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Feelings in Words: Emotion Word Use and Cardiovascular Reactivity in Marital Interactions

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Authors' Notes

This study was not preregistered. The analysis script can be found on the Open Science Framework: https://osf.io/ry382. Materials and data from this manuscript are available upon request. Correspondence concerning this article may be sent to Claudia M. Haase, Northwestern University, School of Education and Social Policy, Annenberg Hall, 2120 Campus Drive, Evanston, IL 60208. E-mail: claudia.haase@northwestern.edu.

Abstract

Putting feelings into words is often thought to be beneficial. Few studies, however, have examined associations between natural emotion word use and cardiovascular reactivity. This laboratory-based study examined emotion word use (i.e., from computerized text analysis) and cardiovascular reactivity (i.e., interbeat interval changes from baseline) across two interaction contexts (i.e., conflict and positive conversations) in 49 mixed-sex married couples (age: M = 43.11, SD = 9.20) from diverse socioeconomic backgrounds. We focused on both frequency (i.e., relative proportion of emotion words) and diversity (i.e., relative proportion of *unique* emotion words) of emotion words. Data were collected between 2015 and 2017 and analyzed treating both partners and conversations as repeated measures, resulting in 196 observations overall (four per dyad). Findings showed that (1) when spouses used more negative emotion words (especially anger), they showed higher cardiovascular reactivity. This finding was robust when controlling for covariates; generalized across gender, interaction contexts, and socioeconomic status. Moreover, (2) when spouses used a more diverse negative emotion vocabulary, they showed higher cardiovascular reactivity, but this was not robust when controlling for negative emotion word frequency. Associations between (3) positive emotion word use and cardiovascular reactivity were not statistically significant. Verbalizing negative emotions thus seems to go along with higher cardiovascular reactivity, at least in the short term. Replication is needed across other relationship types, genders, and sexual orientations. These findings highlight emotion word use as an indicator of cardiovascular reactivity, which has implications for the identification of potential health risks that emerge during marital interactions.

Keywords: Emotion word use; cardiovascular reactivity; health; couples; dyadic interactions

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Close relationships play an important role in our lives and how we navigate them has far-reaching consequences for health and longevity (e.g., Holt-Lunstad et al., 2010). Romantic relationships are particularly important for many people (Haase et al., 2016; Levenson et al., 2014). Researchers have long been interested in how partners navigate conflict – and cardiovascular reactivity during conflict in particular has emerged as a notable predictor of long-term relationship quality and health (Ginty et al., 2017; Gottman & Levenson, 1992; Levenson et al., 2014; Robles & Kiecolt-Glaser, 2003). Yet, while many studies have examined the consequences of cardiovascular reactivity during marital conflict, less is known about its proximal correlates. Drawing from prior research (e.g., Karan et al., 2017; Torre & Lieberman, 2018; Vine et al., 2020), the present laboratory-based study examined natural emotion word use as a promising and potentially modifiable correlate of cardiovascular reactivity across two marital interactions in a sample of married couples from diverse socioeconomic and racial/ethnic backgrounds. Building upon recent work in this area (Vine et al., 2020), we focused on both frequency and diversity of emotion word use.

Emotion Word Use and Cardiovascular Reactivity

Language provides a window into our inner experiences (Pennebaker et al., 2003) and is an important medium to share emotions with others (Rimé, 2009). Emotion word use can be defined as the negative (e.g., angry, frustrated) and positive (e.g., happy, glad) emotion words individuals use and has attracted considerable interest in affective, clinical, and relationship science (e.g., Karan et al., 2017; Pennebaker, 1997; Torre & Lieberman, 2018; Vine et al., 2020). A potential correlate of emotion word use with particular relevance is cardiovascular reactivity,

which is commonly indexed by differences in heart rate or blood pressure between rest and trial periods (Centers for Disease Control and Prevention, 2020). A long line of research has shown that elevated cardiovascular reactivity to stress and challenge is a risk factor for the development of cardiovascular disease, one of the leading causes of death worldwide (e.g., Krantz & Manuck, 1984; Smith et al., 2013; Treiber et al., 2003). Another long line of research has implicated social relationships in physical health and longevity (e.g., Holt-Lunstad et al., 2010). Cardiovascular reactivity during marital interactions may be a critical mechanism linking close relationship functioning with physical health (Robles & Kiecolt-Glaser, 2003) and is the focus of the present study. Interestingly, there exist widely divergent views about the physiological correlates (e.g., cardiovascular reactivity) of emotion word use.

Emotion Word Use Relates to Lower Cardiovascular Reactivity

One prominent view, also commonly shared by laypeople, is that verbally expressing emotions — positive as well as negative — is broadly beneficial and soothing (Greenberg, 2019; Pennebaker, 1997; Torre & Lieberman, 2018). Verbalizing emotions when stressed is thought to help individuals down-regulate physiological arousal (Torre & Lieberman, 2018) and emotion word use has consequently been seen as an implicit form of emotion regulation (e.g., Torre & Lieberman, 2018). Using emotion words may foster emotional awareness (Torre & Lieberman, 2018) and in turn go along with lower cardiovascular reactivity (Borelli et al., 2018). Supporting this view, studies that experimentally manipulated emotional language through affect or emotion labelling (for a review see Torre & Lieberman, 2018) often found decreases in cardiovascular reactivity (e.g., heart rate) in trials where individuals verbally labeled their emotions compared to trials without labelling (Matejka et al., 2013; McRae et al., 2010). Importantly, however, in many studies, decreases were only evident with a delay (e.g., at a 1-week follow-up session) and not

during the actual verbalizing phase (Kircanski et al., 2012; Mendolia & Kleck, 1993; Tabibnia et al., 2008).

