders. Anecdotal accounts abound with stories of institutionalized children and senior citizens who visibly brighten when an animal arrives to visit. Yet, studies examining the impact of animal therapy have produced inconsistent results. Several experiments, however, provide encouragement for the efficacy of animal therapy. For example, Mugford & M'Comisky (1975) found a positive relationship between keeping a bird and measures of mental health among senior citizens [6]. Similar results have emerged for cats and dogs, underscoring the need for additional research employing methods that are consistent with EBM.
This effect has been investigated by measuring the physiological state associated with looking at a dog. Friedmann, Katcher, Thomas, Lynch, & Messent (1983), using a sample of children, found a clear positive relationship between the presence of a dog on the one hand, and lowered cardiac rates and blood pressure on the other [7]. This may be termed the “stillness effect” of being in canine company.
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3 Calculation of the Lyapunov Exponent

Figure 1 shows the flow diagram showing the procedure from the measurement of pulse waves to calculation of the Lyapunov exponent [1]. To construct the attractor, we set a delay time and the number of embedding dimensions according to Tarkens theory. We used four embedding dimensions and a delay time of 50 msec. Right figure illustrates the method of embedding in three-dimensional phase space. Although effective information can be obtained from the shape of the four-dimensional attractor, we calculated the Lyapunov exponent, which is an index of trajectory instability and a characteristic of chaos.

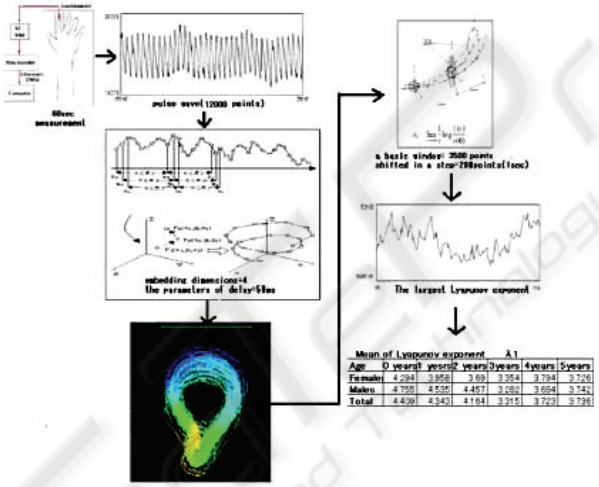

Fig. 1. Flow diagram showing the procedure from the measurement of pulse waves to calculation of the Lyapunov exponent.

By the measurement of pulse of one minute, 43 Lyapunov exponents is obtained. We performed comparison of each condition using average of these values [2], [3].

4 Methods of Music Therapy and Measurement of Effectiveness

4.1 Study Subjects

The subjects were 7 elderly people who ranged in age from 73 to 88 years (mean 82.9 years old).

4.2 Study Location

The experiment was conducted at A nursing home in Shiga, Japan.

4.3 Study Period

The study was conducted in February 2008.

4.4 Measurement Detail and Methods

Pulse waves were measured for one minute both before and after music therapy. Therapy session lasted slightly less that one hour. Room temperature was set at the presumably optimal 25 degrees.
Contents of music therapy :
Therapists: 4 members. Therapy time: about one hour

1. All the subjects hear a chorus of therapists.
2. All subjects hear a chorus of therapists.
3. An exercise vocalizing a musical scale: "Do-Re-Mi;"
4. Physical exercises for the purpose of relaxing muscles (e.g., putting an arm up while taking a deep breath);
5. A participant accompanies the music with a tambourine, a bell so on
6. Breathing: Using both hands and the rhythm of abdominal breathing;
7. Singing seasonal songs as a group;
8. A song to end the session: "Today's good day;"

4.5 Results Regarding the Efficacy of Music Therapy

Fig. 2 shows the results of music therapy: an increase in the Lyapunov exponent, reflecting a positive impact on cardiac functioning among six out of seven subjects. These results confirm that music therapy produced a strong positive effect.

