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Psychological inhibition and CD4 T-cell levels in HIV-seropositive women

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Abstract

Objective: This cross-sectional study examined the hypothesis that the capacity for emotional expression is a critical moderator of the emotional support–health relationship. **Methods:** In a sample of 61 HIV-seropositive women without AIDS, coping interviews were conducted to assess HIV-specific emotional support and emotional expression and inhibition (percentage of positive/negative emotion words and inhibition words, respectively). **Results:** Hierarchical regression analyses revealed no relationship between availability of HIV-specific emotional support and concurrent CD4 levels and no moderation of emotional expression or inhibition. However, a higher percentage of inhibition words was associated with lower CD4 T-cell levels controlling for health behaviors, demographics, and treatment regimen (ΔR^2=.08, $P<.05$). **Conclusions:** These findings are consistent with prior theory and research showing a relationship between psychological inhibition and deleterious health outcomes.

Keywords: Emotional expression; Health; HIV; Inhibition; Psychoimmunology; Social support

Introduction

Social support is a consistent, and in many cases, robust predictor of physical health. Social support has been shown to be associated with morbidity and mortality from cerebrovascular disease, coronary heart disease (CHD), and cancer [1–3]. One type of social support that is generally believed to be strongly associated with health is emotional support or the presence of others in one's network with whom one can talk about stressful or difficult issues [4].

There is also growing evidence that the nature of a person's social support system can influence the immune system during stressful events. Deficiencies in perceived adequacy of social relationships have been related to immune function alterations in medical students during examinations [5,6] in separated or divorced men [7], in bereaved spouses [8], in Alzheimer's Disease caregivers [9], and more recently, in homosexual men with HIV [10]. Behaviors related to support giving have also been associated with immune parameters in nonhuman primates [11].

In a separate literature, large individual differences have been demonstrated in the extent to which individuals experience and express their emotions [12,13]. These individual difference factors may be important for a variety of reasons, including emerging evidence that emotional expression, or the act of communicating one's feelings, may have positive health consequences, while psychological inhibition, or the act of suppressing the expression or experience of one's thoughts or feelings, may have negative health consequences [14–16].

One body of literature that bears on the question of the effects of expression and inhibition has focused on writing or talking about a stressful event. Pennebaker et al. [17–19] have shown that individuals instructed to write about their deepest thoughts and feelings about past traumatic events over a period of four consecutive days reported fewer visits to physicians in the following 6 months than controls who wrote about a trivial topic. In a similar experimental design, patients with mild to moderately severe asthma or rheumatoid arthritis, who wrote about traumatic events, also showed health improvements compared to controls, 4 months postwriting [20]. In addition, individuals who wrote or spoke into a tape recorder about traumatic experiences showed better

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immune functioning than those who wrote or spoke about trivial events [21–26].

At the same time, inhibiting the disclosure of emotionally charged material has been found to be associated with poorer health. Studies have shown that adults who had experienced a traumatic event were more likely to have current health problems if they had not disclosed the event to others [17,27]. Similarly, HIV-seropositive homosexual males who concealed their homosexuality in more domains of their lives demonstrated accelerated HIV progression and mortality over a 9-year follow-up period compared to those males who disclosed this information to others [28]. These findings were supported by a study in HIV-negative homosexual men showing that concealment predicted greater infections and skin cancers [29].

Synthesizing social support research and emotional expression and inhibition research, we hypothesize that a key to the protective function of social support may lie in the opportunity to express one's emotional reactions regarding stressful and traumatic events [30,31]. We propose that an individual's capacity for emotional expression is a critical moderator of the emotional support–health relationship, such that the combination of the capacity to experience and express one's thoughts and feelings regarding a stressor, along with the perceived availability of individuals with whom one can discuss the stressor, will be associated with better health.

To evaluate how these constructs relate to health and immunity, we examined a population of HIV-seropositive women. Individuals who have been infected with HIV can be considered a good choice for this kind of investigation because there is a large amount of variability in the course of the disease, suggesting that factors other than the virus play a role in disease progression. In addition, immunologic processes related to the course of the disease are known and are capable of being measured. Finally, psychosocial factors, including social support, have been found to predict immunologic and clinical evidence of HIV progression in studies of men [32,33].

Because women comprise 17% of the AIDS cases in the US and are becoming infected with HIV at an increasingly rapid rate [34], it is important to incorporate them into studies examining cofactors in HIV progression. Women with HIV represent a very different population than men with HIV. A much larger proportion of HIV-seropositive women are poor, undereducated, intravenous drug users, and members of ethnic minority groups [34]. Many HIV-seropositive women are also dealing with different types of burdens such as parental and caregiver roles. Thus, in addition to facing the biological and psychosocial challenges of HIV that men face, women must also deal with the stressors that are unique to their disadvantaged social position [35–37].

For the population of HIV-seropositive women, disclosing feelings about HIV may be avoided due to the possibility of being stigmatized. Although nondisclosure of serostatus may prevent negative social consequences, it also decreases opportunities for social support. This can be disadvantageous because satisfaction with social support has been shown to buffer the effects of HIV-related physical symptoms on depressive symptomatology [38]. It is important to assess patterns and outcomes of self-disclosure in this unique population of individuals infected with HIV.

