

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

Psychoneuroimmunology in Patients with HIV in Recovery from Substance Use:

The Effect of Heart Rhythm Coherence Feedback Training

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By

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Dedication

For Ron

His pure heart played the beat that we all synchronized our rhythm to.

And for Bertha

Her song grows stronger and more beautiful by the day.

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Abstract

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This study used a biofeedback intervention that taught patients how to synchronize their heart rhythm with their respiration and their alpha brain waves in order to lower their levels of autonomic nervous system (ANS) activation. In essence, subjects learned how to create more integration between their physical and psychological selves while gaining increased control over their ability to mindfully respond to challenges rather than reflexively reacting with a “fight or flight” response. The goal was to bolster the effectiveness of patients’ Highly Active Anti-Retroviral Therapy (HAART) by decreasing flow of norepinephrine which in turn is expected to lower their HIV viral loads while boosting their CD4 T-Cell counts. The intervention was also expected to have a positive effect on patients’ stress levels and sense of self-efficacy because it

empowered them to develop control over their consciousness and their physiological states through the use of breathing exercises and positive-emotion-focused techniques. The findings indicated that heart rhythm coherence feedback training had a positive impact on the psychological measure of self-efficacy and was found to be linked to a statistically significant reduction in anxiety as well as a statistically significant increase in CD4 T-cells.

Introduction

This study explored the efficacy of a therapeutic intervention that incorporates concepts from the fields of psychoneuroimmunology, positive psychology, neurocardiology, somatic experiencing and quantum neuropsychology. This intervention was delivered in a therapy group setting at Tarzana Treatment Centers' outpatient substance use treatment facility for individuals living with HIV. Its chief aim was to foster enhanced coherence and integration between subjects' psychological and physiological states, empowering them to harness increased control over their own consciousness and practice self-directed neuroplasticity by lowering activity in the sympathetic division of their autonomic nervous system (ANS), effectively modulating their "fight or flight" response. It was hypothesized that the intervention would have both physical and emotional benefits. Similar interventions have been shown to lower stress while boosting self-efficacy. Furthermore, ANS activity has been demonstrated to be inversely proportional to HIV treatment efficacy. The intervention was delivered through the use of the Inner Balance HearthMath app for iPod that enables subjects to receive visual biofeedback related to the shape and variability of their heart rate wave in real time. Expected outcomes included decreased anxiety as measured by the Generalized Anxiety Disorder 7 Item Scale (GAD-7), increased self-efficacy as measured by the General Self Efficacy Scale (GSE), lowered HIV viral load and increased CD4 T-cell count each as measured through the regular collection of HIV labs (blood work).

Literature Review

Neurocardiology

Adherents to the Cognitive Behavioral Therapy paradigm, conceive of emotions as being generated in a fairly linear manner involving thoughts causing feelings which in turn determine behavior (Heslop, 2008). Emerging research, criticizing this view has established that emotions are produced in a far more dynamic, multidimensional fashion involving a feedback loop of communication between the mind and body (McCraty & Childre, 2004). McCraty and Childre's (2004) research focuses particularly on afferent signals sent from the heart to the brain.

“Recent work in the relatively new field of neurocardiology has firmly established that the heart is a sensory organ and an information encoding and processing center, with an extensive intrinsic nervous system sufficiently sophisticated to qualify as a ‘heart brain.’ Its circuitry enables it to learn, remember and make functional decisions independent of the cranial brain.” (McCraty & Childre, 2004).

One of the direct ways in which the heart influences emotion is through its production of hormones, particularly oxytocin (Gordon et al, 2011). Oxytocin's most widely known function is to foster bonding and human connection. It does so much in the same way that dopamine encourages behaviors necessary for survival such as eating and having sex. It makes human connection emotionally rewarding or pleasurable, thereby fomenting feelings of love and attachment (Gordon et al, 2011). Incidentally, oxytocin also regulates cardiovascular homeostasis and body fluid levels (Gordon et al, 2011).

