

Informing via Research: Methods, challenges and success when using a multi-disciplinary team and reverse engineering analysis processes to answer a 200 year old question.

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ABSTRACT

The goal of this study was to develop the foundation for the creation of a 21st century spiritual which could be used to mitigate the effects of stress and violence. Using a multi-disciplinary team and basing the work in the music of the antebellum Negro Spiritual (a group of 6000 works), reverse engineering, extensive use of engineering principles and utilization of existing databases was done to aid in the analysis of the neurological and physiological impact of the musical form and development of an applicable theory.

Keywords: Music, Neurology, Physiology, Negro Spiritual, Reverse Engineer

1. INTRODUCTION

This study was stimulated by the fortuitous discovery that some of the methods used in the Emotional Freedom Technique (EFT) to combat Post-Traumatic Stress Disorder (PTSD) are very similar to the musical and worship practices of the historic Black Church of the Deep South of the United States. Emotional Freedom Technique is approved for use by psychologists by the American Psychological Association and is in the process of being defined as an evidenced-based intervention for PTSD.

It was in the South during the antebellum period that enslaved African Americans were subjected to inhumane

methods of plantation labor force discipline, methods that included flogging, rape, dismemberment, torture, and continuous mental abuse intended to create cowering subservience and a conviction of personal unworthiness within the logic of the master-slave relationship. Given the near-universality of these methods of domination, it would be reasonable to expect that the enslaved population would have exhibited diminished vitality and more of the symptoms of what is now being called PTSD. Folklore left by the slaves conveys their understanding of how they stood up under the combined pressure of undernourishment, overwork and abuse: they said that they sang together, and that it was the singing that strengthened them.

However, the antebellum spiritual used on the plantations has not been in use in the specific form of the period since the Civil War and as of 2010 there were no longer any living survivors of the slave experience. In the 1930s the Smithsonian had collected some slave narratives and some old-time singing, but even those artifacts reflected the passage of time and the change from slavery to freedom as the essential context of the music. Meanwhile, African Americans were leaving the South. In the two Great Migrations of the 20th Century a very large number of African Americans moved to Northern cities and developed worship music more suited to their urban environments. The folkloric rural music began to disappear. By the late

20th Century most of the music still described as the “Negro Spiritual” was actually part of the concert tradition in African American sacred music and consisted of either art songs or choral arrangements performed by classically-trained musicians. There was also an enduring practice of singing spirituals in the style of conventional Christian hymns in churches and community meetings, and the spiritual was the music of the Civil Rights Movement. By the 1980s, however, gospel music had become the dominant form of music for worship, and the old-time plantation spiritual and its successor music of the small rural black church were on their way to becoming objects of mainly antiquarian interest.

2. PROJECT MISSION

The original mission was to build the spiritual for the 21st century. This intention has guided the inquiry. We did not take the characteristics of the original spiritual as our starting place; rather we took those aspects of contemporary practice that have continued the characteristics of the original spiritual. Those have proven durable over the centuries and are familiar to the potential users of the music to be created.

3. HISTORY AND STRUCTURE OF THE SPIRITUAL

The spiritual arises musically out of three African musical traditions: (1) the work song, a typically call-and-response musical form that utilizes an energizing melody and regularized rhythm in order to control and coordinate the rhythm and tempo of work; (2) traditional praise songs and religious chants, often led by the local Griot; and (3) the “ring-shout,” an African form of communal circle dance and song that the slaves adapted to their circumstances. In the Americas, these songs were improvised out of the material of daily life, and included commentary on secular conditions as well as religious content.

Musicologists have also identified a group of characteristics that contribute to an identifiable “Black Aesthetic.” The characteristics include group expression often facilitated by call and response structure; improvisation in both music and lyrics, articulated by all participants; downward flowing melodic lines both of the slow, sustained type and the syncopated, up-tempo type; rhythmic complexity and regularity often expressed through the use of percussive expression; the incorporation of physical movement, use of oral kineticism, and the use of harmonic, pitch and timbre flexibility.