In a related vein, expressive writing studies (e.g., Pennebaker, 1997) have shown that putting thoughts and feelings surrounding traumatic events into words goes along with decreases in physiological arousal (e.g., blood pressure; McGuire et al., 2005; Petrie et al., 1995) and improvements in physical health (Pennebaker, 1997) from the first to the last day of writing. Individuals who used a lot of positive emotion words in their writings showed the biggest improvements (e.g., Pennebaker, 1997). Although the mechanisms are far from clear, it has been argued that emotion word use indicates that an individual is working through (McCarthy et al., 2017; Pennebaker, 1997) or regulating their emotions (e.g., through positive reframing; Monin et al., 2012; Robbins et al., 2019), which in turn can foster coping and reduce cardiovascular reactivity (but see Sbarra et al., 2013, for potential negative effects of expressive writing).

Negative Emotion Word Use Relates to Higher, Positive Emotion Word Use Relates to Lower Cardiovascular Reactivity

A different view suggests that the use of negative emotion words relates to higher cardiovascular reactivity, while the use of positive emotion words relates to lower cardiovascular reactivity during conversations. This view is informed by emotion models (e.g., Levenson, 1999) that view emotions as psychological-physiological phenomena, which manifest across different response systems (e.g., physiology and language; Seider et al., 2009) and is supported by studies on natural word use (e.g., Boyd & Schwartz, 2021; Han et al., 2021; Horn & Meier, 2022; Markowitz, 2022; Monin et al., 2012), which view emotion word use as an indicator of emotional processes that may go along with changes in physiological activation. From this perspective, several negative emotions (e.g., anger) activate the sympathetic nervous system and

deactivate the parasympathetic nervous system, resulting in greater cardiovascular activation; this view is supported by a sizable body of empirical evidence (e.g., Kreibig, 2010). Thus, someone who is in the throes of negative emotions would use more negative emotion words (e.g., angry) while also exhibiting greater cardiovascular reactivity (Levenson, 1999). Positive emotions, on the other hand, which bear special importance in interactions with close others (e.g., Wells et al., 2022), can serve important physiological downregulation functions (Fredrickson, 2001), which has been shown in single-subject (e.g., Moskowitz & Epel, 2006) and dyadic studies (e.g., Yuan et al., 2010). Thus, someone who is in the throes of positive emotions would use more positive emotion words (e.g., love) while also exhibiting lower cardiovascular reactivity (Fredrickson, 2001; Levenson, 1999; Monin et al., 2012).

Surprisingly few studies have examined *emotion* word use in couples. Those that have done so show that partners are more likely to use negative emotion words (especially anger-related words) during moments of relationship distress (i.e., when feeling annoyed with the partner; Han et al., 2021) and have linked negative emotion word use to lower dyadic adjustment (Karan et al., 2017). In contrast, the use of positive emotion words (e.g., happy, glad, grateful) during couple interactions has been linked to beneficial outcomes, including more positive reframing, lower levels of stress, greater dyadic adjustment to a cancer diagnosis (Karan et al., 2017; Robbins et al., 2019), and higher relationship satisfaction (Slatcher et al., 2008). These findings suggest negative emotion words during couple interactions as a marker of more maladaptive processes (e.g., conflict escalation or poor dyadic adjustment; Han et al., 2021; Karan et al., 2017) and positive emotion words as a marker of more adaptive emotional processes (e.g., positive reframing; Robbins et al., 2019). Studies on cardiovascular reactivity are scarce, but those examining natural emotion word use and physiology, or health more broadly,

provide indirect support for the assumption that emotion word use relates to cardiovascular reactivity. For example, negative emotion word use (especially anger) on Twitter has been linked with higher risk for county-level cardiovascular disease mortality, whereas positive emotion word use has been linked with lower risk (Eichstaedt et al., 2015). Positive emotion word use has also been linked to longevity (Pressman & Cohen, 2012), and caregiving spouses who used more positive emotion words when recounting typical partner interactions and partner suffering were found to show lower cardiovascular reactivity (Monin et al., 2012).

Taken together, previous work (e.g., Boyd & Schwartz, 2021; Han et al., 2021; Monin et al., 2012) suggests emotion word use as an indicator of negative and positive emotional processes, which tend to go along with changes in cardiovascular reactivity (see e.g., Eichstaedt et al., 2015; Fredrickson, 2001; Kreibig, 2010; Monin et al., 2012). Drawing from this and from functional accounts of emotion (Keltner & Gross, 1999; Levenson, 1999; but see Feldman Barrett, 2017) that see emotion as manifesting across different response systems, we expect negative emotion word use to be linked with higher and positive emotion word use to be linked with lower cardiovascular reactivity.

Diversity and Frequency of Emotion Word Use

Most studies have examined the frequency of emotion word use (as the percentage of emotion words relative to all words used; e.g., Han et al., 2021; Monin et al., 2012), but an emerging line of literature has looked at the diversity of emotion word use (as the percentage of *unique* emotion words relative to all words used; e.g., Vine et al., 2020). Theories in linguistics (Zipf, 1949) suggest that individuals may develop more diverse (active) emotion vocabularies as a result of accumulated and varied experiences with positive and negative emotions (see Vine et al., 2020). Links between emotion word use diversity and cardiovascular reactivity have not yet

been studied, but some studies provide indirect evidence. For example, research has shown links between emotion word diversity and physical and mental health (e.g., Entwistle et al., under review; Vine et al., 2020) and links between diverse negative (or positive) emotion vocabularies and the upregulation of negative (or positive) emotional experiences, even when controlling for emotion word frequency (Vine et al., 2020). This suggests that, beyond emotion word frequency, emotion word use diversity may also relate to cardiovascular reactivity.

Methodological Considerations

In the following, we highlight several ways to extend previous research on emotion word use and cardiovascular reactivity.

Instructed Versus Spontaneous Emotion Word Use

Existing studies have often instructed individuals to use emotion words, for example through affect labeling or presenting them with a list of emotion words to choose from (Torre & Lieberman, 2018). Studying instructed word use allows for tight experimental control, but may also alter emotional experiences (see Kassam & Mendes, 2013). Studying individual differences in spontaneous emotion word use provides greater ecological validity and is important as individuals vary considerably in their inclination to verbally express emotions (e.g., Pennebaker, 1997; Pennebaker et al., 2003; Vine et al., 2020).

