Using affect as information when remembering lived, bodily states

Christine Ma-Kellams
Harvard University

Lei Lai
Tulane University

Shelley E. Taylor
University of California Los Angeles

Jennifer S. Lerner
Harvard University

Corresponding author: Christine Ma-Kellams is now at the Department of Psychology,

University of La Verne, La Verne, CA 91750. Email: cma-kellams@laverne.edu.

Word count: 4,097

Abstract

It is well-established that affective cues serve as important sources of information in social judgment. When making judgments about current or prospective objects, individuals implicitly or explicitly ask themselves, "How do I feel about it?" (Schwarz & Clore, 1983). In the present studies, we examine the pervasiveness of this tendency, asking whether it might occur even in reverse – i.e., when one has already lived through a concrete, physical reality. Specifically, we hypothesized that the more negative affect one presently feels, the more extreme one's retrospective estimates of past heart rate will be. Two bio-behavioral studies tested this prediction, examining whether negative affective states experienced during stressful events (Time 1) would shape retrospective estimates of past heart rate (Time 2), even when controlling for actual heart rate at the time of each stressful event (Time 1). Results across both studies supported the hypothesis, and suggest that a feelings-as-information process describes judgment behavior even when remembering one's lived physical reality. Negative affective states predicted a tendency to remember visceral reactions as worse than they actually were.

Over the past three decades, a growing body of evidence has emerged for feelings-as-information theories (e.g., Schwarz & Clore, 1983, 2003; 2007; Clore et al., 2001). Together, these approaches center on the idea that feelings are a crucial source of information that allows individuals to make judgments and decisions. Said differently, when an individual is faced with a difficult judgment or decision, they typically ask, "How do I feel about it?"; they subsequently use their affective reactions as a basis for determining their judgment (for more recent reviews, see Clore & Storbeck, 2006; Schwarz, 2010; Keltner & Lerner, 2010; Lerner, Li, Valdesolo, & Kassam, in press). The empirical evidence suggests that while these affective cues can be adaptive and functional (Barrett, Mayer & Salovey, 2003; Damasio, 1994; Hazelton & Ketelaar, 2006), they can also lead to systematic inaccuracies (e.g., Alter & Oppenheimer, 2006; Hirshleifer & Shumway, 2003; Song & Schwarz, 2009). The aim of the present research is to assess the role of affective cues in contributing to judgment (in)accuracy in one particular domain: inferences about *past* visceral states. Here we examine whether the affect-as-information tendency is so pervasive that it might even occur in reverse (retrospection), when one has already lived through a concrete, physical reality.

Although few studies have directly tested individual's capacities to remember past visceral states, a compelling body of judgment and decision-making literature has provided indirect evidence that accurate recollection of past visceral experiences is difficult and subject to a host of incidental factors. For example, studies on colonoscopy patients found that their recollection of painful medical procedures were highly influenced by prototypical moments during the procedure (e.g., the peak and end) and did not take into account the entire duration of the procedure (Fredrickson & Kahneman, 1993; Redelmeier & Kahneman, 1996).

Research on other judgment and decision-making processes has further confirmed that individuals have difficulty accurately tracking their own visceral states. A prime illustration of this is the well-established hot-cold empathy gap in which individuals in "hot" (i.e., viscerally-salient states) fail to accurately predict their desires and behaviors in "cold" (i.e., non-visceral states) or vice versa (e.g., Loewenstein, 1996; Nordgren, van der Plight & van Harreveld, 2006, 2007; Read & Loewenstein, 1999; Read & van Leeuwen, 1998; Sayette, Loewenstein, Griffin, & Black, 2008; van Boven & Loewenstein, 2003). At the heart of hot-cold empathy gaps is the notion that individuals' memory for visceral states is highly constrained—that is, although they can remember the external circumstances that led to the visceral reaction, they have difficulty remembering the actual sensory experience of the visceral reaction itself (Loewenstein, 1996; Lordgren et al., 2006).

