Heart rate variability as an indicator of stress and resilience in HIV+ positive adults:

An analysis of a stigma related stress induction

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Learning of a positive diagnosis of HIV may be one of the most challenging and stressful events in life. The memory of this event is emotionally laden, and even years later evokes an emotional response. Similarly, many people living with HIV (PLH) have memories of the first time they were treated differently because of their diagnosis. While research frequently examines the subjective of stress, few studies have examined biological markers of stress in people living with HIV. Heart Rate Variability offers a non-invasive measure of stress. Beyond serving as a biological marker for stress, changes in HRV are also associated with emotional functioning. Research demonstrates decreased HRV levels in patients with Depression, Anxiety, and PTSD. We conducted a repeated measures MANOVA to examine effects of stress induction on HRV in individuals with high and low levels of HIV-related stigma. We found that the high stigma group was significantly different from the low stigma group in regard to changes in participants’ HRV, Wilks’ $\lambda = .50$, $F (1, 51) = 11.63$, $p < .001$. A hierarchical linear regression examined the relationship between HRV and other measures of stress (Heart Rate and Blood Pressure). We found that systolic blood pressure and heart rate in the stress condition were predictive of HRV (adjusted $R^2 = .29$, $F (5, 46) = 4.07$, $p < .01$). Results of our study support the use of HRV as a measure of stress in HIV-positive adults. Additionally, the results of our study demonstrate significant relationships between stigma, social support and stress in HIV-positive adults.
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Chapter 1

Introduction

HIV/AIDS is a worldwide pandemic that compromises immune functioning. In 2010, over 33 million people were living with HIV/AIDS (PLWHA) worldwide, of which the U.S. accounted for 1.1 million cases (UNAIDS, 2010; CDC, 2012). According to data from the CDC (2012), HIV prevalence rates were highest for African Americans (1819.0 per 100,000); more than three times the prevalence rate among Latino/as (573 per 100,000) and more than eight times the prevalence rate among European Americans (273 per 100,000). Men who have sex with men account for fifty percent of PLWHA in the U.S. According to CDC estimates, gay and bisexual men accounted for sixty-one percent of new cases in 2009 (2012). Survival rates for PLWHA have improved, largely due to the advent of highly active antiretroviral therapy (HAART). HAART slows the onset of AIDS by affecting an individual’s immune response, specifically the CD4 cell count and total viral load, the best indicator of overall physical health in HIV positive individuals (CDC, 2010). In addition to changes in survival rates HIV prevalence rates have increased among groups who have historically been socioeconomically disadvantaged. In 2009, an estimated 48,100 new cases of HIV were diagnosed, with the highest rates among African American males (103.9 per 100,000), Latino males (39.9 per 100,000), and African American females (39.7 per 100,000) (Prejean et al, 2011).

Health Disparities occur when specific members of the population are more affected by a disease than others frequently as a result of disparities in socio-economic factors. Health Disparities in HIV are associated with factors such as poverty, racism, stigma, as well as inadequate education and access to healthcare (CDC, 2010). In 2010, the CDC released a White Paper on the Social Determinants of Health (SDH), which are
defined as “complex, integrated, and overlapping social structures and economic systems that include the social environment, physical environment, and health services; structural and societal factors that are responsible for most health inequities (p. 7).” By examining SDH, researchers shift the focus from the traditional focus on individual behaviors to the role of social phenomena such as discrimination, poverty, and stigma. Attention to social factors is critical because they affect individual behaviors and an individual’s receptivity to traditional interventions.

**Role of Stigma in HIV**

People living with HIV/AIDS (PLWHA) experience not only general life stressors, but also stress associated with their seropositive status (Vanable, Carey, Blair, & Littlewood, 2006). Additionally, a unique source of stress for PLWHA is the stigma associated with HIV (Bogart et al, 2007). Since the early 1980s, HIV/AIDS has been inextricably linked to gays, minorities, intravenous drug users, prostitutes, and the poor; groups already marginalized and devalued within society. PLWHA are treated with disdain and disgust within our society, effectively leaving these individuals feeling isolated from society (Rotheram-Borus, Lester, Wang, & Shen, 2004). Further, cultural devaluation and exclusion of stigmatized individuals are associated with increases in risky behavior due to perceived differences between the stigmatized group and general society (Alonzo & Reynolds, 1995). Internalized stigma is the result of a negative opinion based on an individual’s perception of some aspect of himself or herself as a socially unacceptable trait. This perceived negative bias; may be based on internalized negativity or actual experiences (Hamra, Ross, Karuri, Orrs, & D’Agostino, 2005).
HIV-related stigma is also associated with increased anxiety, depression, and isolation in HIV-positive adults (Vanable, Carey, Blair, & Littlewood, 2006). HIV-positive individuals are stigmatized due to perceived social and sexual deviance. The disease is seen as a result of morally reprehensible behavior and negligence. Fear associated with contraction of the HIV/AIDS is an additional stigma, another factor which further distances the stigmatized person from the dominant culture (Deacon, 2006). Stigma and stereotypes are highly associated with misinformation and lack of exposure to a group (Howarth, 2006). As exposure and knowledge increase, stigma and negative stereotypes should decrease. Research that examines stigma associated with HIV supports this inverse relationship (Searle & Antonio, 2007). From 1991 to 1999 a significant increase occurred in public knowledge about how HIV/AIDS is transmitted. Random telephone surveys of 1300 English speaking adults in the U.S. were conducted to examine stigma associated with HIV. Although researchers found a drop in support for punitive policies, such as quarantine and public disclosure of identities of PLWHA; with approximately 30% supporting such policies in 1991 to only 20% supporting them in 1999; stigma remains high in the general population. Twenty percent of those surveyed reported fear of PLWHA and 25% reported anger towards PLWHA in 1999 (Herek, Capitanio, & Widaman, 2002). This negative social judgment is felt by PLWHA. Perceived stigma is a significant source of stress for HIV-positive individuals. PLWHA report that family and friends treat them differently depending on how the disease was contracted. If the individual contacted HIV/AIDS through blood transfusion or rape there was less negativity and loss of social support (Sayles, Ryan, Silver, Sarkisian, & Cunningham, 2007). This supports theories that personal blame is important
in HIV-related stigma (Deacon, 2006). Perceived stigma affects the willingness of individuals to disclose their HIV-positive status to sexual partners and family members. HIV-positive participants acknowledge a desire to separate themselves from other stigmatized groups (Bond, Chase, & Aggleton, 2002). Heterosexual men with HIV describe being distressed by the general public’s assumption that they are gay (Dodds, 2006). On the other hand, HIV-positive women fear being presumed to be a drug user or sexually promiscuous (Sayles, Ryan, Silver, Sarkisian, & Cunningham, 2007). Participants acknowledged fear of social ridicule as a primary reason to not disclose their HIV-positive status.

Disclosure related stigma and associated stress are associated with risky sexual behavior in HIV-positive adults (Lewis, Chng, & Vosvick, 2010). Men who have sex with men and women (MSMW), commonly referred to as ‘on the down-low’, present a complex phenomena; originally more common among African American and Latino males. African American and Latino cultures are more collective than the European American culture and report higher levels of stigma toward gay and bisexual men (Ward, 2005). As a consequence men are less likely to identify as gay or bisexual due to perceived stigma. African Americans and Latino/as, respectively, represent 49% and 21% of HIV/AIDS cases in the U.S. Within African and Latin American communities men on the down-low are seen as a threat to their communities and blamed for the spread of HIV/AIDS (Aggleton, Parker, Maluwa, 2003; Dodd, 2006; Galvan, Davis, Banks, & Bing, 2008). African American and Latino men reported higher perceived stigma and more negative social consequences associated with disclosure or condom use (Mutchler et al., 2008). PLWHA also experience stress in the form of discrimination in housing,
healthcare, and other forms of social isolation (Bogart et al, 2007). Stigma is a source of significant stress for HIV-positive individuals; the physiological effects of stress pose some unique concerns for PLWHA.