Applied Positive Psychology: Gratitude, Hope and Action

While oxytocin facilitates human connection and bonding on a neurochemical level, gratitude facilitates it on an emotional level. Indeed, practicing gratitude stimulates the production of oxytocin (Algoe & Way, 2014). It has been argued that gratitude provides the basis for all human society by creating the bonds of reciprocal relationships upon which families and communities are built (Emmons & McCullough, 2004). Felt thankfulness and appreciation for support or benefit received inspire the grateful person to “pay back” their benefactor. This process instigates a positive feedback loop of altruistic action directed toward individual people or toward the world in general depending upon whether the actor feels grateful toward a specific supporter or to a higher power, either a God concept or the universe itself (Peterson & Seligman, 2004). Though the phenomenon of gratitude has only recently begun to be seriously studied by psychologists, it has long been considered a virtue of paramount importance central to the values of all major religious traditions. Jonathan Haidt’s (2006) research on this subject indicates that beyond promoting the development of bonds between people, gratitude facilitates spiritual connection between people and something bigger than them, whether it be nature, humanity as a whole or God. Indeed, Haidt (2006) describes gratitude as a pathway to the spiritual dimension of life, noting the uplifted feeling people get in their chests or hearts when having spiritual experiences and how they are apt to point to their heart when experiencing inspiration or elevation. Gratitude is antithetical to feelings of pride and self-pity. On the contrary, it generates feelings of humility and hope.

Peterson and Seligman (2004) elucidate the process through which hope shapes cognition and the making of meaning. They explain how people who practice hopefulness are likely to have an internal locus of control, an overall *active* coping style and optimistic explanatory style. An

optimistic outlook corresponds to a belief that bad things happen indiscriminately; it is random, *not* personal. This perspective creates conditions that facilitate the growth of self-efficacy (Bandura, 2001), a character trait that is of significant importance when it comes to healing (Jeng and Braun, 1994). A pessimistic or hopeless attitude engenders feelings of powerlessness, guilt and shame tied to the idea that when bad things happen they are a result of personal faults or inadequacies. While hope builds self-esteem, pessimism erodes it (Peterson & Seligman, 2004)

In general, hope makes the accomplishment of goals more likely. The belief that goals are attainable encourages investment in taking action to complete them (Peterson & Seligman, 2004). A hopeful attitude can be described as gratitude in the future tense, an appreciation of potential opportunities. What a person with a pessimistic outlook would view as an obstacle or challenge, someone with an optimistic attitude is likely to see as an opportunity for learning and growth, a perspective that promotes a balance between confidence and humility (Haidt, 2006).

Hope and fear are the basic binary responses to uncertainty in the *future* much as gratitude and disappointment/frustration are the basic binary assessments of how things are going in the *present* and have gone in the *past*. Though life can certainly be unjust and the degree to which any individual is objectively fortunate forms an extraordinarily broad spectrum, Csikszentmihalyi (1990) has discovered that beyond a ground level of having basic, lowest layer of Maslow's (1970) hierarchy of needs met, people report similar rates of subjective well-being, happiness and life satisfaction. Csikszentmihalyi argues that as long as a person's immediate safety and survival are secure, the difference between a happy, hopeful person and a frustrated, dissatisfied, pessimistic person comes down to a matter of focus. Csikszentmihalyi (1990) conceives of *attention* as a form of psychic energy, suggesting that at any given time there are things to be grateful for and things to be disappointed or frustrated about. The real difference in a person's mood is determined by

what they choose to focus on. Likewise, overly focusing on what may go wrong in the future vs. what could go right, impacts mood and sense of self. The nature of uncertainty is that it may go either way. Csikszentmihalyi suggests that both negative and positive expectations tend to become self-fulfilling. The idea is that individuals have a finite amount of energy and attention. Thus, focusing on a problem necessarily precludes a person from having as much energy and attention to invest in working toward a solution.