5 Methods of Animal Therapy and Measurement of Effectiveness

5.1 Study Subjects

The sample consisted of 15 students (five males, ten females) with an average age of 19.5 years (range: 18-26).

Subjects were divided into two groups according to attitude toward the animal. The “positive group” consisted of seven subjects (three males, four females) who expressed liking for the animal. The “negative group” consisted of eight subjects (two males, six females) who disliked the animal.

Both groups participated in preliminary investigations and elected to continue the study [9]. The experiment was explained, consent was obtained, and simulations

(including touching the animal) were performed, but subjects were not informed of their group membership.

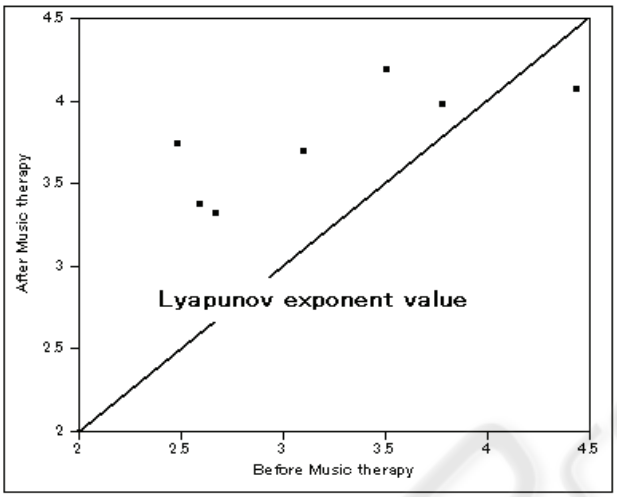

Fig. 2. The effect of music therapy.

5.2 Study Location

O-Laboratory. Room temperature was set at a presumably optimal level.

5.3 Study Period

Observations were made on November 13-16, 2006, 9:00 a.m. to 7:00 p.m.

5.4 Measurement Details and Methods

Contents of animal therapy:

This experiment used a four-year-old female miniature Dachshund, who was appropriate for this research by virtue of her training and quiet disposition.

This experiment examined the effect of canine contact on the digital pulse wave of the subject. The latter was measured, for 2 minutes, with and without canine contact, respectively. Baseline readings of body temperature and blood pressure were obtained at the start of the procedures.

The experimental condition involved the subject gently touching the dog for 2 minutes, followed by pulse wave measurement. Although the ideal experimental condition would have entailed simultaneous canine contact and pulse wave measurement, this was deemed impractical in view of the confounding effects of the vibrations caused by the touching. A third measurement was taken after a 1-minute break, during which the dog was separated from the subject.

Under the control condition, subjects took a break of 2 minutes after the first measurement. The control group was given an equal number of pulse wave measurements, after equivalent breaks, for 2 minutes apiece, but in the absence of canine contact.
Six pulse wave measurements were obtained for each subject.
Figure 3 shows the experimental procedure.

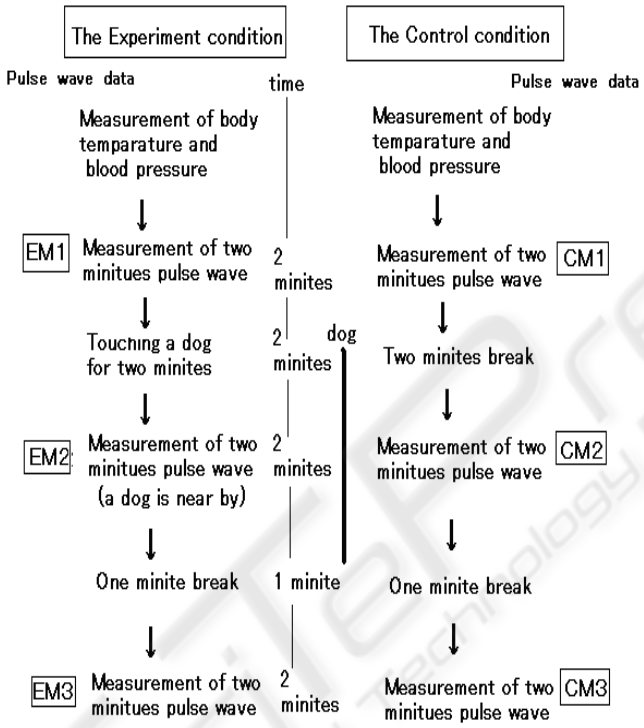

Fig. 3. Experimental Flow.