Studies examining social support and HIV progression in males have demonstrated mixed results. In some cases, social support has been shown to be associated with better immune system functioning while in others, social support has been linked to disease progression [39–43]. In a review that attempted to resolve these conflicting findings, Miller and Cole [44] concluded that for homosexual or bisexual males in the early stages of HIV infection, the presence of social relationships was a risk factor in disease progression. However, for individuals at later stages of infection, social relationships seemed to have a protective effect on HIV progression. There are no published studies to date which specifically evaluate these relationships in HIV-positive women. However, two studies that analyzed the relationship between social support and HIV progression used both male and female participants. Perry et al. [45], whose sample included 16 women, found no relationship between HIV-positive participants' ratings of perceived social support at baseline and CD4 T-cell levels collected 6 and 12 months later. Solano et al. [46], whose sample included 26 women, found that in asymptomatic HIV-positive individuals with lower CD4 T-cell counts, lower perceived social support predicted greater HIV symptoms one year later but was unrelated to changes in CD4 T-cell levels. However, social support was unrelated to disease progression in HIV-positive individuals with higher CD4 T-cell counts.

Although several studies have examined social support associated with HIV-related disease outcomes, only two studies have examined emotional expression and inhibition as a predictor of HIV progression. Cole et al. [28] found an accelerated course of HIV progression in a population of homosexual males who concealed their homosexual identity. Being "in the closet" was taken as a model of psychological inhibition. Similarly, Sherman et al. [47] found that children who disclosed their HIV diagnosis to friends had significantly larger increases in CD4 T-cell levels over a one-year period than children who had not disclosed their HIV status. No studies, however, have been conducted that directly evaluate emotional expression or inhibition as an ongoing way of coping with HIV infection or as a predictor of HIV-related outcomes.

Because of the mixed findings regarding the relationship between social support and HIV progression, we predicted that we would see no difference in immune measures across various levels of emotional support in this cross-sectional study. We predicted that more emotional expression would be associated with better immune system functioning as indicated by higher CD4 T-cell levels. Finally, we predicted that emotional expression would moderate the support–

immunity relationship, such that HIV-specific emotional support would be associated with higher CD4 T-cell levels but only when participants were more expressive of their emotions regarding their HIV status. In addition, we assessed the relationship between psychological inhibition as a method of coping with HIV and corresponding CD4 T-cell levels. Because these relationships might differ in women of different ethnic groups, we also conducted exploratory analyses of these relationships in each of the three ethnic groups represented in our sample: African Americans, Latinas, and Caucasians.

Method

Participants

The present study is based on data from 61 HIV-positive women who were participants in the UCLA Women and Family Project (Principal Investigator: Gail Wyatt), initiated in 1995. By the end of 1997, 257 HIV-positive women (including women with a diagnosis of AIDS) were recruited into the Women and Family Project from the following sources: various public and private health clinics in Los Angeles County; ads placed in newsletters for HIV-positive women (e.g., Women Alive Newsletter); flyers posted at various community colleges, shelters, and drug-treatment programs; and private practice physicians. Potential participants were informed that the purpose of the study was to learn more about how HIV affects women in order to improve the health care available for women. All participants were 18 years of age or older and were from one of five ethnic backgrounds: Caucasian, African American, Latina, Asian/Pacific Islander, and American Indian.

The present study involved 61 HIV-positive women: 14 Caucasian women, 30 African American women, and 17 Latina women. Because the present study was conducted before the full project was complete (before all interviews had been conducted and transcribed), only those women whose interviews had been transcribed could be included in the sample. All women with an AIDS-defining condition were excluded from the study in order to create a more homogeneous sample in terms of health. Non-English-speaking women whose interviews required translation were also excluded. Procedures followed by the Women and Family Project were approved by Institutional Review Boards at UCLA, and informed consent was obtained from each participant after the nature of the study was explained.

Design

The purpose of this cross-sectional study was to determine if emotional expression and inhibition as well as the perceived availability of emotional support, could predict concurrent immune status in HIV-positive women. Four different categories of variables were measured: availability of HIV-specific emotional support (the number of people that participants felt comfortable talking to about HIV concerns); emotional expression (the number of negative and positive emotion terms used during a coping with HIV interview); emotional inhibition (the number of inhibition words used); and an HIV-relevant immune parameter (CD4 T-lymphocyte number). Hierarchical regression analyses determined: (1) the strength of the relationship between the two independent variables (social support, expression/inhibition) and the outcome variable, CD4 T-cell levels and (2) the interaction of each of the two independent variables predicting CD4 T-cell levels. Analyses also determined if the relationships observed were maintained after controlling for any potential confounding factors that were correlated with CD4 T-cell levels with a P value less than .15. The relevant confounding factors that were considered included: ethnicity, socioeconomic status (SES), depression, recreational drug use, health behaviors (exercise, nutrition, sleep patterns, smoking), time since diagnosis, HIV-related symptoms, presence of sexually transmitted diseases (STDs), and HIV-related medication use.

Procedure

Participants who enrolled in the Women and Family Project study agreed to be interviewed every 6 months for a period of 2 years. At each of these times, participants received a medical examination, had their blood drawn, and participated in a structured interview. For the purposes of the present study, we used data from the first assessment point. The medical examination included both health assessment questions and a physical examination. The health assessment included questions about sleeping and eating patterns, health care access, health care use, health status, medication use, and HIV-related symptoms. The physical examination included a pap smear, a blood draw to measure HIV-related immune parameters, and a urinalysis to measure recreational drug use. Blood pressure was also measured.

The Women and Family Structured Interview was a 3- to 5-hour, face-to-face interview consisting of both closed- and open-ended questions. Interviews were translated for Spanish-speaking women (however, the Spanish-speaking women were not included in the present study). The interview included standardized psychological questionnaires (e.g., CES-D, CIDI Depression, CIDI Panic Disorder) as well as semistructured interview sections. Topics of questions included the following: various demographic and behavioral characteristics that are related to HIV infection (e.g., drug use, sexual history); questions regarding coping with HIV infection (e.g., "How did you react when you first found out you were HIV positive?"); sexual decision making (e.g., "I can say to my partner that we should use a condom."); prior physical and sexual abuse; and current and prior sexual behavior.

