Article

The International Journal of Bilingualism

International Journal of Bilingualism
2019, Vol. 23(5) 1106–1120

DOI: 10.1177/1367006918781074
journals.sagepub.com/home/ijb
SAGE

Regulating emotions in two languages: How do emotion regulation strategies relate to physiological reactivity in emotional contexts?

Laura E Quiñones-Camacho
University of California, Riverside, USA

Emily W Shih
University of California, Riverside, USA

Scott V Savage
University of Houston, USA

Covadonga Lamar Prieto
University of California, Riverside, USA

Elizabeth L Davis
University of California, Riverside, USA

Abstract

Aims and Objectives/Purpose/Research Questions: Differences in how people regulate their emotions have been shown across cultures. Yet, whether bilinguals regulate emotions differently based on the language they are speaking is unknown, as is whether these regulatory choices relate to their physiology. The aim of this study was to assess whether self-reported use of emotion regulation strategies that promote emotional engagement would be associated with greater sympathetic arousal while describing emotional experiences for bilinguals.

Design/Methodology/Approach: 99 Spanish–English bilinguals (*M* = 20.8 years; *SD* = 2.11; 73 women) were interviewed about times they felt sad and afraid in both Spanish and English, and described what they did to regulate those emotions. Sympathetic nervous system physiology (pre-ejection period; PEP) was assessed continuously. The within-person experimental design enabled exploration of differences in regulation and physiology that were associated with talking about negative emotions in different languages.

Corresponding author:
Elizabeth L Davis, University of California, Riverside, 900 University Ave., Riverside, CA 92521, USA.
Email: elizabeth.davis@ucr.edu

Data and Analysis: Emotion regulation strategies that indexed emotional engagement (e.g. cognitive reappraisal) were reliably coded from participant interviews. PEP reactivity was calculated as the change from a resting baseline to each language context. We used hierarchical linear regressions to test our hypotheses.
Findings/Conclusions: We found that using fewer engagement strategies was associated with decreased sympathetic arousal, but only for people who were more physiologically aroused when at rest and only when participants were speaking English.
Originality: This study is the first to show that bilinguals' emotion regulatory attempts have different consequences across languages, highlighting how emotional processing is colored by cultural-linguistic lenses.
Significance/Implications: These findings align with growing evidence that bilinguals' physiological reactions to emotional events depend on the language context. Knowledge generated by this investigation contributes to our understanding of cross-cultural differences in people's physiological arousal and emotional processing by highlighting these patterns among the understudied population of bilingual speakers.

Keywords
bilingualism, sympathetic nervous system, pre-ejection period, emotion, emotion regulation

Introduction

Emotions encompass the physiological changes, cognitive states, and expressive behaviors that arise when a goal is lost (e.g. feeling sad after losing a job), appears to be under threat (e.g., hearing weird sounds late at night), or changes status (Campos, Mumme, Kermoian, & Campos, 1994; Thompson, 1994). Although negative emotions (e.g. sadness, fear) are common, sometimes they need to be regulated in the service of goals. For example, service workers must often conceal their contempt for disruptive clientele in the service of creating a positive customer experience (Hochschild, 1983). Emotion regulation is the modification of one's emotional experience to fit situational and psychological demands via strategies that involve either engaging with the negative emotion or disengaging from it (Gross, 2008).

Although prior research reveals cross-cultural differences in how people use emotion regulation strategies (e.g. Davis et al., 2012), several questions about cultural differences in emotion regulation remain unanswered. For instance, little is known about whether bilinguals (people who navigate two languages, and potentially, two cultures) regulate emotions differently based on the language they are speaking. Moreover, no research has considered how bilinguals' regulatory choices relate to their physiological responding. The need to understand the emotional processes of bilinguals—including regulation of emotion—is becoming even more important as the number of bilinguals in the world continues to increase and because emotional processes might differ for bilinguals and monolinguals.

In this paper, we begin to address these concerns by assessing whether and how bilinguals' reported use of emotion regulation strategies associates with physiological arousal to conversations about past negative events. We examine this in the context of two languages (Spanish and English) using physiology to measure aspects of emotional responding that are not detectable at the behavioral level (e.g. Demaree et al., 2006; Kreibig, 2010). Thus, exploring how emotion regulation strategies relate to bilinguals' physiology will provide valuable new information about bilinguals' implicit experience of emotions.

Emotion and emotion regulation among bilinguals

The experience of emotion, particularly for negative emotions, depends in large part on culture (Tsai, Knutson, & Fung, 2006). Cultural processes frame the specific emotions we experience, as well as the expression and management of those emotions (Matsumoto, Anguas-Wong, & Martinez, 2008). Consequently, the way emotions like sadness and fear manifest across cultural groups is likely a function of the extent to which specific cultural expectations or norms are salient to individuals from multicultural backgrounds. According to affect valuation theory, cultures differ in what types of emotions they value most (Tsai et al., 2006). For example, people in the USA prefer feeling joy more than do people from other cultures (e.g. German, French, Japanese; Izard, 1971). Similarly, people from individualistic cultures prefer feeling pride more and guilt less than do people from collectivistic cultures (USA versus China; Eid & Diener, 2001).

