THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 10, Number 1, 2004, pp. 113–122

Measuring Effects of Music, Noise, and Healing Energy Using a Seed Germination Bioassay

KATHERINE CREATH, Ph.D. (Optical Science), Ph.D. (Music),[1–3] and GARY E. SCHWARTZ, Ph.D.[1,3,4]

ABSTRACT

Objective: To measure biologic effects of music, noise, and healing energy without human preferences or placebo effects using seed germination as an objective biomarker.

Methods: A series of five experiments were performed utilizing okra and zucchini seeds germinated in acoustically shielded, thermally insulated, dark, humid growth chambers. Conditions compared were an untreated control, musical sound, pink noise, and healing energy. Healing energy was administered for 15–20 minutes every 12 hours with the intention that the treated seeds would germinate faster than the untreated seeds. The objective marker was the number of seeds sprouted out of groups of 25 seeds counted at 12-hour intervals over a 72-hour growing period. Temperature and relative humidity were monitored every 15 minutes inside the seed germination containers. A total of 14 trials were run testing a total of 4600 seeds.

Results: Musical sound had a highly statistically significant effect on the number of seeds sprouted compared to the untreated control over all five experiments for the main condition ($p < 0.002$) and over time ($p < 0.000002$). This effect was independent of temperature, seed type, position in room, specific petri dish, and person doing the scoring. Musical sound had a significant effect compared to noise and an untreated control as a function of time ($p < 0.03$) while there was no significant difference between seeds exposed to noise and an untreated control. Healing energy also had a significant effect compared to an untreated control (main condition, $p < 0.0006$) and over time ($p < 0.0001$) with a magnitude of effect comparable to that of musical sound.

Conclusion: This study suggests that sound vibrations (music and noise) as well as biofields (bioelectromagnetic and healing intention) both directly affect living biologic systems, and that a seed germination bioassay has the sensitivity to enable detection of effects caused by various applied energetic conditions.

INTRODUCTION

Plants are complex multicellular organisms considered as sensitive as humans for initial assaying of effects and testing new therapies (Benford, 2002; Dossey, 2001; Kristen, 1997). Sound is known to affect the growth of plants. Seeds are sometimes treated with ultrasound to help start the germination process (Shors et al., 1999; Weinberger and Burton, 1981). Foliage planted along freeways to reduce noise pollution often grows differently than foliage planter in a quiet environment (Bache and Macaskill, 1984; Martens and Michelsen, 1981). Sound vibration can stimulate a seed or plant (Braam and Davis, 1990). Studies in the audible frequency range have examined effects on seed germination (Gnanam, 1960; Measures and Weinberger, 1973). They have focused on single frequencies in an attempt to map responses as a function of frequency (Collins and Foreman, 2001; Hageseth 1974; Measures and Weinberger, 1970;

[1]Center for Frontier Medicine in Biofield Science, University of Arizona, Tucson, AZ.
[2]Optical Sciences Center, University of Arizona, Tucson, AZ.
[3]Department of Medicine, University of Arizona, Tucson, AZ.
[4]Departments of Psychology, Psychiatry, Surgery, and Neurology, University of Arizona, Tucson, AZ.

Weinberger and Das, 1972; Weinberger and Measures, 1978). However, these studies did not look at dynamically organized sound with the complexities of musical sound.

Music can have deep meaning for listeners. However, because of the difficulty in obtaining objective data, the results of scientific studies involving music have been controversial. Studies examining the Mozart effect (Chabris, 1999; Raucsher, 1999) focused primarily on psychologic rather than physiologic effects. Neurophysiologic studies have indicated that human physiologic processes are affected by music (Janata et al, 2002), but they have concentrated on how our brains process music and where the neural interactions are focused rather than on systemic physiologic effects. Previous studies on plants using music and/or noise have been controversial (Galston and Slayman, 1979; Klein and Edsall, 1965; Retallack, 1973; Retallack and Broman, 1973; Tompkins and Bird, 1973; Weinberger and Das, 1972; Weinberger and Graefe, 1973; Weinberger and Measures, 1978) and difficult to replicate because the precise experimental conditions were not specified.

Many healing energy studies have been performed with seeds rather than with humans (Roney-Dougal and Solfvin, 2002; Scofield and Hodges, 1991). The largest body of work (Grad, 1967, 1965, 1963, 1964) involved studying recovery from injury in barley seeds caused by stress induced by a 1% saline solution comparing bottles of saline solution treated for 15 minutes by a healer to an untreated control. Grad's procedures were carefully randomized and double-blinded with significant differences in four of six experiments. He found that a larger number of seeds germinated when watered with saline held by the healer. These seedlings were taller with a greater total yield per pot compared to the controls. Other experiments involved treating water (Berden et al., 1997; Haid and Huprikar, 2001). Haid and Huprikar (2001) showed that pea seeds watered with water that had been meditated on to enhance their germination sprouted almost 20% faster than the controls ($p < 0.006$) while wheat seeds that were watered with water that had been meditated on to inhibit their germination sprouted approximately 8% slower than the controls ($p < 0.001$).

Recent reviews of healing energy research (Astin et al., 2000; Crawford et al., 2003; Jonas and Crawford, 2003; Miles and True, 2003) stress the need for independently replicable basic science studies to develop baseline data for clinical and mechanistic studies. We present the results of five experiments utilizing plant seeds as subjects to develop a bioassay for testing the effectiveness of therapeutic modalities and mechanisms of action.

METHODS

The experiments presented in this paper were initially designed to test the effects of musical sound and noise using a rigorous, robust and easily replicable methodology similar to studies testing effects of single frequency sound on seed germination (Creath and Schwartz, 2003, 2002; Hageseth, 1974). We also found that this methodology was easily extendible to testing the effects of healing energy.

