J Behav Med (2018) 41:875–889
https://doi.org/10.1007/s10865-018-9944-5

Past, present or future? Word tense and affect in autobiographical narratives of women with HIV in relation to health indicators

Yudelki M. Firpo-Perretti[1] · Mardge H. Cohen[2] · Kathleen M. Weber[2] · Leslie R. Brody[1]

Received: October 14, 2017 / Accepted: June 12, 2018 / Published online: June 25, 2018

Abstract This study examined how the expression of positive and negative affect words and word tense in autobiographical narratives of 98 HIV+ women, predominantly African American, predicted undetectable HIV viral load (UDVL), CD4+ cells/mm^3 counts and antiretroviral therapy medication (ART) adherence assessed concurrently (T1) and at 3 to 9-month follow-up (T2). Logistic regressions revealed that higher past tense words predicted worse odds of UDVL, CD4+ cells/mm^3 above 350 at T1, and worse odds of 95% ART adherence at T2. However, using both high past tense words and high positive affect words predicted better odds of CD4+ cells/mm^3 $>$ 350 at T2. Higher future tense words predicted better odds of CD4+ cells/mm^3 $>$ 350 at T1. Additionally, using both high present tense words and negative affect words predicted better odds of UDVL at T1. These findings provide preliminary evidence that the quality of affect expression significantly interacts with temporal context to relate to the health of women with HIV.

Keywords Positive affect · Negative affect · Tense · HIV health · Adherence

✉ Yudelki M. Firpo-Perretti
yfirpo@bu.edu

Mardge H. Cohen
mardge.cohen@gmail.com

Kathleen M. Weber
kathleen.weber@hektoen.org

Leslie R. Brody
lrbrody@gmail.com

[1] Department of Psychological and Brain Sciences, Boston University, 648 Beacon Street, Room 227, Boston, MA 02215, USA

[2] Cook County Health and Hospitals System, Hektoen Institute of Medicine, 2225 W. Harrison, Suite B, Chicago, IL, USA

Introduction

Autobiographical narratives allow people to organize and make sense of complex life experiences in ways that reflect their identity, goals, and values (Boals et al., 2011; Boals & Klein, 2005; Klein & Boals, 2010; Ramírez-Esparza & Pennebaker, 2006). Writing or talking about emotional and personal experiences has been found to benefit health, including self-reported depression, anxiety and well-being (Lepore, 1997; Stanton et al., 2002; Sloan & Marx, 2004); academic and occupational performance (Francis & Pennebaker, 1992; Pennebaker & Francis, 1996), and utilization of medical services and immune functioning (Pennebaker & Beall, 1986; Pennebaker et al., 1988; Pennebaker & Graybeal, 2001; Lepore & Greenberg, 2002; Sloan & Marx, 2004). Among individuals with HIV, writing about emotional topics (compared to writing about neutral events) was related to decreased viral load at 2 weeks follow-up and increased CD4+ lymphocyte counts (with higher levels indicating healthier immune functioning) at 6 weeks post-writing (Petrie et al., 2004). Immune cells are continually being activated, generated, and utilized by the immune system to protect the body against infection and there is cross-talk between the immune system (sometimes referred to as our "sixth sense") and the central nervous system (Ziemssen & Kern, 2007); therefore the ways in which people narrate their life stories, and the emotions that are generated, may affect ongoing immune processes.

The current study focuses on understanding linguistic features of autobiographical narratives in women with HIV

as relating to their HIV health behaviors and immune functioning. Previous research has demonstrated that the particular patterns of words people used in when narrating significant life events and categorization and counting of distinct word types in narratives can be more informative than the thematic content (Newman et al., 2003; Pennebaker & Graybeal, 2001). Linguistic features of narratives, including pronouns and affect words, have been found to significantly relate to aspects of personality, social and situational context, as well as mental and physical health (Chung & Pennebaker, 2008; Pennebaker et al., 2003). Specifically, we examined how the frequency of positive and negative affect words and tense use (present, past, and future) expressed in autobiographical narratives relate to health measures concurrently (T1) and at a 3 to 9-month follow-up (T2). These health indicators were HIV biomarkers (i.e., HIV viral load and CD4 T lymphocyte cell count, both measures of immune functioning), as well as to a health behavior, antiretroviral therapy (ART) medication adherence. Understanding the linguistic features in narratives, in particular individuals' affective expression and temporal focus, that relate to immune functioning and medication adherence can serve as a basis for better understanding the factors that affect the health of this vulnerable population.

Studies of health in relation to positive and negative emotions have included measures of both the expression and the experience of emotions. It has been demonstrated that expressing positive emotions, especially sharing them with others who respond in validating ways, boosts the experience of the original positive emotion (Lambert et al., 2013), so that experience and expression of emotion may be synergistic. Numerous studies show that experiencing positive affective states, measured with ecological momentary assessments or self-reports, relates to favorable physical and psychological well-being (Dockray & Steptoe, 2010; Fredrickson & Levenson, 1998; Steptoe et al., 2009; Tugade & Fredrickson, 2004), including health outcomes such as effective emotion regulation, faster cardiovascular recovery from emotional arousal induced by stressful events (Fredrickson & Levenson, 1998; Tugade & Fredrickson, 2004), decreased vulnerability to upper respiratory infection (Cohen et al., 2003), and better antibody response to hepatitis B vaccination (Marsland et al., 2006). Among individuals with HIV, higher positive emotional experiences assessed via self-report are predictive of engaging in HIV care 3 months after receiving the diagnosis, continued use of antiretroviral medications, and viral suppression (Carrico & Moskowitz, 2014; Wilson et al., 2016). In contrast, excessive and/or prolonged experiences of negative affect can be detrimental to health behaviors and are associated with worse physical and psychological health (Cohen et al., 2001; Smith et al., 2004). For instance, self-reported anxiety and perceived stress experienced over a 1–3 month period relate to worse physical and psychological health, including the suppression of immune response to immunization (Cohen et al., 2001). However, specific forms of negative affect (e.g., sadness vs. anger) may have differing motivational pathways and physiological responses (Bodenhausen et al., 1994; Carver & Harmon-Jones, 2009; Schwartz et al., 1981).

Expressing emotional experiences (measured via self-report scales and narrative or conversational content) has also been found to significantly relate to mental and physical health (Esterling et al., 1994; Pennebaker et al., 1997; Pennebaker & Seagal, 1999; Petrie et al., 2004). Generally, a higher ratio of negative to positive affect words in narrative writing relates to worse follow-up health indicators (e.g., physician visits, physical symptoms) in student, community, and incarcerated samples; while a higher ratio of positive to negative affect words relates to better health outcomes (Pennebaker et al., 1997). As consistent with this, Rude et al. (2004) found that depressed individuals used more negative affect words in narratives than did non-depressed individuals. However, relative frequencies of positive and negative affect expressed in narratives are not always respectively associated with positive and negative health behaviors or indicators. For example, (Pennebaker et al., 1997) showed that an increased relative frequency of positive affect words over time when talking about stressful life events related to increased distress at follow-up. And among older men of higher socioeconomic status, moderate levels of self-reported expressed anger, compared to lower levels, were found to be protective against cardiovascular disease (Eng et al., 2003).

There are several possible explanations for these contradictory data on how the expression of positive and negative emotions relates to health. First, researchers have suggested that expressing any type of emotion (positive or negative) helps to regulate emotional experiences (Greenberg et al., 1996), facilitates cognitive and emotional processing (Lepore et al., 2000) and may also elicit positive support from others (Lambert et al., 2013), all of which may benefit health. Moreover, some evidence suggests that it is the coping strategies used to regulate specific types of emotions, rather than the expression of emotions themselves, that may better predict health. For example, in a prospective study examining cardiovascular risk and anger expression during a structured interview, discussing anger in a destructive justification way (i.e., blaming others for one's anger) predicted increased risk for cardiovascular heart disease, even when accounting for depressive symptoms, hostility, and anxiety (Davidson & Mostofsky, 2010). However, writing letters to people or things that participants were most angry at was found to decrease depression

and increase control over pain, with higher levels of expressed anger in the letters significantly relating to better outcomes (Graham et al., 2008). Further, positive and negative emotions are not unitary constructs, and the types of negative emotions (e.g., sadness vs. anger) or positive emotions (e.g. pride vs. warmth) expressed may have differential effects.