Complementing these findings, other cross-cultural research shows differences in emotional intensity, duration, and regulation choice across some cultures (Davis et al., 2012; Matsumoto, 1993; Matsumoto, Kudoh, Scherer, & Wallbott, 1988). Davis et al. (2012), for example, compared college students from the USA and China on their use of strategies to regulate negative emotions evoked via picture stimuli. Chinese students reported strategies such as shifting attention away from the image (emotional disengagement) more often than students from the USA, but students from the USA reported using strategies such as crafting a background story to explain the image (emotional engagement) more than Chinese students. These results suggest that cultural processes shape the specific strategies individuals spontaneously use when regulating negative emotion.

One cultural element that may be of particular importance for emotion regulation is language. Language provides the vocabularies needed to understand, express, and manage emotion (Whorf, 1952) and, as such, frames how people experience emotion. Because different languages may have disparate cultural values associated with them, individuals who speak more than one language may have to juggle competing meaning systems when experiencing emotion. Indeed, according to Matsumoto et al. (2008), bilinguals judge facial expressions of emotion to be different depending on the language they are using, suggesting that language may influence how bilinguals experience emotions. Bilinguals are in a unique position to engage multiple emotion vocabularies and cultural values, which may shape the physiological aspect of emotional experience. Nevertheless, no research has examined whether people who manage two distinct languages (e.g. Spanish and English) use emotion regulation strategies differently based on the linguistic (and cultural) context they find themselves in, nor whether emotion regulation strategies influence physiological reactivity to an emotional event differently for bilinguals in different language contexts. Indeed, no work with bilinguals has utilized measurements of sympathetic reactivity to assess the link between emotion regulation strategies and physiological arousal.

Measuring emotion and emotion regulation in bilinguals

Theories of emotion emphasize physiological and cognitive responses (e.g. appraisals; Schachter & Singer, 1962) as important aspects of the emotional experience. The relations among emotion, physiology, and cognition become increasingly complex for bilinguals, who must navigate the underlying meanings of emotions across two language systems. Thus, it is important to consider how bilinguals process emotional words in both languages, and how this influences their physiological responding. Some studies have shown that bilingual Spanish/English speakers recalled emotional words better than neutral words in their first language (L1) only, regardless of whether the L1 was Spanish or English (Anooshian & Hertel, 1994). Other studies have attempted to measure differences in emotionality across multiple languages by examining physiological responses to

emotional words. While the approaches to measuring physiological response vary, the most common methods involve non-invasively measuring electrical activity in the brain (electroencephalogram (EEG); Jackson, Swainson, Mullin, Cunnington, & Jackson, 2004), or changes in the electrical conductivity of the skin (skin conductance response (SCR); Harris, 2004). Studies using these methods document greater physiological arousal to words presented in the L1 than in the second language (L2) (Caldwell-Harris, Tong, Lung, & Poo, 2011; Eilola & Havelka, 2011).

Other research into the physiological underpinnings of emotion in bilinguals highlights the nuances of this pattern. For example, Harris (2004) compared physiological reactivity to auditory and visual stimuli in early and late learners of English as a L2 (Spanish = L1; English = L2) and found that auditory stimuli elicited higher SCRs than visual stimuli for early learners, but not late learners. The type of word presented also mattered, as SCRs were strongest in response to taboo words in both Spanish and English. Although previous studies have used physiological measures to look at differences in emotionality between languages, it is necessary to move toward a more nuanced understanding of bilinguals' physiological experience by exploring dynamic physiological reactivity—while bilinguals talk about and process emotional information. The current study accomplishes this by examining bilinguals' physiological reactivity while having a conversation about an emotional event.

Sympathetic physiology as an index of emotional arousal

The pre-ejection period (PEP) is a measure of myocardial contractility that reflects sympathetic nervous system functioning (Berntson, Lozano, Chen, & Cacioppo, 2004). The PEP is calculated as the time interval between the onset of the electrocardiograph's (ECG's) Q-wave (ventricular depolarization) to the B-point inflection on the impedance cardiograph (ZCG) wave (the opening of the aortic valve) marking the point of initial ejection of blood from the left ventricle. PEP represents the total duration of the electrical and mechanical events prior to ejection (Newlin & Levenson, 1979). When an individual is exposed to emotionally arousing and stressing events, the body shifts energy from normal homeostatic functioning to allow for an active behavioral response, and sympathetic activity becomes predominant (Boucsein, 1992). Initiation of the "fight or flight" response driven by activation of the sympathetic nervous system has been associated with decreases in the PEP (i.e. a shorter PEP interval or greater sympathetic arousal; Kreibig et al., 2007). Similarly, active task engagement has also been associated with decreases in PEP intervals (Kreibig et al., 2007).

Although the PEP provides precision and specificity in isolating sympathetic influence over the heart, no studies have used the PEP to measure sympathetic arousal in bilinguals, although it may be an especially useful index of physiological responding across different contexts. For example, prior work has shown a shortened PEP after a fear elicitation compared to a neutral or sad elicitation, but no significant differences between sad and neutral elicitations (Kreibig et al., 2007). Research on PEP and emotions shows that a shortened PEP is associated with the experience of most negative emotions (except sadness) and a longer PEP is associated with positive emotions, such as amusement and joy (Kreibig, 2010). Thus, the PEP is a useful index of emotional arousal (Kelsey, 2012). In a study by Demaree et al. (2006), participants who were instructed to regulate their emotional facial expressions (suppress or exaggerate) to an emotionally arousing film experienced a significant shortening of the PEP (an increase in sympathetic arousal) compared to a baseline. These findings suggest that implementing an emotion regulation strategy influences sympathetic responses, as evidenced by the changes in the PEP. However, more research is needed to understand how emotion regulation relates to sympathetic arousal, especially in relation to bilinguals' emotional experience.