Single-Subject Versus Dyadic Interaction Studies

Most existing studies of emotion word use have relied on single-subjects designs. While self-talk and writing for oneself are important, correlates of emotion word use during interactions with close others are clearly important to understand as well. Close relationships are hotbeds of negative and positive emotions (e.g., Haase et al., 2016; Levenson et al., 2014; Wells et al., 2022). Dyadic interactions (e.g., between romantic partners or spouses) thus seem especially

suitable for studying emotion word use and cardiovascular reactivity because they offer high ecological validity and allow for studying emotions at sufficiently high levels of intensity (e.g., Levenson, 2014).

Actor Versus Partner Effects

Relatedly, existing studies have often examined actor effects (i.e., associations between Partner A's word use and A's outcomes) but not partner effects (i.e., associations between Partner A's word use and B's outcomes). Emotions in dyadic interaction are inherently systemic and may relate to both one's own and one's partner's outcomes (e.g., Levenson et al., 2014), including cardiovascular reactivity (Butler & Randall, 2012; Chen et al., 2021). While partner effects have been observed between emotion word use and other aspects of emotional functioning (e.g., use of negative emotion word and partners' annoyance, Han et al., 2021), they have yet to be explored for cardiovascular reactivity.

Selective Versus Inclusive Samples

Existing research has often focused on white, middle-class couples (McGorray et al., 2023) with a recent review (Williamson et al., 2022) concluding that only 10% of relationship studies focused on historically underrepresented groups (e.g., couples from lower socioeconomic backgrounds). Studying couples from all walks of life is important to build an inclusive science and to shed light on the macro-contexts couples are embedded in and affected by (Rogers et al., 2021). For example, a growing literature has found that well-being and health correlates of couples' emotional functioning can be modulated by socioeconomic status (SES; e.g., Hittner et al., 2019; Hittner & Haase, 2021), although other studies have not observed such moderator effects (e.g., Johnson et al., 2023). As an example, emotion regulation strategies aimed at changing one's inner experiences (e.g., positive reframing) were found to be more beneficial for

individuals from lower (but not higher) SES who have fewer possibilities to change external factors related to the problem (Hittner et al., 2019; Troy et al., 2017). Thus, it is important to test whether links between emotion word use and cardiovascular reactivity generalize across different levels of socioeconomic backgrounds.

Negative Versus Positive Emotion Words and Contexts

Finally, research has predominantly focused on negative emotion word use in negative contexts (e.g., stress). While negative emotions and negative contexts are certainly important, there have been repeated calls for more attention to positive emotions and positive contexts across relationship (e.g., Algoe, 2019), affective (Fredrickson, 2016), and health (Pressman et al., 2019) science. Previous work suggests important differences in the adaptiveness of couples' language use across different interaction contexts (e.g., Meier et al., 2021). For example, verbally expressing positive emotions during a conflict might go along with de-escalation and lower physiological reactivity (Monin et al., 2012; Yuan et al., 2010), whereas verbalizing and focusing on positive emotions might be expected and make less of a difference during a positive interaction context with less need for regulation.

The Present Study

The present laboratory-based study examined associations between natural emotion word use and cardiovascular reactivity in a sample of predominantly middle-aged married couples from diverse socioeconomic and racial and ethnic backgrounds across two marital interaction contexts. We examined marriage as a central relationship in the lives of many people (according to recent census data, 93% of US Americans over the age of 65 have been married at least once in their lives; US Census Bureau, 2022). The study design allowed us to consider (a) negative and positive emotion word use, (b) emotion word use frequency as well as diversity, (c) actor as

well as partner effects, (d) conflict as well as positive interaction contexts, and (e) spouses from diverse socioeconomic and racial and ethnic backgrounds.

Drawing from affective science frameworks (e.g., Levenson, 1999), couple studies (e.g., Han et al., 2021; Horn & Meier, 2022; Karan et al., 2017), and research on natural emotion word use (e.g., Monin et al., 2012; Vine et al., 2020), we hypothesized that spouses' negative emotion word use would be linked with higher cardiovascular reactivity, and positive emotion word use would be linked with lower cardiovascular reactivity. We further expected that, beyond frequency, a more diverse negative emotion vocabulary would be linked with higher cardiovascular reactivity, and a more diverse positive emotion vocabulary would be linked with lower cardiovascular reactivity. In addition to actor effects, we explored partner effects without formulating specific hypotheses.

Follow-up analyses examined (a) robustness when controlling for total word count (i.e., to account for the possibility that spouses who talked more might show greater cardiovascular reactivity; Monin et al., 2012), age (i.e., to account for possible age differences in emotional functioning; Meier et al., in press), and socioeconomic status (SES; i.e., to account for possible socioeconomic differences in cardiovascular reactivity; Boylan et al., 2018), and (for analyses on emotion word diversity) frequency of emotion word use as well as (b) generalizability across gender, conversation type, and SES. Moreover, we examined whether (c) significant associations were driven by specific emotion words (i.e., anger, anxiety/fear, or sadness-related words).

Method

Participants and Procedure

We used data from a larger research study that investigated emotional functioning in married spouses from the greater Chicago area, IL, USA. Participating couples were of diverse

socioeconomic and racial and ethnic backgrounds, and had been recruited through flyers, advertisements on public transportation, and online postings. Spouses were recruited between 2015 and 2017 (same-sex marriages were only legalized in 2014 in Illinois) and recruited to have at least one child aged 5 to 18 years (to examine associations between relationship functioning and child outcomes not relevant for the present study). This recruitment strategy resulted in a sample of predominantly mixed-sex couples (a same-sex couple was part of the larger sample but had missing data for key study variables). Some findings of the larger research project have been published previously [BLINDED FOR PEER REVIEW], but none of these studies have examined links between language use and cardiovascular reactivity.