Another possible explanation for the contradictory findings regarding the effects of expressed positive and negative affect on health is that such relationships may be moderated by the temporal focus (e.g., past, present, future) within which the affect words are embedded. Theories support the idea that the consequences of negative vs. positive affect expression may differ depending on the time frame referenced, both the time frame for the experience of the affect (i.e. the present vs. the past being referenced) as well as the time frame of the health consequences (i.e. concurrent vs. longer term). For example, Carver (2001) suggests that some forms of negative affect (e.g., anger) expressed about *current* unfulfilling circumstances motivate us to change them which leads to adaptive future effects. However, ruminating on *past* negative experiences relates to depression, negative cognitive styles, and negative psychological health outcomes (Lam et al., 2003). The literature on mindfulness (a non-judgmental focus on the present) suggests that a present-moment focus on either positive or negative emotions is adaptive for health because it allows psychological resources to be brought to bear as events unfold, as opposed to a focus on the past or the future (Weinstein et al., 2009). Moore and Brody (2009) found that increases in the frequency of present tense words in narratives written daily over a 3-day period significantly predicted increased self-reported mindfulness (non-judgmental acceptance of present-moment experiences) at a 4 to 8-week follow-up period.

Frederickson's "broaden and build" theory also highlights the importance of temporal context for emotions (Fredrickson, 2001). She suggests that an emotion begins with an individual's assessment of the personal meaning of an antecedent event. This appraisal process initiates a cascade of response tendencies, such as subjective experience, facial expression, cognitive processing, and physiological changes. Experiencing negative affect is theorized to narrow a person's momentary thought-action repertoire in current threatening situations, activating "quick and decisive" actions that may lead to "direct and immediate benefit" (Fredrickson, 2001). However, these actions may not necessarily be adaptive for long term health. In contrast, positive emotions broaden attention and cognitive processes, and expand the kinds of thoughts and actions that come to mind. Positive emotions, because they broaden thinking, are theorized to have a reciprocal relationship with finding positive meaning in events and can build long term resilience in the face of challenging events (Frederickson, 2001).

In the context of women with HIV, expressing positive emotions about past events may aid in making meaning, which is especially important because 67% of women with HIV have a history of physical and sexual abuse (Cohen et al., 2000), and meaning making in the face of abuse has been shown to benefit mental health (Wright et al., 2007). In turn, these benefits may facilitate self-care behaviors and adhering to ART going forward (Carrico et al., 2010; Carrico & Moskowitz, 2014), which is critical for survival and stopping the spread of the disease (Chesney, 2003). Expressing negative emotions about present events may promote taking quick actions to address current problems and might have immediate benefits, possibly for health care behaviors such as ART adherence. Both positive and negative affect about the future (including perceptions of future health threats or risks such as cancer and associated regrets) may serve as motivational antecedents that predict expectations of physical health (Carver et al., 2010) and engagement in healthy behaviors (e.g., exercise; Kahana et al., 2005). However, positive affect about the future may be associated with beneficial longer term health than negative future-oriented thinking, given that positive emotions build coping resources that continue to grow and can be later retrieved in the face of future challenges (Fredrickson, 1998, 2001; Fredrickson & Branigan, 2005). Thus, positive thinking about an imagined future may motivate continued proactive coping efforts to achieve desired goals. In contrast, negative affect about the future may be associated with a greater likelihood of "giving-up" and a lower likelihood of planning or taking proactive steps to achieve goals over time (Carver et al., 2010; Schou et al., 2005).

No known studies have made direct comparisons of the effects of expressions of negative vs. positive affect words used when focusing on the past, present, and future on health, concurrently and over time. Most studies on linguistic features of narratives have focused independently on either word tense or affect and have not examined the interaction between affect and word tense in relation to both present and longer-term health. In addition, no known studies have looked at how these linguistic markers are related to *changes* in health over time. The current study investigates the relationships between affect expression and tense used in narratives, and health indicators concurrently (T1), and 3–9 months later (T2) adjusting for health indicators at T1, in women with HIV. The women

were participants in a 20-year longitudinal cohort study, which presents a unique opportunity to study the relationship between linguistic markers with immune functioning over time. It is important to note that the narratives were told in the presence of health care providers who were trained to provide supportive reflective listening. Because the women's expression of emotions in the narratives was supported and validated, it may have synergistically or reciprocally affected their ongoing emotional experiences (Lambert et al., 2013).

The specific aims of the current study were to examine the main effects of and interactions between linguistic tense (past, present, and future-tense words) and linguistic affect valence (positive and negative affect words) in autobiographical narratives of women with HIV in relation to (a) concurrent (T1) health behaviors (adherence to ART) and HIV biomarkers (HIV viral load, and CD4+ cell counts); and (b) changes in ART adherence and HIV biomarkers between T1 and T2. Based on previous literature reviewed above, especially studies emphasizing present-moment awareness (Moore & Brody, 2009; Weinstein et al., 2009), Frederickson's broaden and build theory (Fredrickson, 2001), and Carver's work on the motivational pathways of emotions (Carver, 2001) hypotheses were that: There would be main effects such that (1) a higher present tense frequency would significantly relate to higher T1 CD4+ cell counts, ART adherence, and undetectable VL, and a higher past tense frequency would significantly relate to lower T1 CD4+ cell counts, ART adherence, and undetectable viral load. The main effects between future tense word frequency and CD4+ cell counts, ART adherence, and undetectable VL will be explored. These main effects would be qualified by interactions between affect valence x tense as follows: (2) The expression of positive affect about past events (suggesting meaning-making) would be associated with a positive change in biomarkers from T1 to T2; (3) The expression of negative affect about present events (enabling immediate actions to address stressors) would be associated with higher T1 undetectable viral load, CD4+ cell count, and ART adherence, whereas the expression of negative affect about the past (suggesting rumination and a depressive cognitive style) would be associated with lower T1 undetectable viral load, CD4+ cell count, and ART adherence and negative changes in biomarkers and ART adherence from T1 to T2; and (4) The expression of positive affect about future events (suggesting optimism) would be associated with higher T1 undetectable viral load, CD4+ cell count, and ART adherence and with positive changes in biomarkers and ART adherence from T1 to T2.

Methods

Participants

Participants were from the Chicago site of the Women's Interagency HIV Study (WIHS), a longitudinal cohort study of US women with and at risk for HIV, enrolled during three waves (1 = 1994–1995; 2 = 2001; 3 = 2010–2011; see Barkan et al., 1998 for more details). The current study took place from 2008 to 2012 and included a convenience sample of 98 HIV + women (n = 43, wave 1, and n = 55, wave 2), who were mostly African American women (90.8%) and averaged 45.32 years of age (*SD* = 8.87). 68.3% of women reported an income of or below $12,000 at T1. (See Table 1 for sample demographics).

WIHS participants attend semi-annual visits during which they complete a structured interview, physical and gynecologic examinations, and specimen collections (see Barkan et al., 1998 for more details). A listing of previously published papers including participants from the WIHS study may be found here: https://statepi.jhsph.edu/wihs/wordpress/publications/. Only one previous paper has investigated the autobiographical narratives of a subgroup

Table 1 Demographic characteristics of participants

Characteristic	Frequency	Percentage (%)
Age (*M*, *SD*)	45.32 (8.87)	
Reported ethnicity		
African American	89	90.8
Non-hispanic white	4	4.1
Hispanic	4	4.1
Other	1	1
Education level		
Grades 1–6	1	1
Grades 7–11	43	43.9
High school graduate	30	30.6
Some college	19	19.4
College graduate	4	4.1
Attended/completed graduate school	1	1
Household income		
< $6,001	26	26.5
$6001–12,000	41	41.8
$12,001–18,000	15	15.3
$18,001–24,000	6	6.1
$24,001–30,000	2	2
$30,001–36,000	2	2
$36,001–75,000	4	4.1
> $75,000	2	2

of 20 women with a focus on thematic content indicating resilience (Brody et al., 2016). In 2008–2012, either during a regularly scheduled WIHS visit or during a separate metabolic study visit within 3 months of a regularly scheduled WIHS visit, T1 data collection for the current study took place. The T2 health outcomes were collected at the participants' subsequent WIHS study visit, 3–9 months after time 1 (elapsed average amount of time in months M =5.72, SD = 1.51). WIHS visits occur approximately at 6-month intervals, with the possibility that some participants who attended a visit at the beginning of a 6 month interval of data collection, would attend their subsequent visit more than 6 months after that visit. Similarly, participants who attended their visit near the end of a 6 month visit interval, are likely to have their next visit less than 6 months subsequently. These logistics (along with the fact that some women's T1 data were collected up to 3 months later than their previous regularly scheduled WIHS visit) account for the 6-month range in the elapsed time between T1 and T2.

Women were excluded from the study if they did not speak English and therefore could not complete standardized measures and/or did not have in-person clinic visits and therefore could not complete face-to-face interviews. Written informed consent was obtained for all enrolled women after the study was approved by the Cook County Health and Hospital Systems and Boston University Institutional Review Boards. Participants received a financial payment of $25 in support of their time and effort and reimbursement for transportation.