Current study

We examined sympathetic nervous system psychophysiology as a concomitant of emotional arousal during a conversation about past emotional events among Spanish–English bilingual participants (e.g. Kelsey, 2012). Bilinguals talked about a sad and a scary experience in English and Spanish. To better conceptualize the individual differences in emotionality that would precipitate differences in sympathetic reactivity during conversations about past emotional events, we examined both the resting PEP (i.e. initial baseline levels) and the use of engagement strategies across languages. Participants described their typical use of emotion regulation strategies in each language, and the PEP was measured continuously throughout the emotional conversations. We expected greater use of emotional engagement strategies to be associated with increasing sympathetic arousal (shortening PEP). However, we expected this pattern to depend on bilinguals' resting level of sympathetic arousal (PEP baseline). We also explored differences in language contexts as qualifiers of this relation. Based on previous studies of physiology among bilinguals, we anticipated differences in the associations between emotion regulation strategies and physiological reactivity depending on the language being spoken, but we had no a priori hypothesis about the precise nature of this pattern.

Method

Participants

Ninety-nine (99) Spanish–English bilinguals between the ages of 18 and 28 (M = 20.8 years; SD = 2.11 years; 73 women) were recruited for a study on bilingualism and emotional responding. Participants came from the psychology department's participant pool (n = 86), or the broader campus community (n = 13) by responding to a recruitment flyer. Research pool participants received credit toward a course requirement, and community participants received US$10 for their time. Participants had to demonstrate the ability to speak fluently in both Spanish and English and to self-identify as bilingual. Regarding language dominance, 61% indicated greater proficiency in English, 27% indicated equal proficiency in English and Spanish, and 12% reported greater proficiency in Spanish. Given the inclusion criteria (Spanish fluency) and the region of the country (Greater Los Angeles, whose five counties are in the top 10 counties by Hispanic population in the country; Pew Research Center), the sample was predominantly Hispanic. The university's Institutional Review Board approved the study before research procedures began, and participants provided consent to participate upon arrival to the laboratory.

Design

The study employed a 2 (emotion: sadness, fear; within-person) × 2 (language frame: Spanish, English; within-person) experimental design. Because we were particularly interested in understanding differences across languages, we collapsed across emotions for this study.[1] Each participant saw four video clips, two of which were meant to elicit sadness and two of which were designed to elicit fear. Two of the four clips (one sad- and one fear-eliciting) were introduced by an experimenter who was speaking in Spanish and two were introduced by the same experimenter, speaking in English. The order of the language frame (whether the interviewer spoke to the participant in Spanish or English first) was counterbalanced across participants using four selected combinations of language and emotion. Therefore, language frames and subsequent conversations had two possible orders: Spanish–Spanish–English–English or English–English–Spanish–Spanish. Follow-up questions after each video were asked in the same language the experimenter had used to introduce the film clip.

Procedure

Participants came to the lab for a single 1-hour session. An experimenter explained the procedures, answered questions, and secured written consent. All experimenters received extensive training on how to conduct interviews and acquire physiological data, and were themselves fluent Spanish–English bilingual speakers of the local dialect. All study materials (e.g. the post-film interview questions) were translated and checked by more than one bilingual speaker. These materials were also adjusted to represent distinct dialectal features (e.g. lexicon, syntax, sociolinguistic elements of courtesy) of Northern Mexican/Southern California Spanish (the Spanish dialect spoken by most of our sample). The entire session was video recorded.

A second Spanish–English bilingual experimenter then entered the room to affix the electrodes for collection of cardiac data. Seven self-adhesive spot electrodes were applied to the participant's torso to collect ECG and ZCG signals that indexed cardiac psychophysiology throughout the study. Resting physiology levels were recorded for 5 minutes at the beginning of the laboratory visit. During this baseline, participants sat quietly while alone in a room (the experimenter left to "check on some things").

Next, the experimenter informed participants they were going to watch some film clips and would be asked about them later. This instruction was provided either in Spanish or in English, depending on which language the participant was assigned to hear first. The experimenter started the first video clip and left the room. After each clip, the experimenter reentered the room, asked the participants to self-report their emotions, and asked them to describe the clip they had just seen. After this, participants were prompted to think about an experience from their own lives that had made them feel the same negative emotion as was expected to be elicited by the film (e.g. sadness after the sad film) and describe what they had done or thought about to make themselves feel better when they had felt that negative emotion. After completing the film task and a separate sociodemographic interview (not described here), participants were debriefed and thanked.

Stimuli and materials

Emotion elicitation. Every participant viewed four emotion-evocative film clips. A separate group of adults who were blind to the research questions and not part of the study ($n = 13$) pilot rated the films to ensure the effectiveness of each clip in evoking the targeted negative emotion. To avoid potential confounds introduced by the language spoken in the film clips, we selected clips with very little dialogue, and then stripped out any remaining dialogue so that only the original background music of the scene was included in the audio track heard by participants.

Emotion self-report. Immediately after watching each clip, participants reported their current emotional states using separate four-point scales for the emotions of sadness, fear, happiness, and anger. The intensity scale ranged from 1 = *not at all* (sad, scared, happy, angry) to 4 = *very* (sad, scared, happy, angry). After this, participants were asked a series of structured questions about the film (described next), and then reported their emotions again.

