The Biophysical and Emotional Effects of Dancing with a Partner

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Abstract

The research on dance's emotional and biophysical effects on a person has expanded in recent years. However, there has been less investigation of the relationship between dance partner-work – involving both proximal and physical interaction – and the body's response. With this in mind, an experimental study was conducted to explore potential correlations between partner dancing and the body. This study investigates how a dancer's anxiety correlates with the degree of human connection throughout a choreographed duet. The methodology included collaboratively choreographing a duet with two dancers and recording biophysical data from the dancers as they performed the duet. Wearable technology measured each dancer's temperature, muscle contraction, heartbeat, electromyography, and spatial information. Brain function was also measured via a fourteen-channel EEG headset that allowed for whole-brain sensing. This data was recorded as the dancers moved together and independently from each other to compare the effects of varying degrees of contact on the body. To generate additional data, the anxiety levels of each subject were quantified through survey responses after they danced via STAI self-reporting questionnaires. The biophysical data gathered is not significant enough to form significant conclusions for the study regarding anxiety levels, however survey data suggests strong decreases in anxiety occur while dancing with a partner. The results of this study support the assumption that proximal and physical interaction levels during dance may directly impact a person's physical and emotional state. This study highlights the need and potential implications for additional research on brain-body responses to partner movement in dance.

Keywords: dancing, partner-work, touch, anxiety, brain, biometrics

Background

Dance Movement Therapy

Dance and movement as a means of healing have grown exponentially since their establishment in Western countries in the 1940s. Dance as a therapy practice is often applied as Dance Movement Therapy (DMT). The American Dance Therapy Association (ADTA) defines DMT on their website as "the psychotherapeutic use of movement to promote emotional, social, cognitive, and physical integration of the individual" (ADTA, 2020). The holistic framework establishing DMT asserts a strong body-mind connection; the interconnection between body, mind, and spirit is a foundational point that the ADTA enforces.

Numerous studies have explored the effects of DMT as a healing method. Psychological states of patients are the primary field of study – motivation, quality of life, anxiety, depression, and stress are all areas connected to DMT in a field of research. A meta-analysis from 2019 synthesized data from 41 independent studies regarding DMT and psychological outcomes and suggested that DMT decreases depression and anxiety (Koch et al., 2019). These measurements were categorized as clinical outcomes and were primarily collected with self-report questionnaires. It was assumed that "DMT and dance interventions improve psychological functions of emotion regulation, which may be mediated, for example, by authentic expression, experienced agency, body–mind integration, and physiological changes" (Koch et al., 2019, p. #). This body-mind integration is a key insight of these findings as it enforces the principal aim behind DMT and exhibits the validity of DMT's therapeutic potential.

Additional studies have explored the benefits of dance intervention for students in particular. Specifically, the anxiety and stress levels of 102 students were evaluated before and after an 8-week dance therapy intervention (Arman & Turkman, 2021). The conclusions drawn in this study mirror those of the meta-analysis previously discussed. According to self-report surveys, it was observed that anxiety and stress levels significantly decreased among the students after the intervention. The connection between DMT and psychological well-being is believed to be not only prevalent but significant, as evident from this study and many others.

Anxiety & the Brain

Anxiety is the most well-studied psychological condition in the context of DMT. As it is relatively easy to quantify with self-report inventories, anxiety is often tied to the therapeutic effects that DMT provides. Anxiety, as it manifests in the brain, is also well understood, allowing for a deeper analysis of how anxiety can alter with specific experimental variables. There are two pathways that anxiety can travel within the brain – the physiological response is either initiated by the cortex or the amygdala (Saumaa, 2022). Further, the type of anxiety that manifests is contingent on the origin of the pathway. Thus, there is growing knowledge on controlling or managing anxiety by targeting specific parts of the brain, namely the amygdala. Saumma (2022) explains that the amygdala is most closely associated with the sympathetic nervous system and often activates in a "fight or flight" situation. This connection directly contrasts the parasympathetic nervous system, which is essential for calming nerves and suppressing anxious feelings. A clear correlation can be made between physical exercise and amygdala activity (Pittman & Karle, 2015). These findings come from neuroimaging experiments that show the influence of exercise on the brain. Pittman and Karle state that the benefits of physical exercise on anxiety levels have surpassed the medical effects of many anti-anxiety medications (2015), and their findings hold significant implications for the potential benefits of DMT. As dance is a form of physical exercise, it can calm the amygdala and decrease the activity of the sympathetic nervous system, effectively decreasing one's anxiety levels.

