Summer Research 2011

Project Proposal

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Hemispheric Specialization of Music Processing in Experienced Dancers and Non-Dancers: An EEG (Alpha and Beta) Study

Under the guidance of Dr. Hiroko Nakano (Department of Psychology), I plan to investigate how alpha and beta frequencies of the brain's electrical activity are affected by dance experience when dancers listen to their preferred dance music. I will be using electroencephalography (EEG), a technique that measures the electrical activity of the neurons of the cortex.

In general, brain waves vary in strength and frequency. The strength of the brain cell signals is determined by amplitude (or power) of EEG waves. Frequency indicates the number of oscillations of waves per second (Hz). Two frequency characteristics of EEG waves are pertinent to my study: alpha and beta activity. Alpha and beta belong to a group of frequency bands that correspond to particular brain states. The alpha band (8-12 Hz) is evident during times of quiet but wakeful resting (Zillmer, Spiers, & Culbertson, 2008). Beta waves (12-35 Hz) are faster and have lower amplitude compared to alpha waves, and are associated with a spectrum of states from overarousal and active, alert thinking, to quiet attention (Zillmer et al.). (Refer to Figure 1.) In an EEG study, Petsche, Richter, Von Stein, Etlinger, and Filz (1993) found that processing music (listening to music in general) was associated with coherent electrophysiological connectivity in the beta band, particularly in the high end of the beta frequency (19-32 Hz).

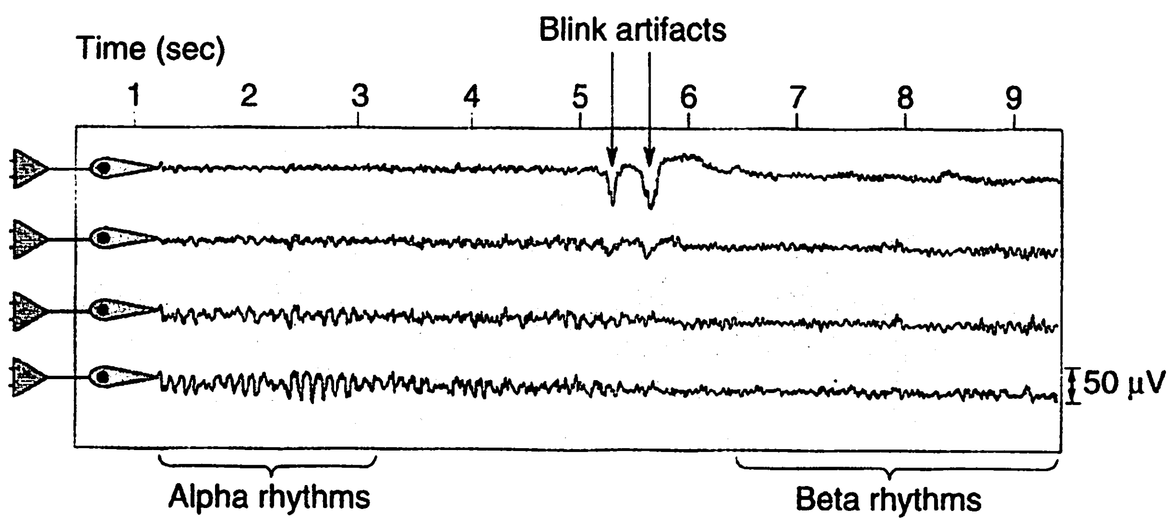

Figure 1. An example of an EEG recording. Alpha rhythms are high-amplitude and slow waves (8-12 Hz, or cycles per second), while beta rhythms have lower amplitude and faster waves (12-35 Hz). (From Bear, M. F., Connors, B. W., & Paradiso, M. A. [1996]. *Neuroscience: Exploring the brain* [1st ed., p. 461, Figure 17.5]. Canada: Williams & Wilkins.)

Beta waves, however, are not the only EEG waves that seem to be associated with music processing. Hirshkowitz, Earle, and Paley (1978) found that alpha waves were also elicited when their participants listened to music. Interestingly, alpha activity was observed in the right cerebral hemisphere only in non-musicians, but not in musicians. Their musicians did not show such hemispheric specialization. The authors suggest that the difference between the non-musicians and musicians, and the difference between the left and right hemispheres are due to the participants' training in music, rather than the music's physical features.