Film interview. After self-reporting the intensity of their emotions, participants were asked to describe the film clip they had just watched (i.e. English: "I haven't seen the movie you just watched. Tell me what happened in the movie starting at the very beginning"; Spanish: "Yo no vi la película que acabas de ver. Cuéntame qué pasó en la película, todo desde el principio") and to describe any other situations in which they would feel similar emotions (sad or scared, depending on which clip they had just watched). After this, participants were asked to describe what they

typically would do to make themselves feel better in such a situation (i.e. English: "When you feel (sad/scared), tell me about what you do or think about when you feel like that. Would (doing/thinking) that make you feel better? What else can you do or think about to make yourself feel better when you feel (sad/scared)?"; Spanish: "Cuéntame qué cosas haces o piensas cuando te sientes (triste/asustado) ¿(Hacer o pensar) esas cosas te hace sentirte mejor? ¿Qué otras cosas haces o piensas que puedes hacer para sentirte mejor cuando te sientes (triste/asustado)?"). The behavioral elements of this last section of the interview and the physiological data acquired during the conversations about the film clips were used in analyses.

Physiological reactivity. ECG and ZCG data were collected for the entire session using ambulatory impedance monitors (Mindware, MW 1000A). These monitors allow wireless collection of ECG and ZCG (for heart rate, heart rate variability, and PEP—our index of sympathetic function). For this study, we focused on the ZCG acquired during the resting baseline (before the emotion elicitation and interview procedures started) and during the film conversations.

Data reduction and coding

Physiological measures. The PEP was calculated offline using the Mindware Heart Rate Variability (HRV 3.0.21; HF range: .12–.24) and the Mindware Impedance Cardiography (IMP 3.0.21) software programs. The PEP was calculated in consecutive 30-second epochs for each portion of the study. The PEP was calculated from the ZCG signal by ensemble-averaging data in 30-second epochs using the IMP 3.0.21 software. All epochs were visually inspected by trained researchers to ensure that plausible values were derived from the algorithm. PEP values were calculated for the pre-baselines and for the four emotion conversations after the film clips by averaging data from all epochs available for each task. PEP reactivity was calculated as the difference between pre-baseline and average conversation values (e.g. average PEP during the English conversations minus the average pre-baseline). Before analyses, PEP data were winsorized to normalize biologically implausible change values. Values that were +/−2 standard deviations (*SD*s) from the mean change score were replaced with the +/−2 *SD* value (similar approaches have been used in other studies; e.g. Frings, Rycroft, Allen, & Fenn, 2014).

Emotion regulation strategy coding. Interviews were transcribed by bilingual speakers and coded for the specific strategies that participants described using. Specifically, we examined participants' responses to the open-ended question of what they had *done or thought about* to make themselves feel better when they had experienced fear or sadness. A coding scheme was developed for this study and applied to participants' open-ended emotion regulation responses. Two reliable coders coded the data for all participants (k = .78). We focused on identifying strategies that could be conceptualized as emotional engagement in order to test our hypotheses about emotional arousal and physiological reactivity among bilinguals. Six engagement strategies were identified: *problem-focused responding; cognitive reframing; breathing; calming down; accepting emotions; seeking social support* (Table 1). The total number of engagement strategies each person described using (out of six possible strategies) was summed to create an index of engagement emotion regulation strategies.

Missing data. We were missing PEP data for 10–13 participants due to equipment malfunction or messy data. An additional six participants were missing emotion regulation strategy data due to equipment failure (no audio recorded from interviews) or irrelevant (uncodable) responses. We multiply imputed these missing data to retain all participants in analyses (Royston, 2004). Ten

Table 1. Emotional engagement regulatory strategies.

Strategy	Example
Problem-focused/problem solving	"I try to solve the problem"
Cognitive reframing	"I think about how it isn't real"
Breathing	"Took a breath"
Focusing on bodily state	"I focus on how I feel and try to calm down"
Acceptance of emotion	"I felt sad, so I cried"
Sought social support	"I talked to my friends about it"

imputed datasets were computed using SPSS 24.0 software and pooled estimates are reported in the analyses.

Results

The results are organized into five sections. Firstly, we present preliminary analyses to identify possible covariates (conducted with the original data before imputation). Secondly, we present descriptive statistics and bivariate correlations, including hypothesized zero-order associations between engagement emotion regulation strategies and physiological arousal. Thirdly, we present mean-level comparisons of people's emotion regulation strategy use and physiological reactivity in English versus Spanish. Fourthly, we describe regression analyses that explored the effects of engagement strategies and the resting PEP on bilinguals' PEP reactivity during Spanish and English conversations in order to explore whether individual differences in resting levels of sympathetic arousal moderated the effect of emotion regulation strategies on bilinguals' physiological reactivity. The last section includes exploratory analyses of the use of each of the emotion regulation strategies across language contexts.

Preliminary analyses

We first assessed whether participants' gender and language dominance related to emotion regulation or physiology. There were no gender differences, ts < -1.59, ps $> .116$. We used a multivariate analysis of variance (MANOVA) to assess differences in use of emotional engagement strategies across the two language contexts based on language dominance (English dominant or Spanish dominant/equally dominant; between-person), L1 spoken in the study (Spanish or English; between-person), and first emotion elicited in the study (sadness or fear; between-person) to identify potential covariates for our primary analyses. No significant effects emerged, whether for self-reported language dominance $F(4,112) = .368$, $p = .831$, $\eta^2 = .013$, L1 spoken, $F(2,55) = .917$, $p = .406$, $\eta^2 = .032$, or first emotion elicited, $F(2,55) = .562$, $p = .573$, $\eta^2 = .020$. Thus, neither language dominance nor experimental order (of language or emotion exposure) was related to participants' use of engagement strategies.