The present study examined a sample of 49 couples (50% female; age: M = 43.11, SD = 9.20 years, range: 21 - 68) who completed the laboratory-based interaction tasks (i.e., a conflict and a positive couple conversation). Sociodemographic characteristics were as follows: Income [annual household income before taxes]: 16.3%: less than $20,000, 12.2%: $20,001 - $35,000, 14.3%: $35,001 - $50,000, 12.2%: $50,001 - $75,000, 14.3%: $75,001 - $100,000, 18.4%: $100,001 - $150,000, and 12.2%: greater than $150,000); Education [in years]: M = 15.71, SD = 2.57, range: 8-21); 40.8% identified as white, 38.8% as Black, 5.1% as Latinx, 8.2% as Asian American, 2.0% as Hawaiian/Pacific Islander and 4.1% as multiracial (1% did not provide information about their race). Cardiovascular reactivity data was missing for 8 wives and 4 husbands in the conflict conversation, and for 7 wives and 5 husbands in the positive conversation. We reran the analysis with missing data imputed (using mean substitution), which did not change the results. Spouses with missing cardiovascular reactivity data did not significantly differ from other spouses in terms of word use and sociodemographic

characteristics (age, years of education; *p*s > .05), except that spouses with missing cardiovascular data had higher income ($p = .012$).

Couples were invited to a laboratory-based assessment of emotional functioning where they engaged in several videotaped conversations, while physiological measures were obtained continuously from each spouse, following established procedures (e.g., Carstensen et al., 1995; Gottman & Levenson, 1992). Spouses engaged in (a) a 5-minute neutral conversation (i.e., about events of the past day) first, (b) a 10-minute conflict conversation about a topic of disagreement (e.g., money; in-laws), and (c) a 10-minute positive conversation about something they enjoyed doing together (e.g., vacations; the family pet) with the order of the conflict and positive conversation counterbalanced (see Supplemental Material for details). Each conversation was preceded by a 2-minute baseline session in which spouses were asked to relax and close their eyes. Couples received total compensation of $100. The study was approved by the [BLINDED FOR PEER REVIEW] University Institutional Review Board.

Transparency and Openness

This study was not preregistered. The analysis script can be found on the Open Science Framework: https://osf.io/g35uf/ [anonymized view-only link for peer-review: https://osf.io/g35uf/?view_only=f9f51563f9ba4c419db77aebf55bada5]. Materials and data from this manuscript are available upon request. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Measures

Emotion Word Use

Conversations were transcribed and then cleaned and prepared for automated language analysis (see Supplemental Material). Following the approach by Vine et al. (2020), we

quantified both the *frequency* (i.e., rate of negative and positive emotion words relative to all words used) using the Linguistic Inquiry and Word Count software (Boyd et al., 2022)[1] and the *diversity* (i.e., rate of *unique,* non-repeated negative and positive emotion words used relative to all words used) of emotion words using the BUTTER software (Boyd, 2020). To illustrate, the utterances (a) "You are making me *angry*. I am so *annoyed* and *mad* at you." and (b) "You are making me *mad*, so *mad*. I am so *mad* at you." would both receive a negative emotion word *frequency* score of 23.1 (3/13 × 100)[2]. In contrast, (a) would receive a negative emotion *diversity* score of 23.1 (3/13 × 100), whereas (b) would receive a negative emotion *diversity* score of 7.69 (1/13 × 100). All scores were computed separately for negative and positive emotion words. Inflections of the same word (e.g., sad, sadly) were treated as the same word.

Cardiovascular Reactivity

We examined interbeat interval (IBI; i.e., the average time [in ms] between two successive R peaks) as a commonly used indicator of cardiovascular reactivity (Centers for Disease Control and Prevention, 2020) that may be particularly relevant in dyadic interaction studies (e.g., Chen et al., 2021) as it tracks moment-to-moment changes in cardiac activity during emotional responding (Cacioppo et al., 2016). During all conversation and baseline trials, participants were attached to non-invasive physiology sensors following MindWare Technologies LTD's standard recommendations for electrode placement (see Rompilla et al., 2021, for detailed description of physiological assessment setup). Electrocardiography (ECG)

[1] For both the frequency and diversity analyses, we used the emotion word dictionaries by Vine et al. (2020) to ensure parallel analyses. For frequency analyses, the dictionary provided by Vine et al. (2020) was used as a customized dictionary within the LIWC software.

[2] Frequency score = (#Emotion words / Total word count) ×100; diversity score = (#*Unique* emotion words / Total word count) ×100, see Vine et al. (2020), Boyd et al. (2022).

was measured using Mindware's BioNex 8-slot chassis and Biolab Acquisition Software (Mindware Technologies LTD, Gahanna, OH). Cardiovascular signals were cleaned for artefacts (e.g., due to movement) by trained research assistants using MindWare HRV Analysis 3.1.5 and exported as second-by-second IBI time series for each participant.[3]

We then aggregated IBI scores across the respective baseline (i.e., before each conflict and positive conversation) and conversation (i.e., conflict and positive conversation) for each participant, and subtracted the respective baseline IBI scores from the conversation trial IBI scores, which resulted in a single IBI reactivity score for each spouse (i.e., husband, wife) and conversation (i.e., conflict, positive). IBI scores were multiplied by -1, so that higher scores represented higher cardiovascular reactivity (relative to baseline).

Socioeconomic Status (SES)

Socioeconomic status was measured using a standardized composite score of education ("What is the highest level of education you have obtained?"; 8 years = high school/GED, 21 years = PhD., MD, or other professional degree) and household income ("What is your family's annual household income before taxes?"; 1 = less than $20,000, 7 = greater than $150,000), which was averaged for each couple (see e.g., Hittner & Haase, 2021).

Data Analysis

To examine links between emotion word use and spouses' cardiovascular reactivity, we conducted a series of linear mixed models in SPSS, following recommendations by West (2013) for analysis of data with a two-level crossed structure (spouses nested in dyads; both spouses participated in the same conversations). Specifically, we treated both spouse (husband, wife) and

[3] To remove outliers, we winsorized IBI observations for each participant in each conversation (i.e., positive, conflict). Specifically, observations were clipped at the 95th and 5th percentiles and replaced with the closest observed value below and above those thresholds, respectively (Tukey, 1962).

conversation type (conflict, positive) as repeated measures, resulting in four observations per dyad. Error variances were allowed to correlate to account for interdependence of dyadic data (Kenny et al., 2006; West, 2013), and we estimated both actor (i.e., associations between one's own emotion word use and cardiovascular reactivity) and partner (i.e., associations between the spouse's emotion word use and own cardiovascular reactivity) effects simultaneously. All continuous predictors were grand-mean centered.

