Bendola Publishing
Psychoneuroimmunology Journal
Vol. 2 (2021), Article ID 246121, 8 pages
doi:10.32371/pnij/246121

Research Article

Associations Between Linguistic Markers of Emotion Regulation and Cardiovascular Disease-Related Inflammation

Anoushka D. Shahane,[1] Christopher P. Fagundes,[1,2,3] Stephen L. Buka,[4] and Bryan T. Denny[1]

[1] *Rice University, Houston, TX 77030, USA*
[2] *MD Anderson Cancer Center, The University of Texas, Houston, TX 77030, USA*
[3] *Baylor College of Medicine, Houston, TX 77030, USA*
[4] *Brown University, Providence, RI 02912, USA*
Address correspondence to Anoushka D. Shahane, anoushka.shahane@rice.edu

Received 19 February 2021; Revised 1 September 2021; Accepted 10 September 2021

Abstract Psychological distancing is a way to regulate emotion by appraising a stimulus with an objective perspective or with spatial/temporal distance. Implicit linguistic distancing (LD) is the degree to which one implements psychological distancing through natural language. Recent work shows that LD is positively associated with successful emotion regulation, and with self-reported indicators of health and well-being. However, the relationship between implicit LD and validated health biomarkers, such as those predictive of cardiovascular disease, remains unexplored. The present study investigates the association between implicit LD and C-reactive protein among participants ($N = 235$) from the New England Family Study. Participants completed questionnaires, an oral prompt, which was then transcribed for the LD analysis, and a blood draw. Implicit LD was negatively associated with C-reactive protein levels. LD was associated with other self-reported health measures that are validated risk factors for cardiovascular disease, including depression, anxiety, and general health. Although correlational, the findings suggest that implicit LD may be protective and adaptive.

Keywords C-reactive protein; emotion regulation; cardiovascular disease; inflammation; linguistic distancing

1. Introduction

Cognitive reappraisal is an adaptive strategy to regulate one's emotions, that involves changing the meaning of an emotionally evocative stimulus [1,2,3]. Indeed, the ability to manage emotions is vital for physical and mental well-being [1,4] and has been shown to be associated with several positive health indicators [2,4,5,6,7,8]. Cognitive reappraisal can be implemented in several ways; one tactic of interest is psychological distancing. Psychological distancing involves changing one's appraisal of an emotional stimulus by employing an objective and impartial perspective and/or increasing the perceived spatial and temporal distance between oneself and the stimulus [9, 10].

Shifting language to reflect psychological distancing helps regulate negative affect; distance to the stimulus reduces the negative affect. The language can encode the distance [2,10,11]. Spontaneously adopting a distanced perspective reduces maladaptive rumination (i.e., thinking about negative stimuli for extended periods). Implementing distanced lexical shifts has also been shown to reduce stress [12,13,14].

Language-based evidence of psychological distancing, referred to as linguistic distancing, has been indexed with a standardized composite metric of one's frequency of first-person singular pronouns, articles, discrepancy words, words greater than six letters, and present-tense verbs. These particular lexical components best track verbal immediacy and have been used to index linguistic distancing in previous literature [8,15,16,17,18]. For example, a sentence reflecting high levels of linguistic distancing could be "*This car crash happened far away from me, medical help was at the scene, and no one was seriously hurt*." More specifically, the sentence incorporates elements of spatial and temporal distance as well as objectivity. Individuals who implicitly (i.e., without any instruction) distanced their language showed associations between this particular linguistic distancing metric and emotion regulation efficacy, indicating that they were more successful at reducing negative affect [17]. In addition, when participants were instructed to implement distanced lexical shifts in their language, greater linguistic distancing was also associated with multiple positive self-reported health indicators, including fewer symptoms of depression, perceived stress, and difficulties in emotion regulation; better emotional well-being, vitality, and social functioning; and increased reappraisal frequency [8]. Although linguistic distancing has been studied in the context of stress, and often with participants who are instructed to implement distanced lexical shifts, no study has yet related *implicitly* (i.e., without instruction to regulate) linguistic distancing to stress-related markers of cardiovascular disease.

Stressful events and the negative emotions they generate can promote elevations in biomarkers of systemic inflammation, such as C-reactive protein (CRP) [19]. CRP is an acute-phase protein produced by the liver; it goes up in response to immune cytokines in peripheral blood [20]. Widely known as an index of cardiovascular risk, elevated CRP levels also predict all-cause mortality [21]. Indeed, the capacity to regulate emotions is crucial for healthy cardiac functioning [22,23,24,25,26]. Based on work showing that linguistic distancing promotes good self-reported health and positive emotion regulation strategies, we sought to understand whether it is also associated with CRP, a clinically meaningful health biomarker. While cognitive reappraisal frequency was shown to be associated with lower levels of CRP [22], no work has demonstrated how implicit (i.e., with no instruction to regulate or implement distanced lexical shifts) linguistic distancing relates to CRP. Kross and Ayduk [11] suggest that distancing may be associated with attenuated cardiovascular reactivity. In addition to CRP, depression, anxiety, optimism, and general health all serve as additional risk factors for cardiovascular disease [27,28]. Thus, we sought to understand if linguistic distancing is associated with these self-reported measures of risk for cardiovascular disease.