Measures

Guided autobiography task (GAT; McAdams, 2006)

An adapted version of the GAT (McAdams, 2006) was used, in which the participants for this study told narratives about three key self-defining memories they considered turning points in their lives. The participants were asked to describe what happened in the event, when it happened, who was involved, and what they were thinking and feeling during the event. They were also asked to describe how the experiences influenced the person they are today. Narratives were told to a supportive listener (a nurse or a social worker who worked with women living with HIV) who was trained to do reflective non-judgmental listening, asking for clarifications or elaborations when necessary. The participants' autobiographical narratives were transcribed and analyzed using the Linguistic Inquiry and Word Count 2007 (LIWC2007) program (LIWC; Pennebaker, Booth, & Francis, 2007a). The LIWC 2007 program uses word counts to search close to 4500 words and word stems, categorizes them into linguistic dimensions, and then converts the raw counts to percentages of total words (Pennebaker, Chung, Ireland, Gonzales, & Booth 2007b). The variables used in the present study were frequency of positive affect words (e.g., love, nice, sweet), negative affect words (e.g., hurt, ugly, nasty), past tense words (e.g., went, ran, had), present tense words (e.g., is, does, hear), and future tense words (e.g., will, gonna). Using a sample of 2800 randomly selected text files, Pennebaker et al. (2007) evaluated the internal reliability of the LIWC by using two methods: (1) determining the correlation between frequency of use of each word in a category and the sum of the other words in the same category; (2) using a binary method that converts the usage of each single words within a given text into either 0 (not used) or 1 (used one or more times) and then calculating a percentage of total words used from each categories. Using these two approaches, the following was reported for the target linguistic studies used in this study (showing raw alpha values and then the binary alpha values): positive emotion (a = .40/.97), negative emotions (a = .61/.97), past tense words (a = .75/.97), present tense words (a = .94/.91), future tense words (a = .02/.75). Pennebaker et al. (2007) provide initial external validity statistics based on 72 narratives collected in an earlier study (Pennebaker & Francis, 1996). Using these narratives, four judges were asked to rate the emotional, cognitive, content, and composition dimensions designs corresponding to the LIWC word count categories. These judges' ratings were then compared to the LIWC output using Pearson correlations (for more details, see Pennebaker et al., 2007). Other studies have provided additional support for the external validity of the LIWC program, for instance, by comparing coding methods between the LIWC and other computerized coding (Alpers et al., 2005; Bantum & Owen, 2009; Kahn et al., 2007; Tausczik & Pennebaker, 2010). Further, the LIWC was developed within the context of Pennebaker, Francis, & Booth's (2001) work on emotional autobiographical writing and it has been used to reliably determine the linguistic features of narratives that predict subsequent health outcomes (Pennebaker & Francis, 1996; Pennebaker et al., 1997).

For descriptive purposes, the autobiographical narratives in this study were also coded for the major content themes the participants described in their narratives by two independent groups of three coders each (undergraduate and graduate students in psychology), who coded for presence (1) or absence (0) of one major theme for each narrative. Women were given scores for major themes based on an average across three narratives—e.g., if they talked about abuse as a major theme in two out of three narratives, their score for abuse as a major theme would be .67. Reliability between groups for the three most frequent themes is reported in the Results section below.

Antiretroviral therapy (ART) adherence

To measure ART adherence, participants reported the percentage of the specific pills taken in the past 6 months using one of five category responses: 1 = 100% of the time, 2 = 95–99% of the time, 3 = 75–94% of the time, 4 = < 75% of the time, 5 = I haven't taken any of my prescribed medications. Previous studies using this self-report measure have found it to relate to health outcomes and to yield data consistent with objective measures (Walsh et al., 2002). Furthermore, a review of studies using self-reported adherence indicates that, although potentially susceptible to social desirability and recall bias, self-reported adherence to antiretroviral medications differentiated clinically meaningful medication-taking behavioral patterns (Nieuwkerk & Oort, 2005). Specifically, lower self-reported adherence rates were associated with higher odds of having a detectable viral load (Nieuwkerk & Oort, 2005). In this study, a categorical variable was created reflecting medications taken > 95%, versus < 95% of the time despite it being medically indicated (based on having a CD4 count < 350 through 2009 or a CD4 count < 500 after 2009). This conservative cut-off of 95% adherence was used based on previous studies that demonstrate that at a cut-off of 95% adherence to anti-retroviral medications, HIV RNA loads of < 400 copies/mL occurred 80% of the time in patients with levels of antiretroviral therapeutic adherence of ≥ 95% (Paterson et al., 2000) and that adherence rates below 95% are associated with increased mortality risk among individuals with HIV (Abaasa et al., 2008). In this sample of participants, > 95% adherence rates at T1 was associated with undetectable viral load at T1, X^2 (1, N = 96) = 14.89, $p < .001$. Similarly, > 95% were associated with undetectable viral load at T2, X^2 (1, N = 87) = 17.17, $p < .001$. Consistent with previous research, these results demonstrate how high rates of adherence are associated with undetectable viral load, a clinically meaningful result.

HIV disease markers

Blood specimens were analyzed for HIV RNA load and CD4+ cells, given in copies per milliliter of blood. During the time of the narrative administration, a viral load was considered undetectable if less than 80 copies/ml of HIV RNA load were found in the blood samples; therefore, for this study viral load was dichotomized as detectable (≥ 80 copies/ml) or undetectable (< 80 copies/ml) based on the equipment's detection limit at the time of this study. Further, because ART was considered medically indicated for women with HIV who had CD4+ cells/mm^3 count below 350, CD4+ cells/mm^3 were dichotomized as CD4 ≥ 350 or < 350. While the investigators considered examining the HIV biomarkers and ART adherence as continuous, these were only examined as dichotomous variables given their clinically significant cut-offs and as consistent with a large body of HIV research that uses similar cut-offs (e.g., Coovadia et al., 2007; De Luca et al., 2000; Terzian et al., 2009).

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS 20, 2011). All covariates, independent variables, and dependent variables were standardized by converting them to z-scores prior to conducting analyses. For descriptive purposes, preliminary analyses examined the relationships between all tense and affect predictors, the participants' age and education, income, and the wave of recruitment for WIHS participation (wave 1 = 1994–1995; wave 2 = 2001) using Pearson correlations. Further, age and wave of recruitment were examined in relation to the health indicators at T1 and T2 using Pearson correlations. Given the past literature indicating that HIV infected adults who are older tend to have better adherence rates than younger HIV-infected adults (Hinkin et al., 2004; Silverberg et al., 2007), age was included as a covariate in further analyses. Additionally, in order to account for the changes in HIV care between recruitment wave 1 (year 1994–1995) and wave 2 (2001), wave of recruitment into the larger study was also included as a covariate.

Primary analyses examined the main effects of tense and affect as predictors of ART adherence, viral load, and CD4+ cell counts T1 and at T2. Models were conducted separately for each health indicator (i.e., adherence, HIV viral load, and CD4+ cell count). Results are presented in three sections corresponding to each health outcome: ART adherence, HIV RNA load, and CD4+ cells/mm^3. Consistent with recommendations for analyzing longitudinal data over two time points provided by Cohen et al. (2013), the corresponding T1 health indicators were included as predictors of T2 health indicators (e.g., when predicting viral load at T2, viral load at T1 was included in the model). This conditional panel model allows for the removal of the potential influence of the health indicators at T1 on these health indicators at T2. We used a conditional change score model rather than calculating residualized change scores for the dependent variables because the conditional model is preferred when prior scores on a variable may affect current assessments of that variable (Finkel, 1995), which is the likely case in this study. A series of hierarchical logistic regression analyses were conducted to examine (1) the main effects of the linguistic features (use of affect words and past, present, and future tense words) on the

health outcomes of CD4+ cell count, viral load and the health behavior adherence for the outcomes at T1 and T2; (2) the interactive contribution of word tense and affect words on the same health indicators. Specifically, in the first step, variables included were participant age, wave of recruitment, and, for models examining health indicators at T2, T1 health indicators corresponding to the T2 health outcomes. The second step included the tense words (i.e. past tense, present tense, and future tense) and affect words (i.e. negative affect words and positive affect words). The third step included the tense words by affect word interactions, meaning that all six interactions were added to the models to examine these effects as predictors of health indicators. Interaction terms were calculated by creating scores consisting of multiplying standardized scores for each variable in the interaction. Significant interactions were interpreted by plotting the regression lines at 1.0 SD + and 1.0 SD− (See Figs. 1 and 2).

Results

Preliminary analyses

The average word count for narratives was 2072.10, *SD* = 1134.72. Although 98 participants completed the autobiographical task at T1, some participants were missing data for the health indicators either at T1 or T2. Therefore, 98 and 95 participants were respectively included in analyses examining viral load at T1 and T2; 98 and 96 participants were respectively included in analyses examining CD4+ cells/mm^3 count and 94 and 89 participants were respectively included in analyses examining ART adherence. At T1, 82 participants were on ART and 14 were not on ART; for 12 of these 14, ART was medically indicated based on having a low CD4+ count. These 12 participants were included in the analyses as being non-adherent to ART. At T2, 77 participants were on ART, and 19 were not on ART; for 12 of these 19, ART was indicated based on CD4 count clinical cutoffs. Similarly, these 12 were included in the models as non-adherent to ART.