The ethnic background of the interviewer was matched with that of the interviewee. Interviewers were extensively

trained to be emotionally responsive in dealing with participants. All interviews were taped and open-ended sections were transcribed. The entire interview process was conducted at the UCLA Medical Center, at Drew Medical Center, or at the participants' homes. Participants received US$50 for each of five interviews, totaling US$250 for their participation in the study.

Psychosocial measures

Measure of social support

The perceived availability of HIV-specific emotional support measure was modeled after the Norbeck Social Support Questionnaire (NSSQ) [48], a self-report questionnaire designed to measure multiple dimensions of social support. The NSSQ asks the respondent to "list each significant person in your life. . .Consider all the persons who provide personal support for you or who are important to you now." There is a space for the respondent to specify the type of relationship for each network member from a list of categories (e.g., family, friends, neighbors, work associates). After listing up to 20 network members, respondents are asked to answer Likert-type questions for each person listed (e.g., functional and network properties of social support). Test–retest reliability for the subscales and variables of the NSSQ ranges from .85 to .92. Internal consistency is .88 or above for each of the functional and network properties [49].

In this study, the adapted version of the Norbeck questionnaire requires participants to list up to 20 important people in their lives, including those who are helpful, as well as those who are not helpful to them. The respondent is asked to specify the type of relationship for each network member (e.g., friend, partner). They are then asked a series of questions about each person such as: "Does he/she know your HIV status?"; "Did you tell him/her?"; "Since he/she found out, are you closer/less close/same?"; and "Are you comfortable talking with him/her about HIV concerns?" The focus of this study was on the last question, the availability of HIV-specific emotional support. For analysis, the social network was divided into three groups. The following groups were defined: intimate others (e.g., partner, lover, spouse), family members (e.g., brother, mother, stepson), and friends and acquaintances (e.g., friend, neighbor). Two scores were derived for each network group which represented: (1) the number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people that were listed as important ("comfort/network") and (2) the number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people that knew the participant's HIV status ("comfort/knowstatus"). Although we used a total score (total number of network members available divided by total number in network or total number of network members available divided by total number who know HIV status) for hypothesis testing, scores from each of the three network groups were analyzed separately as well.

Measure of emotional expression and inhibition

Emotional expression and inhibition were determined by the percentage of negative emotion, positive emotion, and inhibition words expressed throughout the coping portion of the interview. This section included a structured set of questions about the impact of HIV infection such as: HIV-related stressors (e.g., "What would you say it is about being infected with HIV that is most stressful to you?"); thoughts about the future (e.g., "What kinds of feelings do you have when you think about your future health?"); coping with uncertainties about the future (e.g., ". . .Do you feel like you ever get a chance to really think about the effects of HIV on you life and your future?"); meaning (e.g., "In what ways has being HIV positive changed the way you think about yourself?"); and goals (e.g., "What are your most important plans or goals for your future?").

Pennebaker's Linguistic Inquiry and Word Count (LIWC) [50] was used to analyze the content of the interviews. LIWC is a computer software program designed to analyze written text on a word-by-word basis and then calculate percentage totals of 61 selected affective and structural language elements. LIWC's four broad dictionary categories include: Emotional Expression, Cognitive Strategies, Content Domains, and Language Composition. Each of these categories (e.g., Emotional Expression) is then divided into subcategories (e.g., Anxiety), which are defined by various words (e.g., Nervous, Afraid, Uneasy). In this study, we looked at Negative Emotionality, a subcategory of Emotional Expression, which measures the percentage of negative emotion words such as "sad," "hate," "hurt," and "guilty." We also looked at Positive Emotionality, which measures the percentage of positive emotion words such as "happy," "joy," and "peaceful." Percentages were calculated by dividing the number of positive or negative emotion words by the total number of words expressed by the respondent. We also examined Inhibition, a subcategory of Cognitive Processes, which measures the use of inhibition words such as "inhibit," "restrain," and "avoid." Percentages were calculated by dividing the number of inhibition words by the total number of words expressed by the respondent.

Immunologic Measures

The immunologic data were collected at the time of the first interview through a blood sample drawn at the time of the interview. Levels of CD4 T-lymphocytes were measured by two-color (CD4: Leu-3+ Leu-4+) flow cytometry on whole blood [51]. CD4 levels were reported as the absolute number (per cubic millimeter of peripheral blood) of CD4 T-lymphocytes. Levels of CD4 T-lymphocytes were chosen because they can be reliably measured and because declines

in these cells predict the onset of AIDS-defining infections [52]. CD4 T-lymphocytes are key immunoregulatory cells that promote the function of many other immune cells. However, HIV selectively infects CD4 T-cells leading to the death of these cells. Loss of CD4 T-lymphocytes can lead to the development of AIDS-defining conditions [53].

Measures of background characteristics

Demographic and behavioral characteristics that may be associated with immune function and HIV progression could confound the relationships between psychosocial factors and the immune system. Potential confounders include SES, ethnicity, level of depression, recreational drug use, exercise, nutrition, sleep patterns, smoking, time since diagnosis, HIV-related symptoms, HIV-related medication use, and STDs [54,55]. These variables were evaluated in the present study as potential confounding factors.