Despite the substantive body of judgment and decision-making research that has been built on this basic assumption that visceral states are difficult to recall, limited studies have examined the precise conditions that contribute to inaccuracies in visceral retrospections. Nearly all judgment and decision-studies that have relied on the inaccessibility of past visceral states have focused exclusively on the downstream (typically affective) consequences of visceral inaccuracy. For example, the hot-cold empathy gaps use, as their basis, the assumption that visceral states are nearly impossible to accurately recall; as such, individuals in a "cold" (i.e., non-viscerally salient state) will have difficult imagining what it is like to be in a "hot" (i.e., viscerally salient) state and vice versa. Similarly, the colonoscopy studies used to demonstrate the peak-and-end-bias assume that patients have difficulty recalling the actual visceral experience of having a colonoscopy, and thus will rely on highly salient cues—namely, the peak and end—to construct their impression of the experience (Fredrickson & Kahneman, 1993; Redelmeier & Kahneman, 1996). However, relatively few studies have attempted to directly assess visceral retrospection to identify the sources of the inaccuracy.

Loewenstein (1996) reviewed several features of visceral processes that make inaccuracy especially likely to occur. Based on past work by Scarry (1985) and Morley (1993), he observed that people typically focus on the external cause of visceral sensations but rarely on the actual visceral experience itself. Said differently, people tend to remember the event that produced the visceral state but rarely are able to remember the sensory qualities of the visceral state. Taken together with the fact that visceral states are directly linked to hedonic consequences and the fact that visceral states change in response to external circumstances (Loewenstein, 1996), this renders recollections of past visceral experiences particularly prone to mistaking feelings for physiology. Given the close link between visceral changes, affective states, and external circumstances, we propose that negative affective states in response to changes in external circumstances will influence individuals' estimates of their own visceral changes. Consistent with decades of research revealing the powerful effects of negative affect on a wide array of judgments and decision (for review, see Lerner, Li, Valdesolo, & Kassam, in press), we hypothesize that experiencing negative affective states in response to a change in external circumstances will be linked to greater inaccuracy (i.e., increased extremity) in remembering the visceral states experienced during such circumstances, even when actual visceral states are controlled for.

The present research focuses specifically on how negative affect that occurs in response to stressful external circumstances may influence recollection of past visceral states. Across two studies, we investigated the hypothesis that negative affective states experienced during a task would predict more extreme retrospective reports of visceral states, such that individuals who experienced more negative affective states would retrospectively report greater visceral changes. In both studies, we induced negative affect through external circumstances—in this case, stimulation via an engaging, potentially stressful task.

Study 1

Method

Participants. Members of a university community responded to an ad offering $60 in return for participation. Fifty-one participants (28 males and 23 females), screened for mental and physical health, comprised the final sample. Ages ranged from 18-27 (M = 19.80, SD = 2.16), and the racial/ethnic composition of participants was 2% African-American, 41% Euro-American, 39% Asian-American, 6% Hispanic American, and 12% mixed or other race/ethnicity. Sample size was predetermined based on funded grant proposals (see acknowledgments), and the data-collection rule was pre-determined based on how many subjects could be afforded.

Setting and apparatus. Participants completed informed-consent forms and psychosocial self-report scales (see below). Approximately one week later, participants reported to a psychophysiology laboratory and were seated adjacent to cardiovascular equipment and directly in front of a video camera. They were fitted with blood pressure monitors, which automatically recorded their heart rate and blood pressure every two minutes. Participants completed the tasks below as part of a larger study.

Stress-inducing tasks. After participants had acclimated to the blood-pressure cuffs, their baseline cardiac measures were taken. Baseline heart rate was measured 6 times at 2-min interval during the first 12 mins. Given that heart rate is typically elevated upon first arrival at the lab, the first few minutes of baseline heart rate are typically not used in the average baseline value in psychophysiological tasks. Thus, the baseline heart rate measure was the average of the middle 4 measures, excluding the first and last heart rate measures. Participants then completed two widely used stress-challenge tasks: (a) counting backwards by seven from 9,095 and (b) counting backwards by thirteen from 6,233. To encourage participants to take the tasks seriously, the experimenter told them before they began that accurate and rapid responses indicated general intelligence.