Another MANOVA examined differences in PEP reactivity across the two language contexts. There were no effects of self-reported language dominance, $F(4,120) = 1.102$, $p = .359$, $\eta^2 = .035$, or first emotion elicited, $F(2,59) = 1.346$, $p = .268$, $\eta^2 = .044$. There was, however, a multivariate effect of L1 spoken $F(2,59) = 4.740$, $p = .012$, $\eta^2 = .138$. We followed this up with independent sample t-tests to examine differences in PEP reactivity based on whether the L1 spoken was English or Spanish. The t-test was non-significant ts $= -1.08$, ps $= .284$. Because no significant effects

Table 2. Bivariate correlations, means, and standard deviations of key study variables.

	1	2	3	4	*N*	Mean	*SD*
1. Engagement strategies in Spanish	–				73	1.67	1.21
2. Engagement strategies in English	.359**	–			81	1.81	.99
3. PEP baseline	.079	.122	–		–	127.61	10.96
4. PEP reactivity to Spanish interviews	−.037	−.068	−.257*	–	–	2.98	15.36
5. PEP reactivity to English interviews	−.020	.018	−.199	.855**	–	2.27	12.53

Note: *$p < .05$; **$p < .01$.
N: total number of participants who reported using engagement or disengagement strategies during each of the emotion/language contexts; PEP: pre-ejection period.

emerged for language dominance or first emotion elicited and the between-subjects comparison of the effect of L1 spoken were not significant, these variables are not considered further.

Descriptive statistics

Table 2 displays descriptive information for our study variables, as well as the inter-correlations among study variables. Sum scores of engagement strategies used in Spanish and English were positively correlated ($r = .359$, $p < .001$; Table 2). The PEP reactivity variables were also correlated ($r = .855$, $p < .001$), such that greater physiological reactivity to the Spanish conversations was associated with greater reactivity to the English conversations. No significant bivariate associations between physiology and emotion regulation strategy use emerged.

Primary analyses

Before conducting regression analyses, we ran paired-sample *t*-tests to test whether there were differences in the number of regulatory strategies used or physiological reactivity to emotional conversations between the two language contexts. There were no differences in the total number of engagement strategies reported in English versus Spanish, $t_{(3725)} = 1.285$, $p = .199$, or in physiological reactivity to the conversations about past events in English versus Spanish, $t_{(57)} = .510$, $p = .612$. Thus, bilinguals did not use engagement strategies or physiologically react to emotional conversations differently in Spanish versus English.

Do engagement emotion regulation strategies and resting physiology predict bilinguals' sympathetic arousal?

Hierarchical linear regressions tested our hypotheses that engagement strategies and resting PEP would predict PEP reactivity during the Spanish and English contexts. This was tested in separate models because each language context provided unique information about PEP reactivity. The different language contexts in this study all occurred at the same "level" of the design, so running standard hierarchical regression models for each language is appropriate (e.g. Hox, 1998; Peugh, 2010). In Step 1, resting PEP and engagement strategies were entered. In Step 2, the two-way interaction between resting PEP and engagement strategies was entered. Significant interactions

Table 3. Regression models predicting pre-ejection period (PEP) reactivity in Spanish and English Contexts.

	A. PEP reactivity to Spanish interview						B. PEP reactivity to English interview					
	R^2	ΔR^2	ΔF	p	b	SE	R^2	ΔR^2	ΔF	p	b	SE
Step 1	.061	.061	3.127	.095			.048	.048	2.409	.101		
PEP baseline					**−.149**	**.063**					**−.150**	**.072**
Engagement strategies					−.298	.578					.006	.809
Step 2	.067	.006	.633	.556			**.137**	**.089**	**9.769**	**.003**		
PEP baseline					**−.140**	**.066**					−.100	.072
Engagement strategies					−.458	.653					−.444	.815
PEP baseline × Engagement strategies					.039	.075					**.216**	**.072**

Note: Bolded = $p < .05$. Results shown are with multiply imputed data.

were plotted and probed by examining the simple slopes at +/−1 *SD* from the mean values (Aiken, West, & Reno, 1991).

PEP reactivity in Spanish contexts. Step 1 was not significant $F\Delta(2,96) = 3.127$, $p = .095$ (Table 3). Step 2 resulted in a non-significant change to the model, $F\Delta(1,95) = .633$, $p = .556$. Thus, neither individual differences in initial arousal nor the use of engagement emotion regulation strategies related to PEP reactivity during the Spanish conversations about emotions.

