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HealthRHYTHMS Publish Research Summary

Understanding our Genomics Research

Recreational Music Making Modulates the Human Stress Response: A Preliminary Individualized Gene Expression Strategy

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Key Insights for Understanding Our Research

The following information is presented to provide a comprehensive overview of this research investigation.

It is divided into the following sections:

- Understanding the Genome
- Stress and Its Impact
- Research Design
- Our Findings
- Key Insights

Understanding The Genome

- Cells are the fundamental working units of every living system. All instructions needed to direct their activities are contained within the chemical DNA (deoxyribonucleic acid).*
- DNA, a double-stranded molecule, exists in the form of a double helix─ a twisted ladder-like configuration with rungs that link the base pairs.
- DNA from all organisms is made up of the same chemical and physical components. The DNA sequence is the particular side-by-side arrangement of bases along the DNA strand. This order spells out the exact instructions required to create a particular organism with its own unique traits.*
- DNA is found within 23 pairs of chromosomes that are located within the nucleus of each cell.
- The genome is an organism's complete set of DNA. Except for mature red blood cells, all human cells contain a complete genome.*
- The human genome is a personal blueprint that serves as the instruction book for our bodies. It contains an estimated 3 billion chemical nucleotide bases and 20,000-25,000 functional genes.*
- From a musical perspective, Karl T. Bruhn, acknowledged "Father of Music-making and Wellness," envisions the human genome as a continuous piano keyboard spanning from New York to Los Angeles. A note out of tune or played out of sequence adversely impacts our health.
- The human genome was first sequenced on June 26, 2000 using Applied Biosystems' technology. Nobel laureate, Walter Gilbert of Harvard subsequently commented, "The human genome is the holy grail of biology. It changes everything." *Genomics and Its Impact on Science and Society: The Human Genome Project and Beyond - a publication of the U.S. Department of Energy Human Genome Program - March 2003

Stress and Its Impact

- While most people understand stress on a personal level, scientists continue to debate its precise definition. The purpose of this section is to clarify the terms: stress, stressor and stress response.
- From a biological perspective, perhaps the most practical way of conceptualizing stress is to consider health as a complex orchestration of thousands of bodily functions that maintain a delicate balance referred to as "homeostasis." A stressor can be considered as anything that disrupts this balance. The resultant process of biological disruption is the stress response.
- From a psychological perspective, stressors often (but not always) elicit feelings of anxiety or tension. Some stressors are obvious while others are not. People are sometimes unaware of the stressors that affect them especially in a highly-pressured fast-paced society.
- For the purpose of understanding this study, we refer to Hans Selye's definition of stress as "a non-specific response of the body to any demand."

- Over the years, researchers have attempted, with varying degrees of success, to more fully understand and describe that "non-specific response" in terms of complex biological changes that occur within and between the nervous system, endocrine and immune system.
- With the exception of exposure to universal stressors such as a burning building, human stress responses to common stressors are typically unique, and vary considerably due to genetic, situational and psychosocial variables attributable to each individual. For some, working under deadlines may be perceived as stressful, while for others it is not. Essentially, the way in which one perceives "the demand" to a certain degree ultimately influences his/her stress responses.
- The fact that stress responses clearly impact our health is supported by extensive research. Multiple health challenges such as cardiovascular disease, cancer, infections, inflammatory processes, diabetes and autoimmune disorders have been associated with stress responses.
- To more fully understand the marked variability in human responses to a common stressor, consider the following example: a married couple suddenly learns that their retirement savings have been embezzled by a former employer, and as a result, they find themselves destitute. Over the course of ensuing weeks, the husband experiences multiple bouts of chest pain and the wife develops episodes of abdominal pain and vomiting.
- The impact of stress on our lives is substantial. According to Newsweek (September 27, 2004), "Experts claim that 60-90 percent of doctor visits involve stress-related complaints."
- The projected financial impact of stress is excessive. According to The New York Times (September 5, 2004), "Workplace stress costs the nation more than $300 billion each year."