The four most frequent major narrative themes were HIV, trauma (including abuse, assault, witnessing domestic violence, neglect, and abandonment), positive relationships with others, including improvement in relationships over time, and relational conflict/stress. Kappa reliabilities between two independent groups, each consisting of three coders (psychology undergraduate and graduate students) were moderate to high for each of the major themes (HIV Theme: $\kappa = 1.0$; $p < .001$, Trauma Theme: $\kappa = .78$, $p < .001$; Positive Relationships with Others: $\kappa = .87$, $p < .001$; Relationship Conflict/Stress: $\kappa = .83$, $p < .001$. In the case of disagreement between the two groups, final themes were decided by thorough discussion and consensus.

Table 2 displays descriptive information regarding the predictor variables. Pearson correlations indicate that age was significantly related to being 95% adherent to ART at T1 ($r = .20$, $p = .048$), and having an undetectable viral load at T1 ($r = .22$, $p = .027$) and T2 ($r = .22$, $p = .030$). Recruitment wave was significantly related to being 95% adherent to ART at T1 ($r = -.20$, $p = .044$) and T2 ($r = -.22$, $p = .036$), and having an undetectable viral load at T2 ($r = -.31$, $p = .002$). Income was significantly related to having 95% ART adherence at T2 ($r = .21$, $p = .047$), and having an undetectable viral load at T1 ($r = .22$, $p = .030$) and T2 ($r = .22$, $p = .033$). Education level was not significantly associated with any of the health indicators. Race was not included in analyses given that the vast majority of the participants were African American (89.8%), with insufficient racial diversity to investigate race effects. With the exception of recruitment wave being significantly related to negative affect word use ($r = .22$, $p = .033$), there were no significant relationships between the demographic variables and either tense words or affect words. Positive affect was related to both present tense words ($r = .48$, $p < .001$); and past tense words ($r = -.32$, $p = .001$), but not future tense words ($r = .02$, $p = .82$); and negative affect was related to past tense words ($r = .23$, $p < .024$) but not present tense words ($r = -.04$, $p = .68$) or future tense words ($r = .08$, $p = .38$).

Table 2 Descriptive statistics for predictor variables

Predictor	*N*	Min	Max	*M*	*SD*
Elapsed time in days	98	84	270	171.63	45.11
Positive affect	98	.82	5.12	2.12	.86
Negative affect	98	.00	2.96	1.29	.61
Past tense	98	2.36	11.56	8.11	1.80
Present tense	98	3.04	15.65	6.82	2.08
Future tense	98	.00	1.25	.51	.28

Means for the linguistic features are presented as percentages of total words used in the narratives

Primary analyses

ART adherence

At T1, no main effects or interactions between affect valence and tense were found predicting ART adherence. See Table 3 for additional result details. At T2 (controlling for T1), past tense usage significantly predicted odds of 95% adherence, such that a higher use of past tense words was associated with lower odds of being 95% adherent to ART (OR .48, p = .022). There were no significant interactions predicting odds of 95% adherence at T2 (See Table 4).

HIV RNA load

At T1, the results revealed that past tense usage significantly predicted lower odds of having an undetectable viral load (OR .53, p = .016). Further, present tense also predicted lower odds of having an undetectable viral load (OR .52, p = .024) word use. However, the results were qualified by a significant interaction between negative affect and present tense word use predicting viral load. The results indicate a significant crossover interaction between negative affect words and present tense words predicting odds of having an undetectable viral load (OR 2.10, p = .023). Specifically, at low levels of present tense word use, a higher use of negative affect words is associated with worse odds of having an undetectable viral load. However, at high levels of present tense word use, a higher use of negative affect words is associated with better odds of having an undetectable viral load (See Fig. 1). At T2 (controlling for T1), no main effects or interaction effects were found predicting HIV viral load. See Tables 3 and 4 for additional details.

CD4+ cells/mm^3

The results indicate that, at T1, a higher use of past tense words significantly predicted lower odds of having a higher CD4+ count (CD4+ cells/mm^3 above 350): (OR .54, p = .022). Further, there is a significant crossover interaction between future tense word use and positive affect word use (OR 1.85, p =.040), such that, at higher levels of future tense

Table 3 Hierarchical logistic regressions of word tense and affect predicting HIV related health indicators at T1

Variable	T1 adherence (N = 94)			T1 undetectable viral load (N = 98)			T1 CD4N > 350 (N = 98)		
	OR (95% CI)		p value	OR (95% CI)		p value	OR (95% CI)		p value
Step 1									
Recruitment wave	.71	(.41–1.22)	.213	.84	(.53–1.34)	.463	.84	(.53–1.34)	.469
Age	1.41	(.79–2.52)	.243	1.53	(.90–2.60)	.115	1.00	(.60–1.66)	.997
Step 2									
Positive affect	1.48	(.78–2.78)	.228	1.05	(.63–1.76)	.849	1.12	(.66–1.89)	.668
Negative affect	1.00	(.60–1.65)	.999	1.35	(.83–2.20)	.224	1.38	(.85–2.22)	.191
Past tense	.66	(.38–1.15)	.141	.53	(.32–.89)	.016	.54	(.32–.92)	.022
Present tense	.87	(.49–1.55)	.631	.52	(.30–.92)	.024	.80	(.47–1.36)	.409
Future tense	1.04	(.63–1.71)	.889	1.40	(.87–2.27)	.167	1.09	(.68–1.74)	.725
Step 3									
Recruitment wave	.75	(.41–1.37)	.349	.84	(.49–1.46)	.533	1.00	(.58–1.73)	.993
Age	1.65	(.90–3.01)	.106	1.71	(.95–3.08)	.074	1.08	(.62–1.89)	.774
Positive affect	1.55	(.72–3.33)	.258	1.01	(.56–1.84)	.972	1.24	(.61–2.50)	.552
Negative affect	.81	(.46–1.42)	.464	1.19	(.71–2.00)	.508	1.47	(.86–2.50)	.161
Past tense	.45	(.20–1.01)	.052	.49	(.29–.86)	.012	.45	(.25–.84)	.012
Present tense	.81	(.44–1.49)	.495	.50	(.26–.97)	.039	.78	(.43–1.47)	.466
Future tense	.89	(.49–1.62)	.694	1.51	(.88–2.59)	.135	1.18	(.69–2.02)	.547
Negative affect * past	1.65	(.84–3.26)	.146	1.28	(.74–2.23)	.378	1.08	(.61–1.93)	.789
Positive affect * past	.60	(.21–1.72)	.340	.92	(.52–1.61)	.764	.56	(.26–1.20)	.134
Negative affect * present	1.31	(.74–2.31)	.352	2.10	(1.11–3.98)	.023	1.79	(.99–3.26)	.056
Positive affect * present	1.24	(.66–2.31)	.502	1.23	(.71–2. 15)	.463	1.24	(.69–2.21)	.477
Negative affect * future	1.25	(.68–2.29)	.481	1.08	(.66–1.78)	.754	.96	(.60–1.52)	.850
Positive affect * future	.48	(.20–1.14)	.095	.99	(.60–1.64)	.968	1.85	(1.03–3.34)	.040

Table 4 Hierarchical logistic regressions of word tense and affect predicting HIV related health indicators at T2