In preliminary analyses, we examined intercorrelations as well as means and standard deviations for key study variables. To test for potential gender and conversation differences, we conducted mixed models (using the same approach as described above) with word use as the dependent variable and gender (1= husband, -1=wife) and conversation type (1= conflict, -1 = positive) as independent variables.

In the main analyses, we computed four separate models to predict spouses' cardiovascular reactivity (dependent variable) from (1) negative emotion word use (*frequency*), (2) negative emotion word use (*diversity*), (3) positive emotion word use (*frequency*), and (4) positive emotion word use (*diversity*). Each model included the actor and partner effects of the respective emotion word type as well as main effects of gender (1 = husband, -1 = wife) and conversation type (1 = conflict, -1 = positive). Follow-up analyses tested for the robustness of associations between emotion word use and cardiovascular reactivity when controlling for total word count of the conversation, frequency of the respective emotion word category (for models on emotion word diversity), age, and SES, as well as their generalizability across gender, conversation type, and SES by including interaction terms with emotion word use. Additional follow-up analyses also used the available emotion word subcategories of the Vine et al. (2020)

dictionary to test whether significant associations were driven by anger, anxiety/fear, or sadness-related words.

Power Considerations

Guided by other work in this area (Finkel et al., 2015; Gordon et al., 2022), we conducted a sensitivity analysis that reflects the dyadic and longitudinal (i.e., treating conversation type as a repeated measure) nature of our analysis. Specifically, we calculated the effective sample size based on the design effect, $N_{effective} = N/(1 + (n_{cluster} - 1) \times \rho)$, which included the intraclass correlation coefficient (ICC or ρ) to account for non-independence within dyads. With an ICC = .05 and a cluster size = 4, the effective sample size was 170. We then conducted a sensitivity analysis using GPower (Faul et al., 2007). At statistical power of .80 and an alpha level of .05, our study was sufficiently powered to detect main effects of ρ (population correlation coefficient) = 0.2 or larger, or small-to-medium-sized effects (per guidelines by Cohen, 1992).

Results

Preliminary Analyses

Intercorrelations between study variables are presented in Table 1. Means and standard deviations for spouses' cardiovascular reactivity and word use are shown in Table S1 (Supplemental Material).

Mixed models showed that, on average, spouses used more positive emotion words (frequency) in the positive (wives: $M = 0.45$, $SD = 0.42$, husbands: $M = 0.56$, $SD = 0.51$) than in the conflict conversation (wives: $M = 0.21$, $SD = 0.27$, husbands: $M = 0.19$, $SD = 0.24$), indicated by a significant main effect of conversation (B = -.14, SE(B) = .03, $p = .00004$). The frequency of negative emotion words did not differ ($p = .107$) between conflict (wives: $M = 0.35$, $SD =$

0.44, husbands: *M* = 0.26, *SD* = 0.44) and positive (wives: *M* = 0.21, *SD* = 0.24, husbands: *M* = 0.20, *SD* = 0.23) conversations.

Moreover, spouses used a more diverse positive emotion vocabulary in the positive (wives: *M* = 0.22, *SD* = 0.16, husbands: *M* = 0.27, *SD* = 0.20) than in the conflict (wives: *M* = 0.15, *SD* = 0.17, husbands: *M* = 0.12, *SD* = 0.13) conversation, indicated by a significant main effect of conversation (B = -.05, SE(B) = .01, *p* = .0003), and this seemed to be particularly the case for husbands, indicated by a significant gender*conversation interaction (B = -.02, SE(B) = .01, *p* = .040). The diversity of negative emotion word use did not differ between conflict and positive conversations (*p* = .542). Husbands and wives did not differ in their use of emotion words or cardiovascular reactivity (*p*s > .050), but, on average, wives (*M* = 827.76, *SD* = 316.00) used more words overall than husbands (*M* = 679.94, *SD* = 263.51) in the positive conversation (indicated by a significant gender*conversation interaction; B= 33.10, SE(B) = 14.10, *p* = .023).

Emotion Word Use and Cardiovascular Reactivity

Detailed results with all estimates and 95% confidence intervals are presented in Table S2 (Supplemental Material). Unstandardized estimates with 95% confidence intervals are presented in Figures 1 and 2.

Negative Emotion Words

Mixed models showed a statistically significant actor effect between spouses' use of negative emotion words (frequency) and cardiovascular reactivity (B = 21.16, SE(B) = 8.44, *p* = .014). That is, spouses who used more negative emotion words had higher cardiovascular reactivity. Follow-up analyses showed that this association (a) remained robust when controlling for overall word count (*p* = .015), age and SES (*p* =.004) and (b) generalized across gender (husbands and wives), conversation type (conflict and positive), and different levels of SES,

indicated by non-significant interaction effects (*p*s > .050). Follow-up analyses further revealed that this association (c) was driven by anger-related words, which were associated with higher cardiovascular reactivity (B = 54.43, SE(B) = 17.75, $p = .003$), whereas no significant actor effects were found for anxiety or sadness-related word use (*p*s > .050).

Mixed models also showed a significant actor effect between the diversity of spouses' negative emotion vocabulary and cardiovascular reactivity in the expected direction (B = 49.45, SE(B) = 19.70, $p = .014$). However, this association was not robust ($p = .172$) when controlling for negative emotion word frequency and overall word count.