Series of five experiments

This study consisted of a series of five experiments (I–V), each designed to replicate and extend the previous experiment. Table 1 outlines the number of trials performed and the conditions present for each of the five experiments. This series of five experiments began in mid-March and went through the end of June 2002. Each trial was 72 hours long and begun at the same time of day.

The first experiment compared musical sound to a control with no sound in a similar environment. This experiment comprised two trials in which the two conditions were swapped between trials. For the second experiment, the positions of the two chambers in the laboratory were shifted to provide better control of the temperature difference between chambers. Two trials were again performed counterbalancing for position of condition.

The third experiment added a third chamber and a third condition using healing energy to compare to musical sound and control. This experiment involved two trials with the conditions moved to different chambers between trials. In addition, an independent scorer blind to the conditions was added to count the number of sprouted seeds at the 60-hour mark of each trial.

Experiment IV added a fourth growth chamber to compare musical sound to noise to control and healing energy to control. This experiment had four trials and positions of the conditions were randomized among the chambers. Experiment V was a replication of experiment IV in terms of music and noise versus control. Assignments of conditions in growth chambers were randomized and counterbalanced so that between experiments IV and V all conditions had been in each chamber twice. The healing energy condition in experiment V was modified to explore different thera-

Table 1. Overview of the Five Experiments

		Conditions tested			
Experiment	*Number trials*	*Control*	*Music*	*Noise*	*Healing energy*[a]
I	2	x	x		
II	2	x	x		
III	2	x	x		x
IV	4	x	x	x	x
V	4	x	x	x	x[a]

[a]Protocols for healing energy were varied in experiment V and differed from those used in experiments III and IV. Healing energy results for experiment V are not reported in this paper; however, all other aspects of experiment V are included in data presentations.

peutic protocols. Because the experiment V healing energy protocols varied and were not consistent with protocols used for experiments III–IV, the healing energy results for experiment V were not reported here, but all other aspects of experiment V are included in data presentations.

Growth chambers

Identical chambers each consisted of a large, gray plastic container with lid surrounded with an enclosure of gray, convoluted acoustical foam (Fig. 1A). Six (6) liters of sand in the bottom of the chambers isolated the speakers from direct mechanical vibration of the seeds between chambers. A resonant chamber was created using an upside-down flowerpot with a hole cut to hold a 4-inch Fostex speaker (Lowther Speakers, Chesterfield, MO) (Fig. 1B). Petri dishes containing seeds were placed in a sealed plastic container suspended in the top of the chamber using point contacts from machine bolts in the corners of the seed container (Fig. 1C,D).

HOBO data loggers from Onset Computer Corp. (Bourne, MA) were mounted in each seed container to automatically log temperature and relative humidity at 15-minute intervals (Fig. 1D and Figure 2). Petri dishes were always placed in the same orientation and position within a seed container and the seed containers were oriented relative to magnetic north as shown in Figure 2.

Chambers were spaced a few feet apart and away from walls to ensure air circulation. The experiments spanned

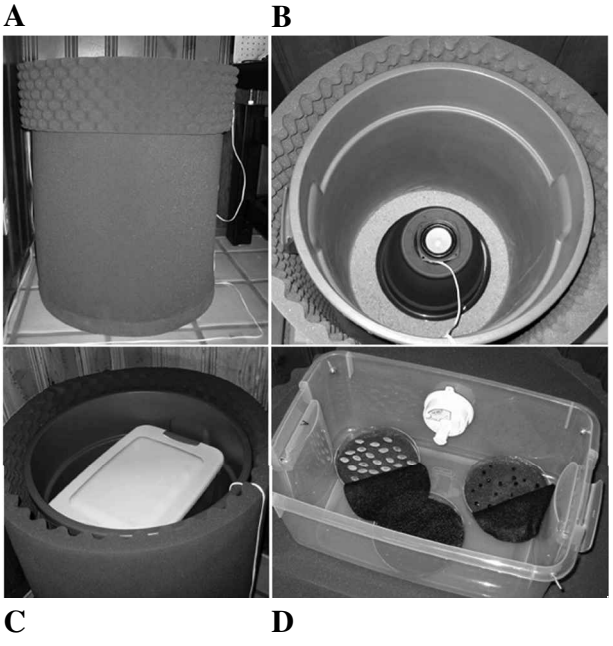

FIG. 1. Growth chambers. **A:** Outside view. **B:** Speaker in bottom. **C:** Seed container suspended in chamber. **D:** Open seed container showing petri dishes with seeds covered with felt and data logger.

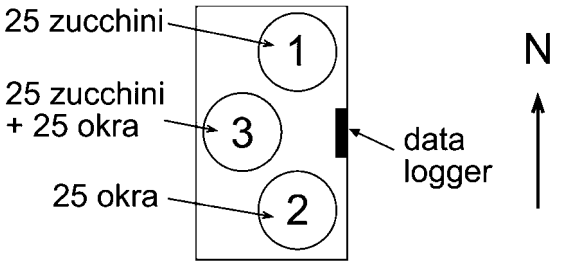

FIG. 2. Arrangement of seed dishes in seed container with orientation relative to magnetic north.

from March through June 2002 over two seasons with large outside temperature variations. During the first two experiments room temperature was maintained using heat. In the next two experiments evaporative cooling was used, while in the last experiment air conditioning and circulating fans were necessary to maintain similar mean temperatures.