Then there were the lyrics to the songs. The EFT literature teaches that the substitution of a positive or affirming thought for a negative one can have a transformative effect on an individual’s stress response. This is quite evident in the spiritual. The words to the spiritual frequently included Judeo-Christian biblical themes drawn from both the Old and New Testament. Familiarity with the Biblical texts inspired the slaves to cast themselves in the role of the Israelites in the Old Testament stories, to cast the slave owners in the role of Pharaoh, whose attempt to prevent God’s liberation of the Israelites was famously and disastrously unsuccessful, and to identify the suffering and resurrected Jesus as their friend and brother. This was an authoritative Christian antidote, from the masters’ own religion, to the secular English legal doctrine that the enslaved were chattel property. The enslaved Africans and their descendants later reported that their singing had been the source of their strength, the means of preserving their culture, and the vehicle for expressing their wisdom and their faith that slavery would end.

After slavery ended, the spiritual and the secular motifs within African American folk music tended to separate, with the spiritual going into the emerging black church and the secular evolving into a variety of commercial music, e.g. ragtime, minstrelsy and vaudeville, Tin Pan Alley,

blues, jazz and eventually general popular music. However, the explicitly spiritual aspect of the music has been accorded an exalted place because of its emphasis on liberation, transformation and transcendence and the cultural centrality of the black church. The challenge was to transition from the “lived” experience in historic literature into a theory of the neurological and physical effects of the spiritual based on neuroscience. The result has been to project a portrait of the effects of the folk spiritual as used in the historical small black church that, while not susceptible of validation by clinical trials, is surprisingly consistent with both historic and contemporary reported experience.

4. REVERSE ENGINEERING AND DATA ANALYSIS

Since we were essentially doing a “design recovery”, reverse engineering was selected as the process methodology with which to develop the necessary information. Reverse engineering is defined as “the process of taking something apart and analyzing its workings in detail.” (Chikofsky and Cross, 1990) Thus, the very first step was to compile an historical record of observations and commentary regarding the spiritual.

We determined there were several types of consistent experiences: the experiences of being “saved” and then baptized, descriptions of the “power of the lord”, fellowship as a factor of a strong community and in providing support to individuals, and the sense of community magnified through the church experience. Common in descriptions was the phrase “the sound of your grandmother humming” and the stalwart support of the church being based in the women of the community.

The next step was to define the foundations of the musical structure and its effects and see how they matched historic practice and effects. We identified the following elements in the structure of the music which existed in both time periods:

positive spin, looking forward, recognition of cognitive dissonance, affirmation, fellowship, unity of experience and purpose. These elements then underlined and defined the rest of the investigation.

Matching was then done of the stated responses with the neuroscience of the same types of physiological and psychological experiences. Once those areas of the brain were defined, we then searched the literature in the following databases to find neurological research on music that matched the same areas of the brain: PubMed, PsychInfo, Medline, EMBASE, Cochran Reports, and Google Scholar. We looked for studies that included both specific and relevant brain regions and significant empirical methodology. We primarily selected studies that included: MRI, fMRI, PET and EEG with MEG or QEEG analysis. After the basic selection of studies was reviewed, studies which specifically involved the Polyvagal system were also included. From this work an annotated bibliography and theory were developed as the final step.

5. DETAILED EXAMPLE

A detailed example of this process begins with a book written in 1861 *Incidents in the Life of a Slave Girl* which was published for the author Linda Brent by Harriet Ann Jacobs. After reading the book, relevant sections of the original narrative were selected for further exploration. For example pp 64 “If I ever know of your speaking to him, I will cowhide you both; and if I catch him lurking about my premises, I will shoot him as soon as I would a dog.” And page 94 “He sprang upon me like a wolf, and grabbed my arm as if he would have broken it.” In conflict with her master Linda had denied him access to her bed short of raping her and her master was continuously threatening her with physical violence as a result. He began this systematic abuse when she was 15.