Csikszentmihalyi (1990) coined the term *flow* to describe a state of consciousness in which action and awareness have merged to the point that a person is so “in the zone”, so engrossed in what they are doing that they have no attention or mental energy left to devote to sources of stress or worry. Indeed, in a flow state, it is common for people to lose track of time or even lose track of themselves. Csikszentmihalyi (1990) notes that many people report feeling as though when they are being creative or athletic in a flow state, their sense of self-awareness melts away and it feels like it is not actually them who is doing the creation or athletics they are engaged in. Rather, energy is “flowing” through them effortlessly. This healthy, transcendent escape from life’s problems through becoming completely immersed in constructive activity provides many of the benefits that make substance use an alluring form of coping and it provides them in a safer way. In order for a flow state to be achieved, the activity a person is engaged in, (whether it is work, exercise, sports, or something creative like writing, dancing, playing music or making art), must be challenging enough that the person has to devote all of their energies to doing it yet at the same time not *so* challenging that they are unable to lose themselves in the activity because it itself has become stressful or overwhelming (Csikszentmihalyi, 1990).

Mindfulness, a concept related to flow is a state of consciousness that involves a contrasting form of attentional focus characterized by objective awareness of internal states and environmental

surroundings accompanied by a sense of non-judgmental acceptance (Davidson, 2003). Mindfulness and flow are each ways to become present in the current moment. Yet, while in flow, self-awareness dissolves through the process of focus *zooming in* to a state of total immersion, through the practice of mindfulness, self-awareness becomes heightened by the perspicacity that comes with the wider angle perspective that is achieved through focus *zooming out*.

Quantum Neuropsychology

Csikszentmihalyi's elucidation of the powerful utility of willfully focusing attention and mental energy dovetails smoothly with insights from the field of quantum neuropsychology about self-directed neuroplasticity. Schwartz et al. (2005) describe the relationship between consciousness and the brain as dialectical rather than linear or deterministic, pointing out that classical conceptions of neurologic function completely fail to take into account the role of agency and choice on the part of the individual. While the brain and the senses certainly provide a flow of information to an individual's awareness that may impact their state of consciousness, proponents of the quantum neuropsychology approach argue that the free choice exercised and effort expended by that autonomous consciousness in turn impacts the state of the brain. In other words, people alter their brain's structure and neurologic pathways depending on what perspectives, attitudes, coping styles and habits they adopt. Phan et al. (2005) demonstrate this in their study that uses functional Magnetic Resonance Imaging (fMRI) technology to illustrate the neurologic impact of practicing cognitive reappraisal to change the meaning attributed to photos depicting "highly arousing, aversive content". Subjects in the experimental group were instructed to positively reframe the meaning of the potentially disturbing images they were exposed to. The control group was asked to simply allow themselves to be aware of whatever feelings were evoked by the pictures. Phan et al. (2005) discovered that the voluntary act of adopting a positive interpretation

of an image initially perceived as repulsive causes a suppression of activity in the limbic system accompanied by increased arousal in the pre-frontal cortex. Conversely, exposure to graphic, disturbing images without such cognitive reappraisal leads to a suppression of activity in the pre-frontal cortex accompanied by increased arousal in the limbic system. Furthermore, in a very real sense, the brain *is* what it *does*. Repetitive, patterned activation of particular neural structures, deepens the groove of those pathways and increases the density of the dendritic connections therein (McCauley, 2004).

Psychoneuroimmunology

The dialectic of mutual influence that characterizes experiential consciousness and the physical/chemical brain, shares much in common with the connection between the mind and body. As noted in the discussion of neurocardiology literature, the distinction between the psychological and the physiological dimensions of the human organism are more blurred than originally thought. Scholars from the field of addiction (McCauley, 2004) as well as clinicians using somatic experiencing techniques to heal trauma (Levine, 2008) know that resolving dissonance between patients' physical and emotional selves through the process of identity integration is key to recovery. Jonathan Haidt (2006) calls the phenomenon of successful integration of a person's physical, psychological and social aspects of self, "cross level coherence" but as he points out, in various cultural contexts, people have discovered the similar concepts of "cohesion between mind, body and spirit" and "alignment of the chakras".