Seeds

Two types of seeds were used for these studies: black zucchini squash (*Cucurbita pepo*) and Clemson spineless okra (*Hibiscus esculentus/Abelmoschus escenlentus*) seeds. Both are dicots. Okra and zucchini were chosen after exploratory trials with a number of different seed types. Both seed types sprout quickly and it is easy to tell when they have sprouted. A seed was counted as sprouted when the radicle (root shoot) pierced and was visible through the testa (seed coat). Figure 3 shows drawings of each type of seed and photographs of recently sprouted seeds.

Each seed container held 3 petri dishes of seeds (Fig. 2): one containing 25 zucchini seeds, a second containing 25 okra seeds and a third containing 25 okra and 25 zucchini seeds. The placement of the seed dishes in the container was maintained from day to day, run to run, chamber to chamber, and experiment to experiment. Zucchini seeds were al-

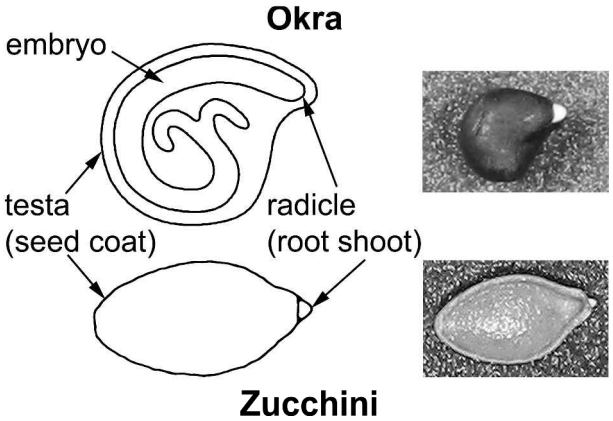

FIG. 3. Schematics and photographs of okra and zucchini seeds showing where they sprout.

ways oriented with the end that sprouts pointing north. Okra seeds tended to roll around and did not have a fixed orientation.

Seeds were first sorted to remove cracked and discolored as well as large and small seeds. They were then agitated in a 1% bleach solution with tap water and rinsed 10 times followed by 30 minutes of soaking. Seeds were lined up in random order and placed one by one using forceps into grids in petri dishes. Each seed container had 2 groups of zucchini seeds and 2 groups of okra seeds for a total of 50 seeds of each type per condition. Seeds were sandwiched between layers of felt to retain moisture and ensure darkness (Fig. 1D).

Seeds were monitored every 12 hours always at the same time of day. During exploratory trials it was determined that monitoring every 12 hours was sufficient to take care of the seeds and to count the sprouted seeds. Monitoring more often disturbed the seeds more and did not appear to provide extra information. Monitoring less often would have not given as much detail about the sprouting rate. Monitoring consisted of digitally photographing the seeds, counting the number sprouted and adding measured amounts of water that had been worked out over exploratory trials.

Sound conditions

Each growth chamber had an identical speaker inside. The difference between conditions was whether the sound was on and what sound was played through the speaker. Equal sound pressure levels across chambers were set by adjusting the volume to the speaker for the dynamically organized sound and noise conditions. Levels were monitored using a RadioShack sound meter (Radio Shack, Fort Worth, TX) averaging over 199 seconds. Sound conditions were applied continuously for 16 hours per day using a timer to turn the amplifier on and off while the CD players continually replayed.

The musical sound consisted of a 74-minute CD of musical selections from albums by R. Carlos Nakai and Paul Horn (Horn and Nakai 1997; Nakai 1992). These selections incorporate sounds of nature such as birds and echoes, are mostly improvised, contain short phrases with pauses for breath, and are predominantly performed on Native American flute. This music was chosen because it contained natural sounds, the music was gentle, and it was preferred by the experimenter who listened to it many hours a day during the course of the study.

Noise consisted of a 3-minute track of pink noise produced by Behringer Test CD (Behringer International GmbH, Willich, Germany) Audio to test loudspeakers. Its power spectrum is close to white noise with the lowest frequencies rolling up and the highest frequencies rolling off. Sound conditions were assigned randomly to growth chambers and counterbalanced for position. A more thorough analysis of the music is available in Creath.*

Healing energy condition

The biofield therapy used for the healing energy condition was a relatively new therapeutic modality VortexHealing® (VH) founded by Ric Weinman, B.A., in 1994 (Weinman, 2000, 2002). It is a recognized therapy of the Associated Bodywork and Massage Professionals (ABMP). VH claims to trace its roots to a man named Mehindra who lived 5600 years ago in India. It is a bioenergetic therapy purportedly taught via transmission. The five levels of training concentrate on teaching the practitioner how to focus their intention on what is needed for the receiver while being open to act as a channel for divine energy (Weinman 2003a, 2003b). This modality was chosen because the senior author (K. Creath) has formal training in VH.

Sets of seeds receiving healing energy were treated for 15–20 minutes twice per day with VH by Creath after the seeds were monitored receiving a total of six treatments during a trial. Petri dishes of seeds were stacked for treatment. Seeds were in the dark under black felt for the treatments. Four points of the hands (tip of ring fingers and side edge of palms) barely touched the top of the stack of three petri dishes as shown in Figure 4. The contact on the dishes was minimal. The center of the palms was approximately 3 inches away from the top center of the stack. This distance is similar to that reported in separate studies by Kiang and Berden (Berden et al., 1997; Kiang et al., 2002).

A treatment consisted of (1) consciously connecting to the seeds, (2) focusing intention for the seeds to germinate faster than the controls, (3) asking for energetic structures to enable this, (4) letting all energetics necessary for this to flow, (5) help from divine consciousness to integrate and ground this energy, and finally (6) becoming an open channel for divine energy to flow through. This sequence is standard practice in VH treatments. The practitioner mentally focuses on each of these steps sequentially. A total of six trials using this protocol were performed in experiments III and IV.