Indeed, examining linguistic mechanisms of psychological distancing sheds light into implicit psychological processes that may otherwise be indiscernible. The present work disentangles complex psychological processes using a recently validated linguistic distancing measure [8,17,29]. The novelty of this implicit measure of psychological distancing via language, therefore, merits investigation. Thus, the present work aimed to examine the association between a relatively stable marker of systemic inflammation that has shown to be responsive to chronic stress, CRP, and the novel linguistic distancing metric.

The present study aimed to probe aspects of previously posited affect-immune theoretical models. For example, Thayer and Lane's (2000) neurovisceral integration in emotion regulation and dysregulation model outlined the physiological systems that subserve the relationship between attentional regulation and affective processes [30]. Notably, Williams et al. (1999) posited that research must identify specific emotional risk factors that may signal resilience to promote cardiovascular health [31]. In the current study, we investigated inflammation as one explanatory potential physiological mechanism that may account for the relationship between negative emotions and immune dysregulation.

The present study examined how behavior—i.e., implicit utilization of psychological distancing via distanced lexical shifts—specifically encodes affective processes related to physiological responses. In keeping with Kiecolt-Glaser et al.'s (2002) framework relating negative emotions to immune and endocrine dysregulation [32], Lopez et al.'s (2019) neuro-immuno-affective framework suggested that during emotion regulation, activity in the ventro- and dorsolateral prefrontal cortex, as well as the ventromedial prefrontal cortex, impacts autonomic nervous system and hypothalamic-pituitary-axis activity, which contributes to regulation of negative affect, cardiovagal output, and responses to stress, which in turn reduces inflammation [33]. The current work probed this framework further, as it investigated implicit emotion regulation and its relationship to immune system functioning. In particular, language is a fundamental human capability through which implicit emotion management processes and their relationships to health may be better understood [34,35]. Translating feelings into words is often an adaptive process [36], and writing about emotional topics reduces negative affect and enhances an adaptive immune system [34]. Previous research also shows that distanced lexical shifts are associated with improvements in health [37].

We aimed to investigate the relationship between implicit linguistic distancing and a health biomarker strongly associated with cardiovascular disease risk (i.e., CRP). We predicted a negative association such that greater linguistic distancing would be related to lower levels of CRP. We also sought to examine the relationship between one's implicit use of linguistic distancing and other self-reported health measures that are validated psychological risk factors for cardiovascular diseases, such as depression, anxiety, and general health [27,28]. We hypothesized that linguistic distancing would be negatively associated with depression and anxiety and positively associated with dispositional optimism and general health. To our knowledge, this is the first study to move beyond self-report and investigate linguistic distancing's association with health-relevant biomarkers.

2. Methods

2.1. Participants

We used data from the New England Family Study (NEFS). The NEFS was established to interview and assess the adult offspring from the Collaborative Perinatal Project, an earlier cohort study that aimed to identify neurodevelopmental consequences of pregnancy and delivery complications [38,39,40]. Human subjects committees at the Harvard School of Public Health, Brown University, and Rice University approved the study protocol. Out of 618 participants assessed as adults, 480 completed the oral prompt (described below); of these, 330 also had CRP data. We included participants who had complete data for all the covariates described below; thus, the final sample size was 235 participants, as seen in the flowchart in Figure 1 (53%

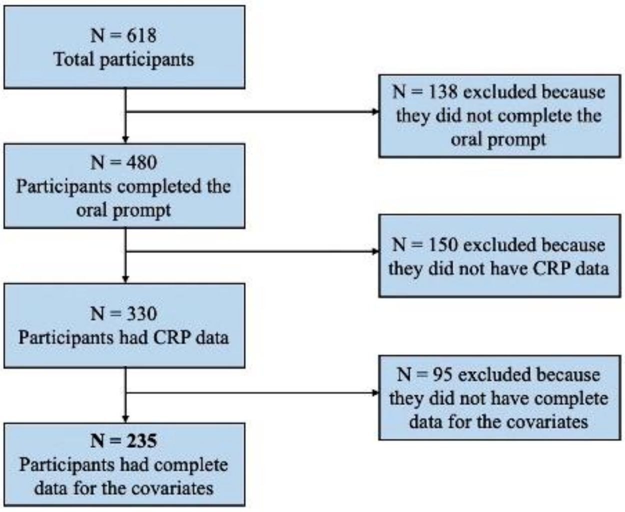

Figure 1: Flowchart showing route to final analytic sample N size for CRP analyses: there were 618 total participants, 480 participants who completed the oral prompt, 330 who had CRP data, and 235 who had complete data for key covariates used in the current CRP analyses.

female; 82% Caucasian, $\sim$ 14% African-American, $\sim$ 3% Hispanic or Latino, $\sim$ 2% Other; M_{age} = 42.2 years, SD_{age} = 1.73). We also examined zero-order correlations between linguistic distancing and self-reported health measures of depression, anxiety, optimism, and self-rated health. For these zero-order correlation analyses, each correlation's sample size varied depending on which measures had complete data. These ranged from 477 participants with complete oral prompt and depression data to 315 with oral prompt and social functioning data.