Variable	T2 adherence (N = 89)			T2 undetectable viral load (N = 95)			T2 CD4N > 350 (N = 98)		
	OR (95% CI)		p value	OR (95% CI)		p value	OR (95% CI)		p value
Step 1									
Adherence at T1	2.53	(1.53–4.19)	.000						
Viral load at T1				7.16	(3.51–14.62)	.000			
CD4N > 350 at T1							6.11	(3.32–11.26)	.000
Recruitment wave	.77	(.44–1.33)	.765	.49	(.25–.96)	.038	.67	(.34–1.30)	.233
Age	1.37	(.72–2.62)	.342	.93	(.45–1.92)	.843	.56	(.28–1.24)	.162
Step 2									
Positive affect	.83	(.42–1.63)	.587	.86	(.41–1.79)	.835	1.40	(.59–3.33)	.452
Negative affect	.91	(.52–1.59)	.741	1.08	(.58–2.03)	.683	.84	(.43–1.64)	.607
Past tense	.48	(.25–.90)	.022	1.12	(.58–2.16)	.141	1.59	(.76–3.33)	.215
Present tense	1.63	(.78–3.41)	.196	1.29	(.57–2.88)	.177	.54	(.23–1.31)	.175
Future tense	1.43	(.81–2.51)	.218	.91	(.47–1.73)	.797	2.35	(1.09–5.05)	.029
Step 3									
Adherence at T1	3.71	(1.80–7.63)	.000						
Viral load at T1				9.50	(3.90–23.15)	.000			
CD4N > 350 at T1							15.18	(4.73–48.64)	.000
Recruitment wave	.55	(.26–1.16)	.116	.52	(.25–1.10)	.088	.70	(.30–1.64)	.405
Age	1.40	(.62–3.17)	.416	.99	(.44–2.19)	.970	.39	(.13–1.15)	.089
Positive affect	.89	(.39–2.03)	.788	.64	(.25–1.64)	.348	2.96	(.88–9.94)	.080
Negative affect	.71	(.35–1.42)	.329	1.41	(.63–3.17)	.407	.73	(.29–1.82)	.498
Past tense	.44	(.19–1.01)	.052	.94	(.44–2.01)	.870	1.52	(.71–3.23)	.280
Present tense	1.84	(.68–4.99)	.230	.86	(.35–2.12)	.738	.44	(.14–1.37)	.157
Future tense	1.99	(.90–4.34)	.089	1.00	(.47–2.16)	.993	4.11	(1.16–14.51)	.028
Negative affect * past	1.92	(.91–4.03)	.086	.80	(.42–1.54)	.506	1.14	(.53–2.45)	.744
Positive affect * past	1.51	(.64–3.56)	.349	1.01	(.56–1.82)	.966	2.96	(1.33–6.58)	.008
Negative affect * present	.50	(.22–1.15)	.103	.90	(.37–2.23)	.825	.69	(.26–1.85)	.465
Positive affect * present	1.50	(.51–4.47)	.463	2.04	(.87–4.76)	.100	1.62	(.40–6.61)	.501
Negative affect * future	.60	(.33–1.07)	.083	.94	(.53–1.67)	.831	1.04	(.54–2.02)	.904
Positive affect * future	1.41	(.70–2.84)	.335	.75	(.37–1.54)	.430	2.82	(.70–11.40)	.146

words, a higher use of positive affect words is associated with better odds of having CD4+ cells/mm^3 above 350. Conversely, at lower levels of future tense words, a higher use of positive affect is associated with worse odds of having CD4+ cells/mm^3 above 350. At T2 (controlling for T1), a higher use of future tense words is associated with higher odds of having CD4+ cells/mm^3 above 350 (OR 2.35, p = .029). Further, there is a significant crossover interaction between the use of positive affect and past tense word use predicting CD4+ cells/mm^3 above 350 at T2 (OR 2.96; p = .008). Specifically, at higher use of past tense words, a higher use of positive word use is associated with better odds of having CD4+ cells/mm^3 above 350. However, at lower levels of past tense words, there is no effect of positive affect word use and odds of having CD4+ cells/mm^3 above 350. (See Figs. 2 and 3) See Tables 3 and 4 for additional result details.

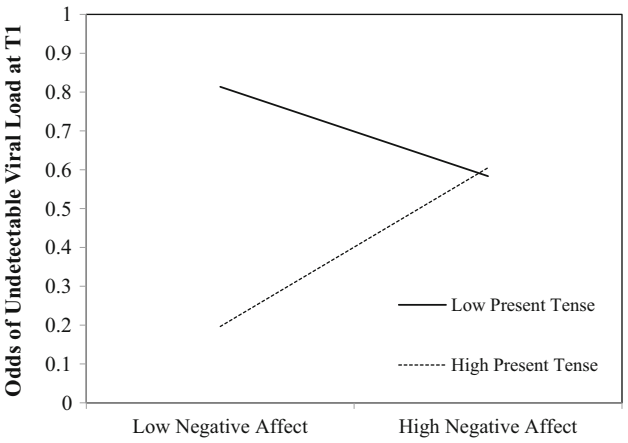

Fig. 1 Odds undetectable viral load at T1. Here shown are the odds of having an undetectable viral load (< 80 copies/ml of HIV RNA load) when participants used relatively low present tense words vs. high present tense words at low vs. high use of negative affect words

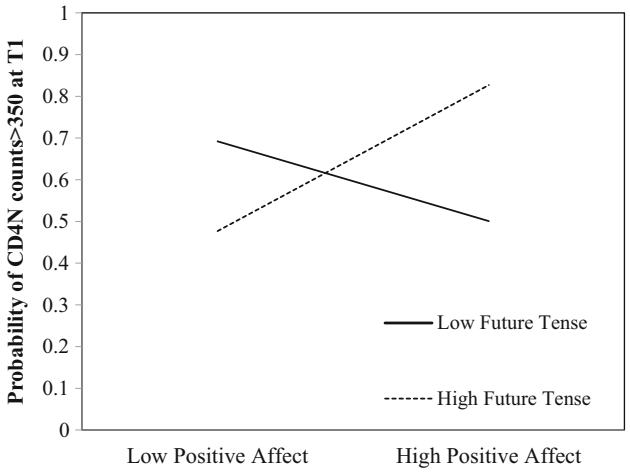

Fig. 2 Odds CD4N Counts > 350 at T1. Here shown are the odds of having CD4+ cells/mm^3 counts greater than 350 when participants used relatively low future tense words versus high future tense words at low versus high use of positive affect words

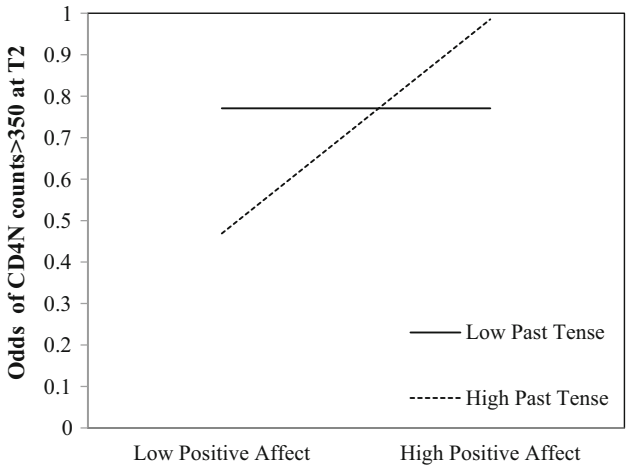

Fig. 3 Odds CD4N Counts > 350 at T2. Here shown are the odds of having CD4+ cells/mm^3 counts greater than 350 at T2 when participants used relatively low past tense words versus high past tense words at low versus high use of positive affect words

Discussion

Our study provides evidence that, in women with HIV, linguistic features—specifically, the frequencies of words connoting tense and positive and negative affect in autobiographical narratives—relate to concurrent immune functioning, as well as changes in ART adherence and immune functioning over time. The data confirm our hypotheses that high levels of past tense word use expressed in autobiographical accounts relate to negative health behaviors and outcomes—specifically, worse adherence to ART over a 3 to 9-month follow-up period, as well as worse concurrent CD4+ cells/mm^3 count and viral load. Also confirming our hypotheses were that past tense word use in the presence of positive affect words expressed in autobiographical accounts related to better biomarkers 6 months subsequently, i.e. a higher follow-up CD4+ cell count. Expressing a higher frequency of positive affect words in the context of higher future tense word usage related to higher concurrent CD4+ cells/mm^3 count. Finally, relatively high negative affect word usage in the context of relatively high present tense usage was predictive of a higher likelihood of having concurrent undetectable viral load. These findings add to the literature on health outcomes in people with HIV, providing evidence relating specific linguistic narrative features (affect valence and word tense) to HIV-specific health behaviors and immune functioning (Esterling et al., 1994; Pennebaker et al., 1997; Pennebaker & Seagal, 1999; Petrie et al., 2004).

Our findings that a higher use of past tense words was related to lower concurrent CD4+ counts, concurrent undetectable viral load, and less ART adherence over time, is consistent with the view that a relatively high focus on the past when disclosing stressful life experiences, may make it difficult to adaptively respond to present moment stresses (Weinstein et al., 2009), and perhaps compromise immune functioning (Leserman et al., 2000). However, in the context of a higher use of past tense words, using positive affect words when expressing stressful life experiences was predictive of better immune functioning, i.e., higher CD4+ cells/mm^3 above 350, several months subsequent to narrative administration. This finding is consistent with the literature indicating that positive reappraisal of past stressful life events is associated with good health outcomes—a process that may be related to meaning-making, or the redemption of a painful or negative experience (Cruise, 2014; McAdams, 2006). These findings are in line with the idea posited by Tugade and Fredrickson (2004) that positive affect may help individuals engage in healthy coping behaviors.