Ader (2001) explains the biochemical mechanisms that make such alignment possible including coherence between the human system's various rhythmic activities such as heart rate, respiration and nervous system activity. Cole (2001) establishes a correlation between autonomic

nervous system (ANS) activity and HIV replication. Highly Active Anti-Retroviral Treatment (HAART) has been found to be less effective in individuals with high levels of ANS activity. The increased flow of norepinephrine (adrenaline) kindled by activation of the sympathetic nervous system stimulates HIV replication, raising viral load and in turn lowering CD4 T-cell counts. Leserman (2003) reviewed 11 studies examining correlations between depression, stress and HIV progression. Results were mixed but several of the studies including Ickovics et al (2001) found that psychological distress correlated with decline in CD4 T-cell counts. Greeson et al (2008) found that 67% of variation in HIV severity is attributable to changes in NK (Natural Killer) cell immunity and cytotoxic CD8 T-cell activation caused by psychological distress. Perhaps most relevant to the present study, Chida and Vedhara (2009) confirm the connection between psychological distress and HIV severity but further found that coping style (active vs. avoidant) is more strongly associated with variation in HIV progression (as measured by viral load increase and CD4 T-cell decline) than both exposure to stress stimuli and the experience of psychological distress.

This study used a biofeedback intervention that taught patients a new active coping strategy: synchronizing their heart rhythm with their respiration and their alpha brain waves in order to lower their levels of ANS activation. In essence, subjects learned how to create more integration between their physical and psychological selves while gaining increased control over their ability to mindfully respond to challenges rather than reflexively reacting with a “fight or flight” response. The goal was to bolster the effectiveness of patients’ HAART therapy by decreasing flow of norepinephrine, which in turn was expected to lower their HIV viral loads while boosting their CD4 T-Cell counts. The intervention was also expected to have a positive effect on patients’ stress levels and sense of self-efficacy because it empowered them to develop

control over their consciousness and their physiological states through the use of breathing exercises and positive-emotion-focused techniques including the cultivation of gratitude and hope. The intervention used in this study is similar to the one used by Paul and Garg (2012) and examines the same two psychological outcomes: self-efficacy and anxiety. This study however, also used the intervention to replicate Cole's (2001) findings related to improved HIV outcomes caused by lowered ANS activity.

Methods

Sample: The sample for this study was drawn from a population of adult patients of Tarzana Treatment Centers’ outpatient substance use treatment program who are enrolled as patients of the agency’s HIV specialty care clinic and have been on their current HIV medication regimen for at least 90 days. Subjects were invited to participate as part of their ongoing outpatient treatment. The population of 16 people ranged in age from 25-62. It consisted of 13 cisgender men, 2 transgender women and 1 cisgender woman. The population was 50% White, 38% Latino and 12% African-American. Over two thirds of the population’s baseline HIV viral loads were already undetectable. The subjects were divided into two groups that went through the intervention as a cohort: Group 1 (n=9) and Group 2 (n=7).

Study Design: Data was collected using a switching replication study design as follows (Rubin & Babbie, 2007).

R	O	X ¹	X ²	X ³	O ⁺				O
R	O				O	X ¹	X ²	X ³	O ⁺

R = Randomized assignment of subjects into Group 1 or Group 2.
 O = Collection of GAD-7 and GSE questionnaires as well as HIV labs.
 X¹ = Stage 1 of intervention (group session).
 X² = Stage 2 of intervention (group session).
 X³ = Stage 3 of intervention (group session).
 O⁺ = Collection of GAD-7, GSE, HIV labs and data from Inner Balance Heart Math app.

Secondary analysis of patients’ blood work was done to determine their T-cell count and HIV viral load. GAD-7 (Generalized Anxiety Disorder) scales were administered to measure patients’ levels of stress and GSE (General Self-Efficacy) scales will be collected to measure patients’ confidence in themselves. The GSE was quantized so that a numeric score could be generated. For each of the 10 statements on the questionnaire an answer of “Not at all true” was assigned

the numeric value of “0”. An answer of “Hardly true” was assigned the value of “1”, an answer of “Moderately true” was assigned the value the value of “2” and an answer of “Exactly true” was assigned the value of “3”. The range of possible scores for the GAD-7 was 0-21 and the range of possible scores on the GSE was 0-30. Though gratitude, mindfulness and flow are each states of consciousness cultivated by the intervention in this study, they were not measured as outcomes. Rather, these are each considered independent variables and their development is expected to lower anxiety and increase self-efficacy.