This energy healing treatment includes possible thermal and other bioelectromagnetic effects, as well as healing in-

FIG. 4. Hand position for healing energy (Vortex Healing® [VH]) treatment.

*Creath K. Effects of Musical Sound on the Germination of seeds [dissertation]. Tucson, AZ: University of Arizona, 2002.

tention effects. Because the primary comparisons were for the sound conditions and there was not another chamber available for a second control, there were no controls in this study accounting for either the extra time the healing energy condition seeds were out of their chamber or for the close proximity of the hands. These additional controls will be incorporated in future studies to examine the potential role of each as well as their interaction on seed germination.

Data scoring and analysis

Every 12 hours the number of seeds that had sprouted out of groups of 25 seeds was counted and logged for each group of seeds for each condition. Photographs of each petri dish were taken at this time as well. Figure 5 shows dishes of okra and zucchini sprouts after 60 hours. The zucchini sprouts are much smaller because zucchini germinates slower than okra.

Beginning with the third experiment an independent scorer blind to the conditions was utilized to have an independent count of the number of seeds sprouted. Temperature and relative humidity were logged every 15 minutes inside each seed container.

Data consisted of the number of seeds sprouted out of groups of 25 seeds. There were 2 groups of 25 seeds for each of 2 seed types for each condition yielding 4 independent subjects per condition per trial. A total of 3600 seeds were included in the data analysis, half of each type.

Seed count data were analyzed using five-way analysis of variance (ANOVA) of mixed design. Between group factors were the number of experiments (1–5), petri dish locations (2), and seed types (2). Condition (or position) and time were considered as repeated measures. The dependent variables were the number of seeds that had sprouted for a given condition or position (2–3) and time (7 time points). The number of seeds sprouted for a single group of seeds (25 seeds = 1 subject) at a single time point was compared versus condition. Data from the zero hour time point were compared for all conditions, as were data from each subsequent time sample.

Temperature data were analyzed with three-way ANOVAs of mixed design. Data taken inside seed containers were sampled at 3-hour intervals yielding a total of 25 sample points per trial. Between group factors were experiments (I–V) and condition or position (2–3). Temperature values as a function of time (25 time points) were considered as repeated measures.

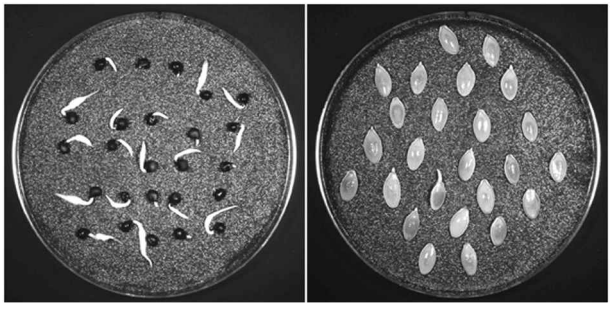

FIG. 5. **A:** Okra sprouts. **B:** Zucchini sprouts at 60 hours.

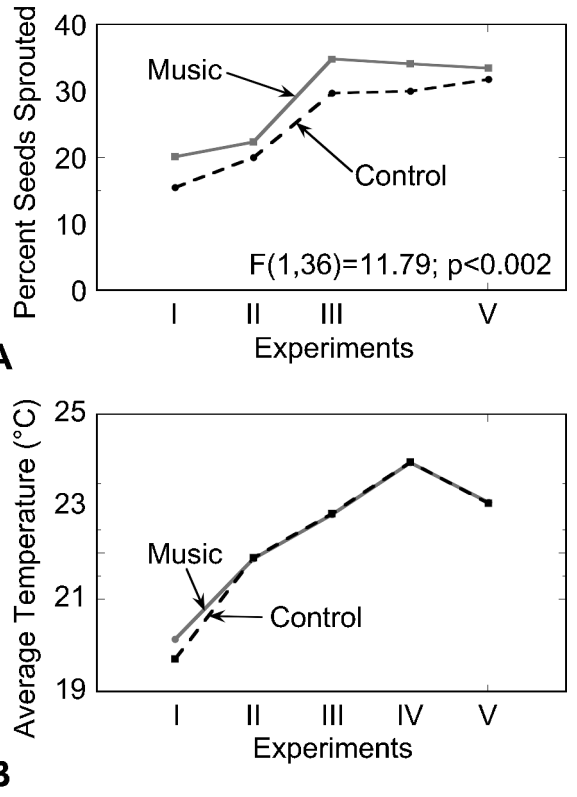

FIG. 6. **A:** Percentage of seeds sprouted for the musical sound and control conditions averaged over seed type, dishes, and time versus experiment. **B:** Average temperature for musical sound and control conditions versus experiment.

RESULTS

Musical sound versus control

Figure 6A shows the results for music and control versus experiment averaged over seed type, petri dishes, and time versus experiment. In all five experiments, seeds exposed to musical sound sprouted faster than the untreated control. These data show this effect is highly significant with $p < 0.002$ for the main condition using a five-way ANOVA of mixed design. Condition and time were treated as repeated measures while experiment, seed type, and petri dish were treated as between group factors. The two-way interaction between condition and time yields a $p < 0.000002$. For each condition there were 2 subjects (2 groups of seeds) per seed type yielding 4 subjects per trial. These data represent 14 total trials over 5 experiments including 1400 seeds per condition.