**Physiology of stress**

Stress is negatively associated with positive health outcomes in a number of studies that examine chronic illness, including HIV/AIDS (Bogart et al, 2000). Chronic stress decreases immune function in healthy individuals. This is a particular concern in PLWHA because of already compromised immune systems (Alonzo & Reynolds, 1995). Research into the physiological effects of stress typically focuses on two interrelated systems, the autonomic nervous system (ANS), which involves cardiovascular activation and involuntary responses, and the hypothalamic-pituitary-adrenal (HPA) axis, which involves the release of cortisol and other hormones through sympathetic activation of the adrenal medulla (Ahrens et al, 2008). Activation of the autonomic and neuroendocrinological systems manages the body’s metabolic functions and facilitates the fight or flight response (Cacioppo et al, 1998), these systems will be discussed in more detail later.

In discussing the role of stress in HIV, it is important to briefly review the infection and proliferation of the virus in the body. Following infection the virus targets and binds to CD4+ cells, which are essential in the immune response. T-cells are involved in the lysis of infected cells and stimulate antibody production (Uchino, Smith, Holt-Lunstad, Campo, & Reblin, 2007). The CD4+ cell count of a healthy individual ranges from 500-1000 cells/mm3; however, to be diagnosed with AIDS an individual must have fewer than 200 cells/mm3 (Panel on Antiretroviral Guidelines for Adults and
Adolescents, 2011). As an individual’s CD4+ cell count decreases, they are more susceptible to opportunistic infections. Given the adverse effects of the virus on the immune system, researchers have sought to find connections between the HIV virus and cortisol.

Chronic stress is linked with increased risk or adverse outcomes for a number of conditions including cardiovascular disease (Rozanski, Blumenthal, & Kaplan, 1999), metabolic syndrome (Candola, Brenner and Marmot, 2006), autoimmune disease (Stojanovich & Marisavljevich, 2007), certain cancers and viral infections (Miller, Cohen, & Ritchey, 2007) including HIV (Vanable, Carey, Blair, & Littlewood, 2006). In examining the associations between stress and illness researchers focused on the neuroendocrine activation of the HPA axis (Miller, Chen & Zhou, 2007). Of the hormones secreted during the stress response, cortisol has been a primary focus of research (Uchino, Smith, Holt-Lunstad, Campo, & Reblin, 2007). Following the activation by a stressor, (1) the hypothalamus releases corticotrophin releasing hormone (CRH), which then signals (2) the pituitary to secrete adrenocorticotrophin hormone (ACTH) into the plasma, finally (3) ACTH stimulates the adrenal gland to release cortisol (Clow, 2004; Miller, Chen, & Zhou). Cortisol has adaptive and protective roles in acute stress response such as enhancing wound healing and decreasing inflammation; however prolonged and excessive exposure to cortisol due to chronic illness or chronic stress is believed to result in glucocorticoid resistance leading to decreased immune and anti-inflammatory actions (Miller, Cohen, & Ritchey).

Researchers interested in biological markers of stress have traditionally focused on cortisol but its use as a stress marker is somewhat controversial in a HIV population.
During the progression of HIV, an increase in proinflammatory cytokines occurs, which aids in cellular replication of the virus, this process can also lead to an increase in cortisol levels (Kumar et al, 2003; Robinson, Mathews, Witek-Janusek, 2006). Certain HAART medications also affect cortisol levels; one study found that patients who receive non-nucleoside reverse transcriptase inhibitors (NNRTI) had higher levels of cortisol than participants receiving other HAART medications and no antiviral treatment (Collazos, Mayo, Martinez, & Ibarra, 2002). Given these potential confounding factors associated with cortisol as a biological marker of stress in HIV-positive people, a need exists for an alternate biological marker. Heart Rate Variability (HRV) may be a potential biological marker of stress that can be used in place of cortisol (Zefferino et al, 2003); however, little research examines its usefulness in HIV populations.

**Heart Rate Variability in Physiological Research**

Understanding the role of HRV in the stress response begins in the mechanism of action of the autonomic nervous system (ANS) which modulates cardiovascular activity through the opposing actions of the sympathetic and parasympathetic branches (Sztajzel, 2004). Sympathetic activation results in increased rate and contractility of the heart, vasoconstriction, which results in increased blood pressure, pupil dilation, increased sweating, and release of epinephrine from the adrenal medulla (Kaltsas & Chrousos, 2007; Lovallo, 2005 p.46-50). The sympa-tho-adrenal response, commonly referred to as the fight or flight response, is a stress reaction which causes an imbalance in the body’s homeostatic functions. The parasympathetic nervous system is primarily involved in inhibition of sympathetic activity; this system maintains vagal tone and homeostasis (Sztajzel). While most measures of physiological stress focus on the sympathetic
activation, such as measuring skin conductance or blood pressure, heart rate variability is a measure of combined autonomic activity.

Heart rate variability (HRV) is a non-invasive measure of parasympathetic and sympathetic activation, which is used to assess the stress response (Rockliff, Gilbert, McEwan, Lightman, Glover, 2008; Sztajzel, 2004). Heart rate is measured over the course of the cardiac cycle (Figure 1) through use of an electrocardiograph (ECG). Two accepted methods of measuring HRV include 1) time domain, which measures changes in heart rate over fixed intervals; and 2) frequency domain, which measures changes in heart rate frequency through power spectral analysis (Sztajzel). Time domain measures the interval between R peaks (RR intervals) between adjacent QRS complexes during the cardiac cycle. According to the taskforce standards (1996), the time domain approach is preferred to the frequency approach for long-term measures (>18 hours). However, SDNN, a time domain approach, yields interpretable data when using standardized time intervals, such as 5 minute epochs or nominal 24 hour periods (Taskforce).

The most commonly used frequency approach to HRV is the nonparametric fast Fourier transformation (FFT) that measures RR intervals, which is then transformed into frequency bands (Taskforce). High frequency (HF) represents vagal tone, while low frequency (LF) is influenced by primarily by the parasympathetic nervous systems. The frequency approach is best suited for 2-5 minute intervals (Taskforce). While time and frequency domains are highly correlated, each offers advantages depending on the type of data. Spectral analysis is sometimes preferred because of (1) ease of interpretation of clinical data, (2) more accurate assessment of autonomic activity, and (3) accuracy in short intervals (<5 minutes; Sztajzel). However, the normalizing of data, by removing
artifact, affects the total power of LF and the VF because it inflates the LF and minimizes the HF.