Self-report measures of affect. To assess the role of affective states in influencing visceral retrospection, participants rated the degree to which they were experiencing 16 different emotions both before the laboratory session and immediately after it. Emotions included 12 negative and four positive (see Gross & Levenson, 1995; Lerner, Goldberg, & Tetlock, 1998). Emotion terms appeared as follows: afraid, angry, anxious, contemptuous, disgusted, downhearted, engaged, fearful, frustrated, gleeful, happy, interested, irritated, nervous, repulsed, and sad. Their response options ranged from 0 ("I do not feel this emotion even the slightest bit") to 8 ("I feel this emotion more than ever before in my life"). Individual items were clustered into four face-valid factors. These were: (1) *sadness* (items included downhearted and sad; a = .93 before and a = .87 after the laboratory session); (2) *engagement* (engaged, interested, gleeful and happy; a = .76 before and a = .68 after the laboratory session); (3) *hostile anger* (angry, contemptuous, irritated, disgusted, repulsed, and frustrated; a = .79 before and a = .89 after the laboratory session); and (4) *anxiety* (anxious, fearful, afraid, nervous; a = .86 before and a = .91 after the stress-challenge tasks).

Actual visceral states. Actual visceral change was measured using heartbeats per minute (BPM). Additional measures of reactivity were also automatically generated by the monitor: systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pulse (MAP). To establish a baseline, the first four measures (i.e., data points), taken at two-minute intervals, were averaged on each dimension. For each of the two counting tasks, two visceral measures were averaged on each dimension at two-minute intervals, creating one index of each dimension for each task.

Retrospective visceral perception. After engaging in the two counting tasks described above, participants were given a 20-minute break. They were then asked to retrospectively estimate what their actual heart rate had been during each of the two counting tasks. We asked them to estimate only heart rate (BPM) because SPB, DPB, and MAP were thought to be too complex for untrained participants to estimate.

Because previous research has suggested that people are often quite poor at estimating their actual heart rate (e.g., Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005), and we wanted to provide a fair chance that participants would accurately retrospect, guidelines were provided to help participants make these estimates. Specifically, the experimenter told each participant the exact value of his/her resting heart rate (idiographically) at the start of the study and what it would be if it were tripled (presumably an upper bound). Next, the experimenter explained that most heart rates go up when people exercise vigorously or when they feel stressed. The questions asked participants to provide their best estimates of their heart rate. Taken together, the instructions intentionally anchored participants on their own indiographic values (Tversky & Kahneman, 1974). Importantly, providing idiographic information did not confound the dependent variables because the study aimed to investigate potential relationships among retrospective estimates, actual values, and negative affect, *not* absolute estimates per se.

Results

Effects of stress tasks on emotion and actual visceral states. The stress task had its intended effects, significantly increasing each of the three negative emotion factors (anxiety, anger, and sadness). Results from paired t-tests were: *M*anxiety-baseline = 1.29, *M*anxiety-challenge tasks = 1.66, $t(50) = -2.71$, $p < .01$, 95% CI of the difference [-.64, -.10]; *M*anger-baseline = .35, *M*anger-challenge tasks = 1.43, $t(50) = -6.93$, $p < .001$, 95% CI of the difference [-1.40, -.77]; *M*sadness-baseline = .50, *M*sadness-challenge tasks = 1.09, $t(50) = -3.23$, $p < .01$, 95% CI of the difference [-.95, -.22]). The stress-challenge manipulation also decreased the engagement factor (*M*baseline = 2.05, *M*challenge-tasks = 1.54, $t(50) = 4.08$, $p < .001$, 95% CI of the difference [.26, .76]).