The plot in Figure 6B shows the average temperature for the conditions of musical sound and control versus temper-

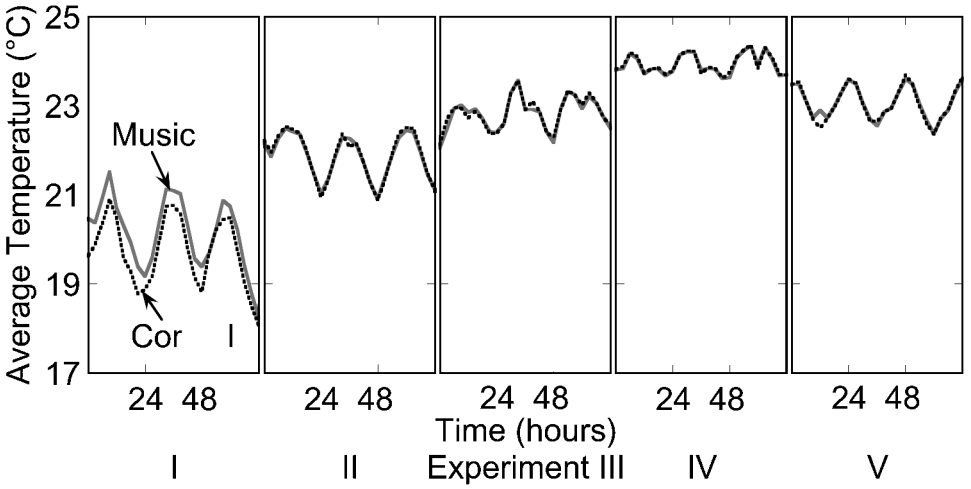

FIG. 7. Temperature averaged over all runs of each experiment versus time for musical sound and control.

ature. Notice that the mean temperatures differed by a few tenths of a degree in experiment I and after that the temperatures were virtually identical. The variations between chambers were within 0.15°C (1σ). There is a correlation between temperature and the number of seeds germinated. When the temperature rises, the number of seeds germinating increases. A more detailed look of temperature versus time for all five experiments is shown in Figure 7. For Experiments II–V, the temperatures for the control and musical sound conditions track one another almost exactly. These analyses indicate that temperature was not a factor for the increased seed germination of the musical sound condition compared to the control condition.

The plots in Figure 8 show the average over all trials of all experiments at each time point of musical sound versus control separately for okra and zucchini. More okra seeds have sprouted after 72 hours than zucchini and the effect was consistently larger in okra than zucchini. These data show that the increased seed germination effect was replicated by both types of seeds.

Data averaged over seed type and all experiments are shown for groups of seeds in the center petri dish (dish 3 of Fig. 2) and the outer petri dishes (dishes 1 and 2) in Figure 9. For both the sets of dishes the seeds exposed to musical sound germinated faster than the control independent of seed type and experiment. This three-way interaction between dish (center and outer), condition (musical sound and control), and time was not statistically significant with $p < 0.69$ indicating that placement of petri dishes in the seed containers was not a factor in the outcome.

Figure 10 shows plots of the percentage of seeds sprouted versus time averaged over all eight trials of experiments IV and V, seed type and petri dishes as a function of time for each of the four growth chamber positions A–D. This two-way interaction was not significant with $p < 0.56$. The graph shows that the number of seeds sprouted at each time was consistent for all of the growth chambers. No main effects or interactions with position were observed in this analysis of variance. This analysis with all four growth chambers averaged over eight trials of experiments IV and V (with position counterbalanced) shows that the musical sound versus control effect cannot be explained by the assignments of conditions to different growth chambers.

Correlations between seed counts determined by the experimenter and the independent scorer averaged over seed type were very high (above $r = 0.96$) for all conditions. Comparisons at the 60-hour point were investigated using a five-way ANOVA of mixed design. Between group factors were experiment IV and V, seed type, and dish. Repeated measures were condition and scorer. Figure 11 shows that both scorers replicated counting a greater number of sprouted okra seeds than sprouted zucchini seeds ($p < 0.000001$), and both scorers replicated counting more zucchini seeds sprouted in experiment V than in experiment IV with $p < 0.003$. As might be predicted, the experimenter (A)—who was more experienced in detecting seed spouting—counted

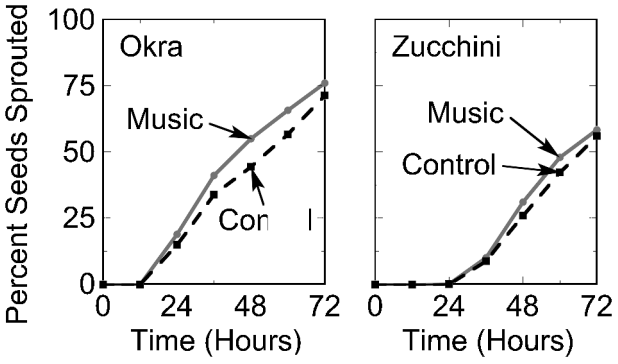

FIG. 8. Percentage of seeds sprouted for musical sound and control averaged over dishes and all five experiments.

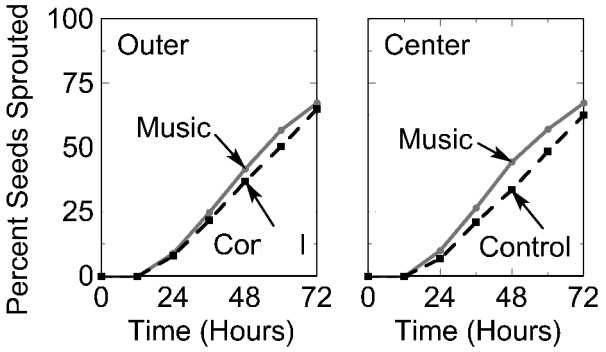

FIG. 9. Percentage of seeds sprouted versus time averaged over seed type and all five experiments comparing outer (dishes 1 and 2) and center (dish 3) petri dishes.

slightly more total seeds (approximately 0.6 seeds per dish of 25) having sprouted than the independent scorer (B) averaged over all conditions with $p < 0.00001$. The two scorers consistently ranked the conditions in terms of number of seeds sprouted (i.e., between scorer's correlations generated r's = >0.96); hence, there was no apparent bias resulting from scoring.