Hemispheric specialization (also *lateralization* or *asymmetry*), refers to the functional difference of the left and right hemispheres of the brain. The left hemisphere is involved in analytical thinking, and linear or sequential processing of information, as in language and math. The right hemisphere, on the other hand, is active in holistic thinking that entails simultaneous processing of information, such as the appreciation of music or other art forms (Zillmer et al., 2008).

Given Hirshkowitz et al.'s (1978) finding, it appears that trained musicians do not process music holistically, but more possibly in an analytic manner. Although the aforementioned study by Petsche et al. (1993) did not find conclusive evidence for hemispheric specialization in music processing, the connectivity in beta waves of the right hemisphere was stronger when participants were involved in holistic mental work (by listening to the music for pleasure and paying no particular attention to the structure of the musical composition) than when they listened to music sequentially (by focusing on the structure and patterns of the music). Hence, it seems that in general, when people are listening to music simply for enjoyment and are paying attention to it as a whole, hemispheric specialization occurs with more powerful alpha and beta activity in the right hemisphere relative to the left. On the contrary, when listeners are structurally analyzing the music, the hemispheric specialization of alpha and beta disappears.

My main research question explores how non-dancers and experienced dancers (divided further into Argentine Tango and ballroom dancers) differ in alpha and beta power (signal strength) and hemispheric processing dominance while listening to their preferred or other music. That is, for dancers, their own preferred dance music; for non-dancers, simply their own preferred music. I hypothesize that experienced dancers will have either more powerful alpha and beta activity in the left hemisphere than in the right hemisphere, or no hemispheric specialization at all, whereas non-dancers will show more alpha and beta power in the right hemisphere. Experienced dancers are expected to be more analytic when they listen to their own music because they may think mainly of the details of their movement as they listen to the music, while non-dancers will tend to listen to the music more holistically or simply for pleasure.

Furthermore, among dancers, I am expecting that the Argentine Tango group will have magnified alpha-beta power in the left hemisphere, while the ballroom group will show less power compared to Argentine Tango dancers. Argentine Tango dance largely requires improvisation of movement, and should therefore elicit more analytical processing, whereas ballroom dance mainly entails adhering to fixed, predictable patterns of movement which get memorized and automatized (Hackney & Earhart, 2009), and should therefore be less analytic.

I plan to test non-dancers and Argentine Tango and ballroom dancers (six to ten participants in each group) in the neuroscience lab (Brousseau 123). This proposed study is nested under Dr. Nakano and Dr. Rosario's (Department of Physics) Argentine Tango and EEG research project. The IRB has thus been approved with six participants in each group. However, I shall submit an addendum in case I am in need of more participants.

The rough timeline is as follows: test participants from weeks one through five; analyze data and test more subjects if needed, from weeks two through nine; then prepare for presentation during weeks nine to ten.

Since spring 2010, I have been exploring relevant background literature as a volunteer research assistant to Dr. Nakano: I have summarized about fifteen scientific papers and met with Dr. Nakano every week for discussion. Last semester (fall 2010) under Dr. Nakano and Dr. Rosario's supervision, I began testing participants with fellow volunteer research assistant (Nicholas Wan). In the process, I have been learning how to design an experiment, record data using an EEG amplifier, and analyze data in terms of frequency using MATLAB and EEGLAB.

One participant generally takes a total of three hours to test, from preparation of materials and acquiring of data, to post-experiment procedures adhering to experiment and IRB guidelines. The collaboration with Nicholas has been very encouraging; without his aid, it would take me five to six hours to test one subject. The teamwork has also paid off in that it enables us to help each other when we need to deal with all kinds of unfamiliar hardware and software, as well as new knowledge about EEG techniques. Dr. Nakano always emphasizes the importance of collaborative work, and I am pleased that in this regard, Nicholas and I have been doing it quite well.

In addition to participating in the Brousseau poster session in the fall 2011 semester, I plan to present the results of the proposed study at conferences such as the Western Psychology Conference for Undergraduate Research (WPCUR), the SMC Undergraduate Research Symposium, and possibly at the meetings of the Cognitive Neuroscience Society and Sigma Xi.

From summer research, more than hoping for significant results or presenting, I simply intend to hone my skills in experimental design and data analysis. These skills will certainly aid in my graduate studies and future career as a researcher, which I intend to pursue. Eventually, I would like to bring back my research experiences to the Philippines where knowledge in this particular field is currently limited, and where the research culture seeks improvement.

References

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