The stress tasks also led to significant increases on all four dimensions of visceral states. Paired t-test results were: *M*systolic-baseline = 110.32, *M*systolic-counting by 7s = 129.14, $t(50) = -13.42$, $p < .001$, 95% CI of the difference [-21.63, -16.00], *M*systolic-counting by 13s = 133.26, $t(50) = -12.73$, $p < .001$, 95% CI of the difference [-26.56, -19.32]; *M*diastolic-baseline = 63.14, *M*diastolic-counting by 7s = 76.36, $t(50) = -16.12$, $p < .001$, 95% CI of the difference [-14.87, -11.58], *M*diastolic-counting by 13s = 76.68, $t(50) = -12.38$, $p < .001$, 95% CI of the difference [-15.74, -11.34]; *M*heart-rate-baseline = 68.74, *M*heart-rate-counting by 7s = 85.25, $t(50) = -11.35$, $p < .001$, 95% CI of the difference [-19.44, -13.59], *M*heart-rate-counting by 13s = 87.00, $t(50) = -11.21$, $p < .001$, 95% CI of the difference [-21.53, -14.99]; and *M*mean-arterial-pulse-baseline = 80.46, *M*mean-arterial-pulse-counting by 7s = 97.09, $t(50) = -17.09$, $p < .001$, 95% CI of the difference [-18.58, -14.67], *M*mean-arterial-pulse-counting by 13s = 98.85, $t(50) = -14.13$, $p < .001$, 95% CI of the difference [-21.01, -15.78].

High correlations among all 12 of the negative emotion items (all *r*s > .57, *p*s < .001) justified the creation of a global factor for state negative affect. We therefore averaged all 12 negative emotion items into one index (α = .93).

Effects of negative affect on retrospective estimates of heart rate. Preliminary correlational analyses suggest that baseline heart-rate estimates were positively correlated with actual heart rate during the stress tasks ($r = .50$, $p < .001$, 95% CI of the correlation [.26, .68] for counting by 7s and $r = .55$, $p < .001$, 95% CI of the correlation [.32, .72] for counting by 13s), and actual heart rate during the stress-challenge tasks was also positively correlated with retrospective heart-rate estimates ($r = .60$, $p < .001$, 95% CI of the correlation [.39, .75] counting by 7s and $r = .72$, $p < .001$, 95% CI of the correlation [.56, .83] for counting by 13s). In addition, state negative emotion was positively related to participants' retrospective heart-rate reports for both stress tasks ($r = .43$, $p <.01$, 95% CI of the correlation [.18, .63] for counting by 7s and $r = .33$, $p <.05$, 95% CI of the correlation [.06, .56] for counting by 13s).

Table 1 (top two panels) presents the regression results for our main hypothesis. Each model controls for baseline heart rate. Note that pattern of the findings regarding the association between state negative affect and retrospective estimates of heart-rate, independent of actual heart rate, is identical with or without controlling for baseline heart rate. Two outlying cases were excluded from the counting-by-13s analysis (but not counting-by-7s) because the dependent variable -- i.e., retrospective estimate of heart rate -- exceeded the mean by more than three standard deviations. All cases with missing dependent variables were removed prior to regression analyses.

The main variables of interest were self-reported state negative affect during the counting tasks, actual heart rate during the counting tasks, and participants' retrospective reports of what their heart rate was during the counting tasks. We examined the relations among these variables in OLS regression equations for each challenge task separately. Specifically, regression analyses (models 3 and 6) with state negative affect and actual heart rate predicting retrospectively recalled heart rate revealed that participants' subjective feelings had a large and significant influence on retrospective heart-rate reports ($b = .34$, $p < .01$for counting by 7s and $b = .22$, $p < .05$ for counting by 13s), independent of actual heart rate. As the results in Table 1 reveal, the same pattern replicated across two different stress tasks, thus providing greater confidence in the validity of the overall model. Given that baseline heart rate, actual heart rate during the stress task, state negative affect, and retrospective estimated heart rate during the stress task were intercorrelated, we tested for multicollinearity. Despite the correlations among independent variables, all VIF in various combinations across the tasks for both studies were below 3, suggesting that multicollinearity was not an issue. As an additional precaution, we took a two-step approach to fully partial out confounds. In a first step, estimated HR during the stress task was regressed on actual heart rate, and the residuals saved. Then the residuals were regressed onto negative emotion in order to test the truly unique effect. Doing so did not change the pattern of results. Thus, the data support the hypothesis: people experiencing negative emotion have an exaggerated view of their visceral reactions.

Study 2

Study 2 sought to determine if the findings replicate across samples and across stressful situations.