In the context of a higher use of future tense words, using more positive affect words also related to better concurrent health (CD4+ cells/mm^3 above 350). However, using more positive affect words with lower use of future tense words was associated with concurrent worse CD4+ counts (lower odds of having CD4+ cells/mm^3 above 350). Thus, these results suggest that the expression of positive affect alone may not be enough to benefit health of women with HIV—but rather that expressing positive affect in the context of a past or future oriented focus may be helpful. Other research has indicated that an optimistic future-oriented view is beneficial to health (Schou et al., 2005) and serves as a motivational antecedent that predicts engagement in healthy behaviors (e.g., exercise; Kahana et al., 2005). It is possible that having positive feelings about the

future helps maintain interest in tasks necessary to achieve future goals and good health (Aspinwall, 2005).

Finally, results also indicated that expressing negative affect in the context of present tense words was predictive of having better odds of having an undetectable viral load concurrently. Although these findings are focused on the expression of negative affect words and not necessarily negative emotional experiences, given the assumption that expression and experience of emotion are reciprocal and synergistic (Lambert et al., 2013), this finding provides support for Fredrickson's (2001) theoretical model that a focus on negative affect in the immediate moment serves to narrow cognitive focus and may motivate immediate change, enabling actions that may lead to "direct and immediate benefit" in current threatening situations (Fredrickson, 2001; Fredrickson & Branigan, 2005). Another explanation for this interaction may be that individuals who used more negative affect words and higher present tense words were more insightful and aware of ongoing stressful life experiences, reflecting higher levels of cognitive and emotional processing, which has previously been linked to health benefits (Greenberg et al., 1996; Lepore et al. 2000; Pennebaker & Seagal, 1999).

It is also possible that the relationship between health outcomes and the frequency with which participants used affect or tense words was influenced by interactions between the content of narratives and participants' personality characteristics. More specifically, narratives with high positive affect may also have included more positive events, with positive health outcomes due to those participants actually having had fewer stressful life experiences. Further, those who used more past tense words may have been lower in experiential avoidance and higher in conscientiousness, cooperating with the task demand of narrating three events that had happened in the past. Since the majority of the sample narrated past events that were traumatic or related to their HIV diagnosis, participants who were high in avoidance or who had experienced higher levels of trauma might focus on the present or future instead of the past. Similarly, those who focused on the present might have been higher in dispositional mindfulness. These personality characteristics may have influenced health behaviors and immune functioning, perhaps mediated or moderated by emotional expression and word usage. Further research is needed to explore these possibilities.

Noteworthy in our results, neither tense or affect word usage predicted concurrent levels of ART adherence, but at the 6-month follow up, adherence was significantly negatively related to past tense usage. Perhaps this indicates that talking about the past, especially if traumatic, may reciprocally relate to subsequent negative experiences or rumination in a downward spiral that affects later health behaviors. The reverse was true of HIV viral load: at the 6-month follow-up, none of the narrative word usage variables significantly related to viral load; but higher concurrent viral load did significantly relate to high past and present word tense use and lower concurrent viral load significantly related to high present tense use with high negative affect. This suggests that the way in which people linguistically process their life experiences may be related to their concurrent immune functioning, with one explanation being that having worse viral load and feeling ill might impact participants' mood states and how they perceive and narrate information about their lives. Alternatively, psychological factors such as emotional expression may mediate the cross-talk that occurs between the immunological and neurological systems, with the immune system being sensitive to emotional signals or perceptions of danger or safety so that it can maintain the body's adaptation in the face of environmental, social, and emotional stressors (Ziemssen & Kern, 2007). As consistent with these ideas, higher levels of CD4+ count (with higher levels associated with healthier immune function), was significantly positively related to concurrent use of positive affect and future tense words (perhaps reflecting optimism), and significantly negatively related to using past tense words (perhaps reflecting a focus on or even rumination about previous traumas). Using positive affect and past tense words (perhaps reflecting meaning making) as well as future word tense was significantly positively related to higher CD4+ count 6 months later. The pattern of results as to how linguistic markers relate to concurrent as compared to future immune system functioning and health behaviors requires replication and further investigation.

A primary limitation of this study is the small sample size, which may have resulted in underpowered regressions which increased the probability of spurious findings. Further, the study examines a sample of women with many vulnerabilities, including ethnic minority status, having an HIV diagnosis and a significant trauma history. These demographics and multiple vulnerabilities may limit the generalizability of the study and highlight the need to replicate the study in samples with different demographics as well with larger numbers of participants. In particular, because our participants had such high levels of trauma, talking about the past may be especially stressful for them in contrast to other samples. Nevertheless, the findings shed light on and increase our understanding of a hard-to reach and underserved population.

Another limitation of the study is that we cannot determine the specific cognitive or social processes that might account for the relationships we found between linguistic features and health outcomes. It is possible that the linguistic features of the narratives reflect a general cognitive style that affects health on an ongoing basis. The fact that there was a 6-month range in when the follow-up assessment of health indicators was collected (T2), and that

significant relationships were found nonetheless, suggests that the pattern of results may reflect habitual or dispositional tendencies as discussed above. Alternatively, participating in a study in which autobiographical narratives are shared with an interested listener may have therapeutic effects on emotional experiences and/or immune functioning at a subsequent point in time. Narrating stressful or important life experiences either orally or in writing, when compared to narrating neutral events, has been found to facilitate cognitive processing and allow for reappraisal of negative experiences, resulting in better health outcomes (Greenberg et al., 1996; Pennebaker & Seagal, 1999), including better immune functioning (decreased viral load and increased CD4+ cell count) in men with HIV (Petrie et al., 2004).

Another limitation of the study is that the participants were asked to identify three turning points in their lives without specific instructions as to what they might discuss. The major linguistic variables of interest (tense and affect valence) were not targeted during the data collection stage, which may have masked or changed the nature of the relationships between these variables and health outcomes. Additionally, although the LIWC word categories have been used extensively and been found to relate significantly to health outcomes in previous research (Alpers et al., 2005; Bantum & Owen, 2009; Tausczik & Pennebaker, 2010), they are somewhat broad, may not include all words encompassing positive and negative affect, and may not correspond exactly with other categorizations of affect or word tense. However, the most frequent themes described in the narratives (e.g., trauma) were consistent with content that has emerged in other studies examining emotionally laden narratives (Petrie et al., 1995, 2004). Further, the instructions allowed participants to provide an ecologically valid sample of how they tell the story of their lives, perhaps providing a more meaningful sample of word use.

It bears explanation that our findings varied across health outcome indicators. It would be more logical to expect that health indicators corroborate each other—i.e. if a participant has low viral load, they should have high adherence and a high CD4+ cell count. The discrepancies across health indicators may be due to a number of factors including: (1) individual participant differences in the magnitude of viral load prior to ART initiation (Murray et al., 1999); (2) the amount of time participants were on ART medication; prognosis is best predicted by CD4+ cell count and HIV RNA response after 6 months of treatment (Antiretroviral Therapy Cohort Collaboration et al., 2003); and (3) individual differences in rates at which HIV-1 viral load concentration declines and CD4+ cell counts recover (Kaufmann et al., 2003). However, finding significant effects on adherence, CD4+ cell counts and viral load with a small sample that was studied many years after the immediately post-ART initiation period, is a strength of the study and indicates that the way women with HIV tell the stories of their lives impacts both health behaviors and immune functioning—even long after ART therapy has been initiated. The average length of time women in this sample were on ART is 9.17 years and the range was 6-months to 14.90 years.

This work provides preliminary evidence for the relationship between specific linguistic features in relation to HIV-related health outcomes among women with HIV, supporting some aspects of Frederickson's broaden and build theory (Fredrickson, 2001) as well as Carver's theoretical discussion of the motivational aspects of emotion (Carver, 2001). Women with HIV whose life stories are marked by a lack of positive affect word usage when talking about either the past or the future may be at particular risk for poor health outcomes. In contrast, the expression of negative affect words in the context of present tense words when expressing life experiences may relate to better immune functioning. Replication studies are needed in order to support these findings both in other samples of participants with HIV as well as community samples, to provide further evidence on the relationships among language use, health behaviors, and immune functioning, and to guide future steps to improve health.

Acknowledgements We would like to thank the WIHS participants and WIHS staff, especially Sally Urwin, Cheryl Watson, and Karlene Schowalter, who collected and managed data, and Sannisha Dale, Gwendolyn Kelso and Ruth Cruise who transcribed and coded data.

Funding This study was funded by the National Institute of Allergy and Infectious Diseases Grant U01-AI-34994 (PIs, Dr. Mardge Cohen and Dr. Audrey French) and co-funded by the National Cancer Institute and National Institute of Drug Abuse. The contents of this publication are solely the responsibility of the authors and do not necessarily represent the views of the National Institutes of Health.

Compliance with ethical standards

Conflict of interest Yudelki M. Firpo-Perretti, Mardge H. Cohen, Kathleen M. Weber, and Leslie R. Brody declare that they have no conflict of interest.