The Women and Family Structured Interview assessed demographic characteristics of the participants: age (birthdate); SES (e.g., "What is your current total income from all economic sources?"); level of education; and ethnicity. The interview also assessed the practice of the following health-relevant behavioral factors over the previous week: cigarette smoking, alcohol consumption, use of inhalants/marijuana/hallucinogens/cocaine/heroin/methamphetamine/tranquilizer/barbituates/methodone, nutrition, exercise, and sleep disturbance. A toxicology screen assessed the use of alcohol and various drugs (e.g., cocaine metabolites, methadone, opiates). The interview also assessed self-reports of whether the participant had been told that she has an STD in the past 6 months.

Measure of depression

Depression was also evaluated as a potential confounding variable. Symptoms of depression were measured by the 20-item Center for Epidemiologic Studies Depression Scale (CES-D) [56]. The time frame was the past week. Summary scores greater than 16 have been shown to indicate the presence of clinical depression [57]. In studies of both community and clinical samples, the CES-D has shown excellent internal consistency (α=.94), good stability, and good convergent and discriminant validity [56].

Measures of health status and HIV-related treatment

Health status and medication regimens may confound the psychoimmunologic relationships under investigation. Thus, the following variables were evaluated as potential confounds: HIV-related symptoms; HIV-related medication use (protease inhibitors); and other non-HIV-related medication use that could influence the immune system (e.g., corticosteroids, testosterone). A composite score of four HIV-related symptoms (weight loss, diarrhea, yeast infections, chronic fever) over the past 6 months was constructed. The chosen symptom list was based on prior symptom lists used in studies of men with HIV and was adapted by the principal investigating medical doctor based on expertise in women with HIV infection and in order to ensure that the symptoms chosen were the most objective and least likely to be influenced by self-reporting biases. For HIV-related medication use, dichotomous scores were created based on the use or nonuse of protease inhibitors within the past 6 months, which can significantly impact CD4 T-cell levels [58].

Results

Sample characteristics

Means and standard deviations for psychosocial, behavioral, and immunologic variables are presented in Table 1. These data indicate that participants (Age: M = 37.20, S.D. = 8.38) were predominantly minority women (49.2% African American and 27.9% Latina) of low SES (mean income = US$706.15 per month). On average, most women had a high school level education (M = 12.15 years, S.D. = 2.46). Health behaviors and drug use varied widely within the sample. A urinalysis revealed that 44.3% of the population tested positive for some kind of drug or alcohol use. The most frequently used drugs were cocaine (24.6% of the population), marijuana (11.5% of the population), and benzodiazepines (11.5% of the population). Protease inhib-

Table 1
Means and standard deviations for study variables in whole sample (N = 61)

Variable	M	S.D.
Age	37.20	8.38
Income (monthly)	706.15	670.59
Aerobic exercise (days/week)	0.63	1.44
Anaerobic exercise (days/week)	4.03	2.80
Number of days eaten breakfast (weekly)	4.47	2.78
Number of days eaten fruit (weekly)	4.94	2.54
Number of days eaten vegetables (weekly)	4.56	2.10
Number of days taken vitamins (weekly)	3.98	3.28
Nights with too little sleep (weekly)	2.91	2.59
Number of cigarettes per day	8.32	10.45
Percentage of sample using protease inhibitors (%)	21	–
Percentage testing positive for various drug use (%)	44	–
Number of HIV symptoms (1–4)	0.92	0.99
Comfort/network (0–1)[a]	0.64	0.28
Comfort/knowstatus (0–1)[b]	0.79	0.25
Percentage of positive emotion words used (%)	3.03	0.76
Percentage of negative emotion words used (%)	1.74	0.71
Percentage of inhibition words used (%)	0.03	0.02
CES-D depressive symptomatology (1–60)	17.86	11.95
Number of CD4 T-cells	442.28	273.96

[a] The number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people who were listed as important.

[b] The number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people who knew the participant's HIV status.

itors were used by 21.3% of this population. CES-D scores ($M = 18.28$, S.D. = 12.07) revealed that, on average, this sample of women appeared to be clinically depressed as a score of 16 or more indicates clinical depression. CD4 T-cell values ($M = 442.28$, S.D. = 273.96) comprised a large range with a low of 14 and a high of 1150. This, however, is not atypical and is comparable to other samples of HIV-positive women without AIDS.

Statistical analyses

To assess the relationship between the predictors and the number of CD4 T-cells, we conducted hierarchical regression analyses controlling for potential confounding factors. In all analyses, we controlled for ethnicity and SES (measured by income and education level) because these factors have been shown to be predictors of CD4 T-cell levels in HIV-seropositive individuals (see Ref. [32]). We also controlled for any potential confounding factors that were correlated with CD4 T-cell levels with a P value less than .15. For potential confounding factors that were dichotomous (scored as either "yes" or "no": use of protease inhibitors, drug use as indicated by a toxicology screen, presence of STDs), we conducted one-way ANOVAs to see if the two levels were significantly different from each other when predicting CD4 T-cell levels. Again, we controlled for any dichotomous variables that produced a P value of less than .15 in these analyses. Potential confounding factors included: level of depression, drug use, exercise, nutrition, sleep patterns, smoking, time since diagnosis, HIV-related symptoms, HIV-related medication use, and presence of STDs. The variables that were either correlated with CD4 T-cell levels with a P value less than .15 or that had a P value less than .15 as indicated by ANOVA analyses included[1]: the amount of anaerobic exercise performed in the past week [$r(59)=.19$, $P=.14$], the number of times breakfast had been eaten in the past week [$r(59)=-.21$, $P=.11$], time since HIV diagnosis [$r(59)=-.21$, $P=.12$], the number of HIV symptoms [$r(60)=-.27$, $P=.04$], the use of drugs as assessed by a toxicology screen [$F(1,60)=2.45$, $P=.12$], and the use of protease inhibitors [$F(1,59)=10.60$, $P<.01$] (Table 2).