Method

Participants. One hundred-and thirty-five participants (54 males and 71 females; 10 missing), screened for mental and physical health, comprised the final sample. Their ages ranged from 18-36 (*M* = 21.27, *SD* = 2.63), and their racial/ethnic composition was 3.7% African-American, 38.6% Euro-American, 34.1% Asian-American, 11.1% Hispanic American, 4.4% mixed or other race/ethnicity, and 8.1% missing data). As with Study 1, sample size was predetermined based on funded grant proposals, and the data-collection stopping rule was predetermined based on how many subjects could be afforded.

Procedures. The procedures were the same as in Study 1, except that the stress tasks came from the standardized Trier Social Stress Task (TSST; Kirschbaum et al., 1993). The TSST requires participants to both deliver an impromptu speech in front of a cold, non-responsive panel and to complete a counting task. Thus, Study 2 introduced a more social stressor than that employed in Study 1.

As before, their baseline visceral measures were assessed. Baseline heart rate was measured 5 times at 2-min interval during the first 10 minutes upon arriving at the lab; once again, the baseline HR variable was the average of the last 4 measures, excluding the first measure.

Participants were subsequently told that they would be giving a five-minute speech in which they were to describe “why I would be an ideal administrative assistant.” They were told that they would be evaluated by a panel of their peers and that their speech would be videotaped and evaluated by a panel of experts as well. Participants were given five minutes to prepare their speeches and then five minutes to present them. The speeches, which were videotaped, were delivered to a panel of two non-responsive student evaluators (both females). While still facing the panel, participants then completed the arithmetic task of counting backwards by 13s from 6,233.

After finishing the stress tasks, participants completed standardized post-task questionnaires (the same as in Study 1) which assessed the extent to which they felt specific feelings during the stress task (e.g., anxious, angry).

Results

Effects of stress tasks on actual visceral states. As intended, the challenge tasks led to significant increases on all four dimensions of visceral response: *M*systolic-baseline = 105.26, *M*systolic-speech task = 133.18, $t(123) = -22.17$, $p < .001$, 95% CI of the difference [-30.40, -25.42], *M*systolic-counting by 13s = 131.28, $t(123) = -21.82$, $p < .001$, 95% CI of the difference [-28.38, -23.66]; *M*diastolic-baseline = 60.30, *M*diastolic- speech task = 79.87, $t(123) = -27.12$, $p < .001$, 95% CI of the difference [-21.00, -18.15], *M*diastolic-counting by 13s = 75.56, $t(123) = -23.89$, $p < .001$, 95% CI of the difference [-16.52, -13.99]; *M*heart-rate-baseline = 70.06, *M*heart-rate- speech task = 96.45, $t(123) = -17.77$, $p < .001$, 95% CI of the difference [-29.34, -23.46], *M*heart-rate-counting by 13s = 86.65, $t(123) = -15.44$, $p < .001$, 95% CI of the difference [-18.73, -14.47]; and *M*mean-arterial-pulse-baseline = 76.50, *M*mean-arterial- speech task = 101.61, $t(123) = -27.34$, $p < .001$, 95% CI of the difference [-26.93, -23.30], *M*mean-arterial-pulse-counting by 13s = 97.20, $t(123) = -24.19$, $p < .001$, 95% CI of the difference [-22.39, -19.01]).

As in Study 1, high correlations among all negative emotion items (all *r*s > .57, *p*s < .001) justified the creation of a global factor for state negative affect. An average of all 12 negative emotion items comprised the index (α= .92). No matter how the state negative emotion factor was composed (e.g., weighted versus unweighted factors), the pattern of results still held, suggesting the robustness of the findings.

Relations between state negative emotion and retrospective estimates of heart rate. Using a different, more social, stressor, the findings replicated those from Study 1. State negative affect was positively correlated with the retrospective heart-rate reports during the stress tasks ($r = .30$, $p = .001$, 95% CI [.13, .46] for the speech task and $r = .32$, $p < .001$, 95% CI [.15, .47] for counting by 13s). As expected, baseline heart rate was positively correlated with heart rate during the stress tasks ($r = .42$, $p <.001$, 95% CI [.26, .56] for speech task and $r = .62$, $p <.001$, 95% CI [.50, .72]for counting by 13s), and heart rate during the stress tasks was also positively correlated with retrospective heart-rate estimates ($r = .21$, $p <.05$, 95% CI [.03, .37] for speech task and $r = .27$, $p <.01$, 95% CI [.04, .47] for counting by 13s).