Musical sound versus noise and control

To compare these conditions, a five-way ANOVA of mixed design was performed with between group factors of Experiments IV–V, seed type, and petri dish. Repeated measures were condition and time. There was a significant two-way interaction between condition versus time averaged over experiments IV and V, seed type and dishes with $p < 0.03$ (see Fig. 12) while the main effect for condition approached significance ($p < 0.068$). The three-way interaction between condition, time and experiment was not significant indicating that the results are replicable between the two experiments.

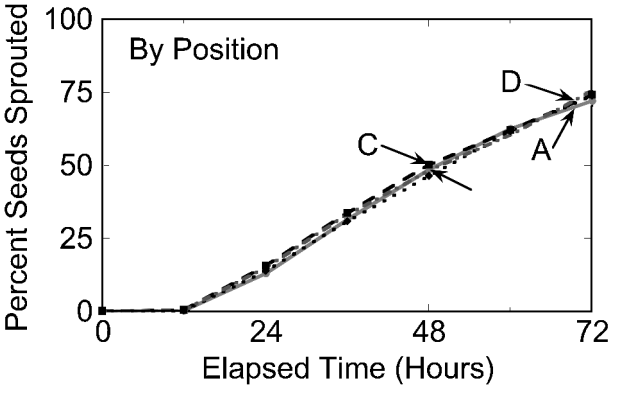

FIG. 10. Percentage of seeds sprouted versus time for each of four growth chambers (**A–D**) (independent of condition) averaged over seed type and dishes for all trials of experiments IV and V in which condition assignments were counterbalanced.

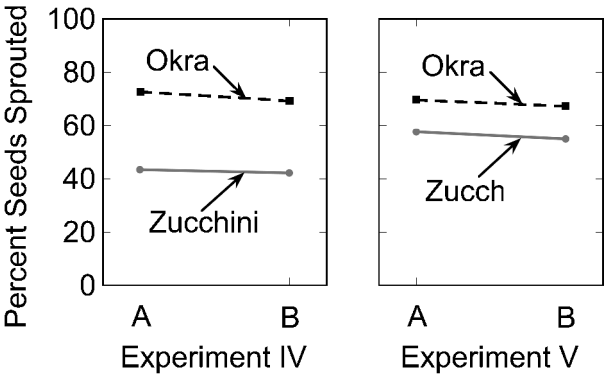

FIG. 11. Percentage of seeds sprouted counted at 60 hours by experimenter (**A**) and independent scorer (**B**) for okra and zucchini for all trials of experiments IV–V averaged over dishes and condition.

Healing energy versus control

Data from experiments III–V over six trials using the same healing energy protocol were analyzed with a five-way ANOVA of mixed design similar to that for the musical sound. These data represent a total of 600 treated seeds and 600 control seeds. As groups of 25 seeds, these data represent 24 subjects each for VH and control. An average over all trials, seed type and dish is shown in Figure 13A for VH and control versus time. The effect was consistent, replicable, and highly significant with $p < 0.0001$. As with the musical sound condition, these effects were independent of seed type, petri dish, temperature and position. The effect was greater with okra than with zucchini (as it was for the musical sound).

Figure 13B shows the data averaged over experiments III and IV, seed type, and petri dishes for all four conditions. Note that the number of seeds sprouted as a function of time for both musical sound and VH follow one another very closely and both are an average 19.7% greater than the control while the number for noise is similar to and slightly greater than the control.

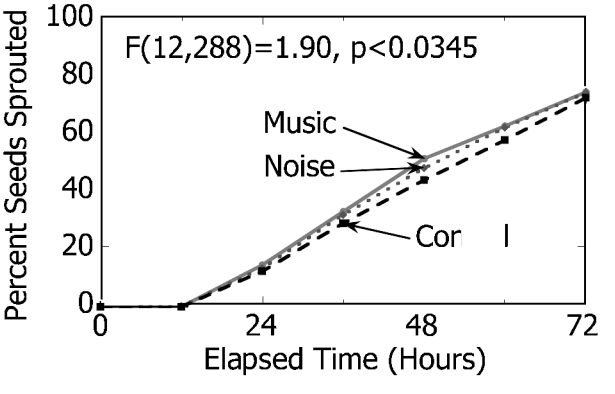

FIG. 12. Percentage of seeds sprouted averaged over seed type, dishes and experiments IV–V versus time for musical sound, noise, and control.