The first session of the intervention (X^1) utilized a heart rhythm coherence feedback app called Inner Balance by HeartMath, to bolster subjects’ ability to synchronize their heart rhythms, respiration and brain waves at their resonant frequency of .1Hz (6 breaths per minute) (McCraty & Childre, 2004). The groups were facilitated in a dynamic fashion that engaged subjects in open discussion about the concepts presented and explored the subjects’ questions, ideas and experiences. The second session (X^2) involved training on positive-emotion-focused techniques as well as psycho-education about the concepts of mindfulness, flow and appreciation. Subjects learned how to achieve heart rhythm coherence through the self-induction of these different states of consciousness. The first two group sessions were each followed by six days of individual practice on the Inner Balance app for 15 minutes each day, honing the skills learned during that week’s session. The third group session provided an opportunity to reflect on progress made and plan how the skills acquired from the training may be utilized in the future.

Analysis: All data was collected at pre, post and follow-up intervals in order to establish baseline information and the efficacy of the intervention over time. Pre and post-test GAD-7 and GSE questionnaire responses were run through a paired sample t-test to determine if any changes over time were statistically significant. Likewise, subjects’ HIV viral loads and CD4 T-cell

counts were examined to discover if the intervention had any impact on these physiological outcomes. This medical data was also run through a paired sample t-test to establish if any changes were significant. The GAD-7 has been shown to be sensitive to fluctuations in stress and fear levels (Spitzer et al, 2006).

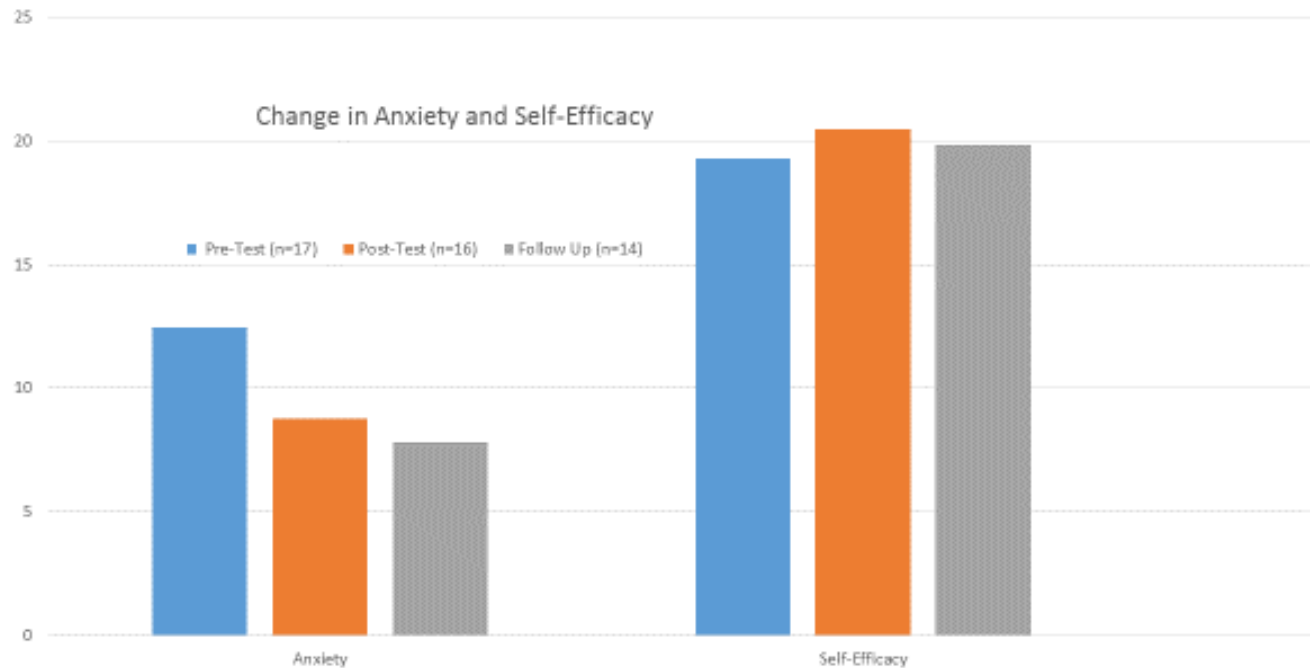
An advantage of the switching replication design was that it strengthened the validity of the study by reducing the ability of extraneous variables to cloud the results. If the intervention had any significant impact, it could be expected that the second set of data from Group 1 and the third set of data from Group 2 would bear a strong resemblance. Whereas, if the second set of data from Group 1 and 2 looked similar, it could be inferred that the intervention did not have a significant impact and any fluctuations in the measured outcomes may be attributable to other factors.