HRV is used to measure stress and autonomic activity in both clinical and non-clinical populations (Cohen et al, 1997). Cacioppo et al (1999) measured the effects of a lab-based stress induction on HRV and cortisol levels of a sample of college students; they found increases in both cortisol levels and sympathetic reactivity following the acute stressor. The researcher repeated the study in a sample of elderly women and found similar results; however, among elderly women, which differed significantly from the college aged sample in terms of health concerns, there was greater autonomic dysregulation. Cohen, Kotler, Matar, & Kaplan (2000), measured changes in HRV in a sample of patients with Posttraumatic Stress Disorder (PTSD) involved in a 10 week drug trail, and correlated these with changes in scores on mood measures. Individuals with PTSD experienced a state of hyper-arousal and chronic stress. Untreated patients evidenced significantly lower HRV and higher reports of depression and anxiety than treated patients and healthy controls, which is consistent with the sympathetic overactivity of a chronic stress state. Similar results are found in patients with other mental health issues such as anxiety disorder, major depressive disorder, and schizophrenia (Ahrens et al, 2008; Musselman, Evans, & Nemeroff, 1998; Mujica-Parodi, Yeragani, & Malaspina 2005).

HRV is also used as a measure of stress response in medical populations. HRV is of particular interest in individuals with cardiovascular disease. Low HRV and sympathetic reactivity associated with chronic stress are risk factors for cardiovascular disease (Schwartz et al, 2003). Giese-Davis et al (2006) measured autonomic and HPA
activation in women with metastatic breast cancer, women with higher levels of depression had lower parasympathetic involvement than women with lower levels of depression. This study demonstrates the importance of parasympathetic regulation in the stress response. Studies examining occupational stress also find significant correlations with HRV (Karasek, Collins, Clays, Bortkiewicz, & Ferrario, 2010; Zefferino et al, 2003).

**Stress induction.** Several studies use laboratory-based stress induction to assess stress response. Research shows that laboratory exercises can be used to illicit negative and positive mood inductions (Etzel, Johnsen, Dickerson, Tranel, Adolphs, 2006). Rockliffe, Gilbert, McEwan, Lightman, & Glover (2008) measured changes in HRV during a compassion-focused and control imagery session. The researchers collected continuous ECG recording while participants completed informed consent, self-report, and multiple imagery sessions. While the researchers found changes in HRV, the direction was not as expected. Several problems existed, which may have affected the results of this study: (1) no true baseline measure; (2) no recovery period between mood states; and (3) use of the time domain, standard deviation between normal RR interval (SDNN), approach complicates interpretation of short-term data, or data collected in period less than a five minutes.

While visualization based imagery is commonly used in relaxation training, guided imagery can also induce negative emotions such as fear, anger and sadness (Mayer, Allen, & Beauregard, 1995). A study of Indian students compared changes in HRV, blood pressure, and skin conductance between students in three groups, threat/no-threat, no-threat/threat, and threat/threat; groups 1 and 3 had significant sympathetic
activation to the threat condition. The Indian study used a multiple baseline design which
allowed participants to recovery between inductions and a frequency approach to
measure HRV. In addition, HRV was significantly correlated with additional measures
of sympathetic activation, blood pressure and skin conductance (Tharion, Parthasarthy, &
Neelakantan, 2009).

Cold Pressor Task. Researchers are also interested in the effects of physical
distress on autonomic functioning. The cold pressor task (CPT) is commonly used to
assess this response. The most common CPT approach involves cold water submersion
of a hand or foot, this invokes a pain response and sympathetic activation (Wirch, Wolfe,
Weissgerber, & Davies, 2006). In comparison to the traditional approach, the forehead
CPT, which mimics the dive reflex, induces a primarily parasympathetic response (Dural
the forehead CPT and a public speaking task among a sample of college students.
Physiological measures during the forehead CPT show a greater increase in systolic
blood pressure and HF.

Biobehavioral Model of Stress

Several studies demonstrate a relationship between psychological, physical, and
perceived stress and immune response in individuals with chronic medical concerns
(Anderson, Kiecolt-Glaser, & Glaser, 1994; Cohen, Tyrell, & Smith, 1991). The
majority of theories on physiological stress focus on autonomic activation and the HPA
axis, though few integrate biological and psychological factors. Anderson, Kiecolt-
Glaser, & Glaser proposed a model for examining the role of psychological and
behavioral factors on disease course in patients diagnosed with cancer (Figure 2). These
researchers assert that chronic illness and associated life changes represent a chronic stressor that effect behavior, in the form of treatment compliance, or adherence, and other health behaviors, and immune response, via physiological mechanisms. Further, the researchers propose that stress only indirectly influences disease course through its effects on behavior and immune response.

The biobehavioral model of illness incorporates concepts of appraisal, coping, and social support from existing literature on psychological stress response. While the disease state is viewed as a form of stress, the researchers also propose that perception of stress, or stress appraisal, is a critical factor. In this model, lifestyle factors such as social support are integrally linked with perception of stress (Anderson, Kiecolt-Glaser, & Glaser, 1994). Multiple studies demonstrate a relationship between lack of social support and immune function (Cohen, Tyrell, & Smith, 1991; Herbert & Cohen 1993). In addition, Cohen & Wills (1985) hypothesized that social support could serve as a stress buffer by influencing an individual’s perception of stress and insulating an individual from the negative effects of stress. Supportive of this theory, Robbins et al. (2003) found that positive family support is associated with higher immune functioning, as measured by CD4 cell count, in HIV-positive women. However, not all social support provides relief from stress; in fact negative social support may be an additional source of stress. Some types of support received by HIV-positive individuals result in increased stress and negative health outcomes (Vosvick et al, 2004). Therefore, it is important to examine not only the availability of support but an individual’s perception of their existing support. While this biobehavioral model was initially proposed for cancer, it has implications for HIV. PLWHA experience psychological distress due to HIV related
stigma. Further, stigma is associated with poor medication adherence, increased 
substance use, and risky sexual behavior in multiple studies (Hatzenbuehler, Cleirigh, & 
Mayer, 2011; Lewis, Chng, & Vosvick, 2010; Rintamaki, Davis, Skripkauskas, Bennett 
& Wolf, 2006; Rao, Kekwaletswe, Hosek, Martinez, & Rodriguez, 2007). Stigma and 
associated maladaptive coping behaviors represent the first two links in the biobehavioral 
model; the next link is the role of stress on physiology and immune response in PLWHA, 
which can be measured through autonomic activation.

**Purpose of the Study**

Researchers interested in stress reaction of PLWHA are increasingly interested in 
identifying a biological marker for stress in this population. Many researchers have 
examined cortisol as a biomarker; however, it is somewhat controversial in a HIV 
population. Research suggests that HIV causes individuals to secrete excess amounts of 
cortisol, which complicates its use as a stress indicator in PLWHA (Robinson, Mathews, 
Witek-Janusek, 2006). Heart Rate Variability (HRV) may be a potential biological 
marker of stress that can be used in place of cortisol (Zefferino, 2003); however, little 
research examines its usefulness in HIV populations. Our primary goal in this study is to 
validate HRV as a biological marker of stress in HIV-positive adults. By examining 
changes in heart rate during both physical and psychological stress, we illuminate 
differences in sympathetic and parasympathetic activity that facilitate immunological 
effects of the HPA axis (Cacioppo et al, 1998). In addition, this study seeks to assess the 
association between perceived stress and physiological reactivity to presented stimuli in 
an HIV-positive population. In discussing perceived stress Cohen, Kamarick, & 
Marmelstein (1983), suggested its use as a measure of an individual’s stress appraisal.
Finally, this study seeks to assess differences in level of social support among individuals with high and low levels of stigma.

**Hypotheses**

This study adapts the Anderson, Kiecolt-Glaser, & Glaser (1994) biobehavioral model of illness to a sample of HIV-positive individuals. Their complex model incorporates both physiological and psychological stressors as well as health behaviors and social support. In light of aforementioned goals, this study is designed to test several hypotheses.