There were no significant differences observed when comparing participants who did complete the oral prompt used for the linguistic distancing assay ($N = 480$) versus those who did not complete the oral prompt ($N = 138$) in terms of age, sex, and socioeconomic status. Out of all the participants who had completed the oral prompt for the linguistic distancing assay ($N = 480$), there were no significant differences in linguistic distancing when comparing those who had CRP data ($N = 330$) versus those who did not ($N = 150$), nor when comparing those who had complete covariate data ($N = 235$; used for analyses; Figure 1) versus those who did not ($N = 95$).

2.2. Questionnaires

Participants completed an in-person three-hour interview, where informed consent, socioeconomic, health, and psychological information were gathered. Participants completed the 10-item form of the Center for Epidemiologic Studies Depression Scale (CES-D; [41]), which assesses depressive symptomology during the past week (Cronbach's α = .92; [42]) rated on a 4-point scale from 1 (rarely or none of the time) to 4 (most or all of the time). Example items include "I felt that everything I did was an effort." or "I was bothered by things that don't usually bother me."

In addition, participants completed the 23-item Minnesota Multiphasic Personality Inventory—Anxiety (MMPI—Anxiety; [43]), which assesses general anxiety symptomology (Cronbach's $\alpha = .82$; [44]) rated on a 4-point scale from 1 (rarely or none of the time) to 4 (most or all of the time). Example items include "Several times a week I feel as if something dreadful is about to happen." or "I worry quite a bit over possible misfortunes."

Next, participants completed the 7-item Dutch Dispositional Optimism scale [27], which evaluates general positive affect rated on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree). Example items include "I have positive expectations about my future." or "Most of the time I am in good spirits."

Lastly, participants completed the Health & Illness Questionnaire [45], which covered general health, norm-based role limitations due to physical health, and norm-based social functioning. While some questions were more general, such as "In general, would you say that your health is…" with answer options ranging from 1 (excellent) to 5 (poor), other questions were more pointed, such as "During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?" with answer options ranging from 1 (all of the time) to 5 (none of the time). Social functioning was assessed with questions such as "During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?" with answer options ranging from 0 (not at all) to 4 (extremely).

2.3. Linguistic distancing

The linguistic distancing data were obtained from the participants' completion of an oral open-response prompt. The prompt asked participants to evaluate a stressful, problematic situation for a hypothetical individual at a doctor's office, which was used with the assumption that the response was similar to other stressful situations (see Supplementary Material for exact wording of prompt). The prompt was recorded; then, we transcribed each participants' recordings to written text. To quantify the degree of linguistic distancing employed by each participant, we used Pennebaker's Linguistic Inquiry and Word Count (LIWC; [46]) which computes percentages of words falling within particular word categories. LIWC has been used considerably in empirical research exploring emotion regulation strategies such as self-distancing. The LIWC analyses focused on a composite linguistic measure of psychological distancing (i.e., using the methodology of Nook et al. (2017)). In particular, the composite psychological distancing score was calculated by z-scoring first-person singular pronouns (e.g., I, my), present-tense verbs, articles (e.g., the, a), discrepancy words (e.g., would, should), and words of more than six letters, which were then averaged as indicated below (see also [8]). Accordingly, the z-scored frequencies of first-person singular pronouns, present-tense verbs, and discrepancy words were reverse-scored (multiplied by -1). They then averaged with the z-scored frequencies of articles and words of more than six letters. Lower linguistic distancing scores suggest that the language is personal and focused on the present. In contrast, higher linguistic distancing scores show that the language is impersonal and not focused on the present, and therefore more reflective of psychological distancing.

2.4. CRP

To quantify inflammation, plasma concentration of CRP (high sensitivity) was calculated, derived from blood samples collected at the time of assessment. Using an immunoturbidimetric assay on the Hitachi 917 analyzer (Roche Diagnostics—Indianapolis, IN, USA), CRP concentrations were determined using reagents and calibrators from DiaSorin (Stillwater, MN, USA). This particular assay had a sensitivity of 0.03 mg/L. The day-to-day variabilities of the assay at concentrations of 0.91, 3.07, and 13.38 mg/L were 2.81, 1.61, and 1.1%, respectively. In this sample, CRP levels ranged from 0.07 mg/L to 80.10 mg/L. Analyses were conducted using all participants, followed by sensitivity analyses that excluded participants who had CRP levels greater than 10 mg/L in case of infections [23]. CRP was log-transformed because of skewed distribution and examined continuously.

2.5. Covariates

Control variables included the standard covariates recommended by O'Connor and colleagues [47] as available in this dataset: age, sex, income, smoking status, sleep (i.e., number of hours of sleep), exercise (i.e., vigorous activity per week), and waist circumference. Several studies suggest that waist circumference or waist-to-hip ratio is more closely associated with the variability of CRP than BMI [47].