Results

Psychological Measures

A comparison of the pre and post GAD-7 results indicated an approximate 30% decrease in reported anxiety levels, a change considered to be statistically significant. As depicted in Figure 1, The mean pre-test anxiety score was 12.44 and the mean post-test score was 8.75 ($t=3.279$, $p=.005$). As per the switching replication design, Group 1's pre-test GAD-7 score was 13.5 and Group 2's was 12.5. The similarity between the two suggests that any changes observed in the post and follow up tests were likely caused by the intervention because the switching replication served to rule out extraneous variables by timing data collection such that Group 1's post-test occurred at the same time as Group 2's pre-test. While reported levels of self-efficacy did increase after the intervention, the paired sample t-test did not find this change to be statistically significant. The self-efficacy pretest mean was 19.31 and the posttest mean was 20.50. The follow up GAD-7 and GSE questionnaires administered either 2 or 5 weeks after the completion of the intervention (depending on whether subjects were in the first or second group cohort) produced an anxiety mean of 7.79 suggesting that the stress reducing effects of heart rhythm coherence feedback training were sustained over time. The GSE follow up results produced a mean score of 19.86 suggesting that if participation in the study did boost self-efficacy, the benefit may not have continued on beyond the duration of subjects' daily coherence practice.

Figure 1

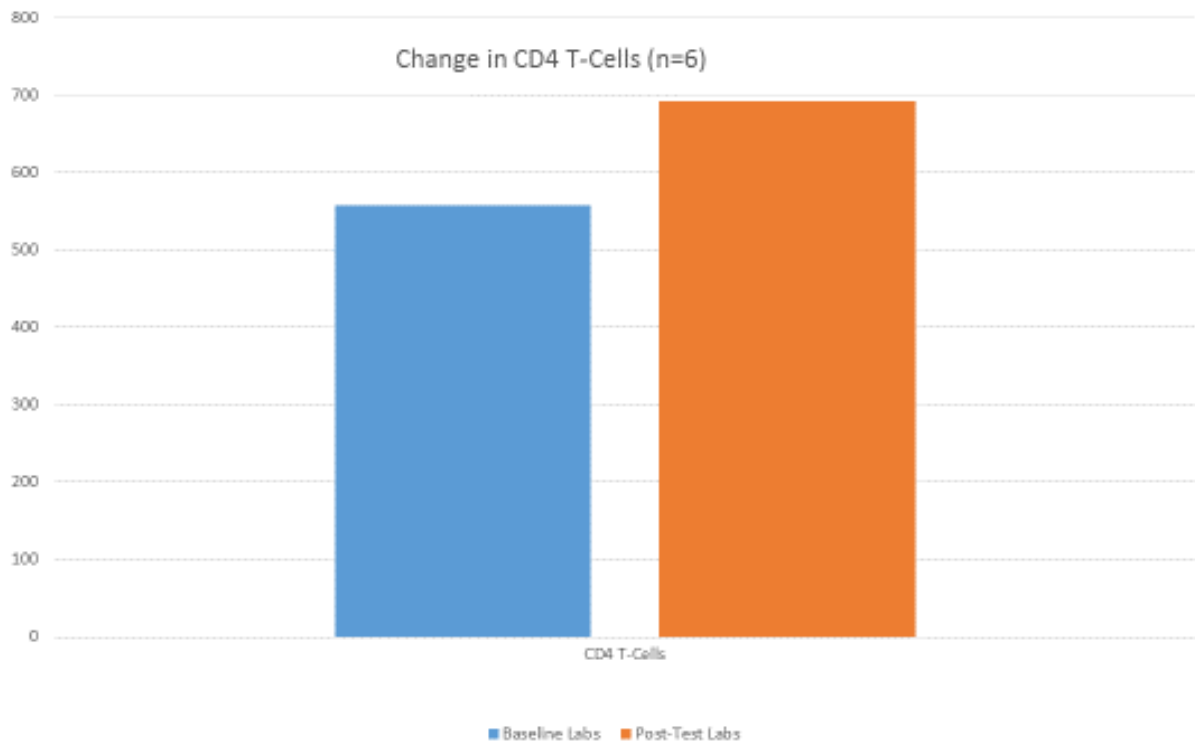


Physiological Measures

Subjects who maintained abstinence from active addiction throughout the data collection period and completed post-test labs within the timeframe experienced an average increase of 135 CD4 T-cells, a 24% increase and a change considered to be statistically significant. The mean baseline CD4 T-cell count was 557.00 while the mean post-test count was 691.83 ($t=-3.176$, $p=.025$). These figures are quite promising particularly considering that over two thirds of the population had an undetectable HIV viral load at the onset of the study. An undetectable viral load essentially means that there are less than 20 copies of the HIV virus per ml of blood. When a patient's HIV medication regimen is not keeping the virus under control, viral load can exceed

millions of copies per ml. The implication is that the majority of this studies' subjects' HIV care was already succeeding at severely limiting the virus's ability to replicate itself, a process which involves hijacking and killing CD4 T-cells. This post-test increase in T-cell counts suggests that practicing heart rhythm coherence feedback training, limited it even more.

Figure 2



Disussion

Significance

The significant increase in CD4 T-cells and decrease in anxiety may be connected in a variety of ways. Perhaps the boost in immune system function was caused by the adoption of active coping styles and optimistic explanatory styles which in turn stymied adrenaline production. It is also possible that through the heart rhythm coherence training, subjects developed increased awareness of internal shifts in consciousness and somatic states and used it to practice self-directed neuroplasticity by “pumping the breaks” on their “fight or flight” response as they felt it arising. Perhaps empowering themselves in this way to mindfully respond to stress stimuli rather than reflexively react to it, was what lowered flow of adrenaline and in turn improved immune system function.