**Hypothesis 1:** HRV is correlated with other measures of autonomic reactivity (blood pressure and heart rate). This hypothesis is the foundation for our study. Existing literature demonstrates the effectiveness of HRV as a biomarker for stress when compared with other physiological indicators such as blood pressure, and skin conductance. If our initial hypothesis is supported, we will be able to further examine the relationship between HRV and stigma. The theoretical biobehavioral model suggests that differences in appraisal will affect stress response.

**Hypothesis 2:** We hypothesize that HRV will be negatively associated with perceived stress. This hypothesis tests the relationship between psychological distress and physiological response.

**Hypothesis 3:** Participants with high levels of stigma exhibit lower HRV than participants with low levels of stigma. Given existing research on autonomic reactivity, we expect higher levels of sympathetic reactivity and autonomic dysfunction among individuals who perceive themselves as stigmatized. Having examined the relationship
between stigma and our indicator of stress, we will examine stigma and perceived stress in terms of the biobehavioral model.

**Hypothesis 4:** Participants with high levels of stigma report higher perceived stress than participants with low levels of stigma; this tests the relationship between psychological distress and appraisal. Our next hypothesis continues the validation of the biobehavioral model, focusing on the role of social support.

**Hypothesis 5:** Social support moderates the relationship between stigma and stress. This hypothesis tests the theory that social support serves as a stress buffer.
Chapter 2

Methods

We received approval from the Institutional Review Board of the University of North Texas prior to beginning data collection for this proposed study. The study was conducted in two sessions; we incorporated a cross-sectional, correlation design for survey data. Phase II of the study also included a repeated measures, multiple baseline design for physiological measurements. We employed snowball and convenience sample techniques to recruit HIV-positive individuals from AIDS Service Organizations in the Dallas/ Fort Worth Metroplex. In 2010, there were over 20,000 PLWHA in the counties which comprise the Metroplex region. Additionally, 1,754 new cases of HIV were reported in this region in 2009 (TDHHS, 2010). Potential participants were screened either in-person or over the phone to ensure they met eligibility requirements prior to being scheduled for participation. Inclusion criteria included: 1) HIV seropositive status; 2) at least 18 years of age; 3) sufficient fluency in English to complete a survey protocol; and 4) willingness to sign an informed consent form. Exclusion criteria included: 1) apparent substance intoxication; 2) any indication of potential for self-harm or harm to others; 3) reported autonomic or cardiac dysfunction; 4) any allergies to adhesives; and 5) those with pacemakers. The student researchers explained the study procedures, as outlined in the IRB approved informed consent document; both the researcher and participant retained a copy of this document. Participants in Phase I received $10 in incentives; those who participated in Phase II received additional incentives of $25.
Participants

Participants (N=120) completed a battery of self-report measures designed to gather information on social and emotional functioning. The average age of our gender balanced sample was 46 years (SD=8 years) and the average education level was 11.87 years (SD =2.59). The majority of our sample was African American (68.9%), while European American only accounted for 25.2% and Latino/as accounted for 3.3% of our sample. The remainder of our sample included two Native American individuals (1.7%), one Middle Eastern individual (.8%) and one Asian American individual (.8%). The majority of our sample was heterosexual (50.8%) while 31.7% was gay or lesbian, 16.7% was bisexual, and .8% was asexual. The majority of our sample was unemployed (91.7%) and reported an income of less than $15,000 (76.5%). After analysis of the data from phase I, a stratified sample of 54 individuals who represented both a high stigma and low stigma group were invited to participate in Phase II. The majority of our participants were female (52% ) was African American (72%). European American accounted for 26% of our study and the remaining participant was Native American (2%).

Measures

Demographics and HIV Questionnaire. Participants completed a demographic questionnaire, which gathered relevant information from the participants such as age, gender, sexual orientation, number of children, and socioeconomic information. Participants also completed a HIV questionnaire, which gathered relevant HIV-related information such as diagnosis date, recent CD4 cell count, and use of HAART
medications. In addition, participants provided a list of prescription and non-prescription medications.

**Perceived Stress Scale.** We administered the Perceived Stress Scale (PSS) as a measure of participant stress (Cohen, Kamarck, & Mermelstein, 1983). The PSS is a self-report measure of an individuals’ appraisal of personal stressors. This measure consists of 10 likert-type items with possible responses ranging from 0 (never) to 4 (very often). A sample item from this measure is “In the last month, how often have you felt nervous and stressed?” Higher scores on the PSS indicate higher levels of perceived stress. The PSS has a reported internal consistency reliability of .78. The reliability of this measure was tested within three non-clinical populations; the Cronbach’s alphas ranged from .84 to .86 in these samples. The construct validity of this measure was established through comparisons with other stress and depression inventories (Cohen, Kamarck, & Mermelstein).

**HIV Stigma Scale.** We also administered the HIV Stigma Scale (HSS), which assessed an individual’s perception of stigma (Berger, Ferrens, & Lashley, 2001). The measure consists of 40 likert-type items with potential responses ranging from 1 (strongly disagree) to 4 (strongly agree). A sample item from this measure is “Most people think that a person with HIV is disgusting.” The HSS consists of several subscales including personalized stigma, disclosure, negative self-image, and public attitudes. However, for the purpose of this study we choose to examine overall stigma. A high score on the HSS indicates high levels of HIV-related stigma. This measure has established temporal stability with test-retest correlation of .92 and established internal consistency with an
alpha of .96. The construct validity of this measure was established through comparisons with stress and health inventories (Berger, Ferrens, & Lashley).

**AIDS Clinical Trials Group (ACTG) Adherence Questionnaire.** The AIDS Clinical Trials Group (ACTG) Adherence Questionnaire (ACTG-AQ) is a comprehensive measure of medication adherence developed for use with the PLWHA. This measure consists of questions addressing medications as well as a 20-item symptom index (Chesney et al, 2000). Additionally, the ACTG-AQ consists of the adherence scale, a medication list, missed dose list, and scale of common barriers to adherence. This measure also has questions designed to assess the complexity of a medication regime. A sample question from this measure is “During the past four days how many times have you missed one dose of your medication.” The questions on the adherence scale have Cronbach’s alphas ranging from .81-.84. Additionally, the researchers conducted exploratory analyses comparing correlates of adherence to establish construct validity (Chesney et al; Reynolds et al 2007).

**The Center for Epidemiological Studies Depression Scale (CES-D).** The CES-D is a 20-item self-report scale designed to measure current levels of depressive symptomatology (Radloff, 1977). A cut-off score of 16 indicates probable depression and 23 indicates significant depression. It is composed of 20 items on a 4-point likert-type scale anchored at 1 = rarely, none of the time to 4 = most of the time. A sample item from this measure is “I felt that I could not shake off the blues even with help from my family or friends.” A high score on the CES-D indicates a high level of depression. It has excellent reported discriminant and concurrent validity and has demonstrated a high
level of internal consistency in both general ($r = .85$) and patient ($r = .90$) populations (Radloff).

**Interpersonal Support Evaluation List - short version.** The ISEL-S is a measure of social support. The measure examined two types of social support; emotional support, which is more abstract such as feeling loved, and instrumental support, which is more tangible and involves actual availability of assistance (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). It consists of 12 items on a 4-point likert type scale with possible responses range from 1 (definitely false) to 4 (definitely true). A sample item from this measure is “There is someone who takes pride in my accomplishments.” A high score on the ISEL-S indicates greater social support. The published reliabilities for multiple health based samples show Cronbach’s alphas ranging from .80 to .90 (Cohen, Mermelstein, Kamarck, & Hoberman).