Table 2

(a) Correlations between CD4 T-cell levels and continuous confounding variables[a]

CD4 T-cell levels		
Variable	r	P
Age	.095	.47
Time since diagnosis	−.205	.12
Highest level of education	−.073	.57
Monthly income	−.118	.37
Aerobic exercise (days/week)	.091	.49
Anaerobic exercise (days/week)	.193	.14
Number of days eaten breakfast (weekly)	−.210	.11
Number of days eaten fruit (weekly)	−.121	.36
Number of days eaten vegetables (weekly)	.070	.60
Number of days taken vitamins (weekly)	−.078	.56
Nights with too little sleep (weekly)	−.125	.35
Number of cigarettes per week	.228	.15
Presence of HIV symptoms (1–4)	−.267*	.04
CES-D depressive symptomatology	−.009	.94

(b) One-way ANOVAs to determine relevant dichotomous confounding variables

Variable	df	F value	P value
Ethnicity[b]	2, 60	0.37	.70
Protease inhibitor use	1, 59	10.60**	.002
Drug use (toxicology screen)	1, 60	2.45	.12
Presence of STDs	1, 46	1.96	.17

[a] Both Pearson and Spearman correlations were used in the analyses because not all of the variables were normally distributed. Because similar results were found for both Pearson and Spearman correlations, we list only Spearman correlations here.

[b] Even though ethnicity was not related to CD4 T-cell levels, it was still controlled for in all regression analyses. However, in all analyses, ethnicity was coded as a dichotomous variable (Caucasian vs. other) as opposed to a categorical variable (Caucasian, Latina, African American).

* $p < .05$.

** $p < .01$.

Analysis of hypotheses

Social support and immunity

Our social support measures were defined as either: (1) the number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people that were listed as important (comfort/network) or (2) the number of people a participant felt comfortable talking to about HIV concerns, divided by the total number of people who knew the participant's HIV status (comfort/knowstatus). As predicted, we found neither comfort/network [$r(61)=-.17$, $P=.20$] nor comfort/knowstatus [$r(60)=-.15$, $P=.25$] to be correlated with the number of CD4 T-cells.

The social support measure was also broken down into smaller subgroups by type of relationship, namely: relationships between participants and partners, between participants and family members, and between participants and friends. None of these measures, however, correlated significantly with CD4 T-cell levels [Partners: $r(27)=-.32$, $P=.10$; Family members: $r(53)=-.13$, $P=.35$; Friends: $r(36)=-.07$, $P=.69$].

Emotional expression, inhibition, and immunity

We predicted a significant main effect of relationship between level of emotional expression and CD4 T-cell levels, such that participants who had higher emotional expression scores would have significantly higher CD4 T-cell levels. We found no significant correlation between percentages of negative emotion words and CD4 T-cell levels [$r(59)=-.12$, $P=.38$] or between percentages of

[1] Both Pearson and Spearman correlations were used in the analyses because not all of the variables were normally distributed. Because similar results were found for both Pearson and Spearman correlations, we list only Spearman correlations here.