The 30% reduction in anxiety replicates the finding of Paul and Garg (2012) and is a major shift that makes a strong case for the broader use of heart rhythm variability feedback training with a variety of populations facing the challenges of coping with stress. Furthermore, the solid increase in CD4 T-cells suggests that heart rhythm coherence feedback training is an innovative new form of intervention to integrate into the overall care of individuals who have HIV. As Leserman (2003) points out, individuals who have an HIV diagnosis are at increased risk for struggles with anxiety as well as depression and could benefit from an intervention that treats the psychological and physiological as two sides of the same coin.

The intervention utilized in this study highlights how patients’ medical and emotional challenges can be treated in a cohesive, coordinated way. This study proposes that integrating

physiological and psychological modes of treatment may help patients to integrate the physiological and psychological dimensions of themselves, creating coherence between the two.

Limitations

The primary limitation of this project is that the sample size (n=16) was relatively small. Future studies with larger sample sizes could establish if the observed increase in self-efficacy after completion of the heart rhythm coherence training is potentially significant. Furthermore, because less than a third of the population studied had a detectable viral load at the onset of data collection, the potential impact of the intervention on viral load was unable to be determined. Hence, offering heart rhythm coherence feedback training to a greater number of patients whose HIV viral load is not already at undetectable levels could make it possible to establish what effect if any, the intervention may have on viral load.

The potential risk of population bias based on the rather large number of subjects (6) who dropped out of the study before data collection was complete is another limitation posed by the relative instability of the population studied. The reasons that subjects withdrew from the study did vary. Some had changes in their work schedules and others apparently relapsed on substances and discontinued their services in general from the agency. It is unclear how this may have skewed the overall data set.

Time constraints also limited the ability of this study to establish the intervention's longer term impact. Future studies with a more longitudinal frame could explore just how long lasting the anxiety reducing effect of heart rhythm coherence feedback training can be.

Implications for Future Research

The prevailing trend toward integrated healthcare creates an opportunity for social workers to advocate for the use of more therapeutic interventions that are designed to foster integration of the mind, body and spirit, balance between patient's physiological and psychological selves. The findings produced by this study suggest that heart rhythm coherence training may be a powerful tool to aid clinicians as they shift toward treating the whole person in front of them rather than focusing narrowly on their mental health challenges.

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