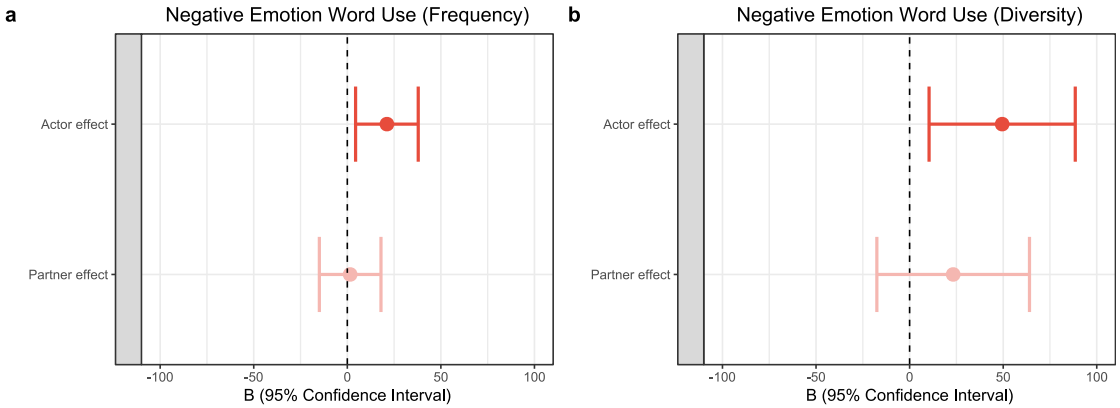
Positive Emotion Words

Associations between positive emotion word use and cardiovascular reactivity were not statistically significant (see Table S2). There was, however, a marginally significant partner effect between positive emotion word use (diversity) and cardiovascular reactivity (B = -30.50, SE(B) = 17.38, $p = .082$) that became statistically significant ($p = .003$) when controlling for positive emotion word frequency and overall word count. While we advise caution in interpreting this result, there may have been a tendency for spouses to have lower cardiovascular reactivity when their partner used more unique positive emotion words. Follow-up analyses moreover revealed that this association was moderated by SES (B = -42.74, SE(B)= 19.11, $p = .027$), indicating lower cardiovascular reactivity for spouses from higher (but not lower) SES backgrounds when their spouse used a more diverse positive emotion vocabulary. The three-way interaction with gender and conversation was also significant (B = 38.91, SE(B) = 17.38, $p = .027$) indicating that husbands showed higher cardiovascular reactivity in the conflict, and lower

cardiovascular reactivity in the positive conversation when their spouse used a more diverse positive emotion vocabulary, while wives seemed to show the opposite pattern.

Figure 1

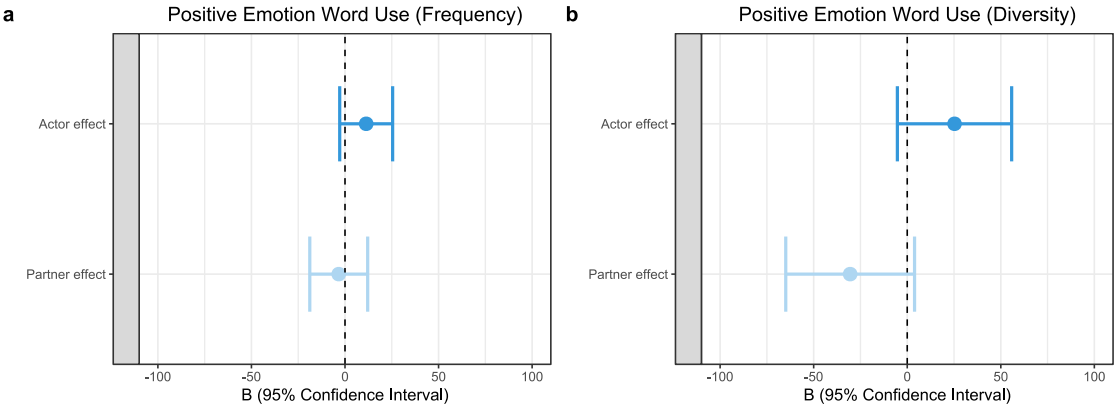
Negative Emotion Word Use and Cardiovascular Reactivity



Note. Presented are unstandardized estimates of fixed effects with 95% confidence intervals from mixed models. The dependent variable was cardiovascular reactivity, independent variables were actor and partner effects of negative emotion word use.

Figure 2

Positive Emotion Word Use and Cardiovascular Reactivity



Note. Presented are unstandardized estimates of fixed effects with 95% confidence intervals from mixed models. The dependent variable was cardiovascular reactivity, independent variables were actor and partner effects of positive emotion word use.

Table 1

Intercorrelations Between Key Variables for Spouses

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Cardiovascular reactivity, *conflict conversation*	**-.18**	.11	-.04	.23	-.11	.36*	.34*	.14	.02	.13	.004	.48**	-.08	.38*
2. Neg emo, frequency, *conflict conversation*	.39**	**.49****	-.07	.80**	-.003	.22	.03	.07	-.24	.16	-.19	.06	-.17	.13
3. Pos emo, frequency, *conflict conversation*	.05	-.01	**.56****	-.03	.87**	.11	-.26	-.26	.17	-.20	.15	.02	-.09	-.01
4. Neg emo, diversity, *conflict conversation*	.29	.80**	.03	**.19**	.05	-.01	.16	-.004	-.18	.12	-.09	-.11	-.17	.05
5. Pos emo, diversity, *conflict conversation*	.11	-.03	.90**	.01	**.32***	-.01	-.28	-.27	.16	-.19	.18	-.07	-.08	.07
6. Overall word count, *conflict conversation*	.05	.01	-.04	-.11	.01	**-.16**	.23	.15	.02	.11	-.10	.71**	.05	.40**
7. Cardiovascular reactivity, *positive conversation*	.42**	.24	-.03	.11	.01	.08	**.02**	.10	.28	.19	.16	.26	.08	-.06
8. Neg emo, frequency, *positive conversation*	.07	.24	-.01	.33*	-.05	.04	.03	**.17**	.06	.79**	.18	.23	.10	.0005
9. Pos emo, frequency, *positive conversation*	.01	-.11	-.07	-.10	-.01	-.21	.17	-.13	**.42****	.16	.87**	.21	-.03	-.02
10. Neg emo, diversity, *positive conversation*	.07	.22	-.08	.28	-.06	.04	.10	.91**	-.08	**.26**	.27	.21	-.04	-.04
11. Pos emo, diversity, *positive conversation*	-.07	.04	-.10	-.09	-.08	-.34*	.04	-.13	.69**	-.09	**.30***	.05	.08	.05
12. Overall word count, *positive conversation*	.02	.11	.12	.05	.07	.60**	.20	.09	-.40**	.06	-.41**	**-.48****	-.07	.40**
13. Age	.06	-.09	.06	-.18	.07	.02	.09	-.16	.28	-.14	.07	.19	**.70****	.08
14. SES	-.13	.29*	.002	.13	.11	-.04	-.26	-.22	-.04	-.24	.26	-.12	-.18	**.72****

Note. Husbands' correlations are below the diagonal; wives' correlations are above the diagonal; correlations between husbands and wives are on the diagonal in bold. Neg emo = negative emotion word use, pos emo = positive emotion word use, SES = Socioeconomic status. Emotion word frequency = % of emotion words relative to all words used, Emotion word diversity = % of *unique* emotion words relative to all words used. * $p < .05$., ** $p < .01$.