Human and animal rights and Informed consent All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

References

Abaasa, A. M., Todd, J., Ekoru, K., Kalyango, J. N., Levin, J., Odeke, E., et al. (2008). Good adherence to HAART and improved survival in a community HIV/AIDS treatment and care pro-

gramme: The experience of The AIDS Support Organization (TASO), Kampala, Uganda. *BMC Health Services Research, 8,* 241.

Alpers, G. W., Winzelberg, A. J., Classen, C., Roberts, H., Dev, P., Koopman, C., et al. (2005). Evaluation of computerized text analysis in an Internet breast cancer support group. *Computers in Human Behavior, 21,* 361–376.

Aspinwall, L. G. (2005). The psychology of future-oriented thinking: From achievement to proactive coping, adaptation, and aging. *Motivation and Emotion, 29,* 203–235.

Bantum, E. O., & Owen, J. E. (2009). Evaluating the validity of computerized content analysis programs for identification of emotional expression in cancer narratives. *Psychological Assessment, 21,* 79.

Barkan, S. E., Melnick, S. L., Preston-Martin, S., Weber, K., Kalish, L. A., Miotti, P., et al. (1998). The women's interagency HIV Study. *Epidemiology, 9,* 117–125.

Boals, A., Banks, J. B., Hathaway, L. M., & Schuettler, D. (2011). Coping with stressful events: Use of cognitive words in stressful narratives and the meaning-making process. *Journal of Social and Clinical Psychology, 30,* 378–403.

Boals, A., & Klein, K. (2005). Word use in emotional narratives about failed romantic relationships and subsequent mental health. *Journal of Language and Social Psychology, 24,* 252–268.

Bodenhausen, G. V., Sheppard, L. A., & Kramer, G. P. (1994). Negative affect and social judgment: The differential impact of anger and sadness. *European Journal of Social Psychology, 24,* 45–62.

Brody, L. R., Jack, D. C., Bruck-Segal, D. L., Ruffing, E. G., Firpo-Perretti, Y. M., Dale, S. K., et al. (2016). Life lessons from women with HIV: Mutuality, self-awareness, and self-efficacy. *AIDS Patient Care and STDs, 30,* 261–273.

Carrico, A. W., Johnson, M. O., Colfax, G. N., & Moskowitz, J. T. (2010). Affective correlates of stimulant use and adherence to anti-retroviral therapy among HIV-positive methamphetamine users. *AIDS and Behavior, 14,* 769–777.

Carrico, A. W., & Moskowitz, J. T. (2014). Positive affect promotes engagement in care after HIV diagnosis. *Health Psychology, 33,* 686.

Carver, C. S. (2001). Affect and the functional bases of behavior: On the dimensional structure of affective experience. *Personality and Social Psychology Review, 5,* 345–356.

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135,* 183.

Carver, C. S., Scheier, M. F., & Segerstrom, S. C. (2010). Optimism. *Clinical Psychology Review, 30,* 879–889.

Chesney, M. (2003). Adherence to HAART regimens. *AIDS Patient Care and STDs, 17,* 169–177.

Chung, C. K., & Pennebaker, J. W. (2008). Revealing dimensions of thinking in open-ended self-descriptions: An automated meaning extraction method for natural language. *Journal of Research in Personality, 42,* 96–132.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge. Retrieved from https://books.google.com/books?hl=en&lr=&id=gkalyqTMXNEC&oi=fnd&pg=PP1&dq=Cohen,+J.,+Cohen,+P.,+West,+S.+G.,+%26+Aiken,+L.+S.+(2013).+Applied+multiple+regression/correlation+analysis+for+the+behavioral+sciences.+Routledge.&ots=tQKTZ3p8ff&sig=XFEocy-4UXjfSJE03fQxbbCEvW4

Cohen, M., Deamant, C., Barkan, S., Richardson, J., Young, M., Holman, S., et al. (2000). Domestic violence and childhood sexual abuse in HIV-infected women and women at risk for HIV. *American Journal of Public Health, 90,* 560–565.

Cohen, S., Doyle, W. J., Turner, R. B., Alper, C. M., & Skoner, D. P. (2003). Emotional style and susceptibility to the common cold. *Psychosomatic Medicine, 65,* 652–657.

Cohen, S., Miller, G. E., & Rabin, B. S. (2001). Psychological stress and antibody response to immunization: A critical review of the human literature. *Psychosomatic Medicine, 63,* 7–18.

Collaboration, A. T. (ART) C, et al. (2003). Prognostic importance of initial response in HIV-1 infected patients starting potent antiretroviral therapy: Analysis of prospective studies. *The Lancet, 362,* 679–686.

Coovadia, H. M., Rollins, N. C., Bland, R. M., Little, K., Coutsoudis, A., Bennish, M. L., et al. (2007). Mother-to-child transmission of HIV-1 infection during exclusive breastfeeding in the first 6 months of life: An intervention cohort study. *The Lancet, 369,* 1107–1116.

Cruise, R. (2014). *Benefit-finding and coherence in the narratives of women with HIV*. Retrieved from https://open.bu.edu/handle/2144/15170

Davidson, K. W., & Mostofsky, E. (2010). Anger expression and risk of coronary heart disease: Evidence from the Nova Scotia Health Survey. *American Heart Journal, 159,* 199–206.

De Luca, A., Giancola, M. L., Ammassari, A., Grisetti, S., Paglia, M. G., Gentile, M., et al. (2000). The effect of potent antiretroviral therapy and JC virus load in cerebrospinal fluid on clinical outcome of patients with AIDS-associated progressive multifocal leukoencephalopathy. *Journal of Infectious Diseases, 182,* 1077–1083.

Dockray, S., & Steptoe, A. (2010). Positive affect and psychobiological processes. *Neuroscience and Biobehavioral Reviews, 35,* 69–75.

Eng, P. M., Fitzmaurice, G., Kubzansky, L. D., Rimm, E. B., & Kawachi, I. (2003). Anger expression and risk of stroke and coronary heart disease among male health professionals. *Psychosomatic Medicine, 65,* 100–110.

Esterling, B. A., Antoni, M. H., Fletcher, M. A., Margulies, S., & Schneiderman, N. (1994). Emotional disclosure through writing or speaking modulates latent Epstein-Barr virus antibody titers. *Journal of Consulting and Clinical Psychology, 62,* 130.

Finkel, S. E. (1995). *Causal analysis with panel data*. Sage. Retrieved from https://books.google.com/books?hl=en&lr=&id=WJI5iN-AwHEC&oi=fnd&pg=PR4&dq=Finkel,+S.+E.+(1995).+Causal+analysis+with+panel+data+(No.+105).+Sage.+&ots=Nvy_XZ7uc5&sig=zxipdxWbESKy5agmsGk2ZlWBSQE

Francis, M. E., & Pennebaker, J. W. (1992). Putting stress into words: The impact of writing on physiological, absentee, and self-reported emotional well-being measures. *American Journal of Health Promotion, 6,* 280–287.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2,* 300.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56,* 218–226. https://doi.org/10.1037//0003-066X.56.3.218

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19,* 313–332.

Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion, 12,* 191–220.

Graham, J. E., Lobel, M., Glass, P., & Lokshina, I. (2008). Effects of written anger expression in chronic pain patients: Making meaning from pain. *Journal of Behavioral Medicine, 31,* 201–212.

Greenberg, M. A., Wortman, C. B., & Stone, A. A. (1996). Emotional expression and physical heath: Revising traumatic memories or fostering self-regulation? *Journal of Personality and Social Psychology, 71,* 588.

Hinkin, C. H., Hardy, D. J., Mason, K. I., Castellon, S. A., Durvasula, R. S., Lam, M. N., et al. (2004). Medication adherence in HIV-infected adults: Effect of patient age, cognitive status, and substance abuse. *AIDS (London, England), 18*(Suppl 1), 19.

Kahana, E., Kahana, B., & Zhang, J. (2005). Motivational antecedents of preventive proactivity in late life: Linking future orientation and exercise. *Motivation and Emotion, 29,* 438–459.

Kahn, J. H., Tobin, R. M., Massey, A. E., & Anderson, J. A. (2007). Measuring emotional expression with the Linguistic Inquiry and Word Count. *The American Journal of Psychology, 120,* 263–286.

Kaufmann, G. R., Perrin, L., Pantaleo, G., Opravil, M., Furrer, H., Telenti, A., et al. (2003). CD4 T-lymphocyte recovery in individuals with advanced HIV-1 infection receiving potent antiretroviral therapy for 4 years: The Swiss HIV Cohort Study. *Archives of Internal Medicine, 163,* 2187–2195.

Klein, K., & Boals, A. (2010). Coherence and narrative structure in personal accounts of stressful experiences. *Journal of Social and Clinical Psychology, 29,* 256–280.

Lam, D., Schuck, N., Smith, N., Farmer, A., & Checkley, S. (2003). Response style, interpersonal difficulties and social functioning in major depressive disorder. *Journal of Affective Disorders, 75,* 279–283.