PEP reactivity in English context. Step 1 was not significant $F\Delta(2,96) = 2.409$, $p = .101$ (Table 3), but Step 2 resulted in a significant change to the model, $F\Delta(1,95) = 9.769$, $p = .003$, $R^2\Delta = .089$, such that the interaction of engagement strategies and PEP baseline was significant, $b = .216$, $SE = .072$, $t = 3.011$, $p = .003$, 95% CI [.075, .357]. Probing the interaction (Figure 1) revealed that for bilinguals who self-reported using fewer engagement strategies (or no engagement strategies) to regulate negative emotions, greater initial sympathetic arousal (shorter resting PEP while at rest) was associated with less sympathetic reactivity during the conversations ($b = −.313$, $t = −3.153$, $p = .002$). In contrast, for bilinguals who self-reported using more engagement strategies to regulate negative emotions, initial sympathetic arousal was not related to sympathetic reactivity during the interview ($b = .113$, $t = .851$, $p = .397$). Thus, using few or no strategies to engage with emotion when speaking in English was associated with decreasing sympathetic reactivity to emotional conversations, but only for bilinguals whose initial arousal levels were high.

Exploratory analyses of differences between languages for specific engagement strategies

To assess whether there were any differences in the use of the six engagement strategies between Spanish and English contexts, we conducted paired-sample *t*-tests for each of the strategies. Only one significant comparison emerged, such that cognitive reframing was reported more often in English ($M = .548$, $SD = .500$) than Spanish ($M = .398$, $SD = .492$), $t_{(92)} = 2.547$, $p = .013$. All other comparisons were non-significant, $ts < 1.394$, $ps > .167$.

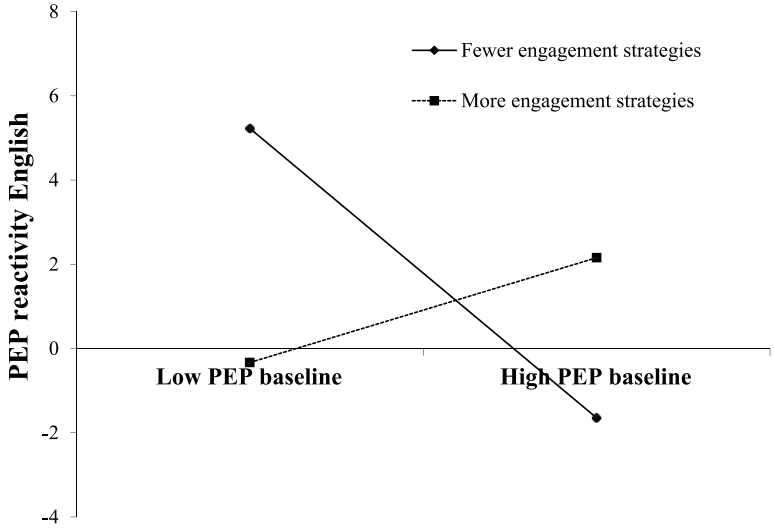

Figure 1. Two-way interaction of emotional engagement regulatory strategies and pre-ejection period (PEP) baseline predicting PEP reactivity (lower reactivity corresponds to increased arousal) during conversations in English.
Fewer engagement strategies: $b = -.313$, $t = -3.153$, $p = .002$.
More engagement strategies: $b = .113$, $t = .851$, $p = .397$.

Discussion

This study examined the psychophysiological concomitants of emotional arousal during conversations about emotional events among Spanish–English bilinguals. We were particularly interested in understanding how the use of emotion regulation strategies that promoted engagement with emotion might relate to physiological reactivity. We hypothesized that the use of engagement strategies would be associated with greater sympathetic reactivity in emotional contexts, evidenced by a shorter PEP. We found indirect support for this hypothesis when bilinguals were speaking in English. Specifically, using *fewer* engagement strategies was associated with decreased sympathetic arousal, but only for people who were more physiologically aroused when at rest. In contrast to our expectations, however, we found no association between initial and reactive sympathetic physiology for bilinguals who described using relatively more emotional engagement strategies.

Although we did find differences in how resting levels of sympathetic activity and the use of engagement strategies related to bilinguals' sympathetic reactivity, comparisons of mean-level differences across context were not significant. Our results with language contexts contrast with the findings of Davis et al. (2012), where differences between *nations* in the use of engagement strategies were found. One reason for this might be that bilinguals have two different sets of language and cultural values that are always active and that they must learn to balance (Kroll, Bobb, & Hoshino, 2014), and although those values might become more salient in one language context versus the other, they are still both influencing the behavior of that person. Thus, perhaps it is not surprising that we see no difference when looking at mean-level differences in emotion regulation and physiology in two language contexts, but a different pattern emerges when we consider individual differences in emotional processing among these bilingual speakers. Moreover, our exploratory analyses of the specific strategies reported across language contexts highlights how the

specific profile of strategies might vary, even if the number of strategies reported does not. This should be further explored in future studies.

The use of regulatory strategies designed to enable engagement with emotion was related to sympathetic reactivity only during English-speaking contexts, suggesting that the combination of emotion regulation strategies and resting physiological arousal (two indices of individual differences in bilinguals' emotional functioning) had different consequences for physiological reactivity, depending on the language spoken. Most previous studies have focused on identifying differences in functioning when comparing bilinguals' L1 and L2 (typically assuming that observed differences emerge because of differences in language dominance). However, language dominance was not a significant covariate in our study. Thus, beyond language dominance, other individual differences (such as resting levels of sympathetic arousal) can influence the processing of emotional information in one language versus the other when bilinguals describe emotional events. An important strength of this study is the fact that we focused on bilinguals' reactivity during *conversations* about experienced emotional events, not reactivity to single words. This enhances the ecological validity of this approach by more closely mirroring the experiences bilinguals are likely to have when thinking about their emotions outside of the lab.