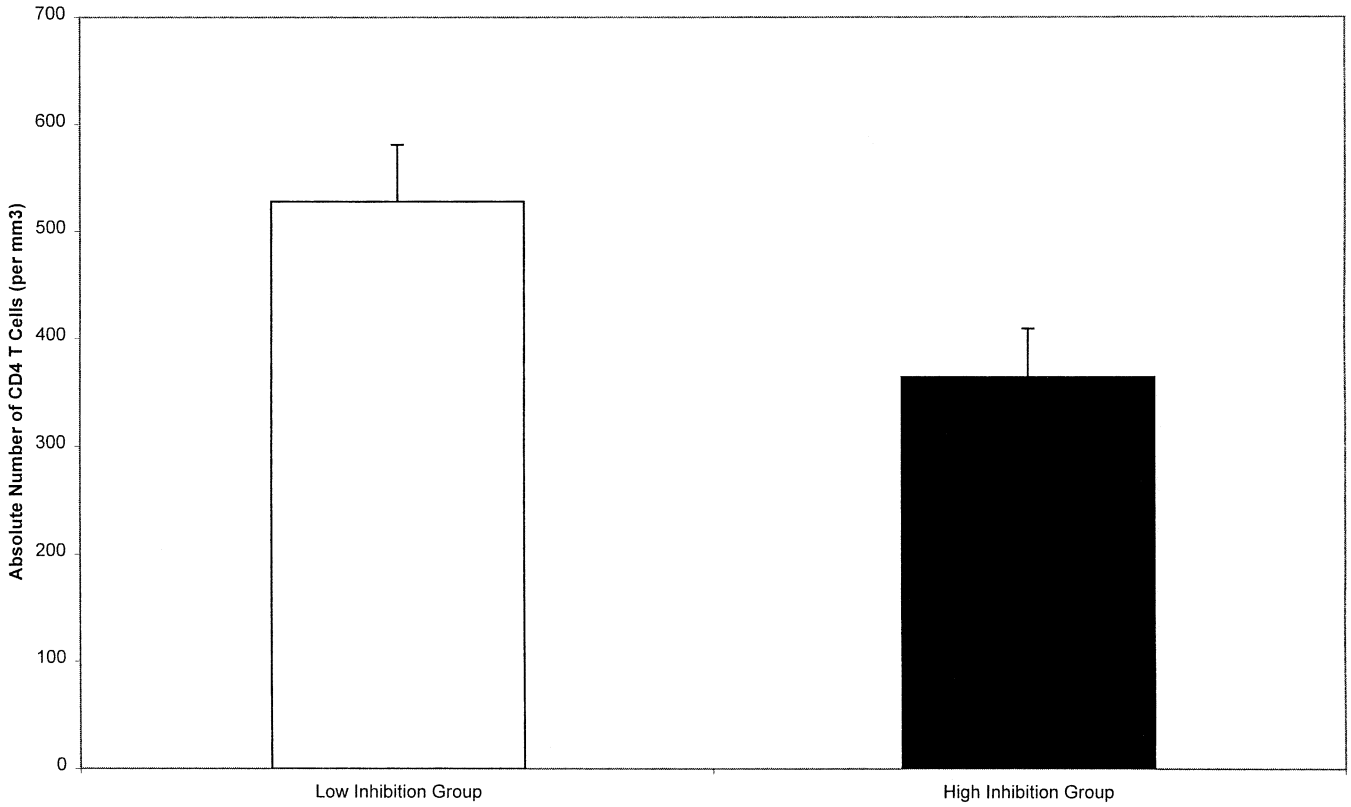

Fig. 1. Mean CD4 T-cell levels as a function of low versus high levels of inhibition words.

positive emotion words and CD4 T-cell levels [$r(59) = -.01$, $P = .92$]. However, we did find a significant correlation between percentages of inhibition words and CD4 T-cell levels [$r(59) = -.34$, $P = .01$]. Higher percentages of inhibition words used (e.g., avoid, withhold, suppress) were associated with lower CD4 T-cell levels. Some examples of phrases used by these women that included inhibition words were: "I guess I *suppressed* my affection from everybody for like seven months" and "You just don't want to think about it. Then you do things to *avoid* it" (Fig. 1).

In order to determine if the relationship between the percentage of inhibition words and CD4 T-cell levels would remain, controlling for potential confounding factors, a hierarchical regression analysis was conducted. The first block of variables always contained demographic variables: race, income, and level of education. The other confounding factors (anaerobic exercise, number of breakfasts eaten in the last week, time since HIV diagnosis, use of protease inhibitors, drug use as indicated by a toxicology screen, and HIV symptoms) were entered in a second step followed by the percentage of inhibition words used in the third step. After controlling for all confounding factors, the relationship between CD4 T-cells and inhibition words remained significant [$\Delta R^2 = .08$, $F(1,43)$ change $= 5.84$, $P < .05$], such that as the percentage of inhibition words increased, the number of CD4 T-cells decreased [$\beta = -0.31$, $t(43) = -2.42$, $P < .02$]. Inhibition words accounted for 8% of the variance in CD4 T-cell levels, controlling for these factors (see Table 3).

Emotional support as a moderator

We hypothesized an interaction between emotional expression and availability of comfort support predicting CD4 T-cell levels, such that comfort would be associated with higher CD4 T-cell levels when participants have had

Table 3
Hierarchical regression analysis for inhibition words predicting CD4 T-cell levels

Variable ($n = 54$)	β	t value	P	ΔR^2	F change	Significant F change
Step 1						
Ethnicity	0.08	0.55	.59			
Income	0.01	0.08	.94			
Level of education	0.11	0.77	.45	.01	0.16	0.92
Step 2						
Anaerobic exercise	0.06	0.44	.67			
Breakfasts eaten	−0.27	−2.16	.04			
Time since diagnosis	−0.03	−0.21	.83			
Use of protease inhibitors	−0.34	−2.36	.02			
Drug use (as indicated by a toxicology screen)	−0.17	−1.39	.17			
HIV symptoms	−0.22	−1.55	.13	.33	3.587	0.006
Step 3						
Inhibition words	−0.31	−2.42	.02	.08	5.841	0.02

higher emotional expression scores. We used hierarchical regression to analyze the interactions. For each analysis, we analyzed the interaction, uncontrolled, and then we controlled for demographic variables (race, income, education) in the first step, followed by all the potential confounding factors in the second step. The independent variables of interest were entered in the third step followed by the interaction term in the fourth step. No significant interaction was found between either negative or positive emotion words and either measure of social support predicting CD4 T-cells. There was also no interaction found between comfort/network and inhibition words predicting CD4 T-cell levels. Prior to controlling for confounding variables, a marginally significant interaction was found between comfort/knowstatus and inhibition words when predicting CD4 T-cell levels [ΔR^2=.06, F(1,54) change = 3.83, P=.06]; high inhibition individuals whose HIV status was known by many network members had lower CD4 T-cell levels than the rest of the sample. However, this interaction was no longer significant when controlling for the potential confounding variables [ΔR^2= .03, F(1,40) change = 2.19, P=.15].

Ethnic differences

Because of the possibility that different ethnic groups may use language in different ways or because different ethnic groups may exhibit inhibition to a greater or lesser extent, we repeated our word usage analyses, for each of the three different ethnic groups in our study: Caucasian, African American, and Latina. Dummy variables were created for the race categories. To test for the presence of an interaction between ethnicity and the use of inhibition words on CD4 T-cell levels, hierarchical regression analyses were conducted, first entering the main effects of ethnicity and inhibition followed in the second step by the Ethnicity × Inhibition interaction term. Results indicated that there was a significant Ethnicity × Inhibition interaction [ΔR^2= .07, F(1,55) change = 4.62, P < .05]. Among the Caucasian women (n = 13), the relationship between inhibition words and CD4 T-cell levels remained highly significant (r = − .75, P < .01) even after controlling for education and income [ΔR^2=.31, F(1,8) change = 6.96, P < .05], such that higher levels of inhibition predicted lower CD4 T-cell levels [β = − 0.59, t(8) = − 2.64, P < .05]. Among the African American women (n = 30), the initial relationship between inhibition words and CD4 T-cell levels (r = − .31, P=.09) lost significance after controlling for education and income [ΔR^2 =.02, F(1,26) change = 0.75, P=.40], such that inhibition words no longer predicted CD4 T-cell levels [β = − 0.16, t(26) = − 0.86, P=.40]. In the sample of Latina women (n = 16), the relationship between inhibition words and CD4 T-cell levels was not significant at all (r=.04, P=.89). These results should be interpreted with caution, however, due to the small sample size in some of the ethnic subgroups.