We then looked at the situation with more modern eyes. This is consistent with a

situation of violence against women, where a woman is under the physical control of a man and is regularly threatened and treated with physical violence. Violence like this produces a whole series of stress factors such as increased blood pressure, increased cortisol levels, and norepinephrine and epinephrine flooding the body creating a state of hyper vigilance. Next was an examination of current literature to determine stress factors and physiological issues in violence against women who experienced it over a length of time which included a number of years. Searches were done on online medical/psychological databases like the National Library of Science data base PubMed. A search using the string “domestic violence against women” yielded over 1500 peer reviewed published articles. Over 100 articles were selected for detailed review. For example “Intimate partner violence in adult women and its association with major depressive disorder, depressive symptoms, postpartum depression: a systematic review and meta-analysis” was one of the studies explored. (Beydoun et al, 2012) Information from the various articles was then analyzed and synthesized and a list of relevant areas of the brain and body developed. Among those relevant to violence against women are the medial pre-frontal cortex, hippocampus, hypothalamus, frontal lobes and temporal lobes of the brain.

A list of studies were developed which looked at the effects of music on the brain and body. Over 3000 studies using such strings as “music”, “music therapy”, “music and neurology” were explored from PubMed and equivalent data bases and 300 studies were selected for initial review. Of those 300 studies reviewed, 116 studies were selected for detailed review and inclusion in the annotated bibliography. We focused on studies which used MRI, fMRI, PET imaging, EEG with MEG or QEEG analysis which provided detailed brain mapping relevant to the physical areas which had been clearly designated as

involved. The subsequent result of the study is a detailed theory.

6. THEORY IN BRIEF

One of the single most important aspects discovered was community. (CDC, 2005 and Krause, 2002, Gardiner, 2012) There is power in fellowship and strength in sharing when the situation is difficult particularly when music is a part of that sharing. Being greeted as a friend when entering the religious space, being able to sit with friends and family with a feeling of safety allows for the down regulation of the nor epinephrine (fight, flight, freeze) cycle. (Griffith et al., 1984) One experiences a level of relaxation which reduces blood pressure. (Loomba et al, 2012, Ofiki et al., 1999) Further, when individuals sing together they begin to breathe together and their hearts beat together. (Modesti et al, 2013) This creates a feeling of unity in the community and allows for more rapid problem solving. When one was valued in the local community to which one was responsible, it further strengthened both ethical and moral standards of behavior.

Children were often brought to the service. This was important because exposure to music and musical training produces a step-wise modulation in brain response (Oechslin et al., 2012) This change in brain response creates “superior brain architecture” (Tervaniemi et al., 2012) resulting in higher quality executive function, increased ability to focus and an increase in creative abilities and innovative thinking. (E et al., 2012). (Oechslin et al., 2012 and Putkinen et al., 2012) There also begins to be an alignment between the neurological activity and word and meter stress in the music. (Rothermich and Kotz, 2013) Taken in total musical training improves brain plasticity (Herholz and Zatorre, 2012 and Lou et al., 2012) which allows the brain to re-pattern the nervous system, respond more flexibly to varied stimuli and retarget the use of specific nerves.

The impact of the words of the music is both profound and subtle. Physiologically, it allowed neurological re-patterning and change in polyvagal response. (Yamasaki et al., 2012 and Paraskevopoulos et al., 2012) This happened because the lyrics themselves redefined and reframed the experience of being a slave. The lyrics gave hope. The use of words defined specific interactions in the world. (Carota et al., 2012) They define the role of the slave owner as the same as the Pharaoh described in the lyrics clearly showing that the slave owner was not in alignment with God's will. (Caldwell, 2004, Gordon et al., 2011) They showed the strength and power in faith in the potential for change (Wilson et al., 2011 and Sammler et al., 2012). As a result the music and lyrics reduce depression and suicide. (Koenig et al., 1992 Ellison, 1995, Young et al., 2003)