Discussion

The present laboratory-based study showed that emotion word use during marital interaction was associated with cardiovascular reactivity in a sample of middle-aged married couples from diverse socioeconomic and racial and ethnic backgrounds. Specifically, spouses who used more negative emotion words showed higher cardiovascular reactivity. Follow-up analyses showed that this association (a) remained stable when controlling for overall word count, age, SES; (b) generalized across gender (husbands and wives), conversation type (conflict and positive), and SES; and (c) was driven by the use of anger words. Spouses also showed higher cardiovascular reactivity when using a more diverse negative emotion vocabulary, but not above and beyond negative emotion word frequency. This suggests that individuals showed higher cardiovascular reactivity when they used more negative emotion words, regardless of whether they used more unique negative emotion words. No significant associations emerged between positive emotion word use and cardiovascular reactivity.

Negative Emotion Word Use and Cardiovascular Reactivity

A large body of research has shown the negative health implications of negative emotions during marital interactions (e.g., Carstensen et al., 1995; Gottman & Levenson, 1992; Haase et al., 2016; Karney & Bradbury, 1995). The present study built on this work to show, for the first time to our knowledge, that greater use of negative emotion words during marital interaction links to higher cardiovascular reactivity. Functionalist views of emotion (e.g., Levenson, 1999) have long posited that emotions come in "response packages" spanning emotional experiences, behaviors, and language (e.g., word use) as well as central and peripheral nervous system activation (e.g., cardiovascular reactivity). From this perspective, negative emotions are thought to manifest in negative emotion word use as well as heightened cardiovascular reactivity

(Levenson, 1999). Similarly, psychological language studies have seen emotion word use as a reflection of an individual's focus on negative or positive emotions (e.g., Boyd & Schwartz, 2021; Markowitz, 2022). Another perspective, supported by affect labeling (Torre & Lieberman, 2018) and some expressive writing studies (McGuire et al., 2005; Petrie et al., 1995) suggests the opposite, namely that the use of negative emotion words would be associated with reduced cardiovascular reactivity. The present findings support the former perspective, converging with other studies, which have shown that partners use more negative emotion words when they feel annoyed (Han et al., 2021) and less satisfied with their relationship (Karan et al., 2017). They highlight the importance of negative emotion words as potential risk markers for heightened cardiovascular reactivity, converging with other studies (Eichstaedt et al., 2015).

Several methodological aspects of the present study allowed us to uncover generalizability and specificity in this association. The present findings generalized across both husbands and wives, conflict and positive conversations, and socioeconomic backgrounds. While potential harmful impacts of negative emotions during marital conflict are well-documented (e.g., Gottman & Levenson, 1992; Haase et al., 2016), our findings suggest they might generalize onto positive contexts where the expression of negative emotions is less expected. Future longitudinal studies are needed to examine the long-term effects of cardiovascular reactivity that goes along with negative emotion word use in conflict versus positive conversation. Moreover, anger-related words drove the association between negative emotion word use and cardiovascular reactivity, mirroring earlier longitudinal findings on anger behavior in marital interactions and the development of cardiovascular symptoms (Haase et al., 2016). Our findings suggest that anger as a potential cardiovascular risk factor may also manifest on the level of verbal behavior and could be studied through emotion word use.

Interestingly, diversity of negative emotion word use did not seem to matter for cardiovascular reactivity beyond frequency, contrasting with some findings from other domains of functioning (e.g., physical health; Vine et al., 2020) and converging with others (e.g., mental health; Entwistle et al., under review). In some studies, diversity of emotion vocabularies only showed unique (beyond emotion word frequency) associations with emotional functioning in samples with clinically diagnosed mental health syndromes (e.g., Entwistle et al., under review). Future research could probe the possibility that a more diverse negative emotion vocabulary – which presumably reflects an intense focus on negative emotions as a result of frequently experiencing negative emotions (Vine et al., 2020) – may have associations with cardiovascular reactivity in individuals (e.g., those with clinical depression) who may have had extensive experience with negative emotions.

Finally, although emotions can become deeply connected between romantic partners (e.g., Butler et al., 2003), we did not find partner effects between negative emotion word use and cardiovascular reactivity. It is, however, possible that partner associations were too small to be detected in our sample. Replications with larger samples are needed before prematurely concluding the absence of partner associations.

Positive Emotion Word Use and Cardiovascular Reactivity

Positive emotions have been theorized to broaden individuals' mindset, invite them to engage in exploratory behaviors, build resources and social bonds (Fredrickson, 2001), and to undo the physiological effects of negative emotions (Fredrickson, 2001; Moskowitz & Epel, 2006). In marital interactions, positive emotional behaviors have shown physiological soothing effects (Yuan et al., 2010) and shared positive emotions have emerged as important antecedents of physical health and longevity (Wells et al., 2022). Our study revealed few associations

between positive emotion word use and cardiovascular reactivity. It is possible that positive emotion word use could go along with both increases and decreases in cardiovascular reactivity, depending on the specific positive emotions (e.g., excitement versus affection; Kreibig, 2010), resulting in an overall nil effect. It is noteworthy that there may have been a tendency (which was further qualified by SES as well as gender and conversation type) for spouses to have lower cardiovascular reactivity when their partner used a more diverse positive emotion vocabulary in the present study. In light of the many benefits of sharing positive emotions with close others (e.g., Gable & Reis, 2010; Wells et al., 2022), it will be fruitful to further explore when and for whom the partner's use of more and more diverse positive emotion words relates to lower cardiovascular reactivity.