**Physiological Measurement.** Thought Technology’s Procomp Infiniti hardware and Biograph Infiniti software (Version 4.0) were used to collect EKG data for analysis of HRV. The Infiniti used a 3 electrode signal to form the triangulation needed for accurate EKG readings (see Figure 4 for diagram of sensor connects). HRV data is collected using both frequency and time domain approaches. The frequency measures include the FFT and LF/ HF ratio. The LF represents parasympathetic involvement while the VF represents sympathetic involvement. The ratio is a measure of the balance between sympathetic and parasympathetic involvement (Thought Technology, 2010). The system calculates the inter-beat interval (IBI) which measures the interval between R waves in milliseconds; this measurement is equivalent to time domain approach examining standard deviation of r-spike to r-spike interval (SDRR; see Figure 5).
Infiniti software calculates the time between consecutive beats, or the IBI from the EKG data using propriety algorithms. From a series of such IBI values, a number of mathematical processes can be applied to extract the standard metrics used for HRV biofeedback. The IBI, therefore, represents the standard deviation of the time, in milliseconds, between R spikes. The Infiniti also has a 3 lead Myoscan -Flex sensor which is a surface electromyograph used to detect and amplify the electrical impulses produced during muscle contraction; this data can be used for separate data analysis and is incorporated into an algorithm to minimize movement related artifacts. The Infiniti uses a multi-channel system for collecting data. Participant’s data was recorded and stored in sessions. Following each session, the data was examined to identify artifacts from muscle movement or electronic interference. Using the Infiniti software, the data was normalized by averaging the consecutive pairs of beats following any abnormally large or small values. This method is preferred to strict exclusion because it avoids causing gaps in the data, allowing the data is treated as continuous (Thought Technology). The resulting IBI is a measure of the standard deviation of the normal to normal interval (SDNN). Finally, the sessions were divided into five minute epochs. IBI is less vulnerable to the effects of normalizing data; therefore we chose this method for our data. Additionally, IBI provides a more comprehensive measure of power than the frequency approach. Blood pressure data is recorded using the Omron HEM-670IT, a programmable one touch wrist blood pressure device; recordings were time stamped then stored using proprietary software (Omron, 2009).
Procedure

We conducted an *a priori* power analysis using G-power version 3.1 to identify the appropriate sample size for the study. Power analysis was conducted using criteria for the planned analysis of repeated measures MANOVA. Olson (1976) suggests using Pillai-Bartlett V as a measure of effect size for multivariate designs; we chose a value of .25 as our desired effect size for an F test. Additionally, we used .80 as our goal for power as suggested by social science researchers. The results of this analysis indicated a sample size of 34 individuals would be needed to reach our desired power level. The sample was also stratified through a screening protocol using the stigma scale in such a way that 50% of the participants were those who report high levels of stigma and 50% who report low levels of stigma.

Psychosocial data was collected using the Questionnaire Delivery System (QDS), a computer-based method of administering questionnaires. Physiological data was collected using the Biograph Infiniti software and The Procomp Infiniti hardware. In Phase I, the baseline survey protocol included use of published measures with strong psychometrics to assess HIV-related stigma (alpha = .96; Berger, Ferrans, & Lashley, 2001), perceived stress (alpha = .84-.86; Cohen, Kamarck, Mermelstein, 1983), adherence (alpha=.81-.84; Chesney et al, 2000), and a standard demographic questionnaire. Participants also completed an event recall questionnaire which was used for their guided imagery session. When scheduled for the following session, participants were asked to refrain from use of stimulants including caffeine on the day of the scheduled session. Upon completion of Phase I, survey data from QDS was exported to
PASW version 18. The HIV-related stigma score was used to compute cut scores for inclusion in Phase II.

During Phase II, we collected additional self-report data. Participants completed a second survey protocol that assessed depression (CESD; alpha = .84) and social support (alpha=.80-.90; Cohen, Mermelstein, Kamarck, & Hoberman, 1985). Baseline collection of physiological data including heart rate variability, blood pressure, and skin conductance began after a five minute rest period (Taskforce, 1996). A three minute forehead cold pressor task was included to examine the effects of a physical stressor on autonomic reactivity. Relative to other CPT approaches, the forehead cold pressor evokes a parasympathetic reflex and is often used to examine individual differences in HRV (parasympathetic) functioning. The stigma induction that required them to recall a personal experience of stigma related to their HIV began five minutes after the forehead cold pressor task (standard recovery time). Trained graduate researchers from UNT’s Center for Psychosocial Health Research conducted the guided imagery session (7 min) using information obtained during Phase I. Prior research demonstrated that mood induction can successfully produce negative affect and significant increases in cardiovascular response (Dockrey & Steptoe, 2010). This task was used to detect changes in autonomic activity in response to a psychological stressor. We continued recording physiological data during the final recovery period (5 min). Upon termination of the session, participants were debriefed and received a list of mental health services to assist in the event of distress.
Data Analysis

Psychosocial and physiological data were exported from QDS, Infiniti, and Excel to PASW (Version 18) and HLM (version 7) for statistical analysis. Physiological data was manually reviewed and analyzed for artifacts, if found, the artifacts were normalized. The physiological data was then divided into 5 minute epochs, before being exported to the statistical software. During the preliminary analysis, we examined demographic information (age, race, and gender), medical variables (symptom load and CD4 count), psychological factors (stigma and perceived stress), and physiological variable (HRV and blood pressure) by calculating descriptive statistics. We planned bivariate correlations to test our hypothesis regarding correlation of HRV and other measures of stress (Hypothesis 1). Independent Sample $t$ Test analyses were used to examine the relationships between several variables including: ethnicity, gender, income, sexual orientation, age, symptom load, CD4 count, social support, adherence, stigma, and stress. We conducted a repeated measure MANOVA to analyze differences in high stigma and low stigma participants on measures of HRV and perceived stress over course of the study (Hypotheses 2 and 3). Further, a linear regression analysis as described by Baron and Kenny (1986) was conducted to examine whether social support moderates the relationship between stigma and stress (Hypotheses 4 and 5).

Multilevel growth curve modeling was used to measure changes in physiological data (IBI, LF/VF, and blood pressure) over time. Growth curve modeling is a powerful statistical technique which is useful in measuring changes over time, the goal of this approach is model fit (Radstaak, Geurts, Brosscho, Cillessen & Kompier, 2012). In growth curve modeling, the outcome variable, measures of time, and two types of
predictors, time-varying and time-invariant, are used to form two models. The Level 1 model is based on a time-dependent outcome and at least one time-varying predictor. The Level 2 model uses Level 1 parameters as the outcome variable for a new model, which can be used to compare groups. Preliminary analyses of the growth curve model assess variability using two models, the unconditional means model (UMM), which tests average variability in the outcome, and the unconditional growth model (UGM), which tests variability over time. The UGM is based on the Level 1 model without additional predictors and the UMM uses the Level 1 model, without an intercept, and the Level 2 model. Hierarchical Linear Modeling 7 was used to conduct growth curve analyses.
Chapter 3

Results

Initial Data Analysis

We began the data analysis by examining missing data. Of the initial 120 participants, one was excluded from the analyses due to missing critical data. As a result of having only one case, we were unable to identify patterns in the missing data. The participant was unable to complete the survey, and was found to be unreachable on subsequent contact attempts. Of the 119 participants who completed the study, none were excluded from the analyses for missing data.