Discussion

This study examined the relationships among emotional expression, inhibition, social support, and CD4 T-cell levels in a multiethnic sample of 61 HIV-seropositive women. We predicted that emotional expression would be associated with elevated CD4 levels and that a relationship between social support and CD4 levels would be observed only in those most able to express their emotions. No relationship was found between social support, as measured by the number of people the participant could talk to about HIV-related concerns, and CD4 T-cell level. In addition, emotional expression, as measured by the percentage of negative and positive emotion words used during an HIV-specific stress and coping interview, was not significantly associated with CD4 T-cell levels. However, when we evaluated Francis and Pennebaker's [50] cognitive measure of "inhibition," we found that the number of inhibition words used when discussing the stresses of HIV infection was significantly correlated with our immunologic measure. The women who expressed a higher percentage of inhibition words (e.g., "inhibit," "restrain," "avoid") had significantly lower CD4 T-cell levels than those women who expressed a lower percentage of inhibition words. In fact, psychological inhibition accounted for 8% of the variance in CD4 T-cell levels after controlling for ethnicity, SES, eating and exercise habits, drug use, time since HIV diagnosis, HIV symptoms, and use of protease inhibitors.

There are a number of possible explanations for the significant correlation between inhibition and CD4 levels in this cross-sectional study. For example, the relationship between low CD4 T-cell levels and psychological inhibition may be due to the fact that women with low CD4 are sicker and/or more distressed as a result of the awareness of the health implications of a low CD4 count. These responses might drive some individuals to inhibit or ignore their HIV-related thoughts and feelings, as a method of protecting themselves from unwanted preoccupation with HIV. While this is a distinct possibility, the women in the study did not uniformly know their CD4 levels and all women with severe illness (AIDS-defining conditions) were excluded. In addition, controlling for other indicators of health status (such as HIV-related symptoms and medication usage) did not reduce this inhibition–CD4 association. However, future longitudinal research and intervention studies will be needed to determine whether this explanation can account for these findings.

Alternatively, the correlation between inhibition and CD4 levels could be a result of the neurophysiological correlates of the inhibitory process. Studies have shown that inhibiting the expression of emotions in an experimental context can increase activity in the sympathetic division of the autonomic nervous system [59,60]. Importantly, norepinephrine, a product of sympathetic arousal, has been shown to accelerate HIV replication in CD4 T-cells in vitro by suppressing production of specific cytokines [61]. HIV

replication is known to induce CD4 cell death and contribute to the progression of HIV infection. In addition, more recently, HIV-positive individuals with greater evidence of autonomic arousal to a wide range of stimuli have demonstrated an impaired response to highly active antiretroviral therapy (HAART) regimens in terms of viral load reductions [62], again suggesting a link between the ANS and viral replication. Thus, inhibition could activate sympathetic arousal, which could lead to HIV replication and the loss of CD4 T-cells (see Ref. [33]). Outside the context of HIV, sympathetic arousal has been shown to have effects on immunologic cells in tissue and in peripheral blood via their effects on beta adrenergic receptors expressed on these cells [63].

On the other hand, by inhibiting thoughts and feelings, individuals do not allow themselves to fully process stressful events [64]. Cognitive processing involves reflection and assimilation of past experiences. With individuals who engage in psychological inhibition, this process may be truncated, which may prevent these individuals from fully understanding or learning from their experiences. In a study of HIV-positive men, we have shown that cognitive processing of an AIDS-related bereavement was significantly associated with finding meaning from the event, which, in turn, predicted slower loss of CD4 cells over time and a lower mortality rate over a 4- to 9-year follow-up period [65]. Thus, psychological inhibition may be important in relation to immune status because it prevents cognitive processing, thus impeding the discovery of meaning and its psychological, and possibly, health benefits.

Other studies have demonstrated a link between psychological inhibition and health processes in HIV-positive persons and others. In a previous study from our research group, Cole et al. [28] used concealment of homosexuality as a marker of psychological inhibition in homosexual men with HIV infection. In a carefully selected sample of healthy HIV-positive men, those who concealed their homosexuality demonstrated accelerated progression to a critically low level of CD4 cells, AIDS onset and death over a 9-year follow-up period, controlling for a range of biobehavioral confounding factors. Among HIV-negative men, concealment of homosexuality predicted greater infections and skin cancers over an extended follow-up period [29]. In addition, psychological inhibition has been found to be associated with an increased risk of physical illness [25,66], heightened sympathetic nervous system activity [59,67], and altered immune processes [26]. In addition, among individuals who are socially inhibited, there is a higher incidence of immunologically mediated disorders [68–70], altered immunologic responses [71], and heightened sympathetic nervous system reactivity [72,73].