Partner Dancing & Contact Improvisation

Another key impact of dance that is often overlooked is its social value. Dance classes are often communal. Thus, dance as a social practice can hold weight regarding one's psychological state – what effects does being part of a shared community have on one's well-being? This area of study grew prevalent with the rise of COVID-19 and a worldwide decrease in social contact; during this time, the effects of limited social interaction were pronounced. One German study found that "impaired social contact was indirectly associated with a negative development in well-being (life satisfaction, anxiety and depression)" (Rudert & Jenke, 2022). The significance of social connections has grown in recent years as the world recovers from the COVID-19 pandemic, and the dance community is no exception. Because dancers often rely significantly on each other to execute their movements, the potential effects of this connection present opportunities for DMT to contribute to research in this area.

Contact Improvisation (CI) and partner dancing is a particular area of dance that incorporates a significant amount of social and physical contact. Dancer and choreographer Steve Paxton established CI in 1972 (Turner, 2010). It is notable that many other significant improvisers have also contributed to and expanded this movement style, such as Nancy Stark-Smith who worked alongside Paxton. This form of dance implements spontaneous generation of movement with at least one other person. The dancers involved are in physical contact most of the – if not the whole –time. This practice requires significant trust from the dancers; each person is responsible for protecting and respecting those partners with whom they are dancing. The physiological effects of this relationship between people have only been studied briefly – brain activity was the central area of research. Thus, it is evident that both the physicality dance and the social connection it relies upon can affect the mind and body. When these two factors combine, what is their impact on one's physiology and psychological well-being?

Aims and Hypothesis

The main research question of this study asked how a dancer's anxiety correlates with the degree of human connection throughout a choreographed duet. The aims of the study were to 1) understand the biophysical responses of the body while it is performing in a choreographed duet, 2) analyze the responses measured on the participants dancing individually versus with a partner, and 3) determine how emotions can vary throughout a performance with another dancer. The assumption was that there would be differences in the biophysical response and emotional state of the dancers when they were dancing together as opposed to alone.

Methods

Participants & Procedure

This study and its procedures were approved by the University of Florida Institutional Review Board (IRB202202333). Recruitment methods for this study included advertising and word of mouth. Participants were eligible for the study if they were current dance majors at the University of Florida during the 2022-2023 school year. Word of mouth and advertisement methods were utilized throughout the UF dance department via the Co-Investigator of the study.

Two participants were chosen on a first-come first-serve basis due to their demonstrated interest in the project. Both participants were female undergraduate students majoring in dance at UF. The average age of the participants was 20.5 (SD=1.5). The participants received no compensation for their involvement in the study; however, they were given an opportunity to perform the choreographed piece for the UF dance area.

The study began with weekly dance rehearsals that varied in length, ranging from 45 minutes to 2-hours long. The five rehearsals took place in the Constans Theatre and were designed to teach the participants a 3-and-a-half-minute choreographed duet. The rehearsal process was collaborative, and the Co-investigator/choreographer ensured the dancers were comfortable executing the movements. Throughout the rehearsal, the dancers provided verbal feedback regarding their comfort levels. If a dancer didn't feel safe executing a piece of choreography, the choreography was altered. The dancers' feedback was incorporated into the final piece.

Once choreography was finalized and the dancers had memorized the piece, each movement was coded per-second with Laban-Bartenieff notation. Independent dance moves made by each participant were coded individually and new codes were created by the Co-investigator to indicate partner-work motifs such as touch, eye contact, and weight-share. Additional movements including stillness, flexion, extension, walk, jump, arm, leg, spin, and plié were also coded.