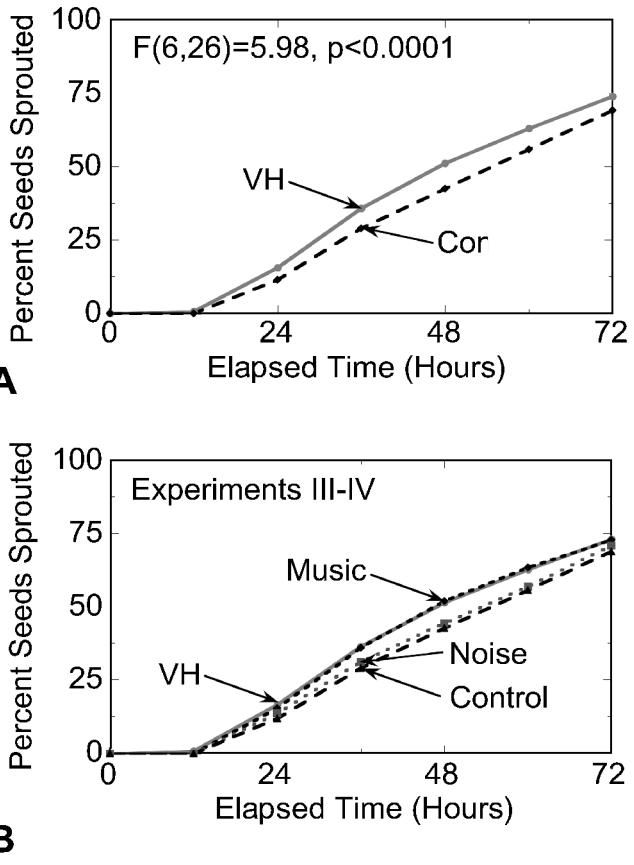

FIG. 13. **A:** Percentage of seeds sprouted averaged over seed type, dishes and experiments III–IV versus time for healing energy (Vortex Healing® [VH]) and control. **B:** Same as (**A**) with the addition of the musical sound and noise conditions.

DISCUSSION

Although it could be speculated that vibration and/or speaker electromagnetics may have been potential mechanisms enabling the seeds exposed to musical sound germinate faster, it is obvious that the effect is more complex because the seeds exposed to noise did not germinate as fast as those exposed to musical sound. Both sound conditions can be argued to have had equal "amounts" of vibration and speaker electromagnetics because of equal average sound pressure levels. The most obvious difference between the two types of sound is that musical sound is dynamically organized and varies with time while noise is constant. There is an organization of melody, rhythm, and form with pauses and silence to musical sound while noise as used in this study has a fixed frequency band that was invariant over long periods of time.*

Experiences of musical sound are often similar to those of healing energy. Many (but not all) musical performances can be described as having healing properties. While music theorists can break down the elements of musical sound into various pitch, rhythm, frequency and time components, there is a potential biofield component of musical performance that has yet to be quantified.

The healing energy effect incorporates potential bioelectromagnetic effects from the hands, including thermal activity, as well as specific healing intentions (which may have nonlocal effects). The present study does not enable us to determine the potential roles of these multiple components. Future research using multiple specified control groups can explore these potential mechanisms.

The results of this study are consistent with the findings of Retallack and Broman (1973) for musical sound, and Haid and Huprikar (2001) in terms of healing energy. It is difficult to compare these results directly to studies involving single frequency sound or many of the healing energy studies because of the differences in methodology and measured outcomes. In general, the published studies involving music and plants do not provide enough detail to replicate the experiment (including Retallack and Broman, 1973), so we are unable to compare our results directly with these other studies. We have included the details of our methodology so that these results may be independently replicated.

CONCLUSIONS

This group of experiments indicates that both the musical sound and healing energy used in this study had replicable and significant effects on the germination of two different types of seeds when compared to an untreated control. The differences in germination rates between different conditions cannot be explained by mean temperature, temperature differences between chambers, petri dish position, growth chamber position, or persons scoring the seeds.

This study has demonstrated a robust and replicable methodology that is sensitive to sound (music and noise) and biofield (bioelectromagnetic and healing intention) energy sources. These results suggest that a seed germination bioassay can objectively measure effects due to different types of applied energy. Because practitioner healing energy for seeds to germinate faster are similar to healing energy for a specific human ailment, this bioassay has potential as a means of determining practitioner effectiveness and as a means of screening practitioners for studies of effects on human populations.

ACKNOWLEDGMENTS

This study was supported by an IDEAs Grant from the Social and Behavioral Sciences Research Institute, College of Social and Behavioral Sciences, the University of Arizona, and, in part, by a National Institutes of Health (NIH) grant P20 AT00774 (GES) from the National Center for Complementary and Alternative Medicine (NCCAM). Its contents are solely the responsibility of the authors and do

not necessarily represent the official views of the NCCAM or the NIH. We gratefully acknowledge the helpful comments of three anonymous reviewers.

REFERENCES

Astin JA, Harkness E, Ernst E. The efficacy of "distant healing": A systematic review of randomized trials. Ann Intern Med 2000;132:903–910.

Bache DH, Macaskill IA. Vegetation in civil and landscape engineering. In: Vegetation in Civil and Landscape Engineering. London: Granada, 1984:317.

Benford MS. Implications of plant genome research to alternative therapies: A case for radiogenic metabolism in humans. J Theoretics 2002;4:1–14.

Berden M, Jerman I, Skarja M. A possible physical basis for the healing touch (biotherapy) evaluated by high voltage electrophotography. Int J Acupunct Electrother Res 1997;22: 127–146.

Braam J, Davis RW. Rain-, wind-, and touch-induced expression of calmodulin and calmodulin-related genes in arabidopsis. Cell 1990;60:357–364.

Chabris CF. Prelude or requiem for the "Mozart effect"? Nature 1999;400:826–827.

Collins ME, Foreman JEK. The effect of sound on the growth of plants. Cana Acoustics 2001;29:3–8.

Crawford CC, Sparber AG, Jonas WB. A systematic review of the quality of research on hands-on and distance healing: Clinical and laboratory studies. Altern Ther 2003;9:A96–A104.

Creath K, Schwartz GE. Effects of intention, musical sound and noise on the germination of seeds: Evidence of entanglement between human and plant systems. In: Quantum Mind 2003: Consciousness, Quantum Physics and the Brain. Tucson, AZ: University of Arizona, Center for Consciousness Studies, 2003; 30–31.