Six sets of pulse waves, each of 2 minutes duration (see Figure. 3), were measured: EM1, EM2, EM3 (under the experimental condition), CM1, CM2, CM3 (under the control condition).

5.5 Results of Animal Therapy

Fig. 4 shows the effect of animal therapy. All subjects belonging to a positive group show that a value of Lyapunov exponent increased at the time of EM3 from time of EM1.

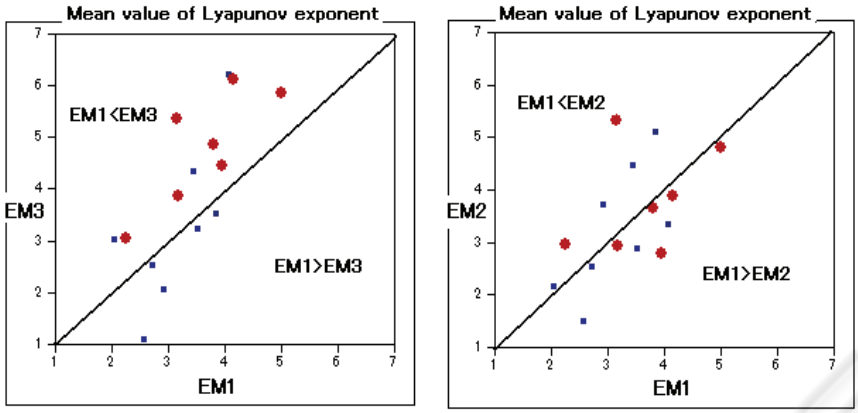

Fig 4. The effect of animal therapy; ○ indicates positive-group subjects; ■ indicates negative-group subjects.

It is clear that animal therapy produced a significant effect.

Figures 5 and 6 graph the mean Lyapunov exponents of each group under the control condition. The longitudinal axis expresses the mean Lyapunov exponent, and the first cross axis expresses the second or third measurement.

No change was found between the first and second measurements in the positive or negative groups. However, the positive group showed increases in the third measurement and under the experimental condition (see Figure. 5, Left), whereas the negative group showed corresponding decrements. This accords with the graph in Figure. 5 ,Right).

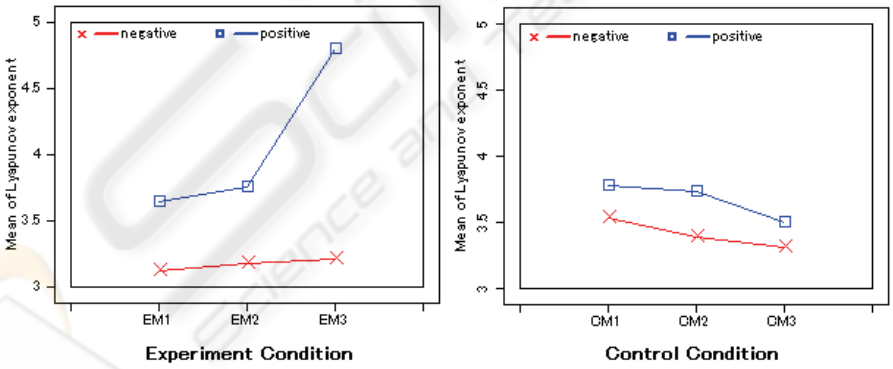

Fig. 5. Change in the Lyapunov exponent under the experimental condition(Left) and Change in the Lyapunov exponent under the control condition(Right).