Strengths and Limitations

The present study has several strengths, including its focus on (a) negative and positive emotion words, (b) emotion word use frequency as well as diversity, (c) actor as well as partner effects, (d) conflict and positive interaction contexts, (e) spouses from diverse socioeconomic as well as racial and ethnic backgrounds and tests for (f) robustness, generalizability, and specificity.

The study also has limitations. Our sample was small by the standards of large survey-based studies, but comparable to other laboratory-based studies of marital interactions (e.g., Karan et al., 2017; Monin et al., 2012) and notable in its inclusion of married couples from a wide range of socioeconomic and racial and ethnic backgrounds, which is quite rare (McGorray et al., 2023; Williamson et al., 2022). While our effective sample was sufficiently powered to detect effects of $\rho = 0.2$ or larger, the number of dyads was comparatively small, which may have limited our ability to detect interaction effects with gender and/or conversation type.

We encourage replication of our findings before making premature conclusions and do not see null findings as "evidence of absence" until they have been replicated in larger samples. Conducting high-powered studies to detect small and very small effects with inclusive samples that include individuals from marginalized backgrounds who often face barriers when participating in time-intense laboratory-based studies remains an important challenge for the field.

Our study was cross-sectional and examined concurrent associations between emotion word use and cardiovascular reactivity on the conversation level. The findings should thus not be taken as evidence of causality. It is possible that changes in cardiovascular reactivity prompted changes in emotion word use and not the other way around. Moreover, spouses used fewer positive emotion words in the conflict (versus positive) conversations. While our mean levels of emotion word use are in line with other studies (see e.g., Han et al., 2021; Pennebaker et al., 2003; Vine et al., 2020), our ability to detect associations between positive emotion word use and cardiovascular reactivity may have been reduced, particularly in the conflict conversation.

Constraints on Generality

Our sample was diverse in some respects (socioeconomic and racial backgrounds), but it consisted of mixed-sex couples due to our focus on married spouses and legislation from the Chicagoland region in the US. Replication is warranted to establish generalizability of our findings across other relationship types, other gender and sexual orientations, and other cultural contexts.

Implications for Future Research

Several directions for future research flow from this work.

Cardiovascular Health

Heightened cardiovascular reactivity can be a risk factor for the development of cardiovascular health symptoms (Krantz & Manuck, 1984; Smith et al., 2013; Treiber et al., 2003). Future studies could extend our work to look at longer-term health correlates of emotion word use, such as the development of cardiovascular disease (Haase et al., 2016) to further evaluate the potential of emotion word use as risk markers. Additionally, because the heart is innervated by both the sympathetic and parasympathetic nervous system and cardiovascular reactivity is thus a nonspecific measure of autonomic nervous system activation, future research may examine specific measures of sympathetic activation (e.g., pre-ejection period) and parasympathetic (e.g., respiratory sinus arrythmia) activation. This work could provide more specific insights into autonomic correlates of emotion word use – and could help elucidate possible links between positive emotion word use during marital interaction and parasympathetic activation (cf. Shiota et al., 2017).

Mechanisms and Specificity

More studies are also needed to uncover mechanisms linking word use and cardiovascular reactivity. While emotion words may simply be manifestations of emotional processes, they could also represent implicit or explicit strategies to regulate emotions. To probe this view, future research could examine whether the use of specific emotion words may further amplify or crystallize these emotions (Nook et al., 2021; see also Feldman Barrett, 2017). This could be particularly harmful in the case of specific negative emotions (e.g., anger; Haase et al., 2016) and negative emotion words directed at the partner ("I am *mad at* you"). Future work could examine specific negative (or positive) emotion words (e.g., anger, contempt) and differentiate between general expressions of emotions versus those directed at the partner. Moreover, future research could probe whether positive emotion word use in marital interaction

may reflect, or perhaps even facilitate, specific emotion regulation strategies, such as positive reframing (Robbins et al., 2019) or savoring (Borelli et al., 2020), and under which circumstances this could impact cardiovascular reactivity. Finally, there are numerous ways, beyond emotion words, for individuals to convey emotion, including metaphors and non-verbal behavior (pitch, intonation), which will be promising for future research to examine.

Benefits of Emotion Word Use

Our study showed that negative emotion word use during marital interactions relates to heightened cardiovascular reactivity in the short term. Yet, sharing emotions is essential for core relationship processes (e.g., Reis & Shaver, 1988; Rimé, 2009) and future research could examine ways in which the use of negative and positive emotion words could also relate to beneficial outcomes. An individual's emotion word use could signal that they are processing their emotions (McCarthy et al., 2017; Pennebaker, 1997), which could be physiologically arousing in the short term, but perhaps still facilitate coping and conflict resolution over the longer term. Like some experimental work found links between emotion word use and attenuated physiological reactivity in follow-up sessions (e.g., Kircanski et al., 2012; Torre & Lieberman, 2018), it could, for example, be examined whether negative emotion word use during marital conflict relates to cardiovascular recovery after the conversations when the conflict is resolved in a way that increases empathy, compassion, and closeness (e.g., Reis & Shaver, 1988; Zaki et al., 2008).

Conclusion

When spouses interact, their emotions may become deeply interconnected on a physiological (Chen et al., 2021), behavioral (Wells et al., 2022), and linguistic (e.g., Horn & Meier, 2022) level. The present study revealed an important connection between spouses' use of

negative emotion words and heightened cardiovascular reactivity, in line with a multi-systems perspective on emotions (Keltner & Gross, 1999; Levenson, 1999) that emphasizes connections between physiology, behavior, and language. The emotion words that romantic partners spontaneously use can thus provide a meaningful window into emotional and physiological aspects of their relationships. The study of language use offers exciting new opportunities to better understand the health implications of emotions in close relationships.

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