Data Collection

Data was collected after the rehearsal process to understand both the biophysical and emotional responses of each dancer while they performed the duet. To gather biophysical measures, various wearable technology was utilized and worn by the dancers. Emotiv Epoc X, a wearable EEG headset, was used for whole-brain sensing. The headset included 14 channels and saline-based electrodes to record brain activity. Emotibit was also utilized as a means for collecting biometric data. The primary streams of data relevant to this study were the dancers' heart rates, heart rate variabilities, oxygen saturations, electrodermal activities, and galvanic skin responses. A third piece of wearable technology, Xth Sense, captured muscle tension. These various pieces of biophysical data were employed to draw conclusions about each dancer's anxiety levels throughout the dance, as specific sympathetic nervous system responses are associated with increased anxiety. Emotional data regarding anxiety was gathered using the State Trait Anxiety Inventory (STAI). This self-reporting questionnaire was administered to each dancer immediately after performing the duet. This survey recorded their perceived anxiety levels after the dance as their state anxiety, as well as their perceived anxiety over the past sixty days as their trait anxiety. These two data sets were analyzed to find a correlation between dancing and anxiety.

Analysis

Biophysical data was collected from three different technologies, each requiring a different analysis procedure. Measurements from Emotiv Epoc X were unavailable due to the financial constraints of the study. Visual data streams of brain wave amplitudes were observed for patterns and relationships to the choreography. Two brain channels were recorded at a time and the channels were paired according to their respective locations on the brain. Channels O1 and O2 were analyzed together, as were P7 and P8, and T7 and T8. Theta, alpha, low beta, high beta, and gamma brain waves were investigated for each pair of EEG channels for each dancer.

Emotibit data was parsed via the Emotibit software. Different biophysical measurements were individually analyzed for general patterns and correlations with the choreography. Electrodermal response, humidity, and infrared photoplethysmography were the most relevant pieces of biophysical data to the study as it pertains to anxiety.

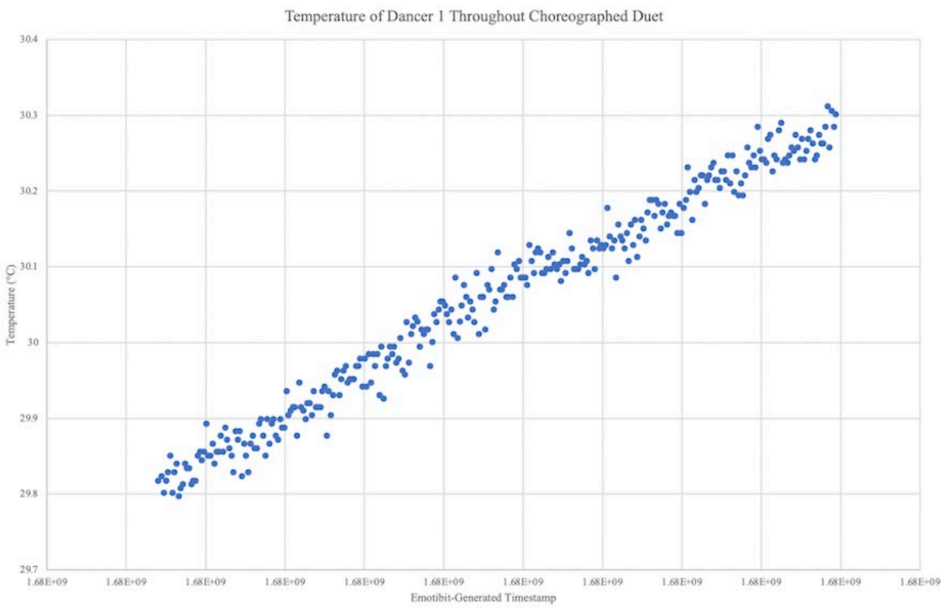
Xth Sense did not provide any significant data for the study. The values recorded exhibited orientation of the dancers, which was not necessarily beneficial in determining anxiety levels. Acceleration, gyroscope, and magnetometer of each dancer was recorded in three-dimensional axes. Muscle tension was not visible in the data set. The XTH Sense data that was integrated into iMotions for analysis was unable to be recorded due to license limitations.