Lambert, N. M., Gwinn, A. M., Baumeister, R. F., Strachman, A., Washburn, I. J., Gable, S. L., et al. (2013). A boost of positive affect: The perks of sharing positive experiences. *Journal of Social and Personal Relationships, 30,* 24–43.

Lepore, S. J. (1997). Expressive writing moderates the relation between intrusive thoughts and depressive symptoms. *Journal of Personality and Social Psychology, 73,* 1030.

Lepore, S. J., & Greenberg, M. A. (2002). Mending broken hearts: Effects of expressive writing on mood, cognitive processing, social adjustment and health following a relationship breakup. *Psychology and Health, 17,* 547–560.

Lepore, S., Ragan, J., Jones, S., & Insko, C. A. (2000). Talking facilitates cognitive-emotional processes of adaptation to an acute stressor. *Journal of Personality and Social Psychology, 78,* 499–508.

Leserman, J., Petitto, J. M., Golden, R. N., Gaynes, B. N., Gu, H., Perkins, D. O., et al. (2000). Impact of stressful life events, depression, social support, coping, and cortisol on progression to AIDS. *American Journal of Psychiatry, 157,* 1221–1228.

Marsland, A. L., Cohen, S., Rabin, B. S., & Manuck, S. B. (2006). Trait positive affect and antibody response to hepatitis B vaccination. *Brain, Behavior, and Immunity, 20,* 261–269.

McAdams, D. P. (2006). The redemptive self: Generativity and the stories Americans live by. *Research in Human Development, 3,* 81–100.

Moore, S. D., & Brody, L. R. (2009). Linguistic predictors of mindfulness in written self-disclosure narratives. *Journal of Language and Social Psychology*. Retrieved from http://jls.sagepub.com/content/early/2009/05/13/0261927X09335264.short

Murray, J. S., Elashoff, M. R., Iacono-Connors, L. C., Cvetkovich, T. A., & Struble, K. A. (1999). The use of plasma HIV RNA as a study endpoint in efficacy trials of antiretroviral drugs. *Aids, 13,* 797–804.

Newman, M. L., Pennebaker, J. W., Berry, D. S., & Richards, J. M. (2003). Lying words: Predicting deception from linguistic styles. *Personality and Social Psychology Bulletin, 29,* 665–675.

Nieuwkerk, P. T., & Oort, F. J. (2005). Self-reported adherence to antiretroviral therapy for HIV-1 infection and virologic treatment response: A meta-analysis. *Journal of Acquired Immune Deficiency Syndromes, 38,* 445–448.

Paterson, D. L., Swindells, S., Mohr, J., Brester, M., Vergis, E. N., Squier, C., et al. (2000). Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. *Annals of Internal Medicine, 133,* 21–30.

Pennebaker, J. W., & Beall, S. (1986). Confronting a traumatic event: Toward an understanding of inhibition and disease. *Journal of Abnormal Psychology, 95,* 274–281.

Pennebaker, J. W., Booth, R. J., & Francis, M. E. (2007a). *Operator's manual: Linguistic inquiry and word count: LIWC2007*. Austin, TX: Liwc. Net.

Pennebaker, J. W., Chung, C. K., Ireland, M., Gonzales, A., & Booth, R. J. (2007b). *The development and psychometric properties of LIWC2007: LIWC. net*.

Pennebaker, J. W., & Francis, M. E. (1996). Cognitive, emotional, and language processes in disclosure. *Cognition and Emotion, 10,* 601–626.

Pennebaker, J. W., Francis, M. E., & Booth, R. J. (2001). Linguistic inquiry and word count: LIWC 2001. *Mahway: Lawrence Erlbaum Associates, 71*(2001), 2001.

Pennebaker, J., & Graybeal, A. (2001). Patterns of natural language use: Disclosure, personality, and social integration. *Current Directions in Psychological Science, 10,* 90–93.

Pennebaker, J. W., Kiecolt-Glaser, J., & Glaser, R. (1988). Disclosure of traumas and immune function: Health implications for psychotherapy. *Journal of Consulting and Clinical Psychology, 56,* 239–245.

Pennebaker, J. W., Mayne, T. J., & Francis, M. E. (1997). Linguistic predictors of adaptive bereavement. *Journal of Personality and Social Psychology, 72,* 863.

Pennebaker, J. W., Mehl, M. R., & Niederhoffer, K. G. (2003). Psychological aspects of natural language use: Our words, our selves. *Annual Review of Psychology, 54,* 547–577.

Pennebaker, J. W., & Seagal, J. D. (1999). Forming a story: The health benefits of narrative. *Journal of Clinical Psychology, 55,* 1243–1254.

Petrie, K. J., Booth, R. J., Pennebaker, J. W., Davison, K. P., & Thomas, M. G. (1995). Disclosure of trauma and immune response to a hepatitis B vaccination program. *Journal of Consulting and Clinical Psychology, 63,* 787.

Petrie, K. J., Fontanilla, I., Thomas, M. G., Booth, R. J., & Pennebaker, J. W. (2004). Effect of written emotional expression on immune function in patients with human immunodeficiency virus infection: a randomized trial. *Psychosomatic Medicine, 66,* 272–275.

Ramírez-Esparza, N., & Pennebaker, J. W. (2006). Do good stories produce good health? Exploring words, language, and culture. *Narrative Inquiry, 16,* 211–219.

Rude, S., Gortner, E.-M., & Pennebaker, J. (2004). Language use of depressed and depression-vulnerable college students. *Cognition and Emotion, 18,* 1121–1133.

Schou, I., Ekeberg, Ø., & Ruland, C. M. (2005). The mediating role of appraisal and coping in the relationship between optimism–pessimism and quality of life. *Psycho-Oncology, 14,* 718–727.

Schwartz, G. E., Weinberger, D. A., & Singer, J. A. (1981). Cardiovascular differentiation of happiness, sadness, anger, and fear following imagery and exercise1. *Psychosomatic Medicine, 43,* 343–364.

Silverberg, M. J., Leyden, W., Horberg, M. A., DeLorenze, G. N., Klein, D., & Quesenberry, C. P. (2007). Older age and the response to and tolerability of antiretroviral therapy. *Archives of Internal Medicine, 167,* 684–691.

Sloan, D., & Marx, B. (2004). Taking pen to hand: Evaluating theories underlying the written disclosure paradigm. *Clinical Psychology: Science and Practice, 11,* 121–137.

Smith, T. W., Glazer, K., Ruiz, J. M., & Gallo, L. C. (2004). Hostility, anger, aggressiveness, and coronary heart disease: An interpersonal perspective on personality, emotion, and health. *Journal of Personality, 72,* 1217–1270.

Stanton, A. L., Danoff-Burg, S., Sworowski, L. A., Collins, C. A., Branstetter, A. D., Rodriguez-Hanley, A., et al. (2002). Randomized, controlled trial of written emotional expression and benefit finding in breast cancer patients. *Journal of Clinical Oncology, 20,* 4160–4168.

Steptoe, A., Dockray, S., & Wardle, J. (2009). Positive affect and psychobiological processes relevant to health. *Journal of Personality, 77,* 1747–1776.

Tausczik, Y. R., & Pennebaker, J. W. (2010). The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology, 29,* 24–54.

Terzian, A. S., Holman, S., Nathwani, N., Robison, E., Weber, K., Young, M., et al. (2009). Factors associated with preclinical disability and frailty among HIV-infected and HIV-uninfected women in the era of cART. *Journal of Women's Health, 18,* 1965–1974.

Tugade, M. M., & Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *Journal of Personality and Social Psychology, 86,* 320.

Walsh, J. C., Mandalia, S., & Gazzard, B. G. (2002). Responses to a 1 month self-report on adherence to antiretroviral therapy are consistent with electronic data and virological treatment outcome. *Aids, 16,* 269–277.

Weinstein, N., Brown, K. W., & Ryan, R. M. (2009). A multi-method examination of the effects of mindfulness on stress attribution, coping, and emotional well-being. *Journal of Research in Personality, 43,* 374–385.

Wilson, T. E., Weedon, J., Cohen, M. H., Golub, E. T., Milam, J., Young, M. A., et al. (2016). Positive affect and its association with viral control among women with HIV infection. *Journal of Health Psychology, 36,* 91–100.

Wright, D. O., Crawford, E., & Sebastian, K. (2007). Positive resolution of childhood sexual abuse experiences: The role of coping, benefit-finding and meaning-making. *Journal of Family Violence, 22,* 597–608. https://doi.org/10.1007/s10896-007-9111-1

Ziemssen, T., & Kern, S. (2007). Psychoneuroimmunology—Cross-talk between the immune and nervous system. *Journal of Neurology, 254,* 8–11. https://doi.org/10.1007/s00415-007-200308