Research Design

- A total of 32 carefully screened adult volunteers participated in the study. Subjects met the following exclusionary criteria: smoking, consumption of more than 1 alcoholic beverage/day, current use of prescription medications, enjoyment of jigsaw puzzles, prior experience playing a musical instrument and adverse reactions to blood drawing.
- Subjects participated in a 2-phase experiment. Each phase lasted 1 hour. During phase I (stress induction), subjects assembled complex jigsaw puzzles, and competed to assemble the most pieces. During phase II, subjects were divided into 3 groups: ongoing puzzle assembly; resting and reading newspapers and/or magazines; and participating in a first group keyboard music lesson, the Clavinova Connection.
- The puzzle assembly stressor was specifically chosen to elicit a stress response in a safe, non-threatening manner. While one might raise the concern that this activity might not have been perceived as stressful to all subjects, it should be emphasized that prescreening was utilized to eliminate subjects who found puzzle assembly enjoyable. Additional factors that potentially amplified stress perception included the initial placement of the intravenous blood drawing apparatus (heparin lock), the anticipatory effect of repetitive

blood drawing, and the verbal prodding/pressure to assemble the most pieces imposed at regular intervals by the research team.

- The Clavinova Connection is a multidimensional Yamaha recreational music making program designed to enable participants without prior musical experience, or those who do not consider themselves musical to enjoy a structured opportunity for creative musical expression in a supportive environment. The program's goals are based upon conditioning a sense of nurturing, camaraderie, non-verbal expression and bonding in contrast to traditional mastery and performance outcomes.
- Blood was drawn on 3 occasions: prior to beginning Phase I, after Phase I, and after Phase II.
- Blood samples were used to assess the activity (expression) of 45 specific genomic markers associated with established stress biology. These markers can be conceptualized as genomic switches that literally turn on the production of specific biological substances within the body.
- Data were reviewed to determine and compare the direction of gene expression (up or down regulation) associated with each phase of the experiment.

Our Findings

- Initial analysis of Phase I (comparing blood sample 2 to blood sample 1) revealed that the direction of expression for each genomic marker during the stress induction phase varied considerably from person to person. Consistent with early insights concerning human stress responses, each individual responded in a unique biological manner to the common stressor.
- In view of these preliminary findings, instead of comparing collective group stress responses, a unique pattern of gene expression was therefore documented for each subject individually. The research team termed these profiles individualized genomic stress induction signatures (stress signatures).
- Each stress signature can be envisioned as a chart showing a person's unique stress response in terms of up or down regulation of 45 genomic markers. It can be considered as a genomic fingerprint unique to each person.
- Each stress signature was subsequently used as a baseline for comparison with Phase II strategies.
- A comprehensive analysis of the data revealed that in individuals relaxing and reading newspapers and/or magazines, reversal of initial individualized genomic stress responses was noted in 6 of 45 genes in contrast to 19 of 45 genes for the recreational music making group. Comparing the activities, more than 3 times the number of reversals were noted in individuals participating in the music group.

Key Insights

- A unique measurable pattern of genomic expression can be elicited for each individual in direct response to a common stressor.

Significance: This unique genomic pattern can potentially shed light on understanding the biological implications and potential health risks (associated with a particular stressor) that are specific to each person.

- Reversal of stress signatures has been successfully accomplished (for the first time) in individuals playing musical instruments.

Significance: Active music making as a stress reduction strategy warrants further consideration as a healthy lifestyle choice.

- Participating in the Clavinova Connection, a keyboard-based recreational music making program developed for individuals without prior musical experience or for those who do not consider themselves "musical" reversed genomic stress responses to an extent that exceeded the impact of a typical relaxation activity (resting and reading newspapers and/or magazines).

Significance: A first group music lesson has been demonstrated to be more effective than a typical relaxation activity in reversing stress responses on the genomic level.

- Since wide variations in human responses to common stressors reflect genetic, situational and psychosocial variables unique to each individual, the process of reversing stress signatures holds significant promise for the future development and testing of a wide range of therapeutic strategies targeted specifically for each person, rather than a group.

Significance: Through ongoing research, the use of stress signatures can potentially help medical scientists improve therapeutic efficacy through the development and prescription of interventions and treatments matched precisely to the individual.

- While it was beyond the scope of this research investigation to analyze stress signatures in the context of predicting one's future health, additional research could potentially shed light on better understanding one's likelihood to develop specific diseases.

Significance: Future studies based upon stress signatures could potentially help better define effective individualized preventive strategies for reducing the incidence of specific diseases and thus optimizing quality of life.