The State Trait Anxiety Inventory (STAI) self-report questionnaire was administered to each dancer after they performed the duet. Responses were quantified via Qualtrics, and each dancer received two scores. Scores corresponded to both their state and trait anxiety levels, or their anxiety in the present moment and for the past two months, respectively. STAI scores can fall between 20 and 80, with a higher score indicating higher levels of anxiety. Dancers were not compared to each other. Instead, each dancer's state anxiety was compared to that of their trait anxiety.

Results

Emotibit technology supplied data regarding temperature, electrodermal activity, and photoplethysmography in infrared light of both dancers. Figures 1-3 exhibit these biophysical values as the dancers progressed through the choreographic duet. Temperatures of Dancer 1 and Dancer 2 are exhibited in Figure 1. While the temperature of Dancer 1 increased throughout the duet, the body temperature of Dancer 2 decreased by approximately 2°C. Electrodermal activities of each dancer were also heterogeneous (Figure 2). Dancer 1 displayed little variation in terms of electrodermal activity; dancer 2 had a steady increase in activity whilst displaying a slight bobbing pattern. Photoplethysmography readings of infrared light (Figure 3) of each dancer did not synchronize in a discernable fashion.

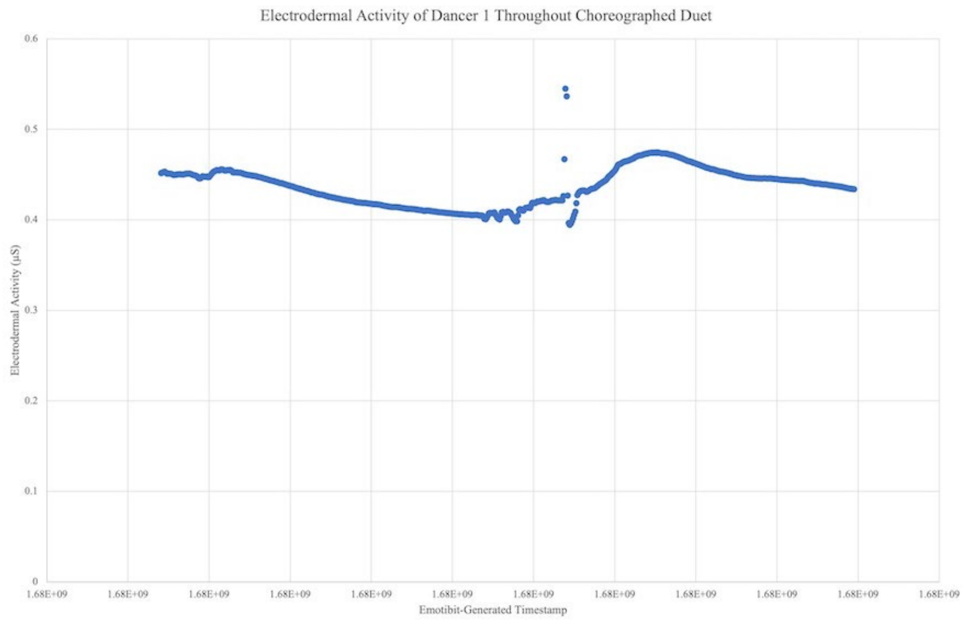
a.)



b.)

Figure 1: Temperature Throughout Choreographed Duet. a). Body temperature of Dancer 1 increases relatively linearly as the duet progresses. b). Body temperature of Dancer 2 briefly increases and then decreases as the duet progresses.

a.)