2.6. Data analysis

The main analysis of interest—the relationship between linguistic distancing and CRP—was conducted in R using the *lmer* function to examine linear mixed effects regression models and visualized using *ggplot*. Given that there were 29 sibling sets among the sample, a random effect of mother was entered to account for potential nested effects. Sex and smoking status were entered as categorical rather than continuous variables. Continuous predictor variables were mean-centered before running the regressions. We also examined whether the association held after accounting for symptoms of depression (i.e., CES-D scores).

Table 1: Descriptive statistics of all variables in the analytic samples.

Variable ($N = 235$)	**Mean**	**SD**
Linguistic distancing	−0.02	0.56
CRP (without natural log [mg/L])	1.95	3.40
Age (years)	42.2	1.73
Sleep (number of hours)	6.63	1.31
Income (score on ladder)	3.37	3.01
Waist circumference (cm)	95	17.2
Exercise (vigorous activity per week)	3.84	1.80
Sex	53.2% female	
Smoking status	22.1% smoke	
Variable	**Mean**	**SD**
Self-rated health ($N = 473$)	2.35	1.02
Symptoms of depression ($N = 477$)	1.59	0.56
Anxiety ($N = 477$)	1.70	0.52
Dispositional optimism ($N = 477$)	4.18	0.69
Role limitations due to physical health ($N = 315$)	48.3	10.6
Social functioning ($N = 315$)	21.7	11.5

Note. Descriptive statistics of all variables in the analytic samples. Linguistic distancing was the score from the LIWC analyses. CRP was the level of CRP without the natural log mg/L. Age was quantified in years. Sleep was quantified as the number of hours of sleep on average per night in the past month. Income was quantified as the total assets minus the amount owed, which corresponded to a score on a ladder. Waist circumference was the waist size measured in centimeters. Exercise was the number of days a week vigorous activity was engaged.

Next, we examined zero-order correlations of linguistic distancing's relationship to depression, anxiety, dispositional optimism, self-rated health, role limitations due to physical health, and social functioning. For the latter three scales, higher values indicate poorer health, fewer role limitations, and poorer social functioning. These analyses were conducted in R using the *apaTables* function and visualized using *ggplot* [48]. We hypothesized that linguistic distancing would be significantly related to positive health indicators and negatively associated with adverse health indicators.

3. Results

3.1. Linear model of linguistic distancing and CRP

Table 1 contains the descriptive statistics for all the variables used in the analytic samples.

Table 2 contains the linear regression model of CRP (M = 1.95 mg/L, SD = 3.40) as the continuous dependent variable and linguistic distancing as the key predictor of interest. There was a significant negative association between linguistic distancing and CRP, $b = -0.27$, $t(233) = 2.31$, SE = 0.12, $P = .022$, such that greater levels of linguistic distancing were associated with lower CRP

Table 2: Linear model of CRP.

	CRP	
Predictors	Estimates	CI
Intercept	0.04	−0.16–0.25
Linguistic distancing	−0.27*	−0.50–−0.04
Age	0.00	−0.07–0.08
Sex	−0.12	−0.40–0.16
Waist circumference	0.04***	0.03–0.04
Exercise	0.02	−0.05–0.09
Sleep	0.00	−0.10–0.10
Income	0.00	−0.04–0.05
Smoking	0.14	−0.17–0.46
Random effects		
α^2	0.95	
$\tau_{00 \text{Mom\_ID}}$	0.04	
ICC	0.04	
$N_{\text{Mom\_ID}}$	200	
Observations	235	
Marginal R^2/conditional R^2	0.271/0.297	

$^{*}P < .05$, $^{**}P < .01$, $^{***}P < .001$.
Note. CI indicates 95% confidence interval.

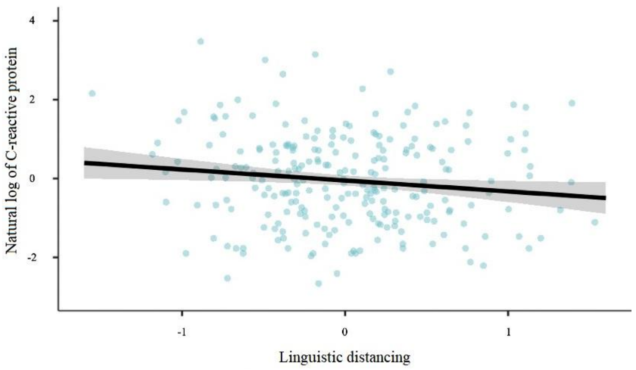

Figure 2: Scatterplot showing relationship between linguistic distancing and CRP.

expression. Figure 2 shows how, as linguistic distancing increases (x-axis), CRP decreases (y-axis). In addition, importantly, the association holds after controlling for symptoms of depression (CES-D), $b = -0.27$, $t(233) = 2.30$, SE $= 0.12$, $P = .022$. Importantly, after removing participants who had CRP levels greater than 10 mg/L, the relationship was attenuated but remained significant, $b = -0.22$, $t(230) = 2.01$, SE $= 0.11$, $P = .045$.