There is also a growing literature indicating that "denial" is associated with more rapid HIV progression. Denial is often defined as a refusal to accept, believe, or acknowledge a painful reality. Self-report measures of denial as a coping strategy have predicted accelerated clinical progression of HIV in homosexual men [10,74] (cf. Ref. [75]). It is possible that the questionnaire-based measures of denial used in these studies and the word count measure of psychological inhibition used in the current study have some overlap. Denial subscales of coping inventories include such items as "I refuse to believe that this has happened" and "I pretend it hasn't happened." Some of these items may overlap with the sentences reported in the coping interview that contained the inhibition words used in the Pennebaker framework (e.g., "You just don't want to think about it. Then you do things to *avoid* it."). However, it is important to recognize the conceptual distinctions between these two concepts. Psychological inhibition is a broader concept that refers to the active holding back of emotional expression or emotional experience. There are a number of processes that can be used to do this, from suppressing facial or verbal *expression* of emotion to cognitive reappraisal of the importance or meaning of an event in order to reduce the actual *experience* of the emotion [76]. Denial can be considered a type of cognitive appraisal process that involves refusing to acknowledge the existence of the circumstances that would produce the negative emotional reactions. Clearly, our psychological inhibition measure does not reflect only denial but may tap denial processes as well as a variety of other methods of inhibiting reactions to events. It would be useful in future research in this area to attempt to capture various subcomponents of the psychological inhibition construct and determine their comparative relationships to physiological and health outcomes.

While we found a relationship between inhibition words and CD4 T-cell levels, we found no relationship between emotional expression and CD4 levels. This pattern of results is consistent with the findings of a recent meta-analysis of studies that examined the health effects of writing about traumas [66]. Results indicated that in many of these studies, the trivial topic control group experienced large increases in physical illness symptoms while the trauma writing group experienced only relatively small health benefits. Cole [66] conducted a study to determine if the deleterious effects of the trivial topic control condition might be due to the ill effects of inhibitory processes, since participants in the control group were warned that they might be asked to write about their most traumatic experiences and were then not given the opportunity to do so. In his study, individuals were either told or not told that they would be writing about their most traumatic experiences, and then either wrote or did not write about those experiences. Only those participants who were told and then did not write about their most traumatic experiences showed an increase in physical illness. This study suggests that the beneficial effects of writing may come from the act of *not* inhibiting thoughts or feelings (e.g., not being assigned to the control condition) rather than from the act of emotionally expressing or disclosing traumas (as part of the disclos-

ure condition). Both the present study and Cole's study [66] point to the possibility that inhibitory processes play a more important role than expressive processes in health effects.

In the present study, no relationship was found between social support, measured in terms of the number of people participants felt comfortable talking to about HIV-related concerns, and CD4 T-cell levels. Many studies have pointed to the beneficial effects of social support on both biological processes and physical health [77–79]. Even though emotional support has been positively associated with health in many clinical samples, there have been mixed results in studies involving HIV-positive participants. Emotional support has been shown to be both positively [10,43] and negatively [42] associated with disease progression indices in HIV-positive males. It has been suggested that social support has a different relationship to disease progression depending on the stage of HIV infection [44]. However, it is not certain that these relationships are the same for HIV-positive females as there are only two published studies [45,46] evaluating social support and CD4 level that include women and the sample sizes are fairly small (16 and 26 females). It is also possible that other measures of social support would have allowed the detection of a social support and CD4-level relationship. In the present study, we specifically measured an individual's self-reported comfort with disclosing to their network, which may not have been a good predictor of CD4 levels. However, it remains possible that a different indicator of social support, such as a more general measure of emotional support available or received, would predict CD4 levels in this sample.

Cohen and Hoberman [80] suggest that part of the importance of social support may lie in the ability to talk to people about one's problems. Following this thinking, we proposed that social support would have benefits but only in those capable of being emotionally expressive. In this study, we used the number of negative and positive emotion words used when discussing the stresses of HIV as an indicator of emotional expressiveness, following on the work of Pennebaker [17]. However, we found no interaction between emotional expression and social support predicting CD4 T-cell levels after controlling for confounding factors. In addition, the interaction between inhibition and social support did not predict CD4 levels when controlling for confounding factors. In other words, social support, as defined in this study, was not associated with CD4 levels in any of the groups defined in this study in terms of emotional processing style.

We found preliminary evidence that the relationship between inhibition and CD4 levels may depend on ethnicity. Specifically, the effect sizes between these two variables were highest for Caucasian women, then African Americans, and close to null for Latinas. The lack of a relationship in the Latinas was not found to be related to education or income and was not related to translation since all interviews used in this study were conducted in English. However, for most of the Latinas, English was a second language and differences in the use of the terms captured by the LIWC program could explain these results. It is also possible that cultural differences in emotional expression patterns might explain these ethnic differences (for a review of cultural variation in emotion processes, see Ref. [81]). Again, these results should be interpreted with caution due to the small sample of women in some of the ethnic subgroups. More research on the relationship between ethnicity, emotional expression/inhibition, and health is needed.

Some of the limitations of this study include the small sample size and the cross-sectional design of the study. Because we used data from only 61 subjects, we lost some power when analyzing the data, especially when controlling for numerous potential confounding factors. In addition, there are limits to the conclusions that can be drawn from the LIWC program. Because the program is a word counting system, it cannot truly capture the ways in which individuals express or inhibit their emotions. For example, the word counts cannot distinguish differences in emotional experience from differences in emotional expression. Also, the number of inhibition words combines the inhibition of thoughts and feelings, and blurs potentially important distinctions between avoidance, distraction, denial, and suppression. Many coping inventories also fail to make these discriminations, despite the possibility that these different strategies have different psychological and even physiological consequences. Future research, using systems that are capable of making these kinds of important distinctions, would be useful in this area.

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