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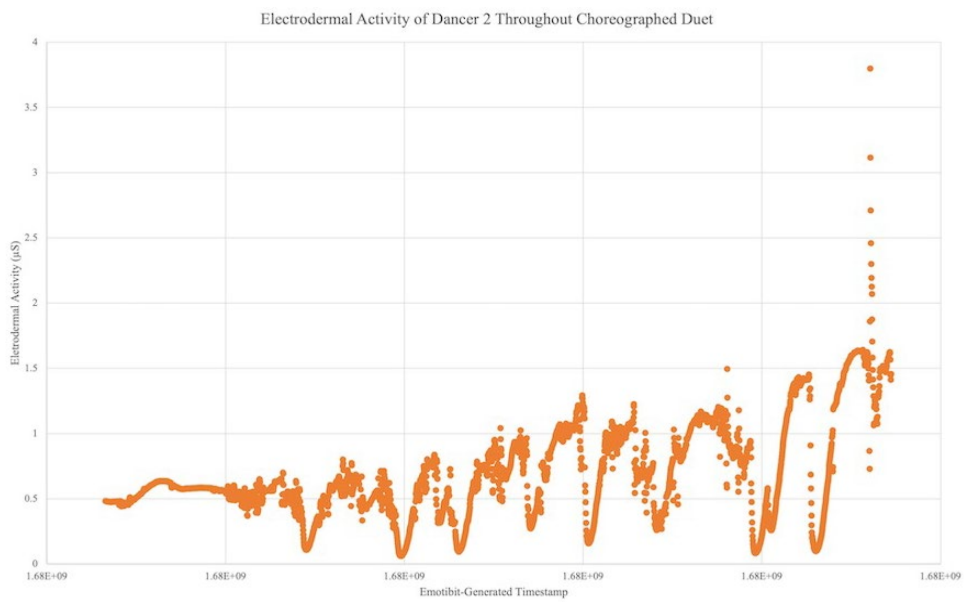
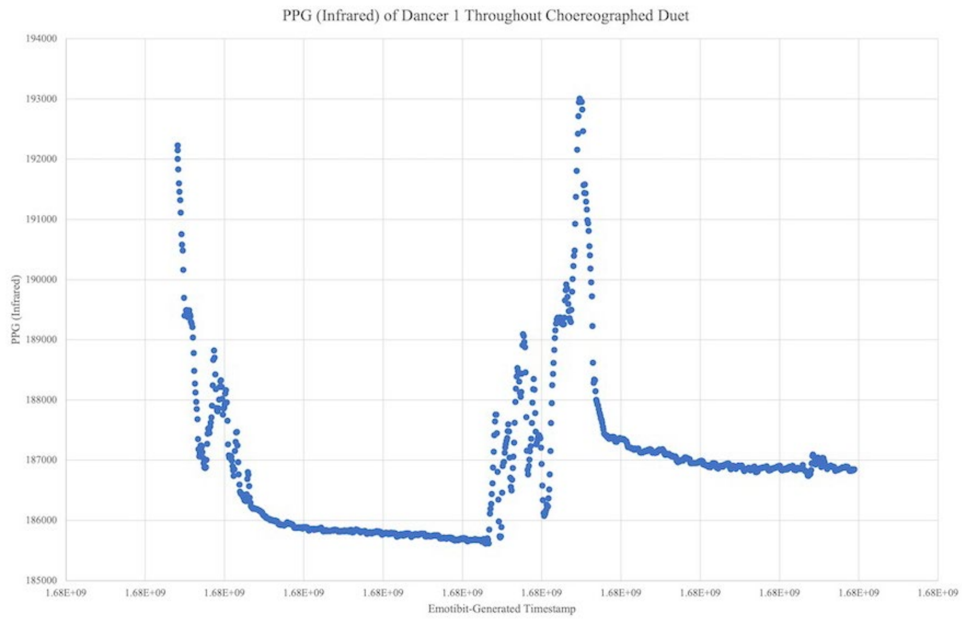


Figure 2: Electrodermal Activity Throughout Choreographed Duet. a). Electrodermal activity of Dancer 1 remained relatively constant, with a slight increase about 2.5 minutes into the duet, followed by a decrease. b). Electrodermal activity of Dancer 2 varied greatly and reached much greater values than dancer 1; electrodermal activity of Dancer 2 slowly increased throughout the duet.

a.)