When looking at the relation between engagement emotion regulation strategies and physiological reactivity in English, we found that the number of strategies bilinguals reported using differentially related to patterns of reactivity during the task, depending on the level of physiological arousal they showed at rest. For bilinguals who showed more initial sympathetic arousal, using fewer engagement strategies was associated with a more pronounced calming response during the conversation. For people who tend to be more sympathetically aroused when at rest, it might be harder to down-regulate negative emotions by engaging with the situations, making it easier to down-regulate emotions by engaging less with the emotional situations.

Although few studies have looked at the links between emotion regulation and sympathetic reactivity, a study by Demaree et al. (2006) showed that instructing people to control their facial expressions (a rudimentary form of regulation) in response to emotional stimuli resulted in changes in sympathetic reactivity. Our results extend these findings by showing that more complex and cognitive forms of emotion regulation, such as thinking about the situation in a different way, also influence sympathetic reactivity. One important difference between our study and Demaree et al. (2006) is that we measured participants' self-reported *typical* use of emotion regulation strategies, whereas they measured in vivo *implementation* of strategies. Our approach is particularly meaningful because we considered a more trait-like use of emotion regulation strategies that might better mimic what people do to regulate negative emotions in their everyday lives. However, future research should also explore in-the-moment strategy use in bilinguals. Despite differences in our approaches, the fact that we still see similar effects of strategies on sympathetic reactivity signals the robust link between the use of emotion regulation strategies and physiology.

It is important to note that our findings about individual differences in initial arousal and regulatory strategy use were specific to English. Our results align with those reported by Matsumoto et al. (2008) in that bilinguals' use of engagement strategies had different consequences for physiological reactivity depending on the language they were speaking. The fact that these differences were observed only when also considering people's resting arousal highlights the importance of using models that incorporate individual differences to better characterize emotional experiences. This study extends our understanding of emotional processing in bilinguals by identifying two important biobehavioral individual differences that influence physiological reactivity to emotional events.

Although we have started to gain some understanding of bilinguals' emotional experience and expression, much is still unknown about bilinguals' emotion regulation. Our study offers novel insight about how bilinguals' regulatory attempts have differential effects on physiology

depending on which language they are speaking. Our findings highlight how cultural-linguistic lenses may shape people's regulatory choices and carry consequences for physiological functioning. Although it is likely that these language differences are being driven by the cultural values associated with those languages and with the level of proficiency and linguistic self-esteem of the participant in each of the languages, this hypothesis should be more thoroughly explored in future studies.

Even though this study advances knowledge about emotional processes in bilinguals, some limitations should be noted. Although useful for understanding bilinguals' typical use of emotion regulation strategies, self-reporting of the use of emotion regulation strategies limits conclusions about how those strategies influence reactivity while they are being implemented, and self-reports may not capture all the things bilinguals do when feeling upset. Still, bilinguals' report of the use of strategies likely reflects their most salient regulatory attempts, which better generalizes to their everyday regulation compared to what might happen in the lab if asked to regulate. In addition, we focused on Spanish–English bilinguals, but different types of bilingual (e.g. Mandarin–English) or multilingual speakers would potentially show different physiological patterns based on their regulatory choices. This should be explored in future studies.

Conclusion

This is the first study to examine emotion regulation and sympathetic physiological reactivity in bilinguals across language contexts. Our results contribute to our understanding of bilingualism, affective physiology, and emotion regulation by highlighting the importance of language context to characterize bilinguals' experience and regulation of emotion.

Acknowledgements

We thank the Center for Ideas and Society at UC Riverside and the research assistants in the Emotion Regulation Lab for their support.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This material is based upon work supported by the National Science Foundation Graduate Research Fellowship under Grant No. NSF DGE-1326120 and a grant from the UC MEXUS program (Award No. ST 14/06-01).

Note

1. We ran paired-sample *t*-tests to assess any potential differences across emotions. There were no differences in PEP reactivity ($t_{(87)} = .806$, $p = .422$) or in the total number of engagement strategies reported ($t_{(91)} = .882$, $p = .380$) between sad and fear contexts.

ORCID iD

Elizabeth L Davis https://orcid.org/0000-0003-2599-4390

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage Publications Inc.

Anooshian, L., & Hertel, P. (1994). Emotionality in free recall: Language specificity in bilingual memory. *Cognition and Emotion*, *8*, 503–514.

Berntson, G. G., Lozano, D. L., Chen, Y.-J., & Cacioppo, J. T. (2004). Where to Q in PEP. *Psychophysiology*, *41*, 333–337.

Boucsein, W. (1992). *Electrodermal activity*. New York, NY: Plenum University Press.

Caldwell-Harris, C. L., Tong, J., Lung, W., & Poo, S. (2011). Physiological reactivity to emotional phrases in Mandarin-English bilinguals. *International Journal of Bilingualism*, *15*, 329–352.

Campos, J., Mumme, D., Kermoian, R., & Campos, R. (1994). A functionalist perspective on the nature of emotion. *Monographs of the Society for Research in Child Development*, *59*, 284–303.

Davis, E. L., Greenberger, E., Charles, S., Chen, C., Zhao, L., & Dong, Q. (2012). Emotion experience and regulation in China and the United States: How do culture and gender shape emotion responding? *International Journal of Psychology*, *47*, 230–239.