During the initial data analysis, we reviewed the reliability of the measures included in our study. The HSS had a calculated alpha of .95 and the CES-D had a calculated alpha of .90. The PSS (α=.79) and ISEL (α=.95) also had high levels of internal consistency for our sample. Participants reported a moderate level of stigma ($M=92.89$, $SD=19.94$) and perceived stress was 25.10 ($SD=7.21$). Participants also report significant psychological distress (CESD, $M=20.09$, $SD=11.48$). Descriptive statistics are presented in Tables 1 and 2.

Bivariate Analyses

Pearson’s product moment correlation coefficients were computed for all variables. The correlations for phase I are presented in Table 3. The Bivariate correlations for key phase II variables are presented in Table 4. We found a significant correlation between stress and stigma ($r=.34$, $p<.001$), depression ($r=.66$, $p<.001$), social support ($r=-.32$, $p<.001$), and the interbeat interval ($r=-.56$, $p<.001$). We also found
significant correlations between HRV and blood pressure ($r = -0.34$, $p < .05$) during a psychological stressors.

**Phase I.** We conducted Independent Sample t-tests to examine relationship between gender, ethnicity, and stigma level and the relevant study variables. The results indicated that gender was not significantly related to any of the study variables. Results examining differences between ethnic groups indicated that African Americans ($M = 90.19$, $SD = 19.33$) had significantly lower levels of stigma than other ethnicities ($M = 98.86$, $SD = 20.24$), $t(117) = -2.23$, $SEM = 3.88$, $p < .05$. Additionally, African Americans reported higher levels of social support ($M=36.79$, $SD=6.07$) than others ethnic groups ($M=32.56$, $SD=6.27$), $t(117) = 3.19$, $SEM = 1.34$, $p < .01$.

**Phase II.** Participants in the second phase of our study were recruited based on their scores on the HIV Stigma Scale. After completing phase I, we analyzed the results of this measure and computed cut scores. Our sample of 120 was subdivided into high and low stigma groups based on the cut scores. Fifty-four participants completed phase II of our study. We conducted Independent sample t Tests to examine relationships between demographic variables and study variables of the phase 2 participants. African Americans experienced higher HRV over the session ($M=797.27$, $SD=144.41$) than non-African Americans ($M=639.38$, $SD=156.77$), $t(52)= -2.58$, $SEM =52.90$, $p < .01$. Participants who experienced high levels of stigma experienced lower HRV in during a physical stressor ($M=694.07$, $SD=211.10$), $t(52)= -2.58$, $SEM =43.09$, $p < .05$ and following a psychological stressor ($M=642.82$, $SD=144.65$), $t(52)= -6.104$, $SEM =28.36$, $p < .001$. Additionally, the high stigma group reported greater levels of perceived stress ($M=26.52$, $SD=6.28$), $t(52)= -2.614$, $SEM =1.02$, $p < .01$. 

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Multivariate Analyses

ANOVA. We conducted an analysis of variance to examine the significance of stigma group and ethnicity on perceived stress. A two-way analysis of variance yielded a main effect for the stigma group, $F(1,118) = 12.71, p < .001$, such that participants with higher stigma reported higher stress ($M = 27.28, SD = 6.13$) than low stigma participants ($M = 22.81, SD = 7.59$). There were also significant main effects for ethnicity ($F(1, 118) = 5.85, p > .05$) with African Americans reporting greater perceived stress ($M = 25.50, SD = 6.91$) than other participants ($M = 24.21, SD = 7.86$). However, the interaction effect was not significant.

MANOVA. We chose to conduct a between subjects multivariate analysis of variance to examine the role of gender, ethnicity, and stigma level on perceived stress, social support, and depression. The MANOVA was preferred because it allowed us to control for correlations between the dependent variables. The three independent variables each had two levels and we included three dependent variables (See Table 5). There were significant differences for stigma group $Wilks' \lambda = .86, F(3, 109) = 5.84, p < .001$, and ethnicity $Wilks' \lambda = .89, F(3, 109) = 4.71, p < .01$. There were no main effects for gender. However, we found significant interaction between gender and stigma group $Wilks' \lambda = .90, F(3, 109) = 4.26, p < .01$; such that the effects of gender were greater for the high stigma group. The assumption of homogeneity of covariance matrices and normality were met.
Regression for Stress and Stigma. We conducted a hierarchical linear regression analysis to examine the relationship between stigma and stress in our total sample. Table 9 provides the results of this regression equation. We found that our model accounted for 18% of the variance in perceived stress (Adjusted $R^2=.18$, $F (6, 112) = 5.20$, $p<.001$). Both social support ($\beta=-.30$, $t=-3.26$, $p<.001$) and stigma ($\beta=.27$, $t=3.00$, $p<.001$) were significantly related to perceived stress. Additionally, African American ethnicity was also significantly related to perceived stress ($\beta=.21$, $t=2.33$, $p<.05$). To test for multicollinearity, we examined Variance Inflation Ranges (VIFs) and Tolerances of all variables included in the model. The VIFs and Tolerances ranged from 1.25-1.87 and .87-.96, respectively, indicating that multicollinearity was not a problem. We tested the assumptions of normality, homoscedasticity, and linearity of residuals for each regression equation. We found that no assumptions were violated. The complete regression model can be found in Table 6. The assumptions for multiple regression analyses were examined and deemed acceptable for analyses.

Based on the results of our initial regression analysis, we conducted a hierarchical linear regression analysis to examine whether social support moderates the relationship between stigma and stress. Before conducting our regression to test for moderation, we centered stigma and social support. Figure 7 demonstrates the interaction between these variables. As with the previous model, we found that stigma, ethnicity, and social support were significant predictors of perceived stress. While both stigma and social support had significant main effects there was not a significant interaction between the effects of the social support and stigma on perceived stress (Adjusted $R^2=.16$, $F (7,111) =4.41$, $p<.001$, $\beta=.003$, $t=.30$, $p=.97$, $ns$).
Regression for Blood Pressure and Heart Rate. We conducted a hierarchical linear regression to examine the relationship between changes in HRV during a guided imagery based stressor and other measures of stress (blood pressure and heart rate) during the corresponding time period. We controlled for factors which might affect cardiovascular health such as age and substance use by entering these variables into a separate block of our regression model. We averaged systolic and diastolic blood pressure and mean heart rate during the stress induction periods. We found that systolic blood pressure and heart rate under the stress condition were predictive of HRV (Adjusted R²=.29, F (5,46) =4.07, p<.01, See Table 7 for statistics).

Repeated Measures MANOVA. We conducted a repeated measure multivariate analysis of variance with stigma group as the within-subject variable and HRV, as measured by the IBI during 4 five-minute epochs representing the IBI during the baseline, CPT, stress induction, and recovery period, as the criterion. Results of the repeated measures MANOVA indicated that the stigma group was significant in regard to changes in participants’ HRV, Wilks’ λ = .50, F (1, 51) = 11.63, p < .001. This suggests that participants in the high stigma group exhibited less change in HRV over the course of the stress induction session. We continued by examining the changes in heart rate variability through hierarchical linear modeling.