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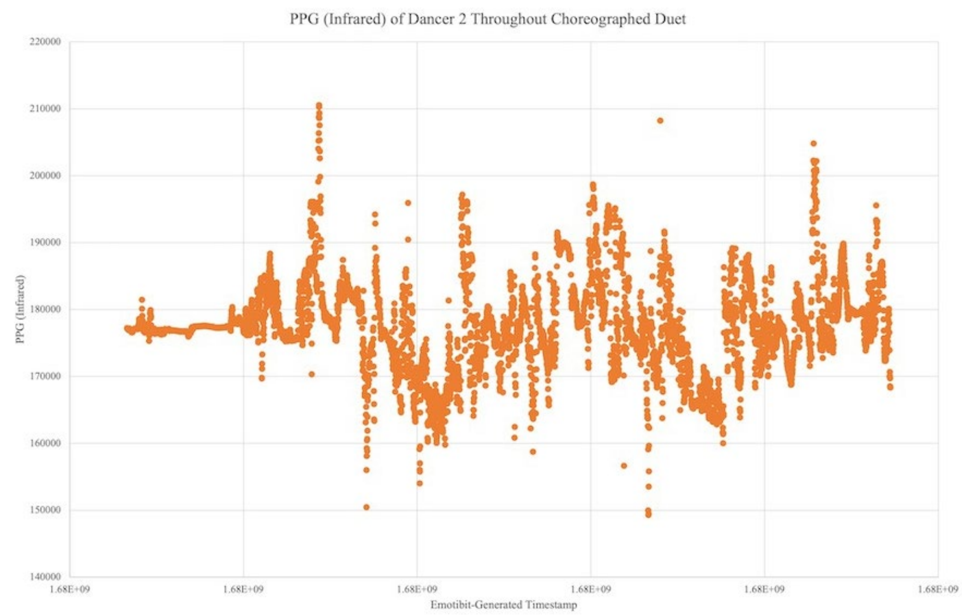
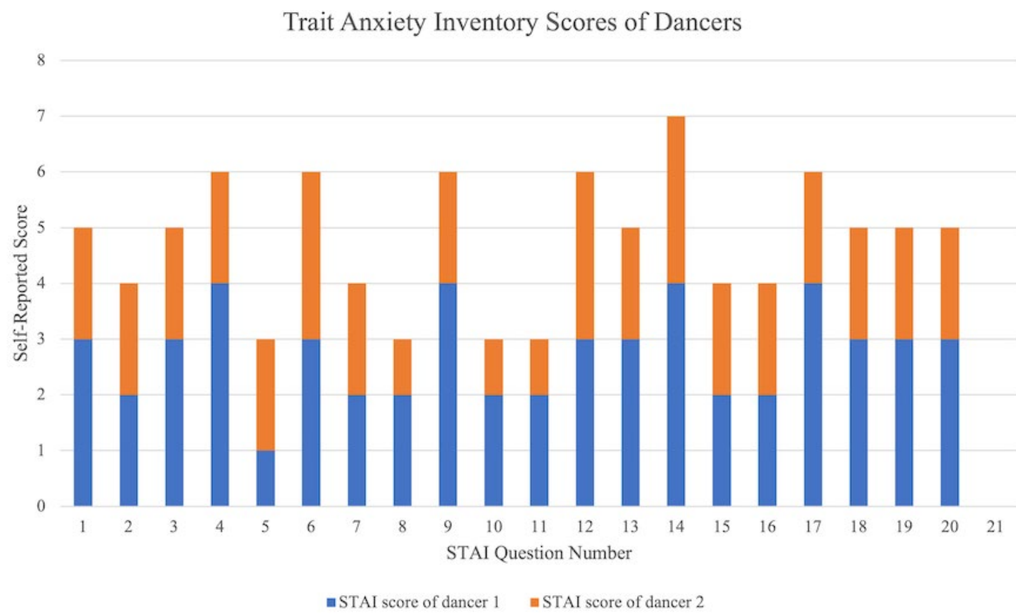


Figure 3: PPG (Infrared) Throughout Choreographed Duet. a.) Dancer 1 exhibited clear boosts and plunges in PPG infrared light; there were also moments of great stability, as seen by two plateaus in the graph. b). PPG Infrared measurements of Dancer 2 were more ambiguous; patterns of relative increase and decrease can be discerned.

STAI scores of each dancer showed a lower state anxiety score than a trait anxiety score. This indicates that for both dancers, self-reported feelings of anxiety were lower immediately after performing the choreographed duet when compared to the past two months. Figure 4 exhibits the distribution of these two scores among both dancers.

a.)