3.2. Zero-order correlations

We conducted zero-order correlations between linguistic distancing and the self-reported questionnaire scores, as seen in the heatmap in Figure 3. There was a significant negative association between linguistic distancing and symptoms of depression (CES-D): $r(475) = -0.10$, 95% CI $[-0.19, -0.01]$, $P = .025$, indicating that as linguistic distancing increased, symptoms of depression decreased. There was a significant negative association between linguistic distancing and anxiety (MMPI—Anxiety): $r(475) = -0.10$, 95% CI $[-0.19, -0.01]$, $P = .022$, indicating that as linguistic distancing increased, anxiety decreased. There was a significant positive association between linguistic distancing and dispositional optimism: $r(475) = 0.11$, 95% CI [0.02, 0.20], $P = .017$, indicating that as linguistic distancing increased, dispositional optimism also increased.

The next three findings come from the Health & Illness Questionnaire, where higher values indicate poorer health. There was a significant negative association between linguistic distancing and poor self-rated health (greater scores on the self-rated health scale indicate poorer health): $r(471) = -0.13$, 95% CI $[-0.22, -0.04]$, $P = .004$, meaning that as linguistic distancing increased, poorer health decreased. There was also a significant positive association between linguistic distancing and fewer role limitations due to physical health (greater scores on the role limitations scale indicate fewer limitations): $r(313) = 0.12$, 95% CI [0.01, 0.23], $P = .037$, indicating that individuals who had higher linguistic distancing scores had fewer role limitations due to physical health. Lastly, there was a significant negative association between linguistic distancing and poor social functioning: $r(313) = -0.13$, 95% CI $[-0.23, -0.02]$, $P = .024$, indicating that as linguistic distancing increased, poor social functioning decreased. The R script pertaining to analyses performed in the present study is available at the following link: https://osf.io/jphgy/?view_only=c75e60358fb54d709e183f485fd059a8.

4. Discussion

4.1. Summary of results

As hypothesized, we found that implicit linguistic distancing (i.e., without any instruction to implement lexical shifts) was associated with lower CRP inflammation. We also found that implicit linguistic distancing was associated with fewer symptoms of depression and anxiety, and greater dispositional optimism and general health [27, 28].

The results of the present study converge with prior evidence from the existing literature—for example, another study showed that self-distancing facilitated physiological recovery from stress when looking at cardiovascular reactivity via blood pressure as an endpoint [11, 24]. Although the procedures and endpoints between the studies differ, the present study concurs that distancing may benefit health. Previous research substantiates that distanced language helps individuals regulate adaptively [8, 17, 49]. The present study is the first to provide evidence of distanced language associating with a clinically meaningful biomarker of cardiovascular disease.

Importantly, the correlation between implicit linguistic distancing and CRP held after accounting for depressive