Growth Curve Model. Finally, we conducted a two-level hierarchical linear growth curve model to examine changes in HRV and the fit of the biobehavioral model. The level one model examined the magnitude of changes during the stress induction session. The IBI was used as an outcome. We regressed linear and quadratic effects during the stress induction. At level 2, we added stigma and stress. In contrast to the
repeated measures MANOVA, this method shows growth over time by fitting the slope at the individual level rather than at the group level. Table 8 presents the results of the GCM. We found that both linear and quadratic time trends were significant in our model. Overall, participants experienced significant increases in HRV over the course of the session ($\gamma_{10} = .49$). Additionally, individuals with high stigma experienced lower magnitude changes in HRV ($\gamma_{20} = -.48$) during the session. Stress level was not predictive of individual magnitude in HRV during the session.
Chapter 4
Discussion

Stress is a complex issue that has been shown to adversely affect an individual’s health and emotional functioning. In psychological research, we commonly rely on self-report measures to assess an individual’s stress level. Given the inherent bias in self-report data, it is important to identify other markers for stress that can be used for both research and intervention. This study was designed to assess the use of HRV as a biomarker for stress in HIV-positive adults. We examined heart rate variability because this measure has not been shown to be affected by HAART medications. While cortisol has more commonly been evaluated, its use has become controversial due to concerns regarding the effects of medications commonly used to treat HIV/AIDS on this measure (Robinson, Mathews, Witek-Janusek, 2006). Beyond establishing the use of HRV, we examined the association cognitive perceptions of stress and measurable physiological reactivity to a stigma-related stressor. Another important factor in this study was the relationship between stigma and stress in our sample.

Hypothesis 1. We hypothesized that HRV is correlated with other physiological measures of autonomic reactivity. Examinations of bivariate correlations between HRV and blood pressure, and HRV and heart rate during the session were significant. Blood pressure and heart rate are common measures of stress. In addition, we found that when controlling for age and substance use both blood pressure and heart rate were predictive of HRV. Our findings are consistent with international studies which examined the relationship between measures of stress and HRV in students, individuals with PTSD and other medical populations (Mayer, Allen, & Beauregard, 1995; Tharion, Parthasarthy, &
Neelakantan, 2009). Given these findings, our initial hypothesis was supported and we were able to assess the biobehavioral model in our sample. Our next step was to examine the relationship between HRV and perceived stress.

**Hypotheses 2:** We hypothesized that HRV would be negatively associated with stress in HIV-positive adults. We found that perceived stress was correlated with HRV in our population of HIV-positive adults. Additionally, we found, when controlling for age and ethnicity, high levels of perceived stress were predictive of lowered HRV. The findings are consistent with research on heart rate variability in other populations. Further, these findings provided support for our use of perceived stress as a measure of overall stress in our sample of HIV-positive adults. The study findings support our hypothesized relationship between psychological distress and physiological response. Further, our findings also have implications for the use of the biobehavioral model which suggests that stress appraisal is related to physiological stress response (Anderson, Kiecolt-Glaser, & Glaser, 1994). We continued to examine this model by looking at stress and appraisal.

**The Biobehavioral Model.** We were also interested in the group differences in factors related to stress such as depression and social support. Researchers proposed that the life changes associated with chronic illness represent a chronic stressor that effect behavior, in the form of treatment compliance, or adherence, and other health behaviors, and immune response, via physiological mechanisms (Anderson, Kiecolt-Glaser, & Glaser, 1994). Further, the researchers propose that stress indirectly influences disease course through its effects on behavior and immune response. Within the biobehavioral model depression and social support are important factors relating to stress response and
Participants with high stigma experienced more stress and depression and less social support than participants with low stigma. This does not provide insight into the direction of the relationship. It is not clear whether individuals with greater social support experience less HIV-related stigma or if the social support provides a buffer for stress.

Social support is generally proposed as a stress buffer but other research suggests that the type of social support is important. Negative social support may increase an individual’s level of stress or depression. Overall, our participants reported lower levels of social support than other medical populations (Cohen, Mermelstein, Kamarck, & Hoferman, 1985). We were also interested in group differences based on gender and ethnicity. African Americans reported high stigma and depression; however, contrary to expectation based on total sample, they also reported higher social support. When examining women in the high stigma group reported more social support than men in the high stigma group while low stigma women experienced less social support than men.

Stigma is a social construct which affects not only PLWHA but their families and friends; more research is needed to understand the complex relationship between stigma and stress.

**Hypothesis 3.** Appraisal is an important factor in stress response. Using the biobehavioral model, we hypothesized that participants with high levels of stigma would report higher perceived stress than participants with low levels of stigma. By examining group differences in perceived stress, we found that high stigma participants reported greater perceived stress; this supports our hypothesis. An individual’s appraisal of stigma
is associated with their level of stress. This finding has important implications for treatment design in clinical settings.

Hypothesis 4. Previous research examining work place stress found that appraisal was predictive of HRV (Zefferino et al, 2003). Therefore we chose to examine group differences in HRV over the course of the stress induction. Our findings supported the hypothesis that participants with high levels of stigma exhibit lower HRV. Individuals with stigmatized self-appraisal took longer to recover following exposure to both physical and psychological stressors. Research has consistently demonstrated a relationship between stress and health. These findings also suggest that cognitive factors such as appraisal of stigma have a role in health outcomes.

While it is clear that both stigma and social support have significant roles in perceived stress, we did not find any moderation effects. However, we did find that participants with lower levels of stigma reported higher social support, in general. Additionally, we found significant effects for ethnicity, with African Americans reporting higher levels of social support. Existing research points to the complex relationship between social support and emotional functioning. The presumption that social support serves as a stress buffer focuses on positive forms of social support. However, other research has shown that negative social support may adversely affect an individual’s stress level. While age is often a concern when assessing physiological reactions, our findings indicate that age was not correlated with any changes in stress response. The effects of age may have been suppressed due to the average age of our participants.

Limitations
We sought to recruit a diverse sample of HIV-positive adults in a major metropolitan area of the US. Certain data in this study were obtained through self-report, which carry inherent bias such as participant memory and appraisal. However, we selected measures with demonstrated reliability and validity. Additionally, physiological data collected supports the findings of self-reported data and provides unbiased results. The initial phase of this study was designed to recruit a diverse sample of HIV-positive adults in the Dallas Forth-Worth Metroplex. As a result we sought to recruit participants from various setting including AIDS Service organization, shelters, local events targeting PLWHA, and electronic media such as Facebook and Craigslist. Due to language requirements for study inclusion, we have a limited number of Latino/as. Geographic limitations may impact the generalizability of our findings; however the Metroplex is a highly diverse population. According to recent statistics from the CDC, Texas was ranked 4th in the nation by number of cumulative HIV cases (CDC, 2012). While the majority of our participants live below the poverty line and our findings may not generalize to individuals of higher social and economic status; this economic imbalance is consistent with the population of PLWHA. Our small sample size is another limitation of this study. A major strength of our study is the inclusion of a large sample of HIV-positive women. Many studies examining PLWHA examine focus on men who have sex with men (MSM); however women, particularly black women, represent a growing population of PLWHA.

**Future Directions and Implications**

Traditionally, researchers interested in assessing biomarkers of stress in HIV-positive adults have relied on cortisol. However, existing research suggests that HIV and
HAART medications may impact cortisol level. Currently, no evidence exist that HRV is affected by medication or disease state. This study provides support for the use of HRV as a measure of stress in this population. HRV is a non-invasive measure which is another advantage for researchers. In addition to the benefits for researchers, our findings also have clinical implications.

This study was designed to assess the use of HRV as an indicator for stress in HIV-positive adults. HRV is a unique measure of stress because it can be used as a measure of stress and it can be adapted for interventions targeting stress reduction. HRV is most commonly used in biofeedback. HRV based biofeedback has been used for stress and relaxation training in several patient populations. HRV has been used in patients with hypertension, cardiovascular disease, and asthma (Giese-Davis et al, 2006). Biofeedback techniques are used to help individuals become more aware of their stress reactions and to help individuals learn to control their reaction to stressful events (Lande et al, 2010).