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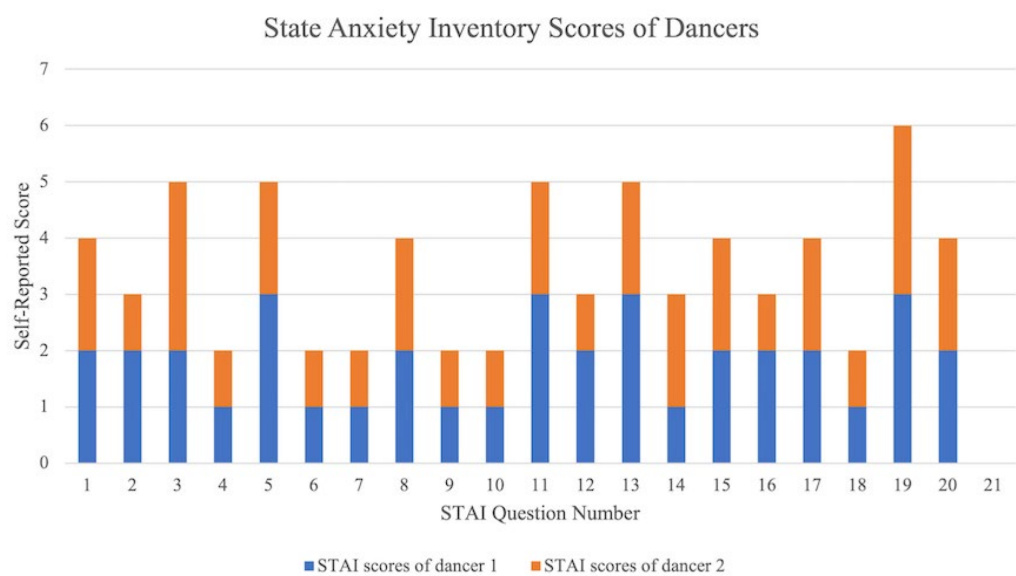

Figure 4: Self-Reported STAI Scores of Dancers. a) Scores of state anxiety pertaining to anxious feelings right after performance. b) Scores of trait anxiety pertaining to anxious feelings over the last two months.

Emotiv provided general data stream patterns for the EEG headset channels. Results were not quantifiable and thus were just observed visually for broad patterns. Figures 5 and 6 present screen captures of O1 and O2 EEG channels of Dancer 1 (Figure 5) and Dancer 2 (Figure 6) at different points in their choreography.