The foregoing demonstrates a change in the Lyapunov exponent as a function of canine contact. We show an example of attractor of the first measurement and tertiary measurement of positive group in an experiment condition in Figure 6. Attractor is drawn in three dimensions. Width of attractor opens, and in comparison with M1

before touching a dog. M3 after having been felt understands that chaous characteristics rise.

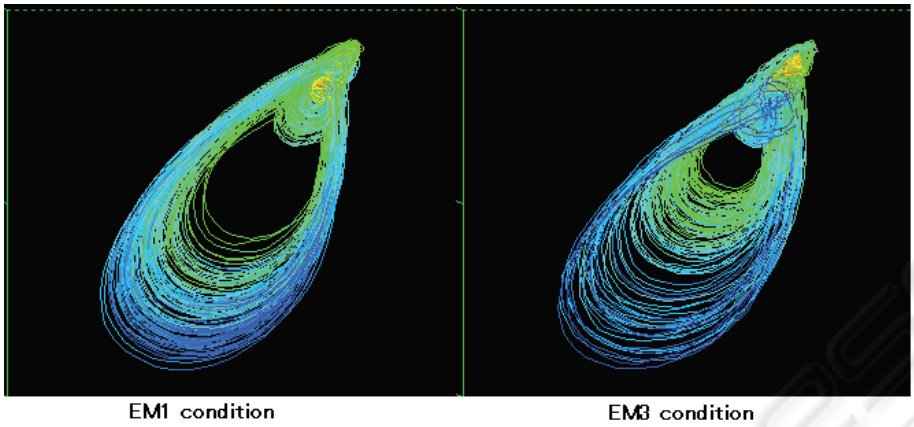

Fig. 6. Attractor of pulse waves of subject A.

6 Conclusions

This study examined the effect of music therapy and animal therapy. The effect was measured by identifying changes in the Lyapunov exponent as calculated by nonlinear analysis of pulse waves. The Lyapunov exponent was chosen due to its association with human adaptability and sanity.

This study had the pleasure of scientifically validating the smile of a lonely old man and the joyful look of an abused child. It provides evidence that meets EBM standards regarding the efficacy of treatments that use music and animals to deal with psychiatric conditions.

A psychometric analysis of stress will be made possible by the innovative methodologies employed by the present study.

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References

1. Oyama-Higa, M., Miao, T. (2006). Discovery and application of new index for cognitive psychology. 2006 IEEE Conference on Systems, Man, and Cybernetics 2006, 2040-2044.

2. Oyama-Higa, M., Miao, T. , Tsujino J., Imanishi A., (2007). Possibility of mental health self-checks using divergence of pulse waves. 2007 IEEE Conference on System, Man, and Cybemetics 2006, 3952-3960
3. Oyama-Higa, M., Miao, T., Mizuno-Matsumoto, Y. (2006). Analysis of dementia in aged subjects through chaos analysis of fingertip pulse waves. 2006 IEEE Conference on Systems, Man, and Cybernetics 2006, 2863-2867.
4. Tomoaki Shinoda supervision (2001),written by Shigeaki Hinohara, Tomoaki Shinoda et al. A proposal from the new music therapy practice spot, Friend Corporation of Music
5. Tetsuya Kosaka & Hiroaki Tateishi Compilation (2006), "A hint from the advice practice spot of music therapy" Minerva Bookshop
6. Donald Michelle & Joseph Pinzon (2007), Practice it with a principle of music therapy, Friend Corporation of Music
7. Mugford, R. A., & M'Comisky, J. G. (1975). Some recent work on the psychotherapeutic value of cage birds with old people. London: Pet Animal Society.
8. Friedmann, E., Katcher, A. H., Thomas, S. A., Lynch, J. J., & Messent, P. R. (1983). Social interaction and blood pressure. Influence of animal companions. Journal of Nervous and Mental Disease, 171, 461-46
9. Yousyutu Sugita (2003), General Social Surveys Study Memoirs for Japan, 2, 127 - 143.
10. Templer, D., Salter, C. A., Dickey, S., Baldwin, R., & Veleber, D. M. (1981). The construction of a pet attitude scale. Psychological Record, 31, 343-348.