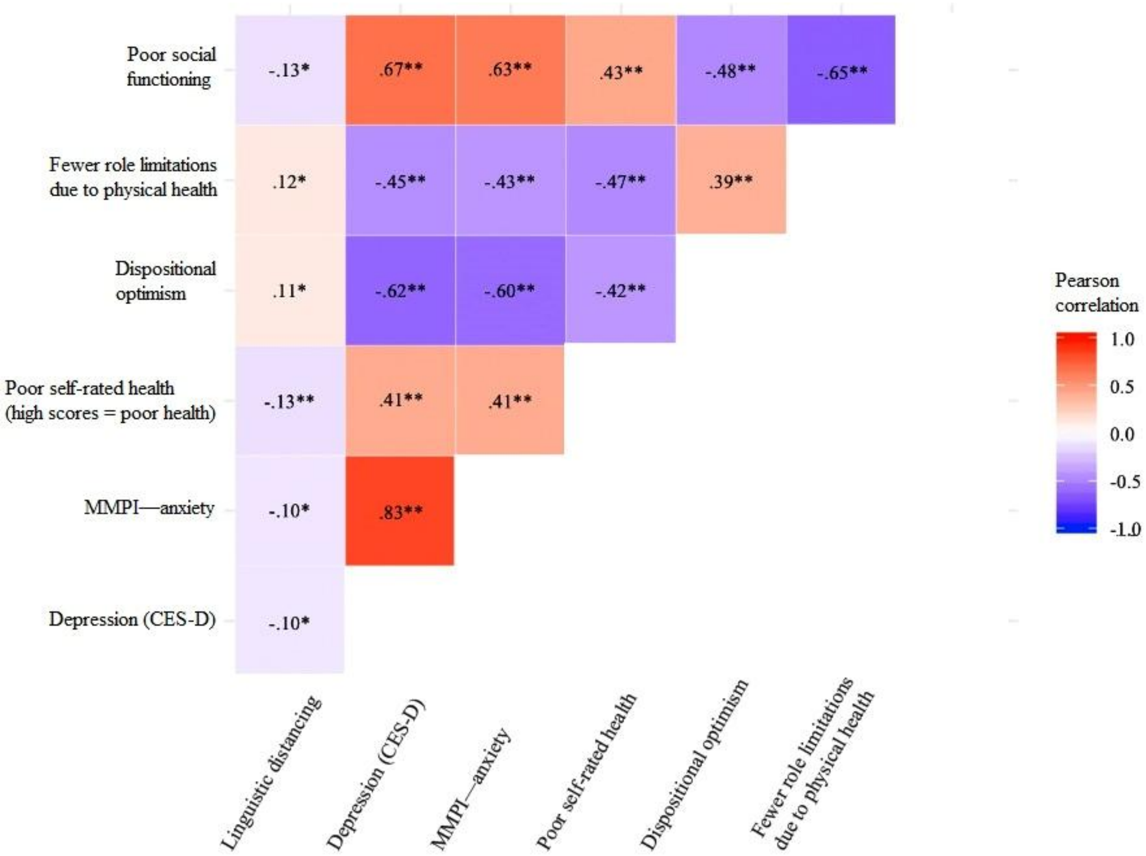

Figure 3: Heatmap showing the zero-order correlations between linguistic distancing and self-report questionnaire measures. Cool colors (e.g., blue or purple) indicate the degree of the negative zero-order correlation, while warm colors (e.g., red or orange) indicate the degree of the positive zero-order correlation. As expected, linguistic distancing shows a negative correlation with depression, anxiety, poor health, and poor social functioning, and positive correlation with dispositional optimism and fewer role limitations associated with physical health. * indicates $P < .05$. ** indicates $P < .01$.

symptoms, suggesting that linguistic distancing may represent an important latch connecting language and cardiovascular health.

4.2. Broadening of theoretical frameworks and psychoneuroimmunological research

Although correlational, this finding illuminates novel interconnections between linguistic evidence of emotion regulation and psychoneuroimmunology, consistent with the neuro-immuno-affective framework previously described in Lopez et al. (2018). The findings also align with what Williams and colleagues had posited as a necessary, crucial next step in research: identifying specific factors that may signal resilience to promote cardiovascular health [31]. Additional work has begun to tap into the connection between cognitive reappraisal and psychoneuroimmunology; for example, those who use cognitive reappraisal less frequently have heightened production of nasal cytokines [50]. Additionally, cognitive reappraisal has been shown to moderate the relationship between heart rate variability and telomere length of lymphocytes [7]. The present work extends these investigations to include assessing implicit cognitive reappraisal via linguistic distancing and its relationship to a validated and clinically meaningful biomarker of systemic inflammation. In particular, language may be relatively effortless [14] and beneficial as a means to regulate emotion and improve health.

4.3. Limitations, future directions, and conclusion

There are several limitations. The results are correlational, with adult participants from two New England sites, limiting the study's generalizability. Furthermore, future work would need to find converging evidence using other relevant biomarkers. Although the current study is observational and involved implicit linguistic distancing, these results may have translational relevance. In future work, it will be important to assess whether interventions explicitly targeting linguistic distancing (e.g., instructing individuals to use less first-person pronouns and present tense verbs) may result in modulation of cardiovascular disease risk as indexed via health-relevant biomarkers. Promisingly, psychological distancing more broadly has shown significant translational potential in clinical populations, including major depressive disorder and bipolar disorder [11].

Overall, these findings illustrate novel relationships among language, emotion regulation, and systemic inflammation biomarkers and risk factors relevant to cardiovascular disease. Future work may examine how linguistic distancing can be a valuable tool to better understand the psychological processes that drive the neuro-immune link.

Funding This work was supported by Grant no. F31 HL147394 from the National Heart Lung and Blood Institute awarded to Anoushka D. Shahane and Grant no. R01 AG023397 from the National Institute on Aging awarded to Stephen L. Buka.

Acknowledgments The authors gratefully acknowledge the assistance of Dr. Lisa Denny for creating the linguistic task and Dr. Michelle Rogers for her help in obtaining the data conducted at Brown University and Harvard University.

Conflict of interest The authors declare that they have no conflict of interest.

References

[1] J. J. Gross, *The emerging field of emotion regulation: An integrative review*, Rev Gen Psychol, 2 (1998), 271–299.

[2] J. J. Gross, *Antecedent- and response-focused emotion regulation: divergent consequences for experience, expression, and physiology*, J Pers Soc Psychol, 74 (1998), 224–237.

[3] J. J. Gross, *Emotion regulation: Current status and future prospects*, Psychol Inq, 26 (2015), 1–26.

[4] J. J. Gross and R. F. Muñoz, *Emotion regulation and mental health*, Clin Psychol Sci Pract, 2 (1995), 151–164.

[5] A. Aldao, S. Nolen-Hoeksema, and S. Schweizer, *Emotion-regulation strategies across psychopathology: A meta-analytic review*, Clin Psychol Rev, 30 (2010), 217–237.

[6] B. T. Denny, *Getting better over time: A framework for examining the impact of emotion regulation training*, Emotion, 20 (2020), 110–114.