Creath K, Schwartz GE. Effects of music on the growth of plants: Evidence of info-energy resonance effects? In: Tucson 2002: Towards a Science of Consciousness. Tucson, AZ: University of Arizona, Center for Consciousness Studies, 2002;119.

Dossey L. Being green: On the relationships between people and plants. Altern Ther 2001;7:12–16, 132–140.

Galston AW, Slayman CL. The not-so-secret life of plants. Am Sci. 1979;67:337–344.

Gnanam A. Activation of photosynthesis in Spirogyra by sound waves of electric bell. In: Proceedings of the Symposium on Algology. New Delhi: Indian Council of Agricultural Research; 1960;144–146.

Grad B. The "Laying on of hands": Implications for psychotherapy, gentling and the placebo effect. J Am Soc Psychical Res 1967;61:286–305.

Grad B. Some biological effects of the "laying on of hands": A review of experiments with animals and plants. J Am Soc Psychical Res 1965;59:95–127.

Grad B. A telekinetic effect on plant growth: I. Int J Parapsychol 1963;5:117–134.

Grad B. A telekinetic effect on plant growth: II. Experiments involving treatment of saline in stoppered bottles. Int J Parapsychol 1964;6:473–498.

Hageseth GT. Effect of noise on the mathematical parameters that describe isothermal seed germination. Plant Physiol 1974;53: 641–643.

Haid M, Huprikar S. Modulation of germination and growth of plants by meditation. Am J Chin Med 2001;29:393–401.

Horn P, Nakai RC. Inside Canyon de Chelley [audio recording]. Phoenix, AZ: Canyon Records; 1997.

Janata P, Birk JL, Horn JDV, Leman M, Tillmann B, Bharucha JJ. The cortical topography of tonal structure underlying Western music. Science 2002;298:2167–2170.

Jonas WB, Crawford CC. Science and spiritual healing: A critical review of spiritual healing, "energy" medicine, and intentionality. Altern Ther 2003;9:56–61.

Kiang JG, Marotta D, Wirkus M, Wirkus M, Jonas WB. External bioenergy increases intracellular free calcium concentration and reduces cellular response to heat stress. J Investig Med 2002;50:38–45.

Klein RM, Edsall PC. On the reported effects of sound on the growth of plants. Bioscience 1965;15:125–126.

Kristen U. Use of higher plants as screens for toxicity assessment. Toxicol In Vitro 1997;11:181–191.

Martens MJM, Michelsen A. Absorption of acoustic energy by plant leaves. J Acoust Soc Am 1981;69:303–306.

Measures M, Weinberger P. The effect of four audible sound frequencies on the growth of Marquis spring wheat. Can J Botany 1970;48:659–662.

Measures M, Weinberger P. Effects of an audible sound frequency on total amino acids and major free alcohol-soluble amino acids of Rideau wheat grains. Cana J Plant Sci 1973;53:737–742.

Miles P, True G. Reiki—Review of a biofield therapy: History, theory, practice and research. Alterna Ther 2003;9:62–72.

Nakai RC. Emergence: Songs of the Rainbow World [audio recording]. Phoenix, AZ: Canyon Records; 1992.

Raucsher FH. Prelude or requiem for the 'Mozart effect' [reply]? Nature 1999;400:827–828.

Retallack D. The Sound of Music and Plants. Santa Monica, CA: DeVorss & Co, 1973.

Retallack D, Broman F. Response of growing plants to the manipulation of their environment. In: The Sound of Music and Plants. Santa Monica, CA: DeVorss & Co, 1973;82–94.

Roney-Dougal SM, Solfvin J. Field study of enhancement effect on lettice seeds: Their germination rate, growth and health. J Soc Psychical Res 2002;66:129–143.

Scofield AM, Hodges RD. Demonstration of a healing effect in the laboratory using a simple plant model. J Soc Psychical Res 1991;57:321–343.

Shors JD, Soll DR, Daniels KK, Gibson DP, inventors; University of Iowa Research Foundation, assignee. Method for enhancing germination. US patent 5,950,362. September 14, 1999.

Tompkins P, Bird C. The harmonic life of plants. In: The Secret Life of Plants. New York: Harper & Row, 1973;145–162.

Weinberger P, Burton C. The effect of sonication on the growth of some tree seeds. Can J Forestry Res 1981;11:840–844.

Weinberger P, Das G. The effect of an audible and low ultrasound frequency on the growth of synchronized cultures of Scenedesnus obtusiusculus. Can J Botany 1972;50:361–366.

Weinberger P, Graefe U. The effect of variable-frequency sounds on plant growth. Can J Botany 1973;51:1851–1856.

Weinberger P, Measures M. Effects of the intensity of audible sound on the growth and development of Rideau winter wheat. Can J Botany 1978;57:1036–1039.

Weinman R. The Recovery of VortexHealing. In: London and Southeast Connection. Series The Recovery of VortexHealing. 2000. Online document at: www.vortexhealing.com
Weinman R. VortexHealing Training Flowchart. 2003a. Online document at: www.vortexhealing.com
Weinman R. VortexHealing Trainings. 2003b. Online document at: www.vortexhealing.com
Weinman R. VortexHealing Website. Online document at: www.vortexhealing.com

Address reprint requests to:
Katherine Creath, Ph.D. (Optical Science), Ph.D. (Music)
Optical Sciences Center
University of Arizona
P.O. Box 210094
Tucson, AZ 85721-0094

E-mail: kcreath@u.arizona.edu