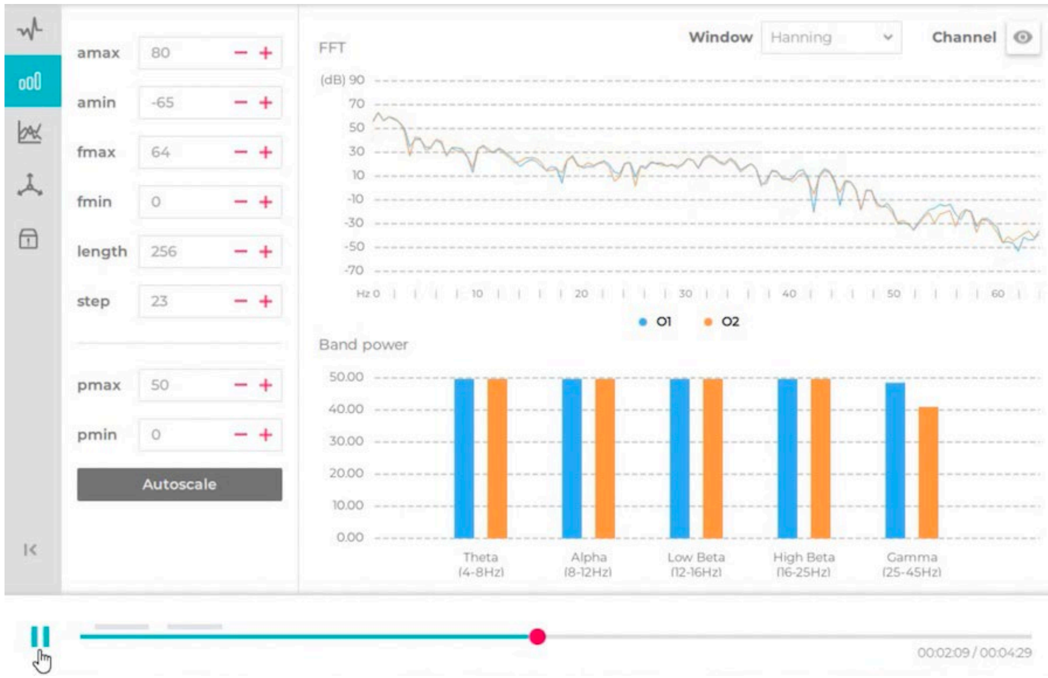

Figure 5: O1 and O2 Channels of Dancer 1 at Timestamp 2:09. High amplitudes of all five brain waves observed, signifying high brain activity. This data is from a timestamp in the choreography in which the dancers were completing choreography alone. No physical contact was occurring between the dancers at this moment.

Figure 6: O1 and O2 Channels of Dancer 2 at Timestamp 3:39. Low amplitudes of all five brain waves observed, with theta waves having the highest amplitude. This data exhibits lower brain activity. Data comes from a timestamp in the choreography in which dancers were in physical contact with each other.

Conclusions

The biophysical and emotional data of two dancers was evaluated in four distinctive ways: brain activity was measured using an EEG headset, Emotibit technology captured various physiological characteristics, XTH Sense recorded muscular tension, (but did not prove to be a usable data source), and a self-reporting questionnaire was administered to elicit data on dancers' perceived anxiety. All these data classes were analyzed to understand each dancer's anxiety level throughout the choreographed duet.

Information regarding the brain activity of the dancers is sparse. More advanced technology is required to draw more comprehensive conclusions from this data, Furthermore, using pro-sumer and open-source technology inhibited this data collection and analysis. However, general patterns can be observed from the data. In both dancers, brain activity consistently spiked during times of choreographic synchronization. O1 and O2 channels exhibited high amplitudes of brain waves during these synchronized timestamps. The dancers were not in physical contact with each other during these times but were responsible for executing the movements at the same time. Few inferences can be made on the differences in brain activity while the dancers were in physical contact with each other as compared to when they were dancing independently. There is a slight pattern of decreased brain activity when the dancers were in physical contact, but the data is not granular enough to draw any conclusions. This lowered brain activity could be attributed to decreased movement as brain wave amplitudes were observed to decrease in moments of stillness.

Biophysical data taken with the Emotibit technology recorded temperature, electrodermal activity, and PPG infrared light in both dancers. These three physiological characteristics of the two participants were not consistent. The temperatures of the two dancers progressed in inverse fashions, with one dancer's body temperature steadily increasing and the other dancer's steadily decreasing. This could indicate that the anxiety of Dancer 1 increased throughout the choreography as the anxiety of Dancer 2 decreased, even though both reported higher anxiety about the performance in the STAI Questionnaire. An additional explanation of this data is the natural temperature fluctuations that accompany physical activity. As such, conclusions linking anxiety levels to body temperature cannot be drawn. Similarly, electrodermal activity and PPG infrared light measurements were different in the two participants; the data from these sensor streams do not reflect choreographic patterns or levels of interaction between the dancers. These pieces of biophysical data are not significant enough to form generalized conclusions for the study regarding anxiety levels.

The STAI self-reporting scores show consistent differences between state anxiety and trait anxiety for both dancers. It should be noted that the state anxiety and trait anxiety scores of each dancer cannot be directly compared to one another as the two surveys employ different questions. Observed in the data is a general decrease in scores for the state anxiety levels of each dancer when compared to the trait anxiety of each dancer. This data suggests strong decreases in anxiety occur while dancing with a partner. However, physical activity has been previously observed to mitigate feelings of anxiety, so these results are homogenous with existing studies. Further, it is not known from this data set whether partnering in dance is a distinct contributing factor.

There is a huge opportunity to leverage what has been discovered about the effects of DMT and to build on the nascent study of dance partnering as a supplemental healing method. It is imperative to select hardware and software that can adequately evaluate biophysical measurements. Furthermore, additional trials on a larger population size must be conducted in order to gather enough evidence to draw significant conclusions. As this study only evaluated two dancers, it is difficult to posit any clear conclusions.

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