[7] A. D. Shahane, A. S. LeRoy, B. T. Denny, and C. P. Fagundes, *Connecting cognition, cardiology, and chromosomes: Cognitive reappraisal impacts the relationship between heart rate variability and telomere length in $CD8^{+}CD28^{-}$ cells*, Psychoneuroendocrinology, 112 (2020), 104517.

[8] A. D. Shahane and B. T. Denny, *Predicting emotional health indicators from linguistic evidence of psychological distancing*, Stress Health, 35 (2019), 200–210.

[9] E. Kross, O. Ayduk, and W. Mischel, *When asking "why" does not hurt. Distinguishing rumination from reflective processing of negative emotions*, Psychol Sci, 16 (2005), 709–715.

[10] Y. Trope and N. Liberman, *Construal-level theory of psychological distance*, Psychol Rev, 117 (2010), 440–463.

[11] E. Kross and O. Ayduk, *Self-distancing: Theory, research, and current directions*, in Advances in Experimental Social Psychology, J. M. Olson, ed., Academic Press, San Diego, CA, 2017, 81–136.

[12] E. Kross, B. D. Vickers, A. Orvell, I. Gainsburg, T. P. Moran, M. Boyer, et al., *Third-person self-talk reduces ebola worry and risk perception by enhancing rational thinking*, Appl Psychol Health Well Being, 9 (2017), 387–409.

[13] E. C. Nook, C. M. Vidal Bustamante, H. Y. Cho, and L. H. Somerville, *Use of linguistic distancing and cognitive reappraisal strategies during emotion regulation in children, adolescents, and young adults*, Emotion, 20 (2020), 525–540.

[14] A. Orvell, O. Ayduk, J. S. Moser, S. A. Gelman, and E. Kross, *Linguistic shifts: A relatively effortless route to emotion regulation?*, Curr Dir Psychol Sci, 28 (2019), 567–573.

[15] M. R. Mehl, M. L. Robbins, and S. E. Holleran, *How taking a word for a word can be problematic: Context-dependent linguistic markers of extraversion and neuroticism*, J Methods Meas Soc Sci, 3 (2012), 30–50.

[16] M. A. Cohn, M. R. Mehl, and J. W. Pennebaker, *Linguistic markers of psychological change surrounding September 11, 2001*, Psychol Sci, 15 (2004), 687–693.

[17] E. C. Nook, J. L. Schleider, and L. H. Somerville, *A linguistic signature of psychological distancing in emotion regulation*, J Exp Psychol Gen, 146 (2017), 337–346.

[18] J. W. Pennebaker and L. A. King, *Linguistic styles: language use as an individual difference*, J Pers Soc Psychol, 77 (1999), 1296–1312.

[19] J. K. Kiecolt-Glaser, H. M. Derry, and C. P. Fagundes, *Inflammation: depression fans the flames and feasts on the heat*, Am J Psychiatry, 172 (2015), 1075–1091.

[20] J. Hurlimann, G. J. Thorbecke, and G. M. Hochwald, *The liver as the site of C-reactive protein formation*, J Exp Med, 123 (1966), 365–378.

[21] T. B. Harris, L. Ferrucci, R. P. Tracy, M. C. Corti, S. Wacholder, W. H. Ettinger Jr, et al., *Associations of elevated interleukin-6 and C-reactive protein levels with mortality in the elderly*, Am J Med, 106 (1999), 506–612.

[22] A. A. Appleton, E. B. Loucks, S. L. Buka, and L. D. Kubzansky, *Divergent associations of antecedent- and response-focused emotion regulation strategies with midlife cardiovascular disease risk*, Ann Behav Med, 48 (2014), 246–255.

[23] A. A. Appleton, S. L. Buka, E. B. Loucks, S. E. Gilman, and L. D. Kubzansky, *Divergent associations of adaptive and maladaptive emotion regulation strategies with inflammation*, Health Psychol, 32 (2013), 748–756.

[24] O. Ayduk and E. Kross, *Enhancing the pace of recovery: self-distanced analysis of negative experiences reduces blood pressure reactivity*, Psychol Sci, 19 (2008), 229–231.

[25] L. D. Kubzansky, N. Park, C. Peterson, P. Vokonas, and D. Sparrow, *Healthy psychological functioning and incident coronary heart disease: the importance of self-regulation*, Arch Gen Psychiatry, 68 (2011), 400–408.

[26] A. Rozanski and L. D. Kubzansky, *Psychologic functioning and physical health: a paradigm of flexibility*, Psychosom Med, 67 Suppl 1 (2005), S47–S53.

[27] E. J. Giltay, J. M. Geleijnse, F. G. Zitman, T. Hoekstra, and E. G. Schouten, *Dispositional optimism and all-cause and cardiovascular mortality in a prospective cohort of elderly dutch men and women*, Arch Gen Psychiatry, 61 (2004), 1126–1135.