The next piece of information of note was involved in the placement of individuals singing in a congregational setting. People singing in a congregational setting often sing slightly different pitches for the same notes. When an individual has different notes sung on either side (microtonal differences) this creates a pseudo-binaural beat situation (Zatorre et al., 2012). Binaural beat music can create cross cortex coherence (Osdamar et al., 2011) altered or spiritually connected states and a reduction in anxiety (Le Scouarnec, 2001) and an increase in the flashes of insight that one experiences. (Backer et al., 2010) Auditory nerves respond nonlinearly to musical stimuli so in addition because more of the brain is engaged in the process, less neurological pruning and greater neuro-plasticity is a result. (Large and Almonte, 2012)

The key in which the music is performed also has an impact. Nerve plexus along the mid-line of the body respond to stimuli at different frequency rates. This allows the nerve plexus to both respond to stimuli and supports appropriate release in the nervous system (Sammler et al., 2012

and Manzke et al, 2009). The key of the music can also act as a stimulus to the body system supporting joy responses and deeper self-reflection. (Lehmann et al., 2001) Tempos of the music are also a factor. When individuals are singing in a congregational setting again there can be small variations in tempo between individuals standing side by side. These small variations in tempo create brain changes which support both improved executive decision making (Nozardan et al, 2011 and Jungblut et al., 2012) and recognition of cognitive dissonance. (Kitayama et al., 2012 and Parakevopoulos et al., 2012) The recognition of cognitive dissonance was particularly valuable within the slave community as it allowed individuals to recognize inherently dangerous situations in advance and sometimes be able to mitigate the effects. Further, it underlined the fundamental incorrect nature of the experience in which they were trapped reinforcing the response to the lyrics of the music. Musical activity with very small changes in rhythmic structure is also one of the few know ways in which the volume of grey matter in the brain is increased. (Teki et al., 2012) Overall these two aspects of the musical experience and the involvement in religious activities promote survival. (Previc, 2006) This was particularly important when the potential survival of the individual was limited.

In addition to the other benefits of singing the Negro Spiritual, it improved total breath of the brain, built increased lung capacity over time, (Kleber et al, 2010) increased the blood oxygen ratio (Stevenson et al., 2011) which in turn increases vascular flexibility (Kleber et al, 2010) in the brain. The total effect of participation in the religious activities and the singing of the Negro Spiritual was improved longevity. While it is unknown what the total increase was 200 years ago, today it is over 14 years improvement in longevity. (Hummer et al., 1999, McCullough et al., 2000)

The final effect that we were able to determine was that the period of contemplation included in the service when the body was in balance and properly stimulate created a momentary pause which then resulted in a need for movement. Essentially it is a pause before action. (Chin et al., 2012) Increased longevity, community unity, improved decision making, greater awareness of pending attacks through recognition of cognitive dissonance, better ability to focus, better brain linkages and increased neuroplasticity were all found to be viable and reasonable part of the explanation for both the survival of members of the community and the more limited effects of such deeply life threatening situations.

7. POTENTIAL FOR USE IN SCIENCE

There are a myriad of unanswered questions in history, science and other disciplines. There is an untapped potential in using existing knowledge and combining that with solid, clear, complete problem definitions and reverse engineering key processes. This holds the potential to advance many disciplines more rapidly. Thousands of scientific dollars a year are wasted because problem definition is done so poorly that the hypothesis of an experiment is not asking the correct questions and the experiment does not test even the existing hypothesis adequately. It is critical that as money becomes tighter, research become more precise in the problem definition process.

8. SUMMARY

It may be possible in the future to use this same basic process using the problem definition, reverse engineering analysis and subsequent multi-modal data mining and data analysis to answer existing historical questions with some degree of accuracy. This can advance many fields more rapidly as it clarifies relevant information and places it in historical context.

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