Additionally, our findings highlight the importance of developing treatment methods targeting appraisal. Cognitive behavioral therapies often target individual’s beliefs about experiences. Research has shown that CBT can be effective at improving an individual’s HRV (Carney, 2000). Additionally, combining biofeedback with CBT has been shown to decrease symptoms of PTSD over time (Lande et al, 2010).

Social support has a complex role in the lives of PLWHA. Our findings suggest that more research is necessary to fully understand the protective features associated with social support. Both stigma and social support have dynamic social components, which do not lend themselves to traditional research methods. Combating such a large social
issue as stigma requires more global efforts in the form of public education and awareness. Community based participatory research efforts could be helpful in understanding the complex relationship between stigma and social support and developing more targeted approaches.

An important factor that came to light during this study was the emotional experience of participants as a result of being able to tell their story. Whether their experiences and evoked memories had been positive or negative, participants frequently reported feeling positive following the guided imagery session. This was not initially considered a part of the study but is consistent with findings on emotional benefits for narrative story telling (Pennebaker, 2000). Research has shown that in both written and oral form story telling can have positive health benefits. This has important implications for future studies which may assess the use of narratives as an intervention.

As with other chronic illnesses, the relationship between HIV and psychosocial variables is dynamic. This study provides important information on the use of Heart Rate variability as a stress indicator in PLWHA. Additionally, our study demonstrates the relationship between stress and psychological factors. This study has important implications as it demonstrates the effectiveness of HRV as a measure of stress. Moving forward researcher may examine the effectiveness of HRV in clinical interventions.
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Table 2

Descriptive Summary – Frequencies  \((N=119)\)

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Bivariate Correlations Key Phase II Variables

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1. Gender
2. African American
3. European American
4. ISEL
5. CESD
6. Stigma
7. PSS
8. IBI-Induction
9. FFT-Induction
10. IBI-Stress
11. FFT-Stress
12. HR-Stress
13. HRV-S
14. Blood Pressure-Stress I
15. Blood Pressure-Stress II
Table 4

*MANOVA for Perceived Stress, Depression, and Social Support*

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<th>F</th>
<th>df</th>
<th>Error df</th>
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Note. ***p<.001. *p<.05, **p<.01
Table 5
*MANOVA Summary of Between-Subjects Effects for Stigma Group*

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<th>p</th>
<th>Group</th>
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Note. a. Adjusted $R^2 = .16$;  
b. Adjusted $R^2 = .14$;  
c. Adjusted $R^2 = .10$
Table 6
*Regression for Perceived Stress*

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<th>Block</th>
<th>Variable</th>
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<th>β</th>
<th>VIF</th>
<th>Tolerance</th>
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Note. Adjusted R²=.18, F (6, 112) 5.20.

***p<.001, **p<01, *p<.05
Table 7

*Regression for Blood Pressure and Heart Rate Variability*

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Note. Adjusted $R^2=.29$, $F (5,46) =4.07$.

*p<.05, **p<.01, *** p<.001.
Table 8

*Hierarchical Linear Model Two Level – Growth Curve for Heart Rate Variability*

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Note. Chi-Square =216.96, p<.001. Reliability estimate .79.

*p<.05, **p<01, *** p<.001.
Figure 1. The Cardiac Cycle

*Figure 1. Diagram of two complete cardiac cycles which highlights the ECG waves of the QRS complex and the associated blood pressure cycle. The cycle begins with atrial depolarization, the P wave, which is followed by ventricular depolarization and the onset of systole, QRS complex. Ventricular repolarization is associated with onset of diastole and the T wave. Adapted from “Cardiovascular Psychophysiology” by G. Berntson, K. Quigley, & D. Lozano, 2007, in *Handbook of psychophysiology* (p. 184), edited by Cacioppo, J., Tassinary, L., Berntson, G. Copyright 2007 by Cambridge University Press.*
Figure 3. Phase II timeline for collection of physiological data. Grey color indicates experimenter manipulation. Timeline begins following informed consent and sensor connection and terminates following recovery period (Total data collection 25 minutes).
Figure 4. Schematic of (a) Procomp Infiniti sensor placements, (b) EKG arm placement yellow and blue represent active sensors and black represents the ground sensor (c) respiration band placement (d) surface EMG placement on two sites, (5) C4 Cervical Paraspinals and (6) Upper Trapezius, and (e) skin conductance two finger sensor placement. From Biograph Infiniti Physiology Suite, 2010. Copyright 2010 by Thought Technology. Retrieved from http://www.thoughttechnology.com/pdf/manuals/SA7971%20V5.1%20Physiology%20Suite.pdf.
Figure 5: IBI Diagram

Figure 5. Diagram of IBI collection by the Biograph Infiniti. An IBI represents the time between R spikes on an EKG (Thought Technology, 2010). For this study, we examined IBI in terms of fixed epochs of five minutes. The IBI, therefore, represents the standard deviation of the time, in milliseconds, between R spikes.
**Figure 6**: Equation for a Two-level Growth Curve Model

**Level 1**: Equation for Within Model with two Time-Varying variables

\[ Y_{ij} = \beta_{0j} + \beta_{1j} \text{Time} + \beta_{2j}X_{ij} + \beta_{3j}X_{ij} + r_{ij} \]

**HRV**:

**Level 2**: Equation for Between Groups with two Time-Varying variables and one Time invariant predictor

\[ \beta_{0j} = \gamma_{00} + \gamma_{01}S_{j} + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} + \gamma_{11}S_{j} + u_{1j} \]
\[ \beta_{2j} = \gamma_{20} + \gamma_{21}S_{j} + u_{2j} \]
\[ \beta_{3j} = \gamma_{30} + \gamma_{31}S_{j} + u_{3j} \]

**Unconditional Growth Model**

\[ Y_{ij} = \beta_{0j} + \beta_{1j} \text{Time} + r_{ij} \]

**Unconditional means model**

\[ Y_{ij} = \beta_{0j} + r_{ij} \]
\[ \beta_{0j} = \gamma_{00} + u_{0j} \]

*Figure 6*. Equation for 2 level growth curve analysis with time varying variables. \( Y_{ij} \) = the predicted outcome for person i at time j; \( \beta_{1j} \text{Time} \) = the value of time for person i at time j; \( \beta_{0j} \) = status at baseline and \( \beta_{1j} \) represents the slope or rate of change over time. The unconditional growth model represents the change without other predictors. For the Level 2 equation the stigma groups were dummy coded (S=1 for High Stigma, S=0 for Low Stigma) and represent a time invariant predictor. Adapted from “Developmental trajectories of adolescent popularity: A growth curve modeling analysis” by A. Cillessen & C. Borch, 2006, *Journal of Adolescence*, 29, pg. 935-959. Copyright 2006 by Elsevier.
Figure 7. MANOVA Graph of Significant Interaction for Stigma and Gender on Social Support
Figure 8: Graph of Interaction on Depression

Figure 8. MANOVA Graph of Significant Interaction for Stigma and Gender on Depression
References


*Psychological Bulletin, 98*(2), 310-357.


Reynolds NR, Sun J, Nagaraja HN, Gifford AL, Wu AW, Chesney MA. (2007). Optimizing measurement of self-reported adherence with the ACTG adherence