Demaree, H. A., Schmeichel, B. J., Robinson, J. L., Pu, J., Everhart, D. E., & Berntson, G. G. (2006). Up- and down-regulating facial disgust: Affective, vagal, sympathetic, and respiratory consequences. *Biological Psychology*, *71*, 90–99.

Eid, M., & Diener, E. (2001). Norms for experiencing emotions in different cultures: Inter- and intra-national differences. *Journal of Personality and Social Psychology*, *81*, 869–885.

Eilola, T. M., & Havelka, J. (2011). Behavioural and physiological response to the emotional and taboo Stroop tasks in native and non-native speakers of English. *International Journal of Bilingualism*, *15*, 353–369.

Frings, D., Rycroft, N., Allen, M. S., & Fenn, R. (2014). Watching for gains and losses: The effects of motivational challenge and threat on attention allocation during a visual search task. *Motivation and Emotion*, *38*, 513–522.

Gross, J. J. (2008). Emotion regulation. In M. Lewis, J. M. Haviland-Jones, & L. F. Barret (Eds.), *Handbook of emotions* (3rd ed., pp. 497–513). New York, NY: Guilford Press.

Harris, C. L. (2004). Bilingual speakers in the lab: Psychophysiological measures of emotional reactivity. *Journal of Multilingual and Multicultural Development*, *25*, 223–247.

Hochschild, A. R. (1983). *The managed heart*. Berkeley: University of California Press.

Hox, J. (1998). Multilevel modeling: When and why. In *Classification, data analysis, and data highways* (pp. 147–154). Berlin/Heidelberg: Springer.

Izard, C. E. (1971). *The face of emotion*. New York, NY: Meredith Corporation.

Jackson, G. M., Swainson, R., Mullin, A., Cunnington, R., & Jackson, S. R. (2004). ERP correlates of a receptive language-switching task. *The Quarterly Journal of Experimental Psychology*, *57*, 223–240.

Kelsey, R. M. (2012). Beta-adrenergic cardiovascular reactivity and adaptation to stress: The cardiac preejection period as an index of effort. In R. A. Wright, & G. H. E. Gendolla (Eds.), *How motivation affects cardiovascular response: Mechanisms and applications* (pp. 43–60). Washington, DC: American Psychological Association.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, *84*, 394–421.

Kreibig, S. D., Wilhelm, F. H., Roth, W. T., & Gross, J. J. (2007). Cardiovascular, electrodermal, and respiratory response patterns to fear- and sadness-inducing films. *Psychophysiology*, *44*, 787–806.

Kroll, J. F., Bobb, S. C., & Hoshino, N. (2014). Two languages in mind: Bilingualism as a tool to investigate language, cognition, and the Brain. *Current Directions in Psychological Science*, *23*(3), 159–163.

Matsumoto, D. (1993). Ethnic differences in affect intensity, emotion judgments, display rule attitudes, and self-reported emotional expression in an American sample. *Motivation and Emotion*, *17*(2), 107–123.

Matsumoto, D., Anguas-Wong, A., & Martinez, E. (2008). Priming effects of language on emotion judgments in Spanish-English bilinguals. *Journal of Cross-Cultural Psychology*, *39*, 335–342.

Matsumoto, D., Kudoh, T., Scherer, K., & Wallbott, H. (1988). Antecedents of and reactions to emotions in the United States and Japan. *Journal of Cross-Cultural Psychology*, *19*, 267–286.

Newlin, D. B., & Levenson, R. W. (1979). Pre-ejection period: Measuring beta-adrenergic influences upon the heart. *Psychophysiology*, *16*, 546–553.
Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, *48*(1), 85–112.
Royston, P. (2004). Multiple imputation of missing values. *The Stata Journal*, *4*(3), 227–241.
Schachter, S., & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review*, *69*, 379–399.
Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development*, *59*, 25–52.
Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology*, *90*, 288–307.
Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*, *138*, 775–808.
Whorf, B. L. (1952). Language, mind, and reality. *Etc: A Review of General Semantics*, 167–188.

Author biographies

Laura E Quiñones-Camacho is a PhD candidate at the University of California, Riverside, USA. Her graduate research is centered on understanding emotional processing throughout the lifespan and the role bilingualism plays in emotional processing. Her dissertation work focuses on bilingualism and emotion processing in Hispanic children growing up in the United States.

Emily W Shih is a PhD candidate at the University of California, Riverside. Her graduate research to date has focused on parental influences on children's behavioral and physiological emotional development, with particular emphasis on the interplay of behavior and physiology in shaping child development.

Scott V Savage is an assistant professor of Sociology at the University of Houston, USA. He received his PhD in Sociology from the University of Arizona, USA. His research interests include identity, status, as well as small group processes and social influences. He is particularly interested in how the self can both change and be changed by social structures, including the experience of bilingualism.

Covadonga Lamar Prieto is an assistant professor of Hispanic Studies at the University of California, Riverside. She received a PhD in Philology from the University of Oviedo, Spain and a PhD in Hispanic Languages and Literature from the University of California, Los Angeles, USA. Her main research interests include the sociolinguistics of Spanish in USA, especially language change, dialectology, and bilingualism.

Elizabeth L Davis is an assistant professor of Psychology at the University of California, Riverside, USA. She received her PhD from the University of California, Irvine. Her research interests include emotional processing and regulation, and psychophysiology. Some of her recent work has focused on emotional bilingualism, bilinguals' change in emotional responses that correspond to the language they are currently using.