[28] D. S. Sheps and D. Sheffield, *Depression, anxiety, and the cardiovascular system: the cardiologist's perspective*, J Clin Psychiatry, 62 Suppl 8 (2001), 12–16.

[29] A. D. Shahane, D. C. Pham, R. B. Lopez, and B. T. Denny, *Novel computational algorithms to index lexical markers of psychological distancing and their relationship to emotion regulation efficacy over time*, Affect Sci, 2 (2021), 262–272.

[30] J. F. Thayer and R. D. Lane, *A model of neurovisceral integration in emotion regulation and dysregulation*, J Affect Disord, 61 (2000), 201–216.

[31] R. Williams, J. Kiecolt-Glaser, M. J. Legato, D. Ornish, L. H. Powell, S. L. Syme, et al., *The impact of emotions on cardiovascular health*, J Gend Specif Med, 2 (1999), 52–58.

[32] J. K. Kiecolt-Glaser, L. McGuire, T. F. Robles, and R. Glaser, *Emotions, morbidity, and mortality: new perspectives from psychoneuroimmunology*, Annu Rev Psychol, 53 (2002), 83–107.

[33] R. B. Lopez, B. T. Denny, and C. P. Fagundes, *Neural mechanisms of emotion regulation and their role in endocrine and immune functioning: A review with implications for treatment of affective disorders*, Neurosci Biobehav Rev, 95 (2018), 508–514.
[34] J. W. Pennebaker and C. K. Chung, *Expressive writing, emotional upheavals, and health*, in Foundations of Health Psychology, H. S. Friedman and R. C. Silver, eds., Oxford University Press, New York, 2007, 263–284.
[35] A. D. Shahane and B. T. Denny, *Emotion regulation and writing*, in Language and Emotion: An International Handbook, G. L. Schiewer, J. Altarriba, and B. C. Ng, eds., De Gruyter Mouton, Berlin, 2022, in press.
[36] M. D. Lieberman, N. I. Eisenberger, M. J. Crockett, S. M. Tom, J. H. Pfeifer, and B. M. Way, *Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli*, Psychol Sci, 18 (2007), 421–428.
[37] J. Park, O. Ayduk, and E. Kross, *Stepping back to move forward: Expressive writing promotes self-distancing*, Emotion, 349–364 (2016), 16.
[38] A. A. Appleton, S. L. Buka, M. C. McCormick, K. C. Koenen, E. B. Loucks, S. E. Gilman, et al., *Emotional functioning at age 7 years is associated with C-reactive protein in middle adulthood*, Psychosom Med, 73 (2011), 295–303.
[39] S. H. Broman, P. L. Nichols, and W. A. Kennedy, *Preschool IQ: Prenatal and Early Developmental Correlates*, Routledge, London, 1st ed., 1975.
[40] K. R. Niswander, M. Gordon, and National Institute of Neurological Diseases and Stroke, *The Women and Their Pregnancies: The Collaborative Perinatal Study of the National Institute of Neurological Diseases and Stroke*, Saunders, Philadelphia, 1972.
[41] L. S. Radloff, *The CES-D scale: a self-report depression scale for research in the general population*, Appl Psychol Meas, 1 (1977), 385–401.
[42] M. Irwin, K. H. Artin, and M. N. Oxman, *Screening for depression in the older adult: Criterion validity of the 10-item Center for Epidemiological Studies Depression Scale (CES-D)*, Arch Intern Med, 159 (1999), 1701–1704.
[43] R. L. Greene, *The MMPI-2: An Interpretive Manual*, Allyn & Bacon, Needham Heights, MA, 2nd ed., 2000.
[44] E. A. Wise, D. L. Streiner, and S. Walfish, *A review and comparison of the reliabilities of the MMPI-2, MCMI-III, and PAI presented in their respective test manuals*, Meas Eval Couns Dev, 42 (2010), 246–254.
[45] J. T. Massey and National Center for Health Statistics (U.S.), *Design and Estimation for the National Health Interview Survey, 1985–94*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, Hyattsville, MD, 1989.
[46] J. W. Pennebaker, R. J. Booth, R. L. Boyd, and M. E. Francis, *Linguistic inquiry and word count: LIWC2015*, Pennebaker Conglomerates (LIWC.net), Austin, TX, 2015.
[47] M. F. O'Connor, J. E. Bower, H. J. Cho, J. D. Creswell, S. Dimitrov, M. E. Hamby, et al., *To assess, to control, to exclude: effects of biobehavioral factors on circulating inflammatory markers*, Brain Behav Immun, 23 (2009), 887–897.
[48] R Core Team, *R: a language and environment for statistical computing*, R Foundation for Statistical Computing, Vienna, Austria. Available online at https://www.R-project.org/, 2018.
[49] A. Orvell, E. Kross, and S. A. Gelman, *How "you" makes meaning*, Science, 355 (2017), 1299–1302.
[50] R. L. Brown, A. D. Shahane, M. A. Chen, and C. P. Fagundes, *Cognitive reappraisal and nasal cytokine production following experimental rhinovirus infection*, Brain Behav Immun Health, 1 (2020), 100012.