Table 1 (bottom two panels) presents the regression analyses. As with Study 1, all cases with missing dependent variables were removed prior to regression analyses.

Following the same analytic process as in Study 1, we examined relations in OLS regression for each of the two challenge tasks and found that participants' state negative emotion had a significant influence on their retrospective heart-rate estimates ($b = .25$, $p <.01$ for speech task and $b = .27$, $p <.01$ for counting by 13s), independent of actual heart rate.

Similar to Study 1, after ruling out the possibility of multicollinearity, as an additional precaution, we repeated the two-step approach to fully partial out confounds. In a first step, estimated HR during the stress task was regressed on actual heart rate, and the residuals were saved. Then the residuals were regressed onto negative emotion in order to test the truly unique effect. Doing so generated no different findings.

General Discussion

The present studies examined whether the tendency to use affect as information is so pervasive that it might even occur in reverse (retrospection), when one has already lived through a concrete, physical reality. In particular, we hypothesized that the more negative affect one presently feels, the more extreme one's retrospective estimates of past heart rate will be. Across two studies, results revealed that the negative affect experienced during stressful events predicted more extreme retrospective perceptions of heart-rate during these events. Importantly, this association is independent of the influence of actual heart-rate on perceptions of heart-rate. Moreover, it held across studies using independent samples and across different kinds of stressful events.

Consistent with affect-as-information theories (Clore & Storbeck, 2006; Schwarz, 2010), these findings show that, when confronted with the difficult question of what their bodies were doing at a past point in time, individuals ask, "How did I feel?" On the one hand, this reliance on affective cues as a way of inferring visceral states can be construed as an adaptive and functional way of assessing an otherwise difficult—if not impossible—task of remembering the precise sensory qualities of previous bodily states. Classic emotion theories (e.g., Cannon, 1927; Schacter & Singer, 1962) and subsequent empirical investigations (e.g., Dutton & Aron, 1974; Hirschman, 1975; Valins, 1966) have long demonstrated that affective and visceral states are profoundly linked; changing the one will change the other. On the other hand, given that affective and visceral states are not perfect proxies for one another, relying on affective cues can produce systematic errors. Namely, as the present findings show, negative affect predicts the tendency to remember visceral states as more magnified than they actually were.

Considered in broad context, the findings highlight a relatively under-explored domain of visceral self-perception, i.e., visceral *retrospection*. To be sure, a large and compelling body of work in the psychophysiology literature has investigated *online* visceral perception—that is, how individuals estimate the cause and magnitude of current, in-the moment bodily fluctuations (e.g., heart rate; Cannon, 1927; Dutton & Aron, 1974; Katkin, Blascovich & Goldband, 1981; Schachter & Singer, 1962). Although much is known about how individuals perceive subtle bodily and sensory cues while they occur (i.e., during online visceral perception), far less is known about how individuals retrieve past bodily events from memory (i.e., during visceral retrospection).

A large and compelling body of work has demonstrated that individuals routinely rely on their feelings as a source of information when making inferences about current states (Schwarz & Clore, 1983, 2003; 2007; Clore et al., 2001). The present paper expanded this feelings-as-information literature by demonstrating that this tendency can also occur when making inferences about past bodily states. Future studies can test the generalizability of these findings to other types of affective experiences as well as alternative visceral states. The present studies were limited insofar as they focused exclusively on visceral retrospection in the context of stressful laboratory experiences and the role of negative affect. Given that positive—and not only negative—affect can also be used as an important source of information, one possibility is that high levels of position emotions would also lead to inaccurate visceral retrospection. Furthermore, little is known about the extent to which retrospection about one form of visceral state—in this case, heart rate—generalizes to other visceral processes. Future research can address these important questions.

References

Adám, G. (1998). *Physiological perception: Understanding internal cognition*. New York, NY, US: Plenum Press.

Alter, A. L. & Oppenheimer, D. M. (2006). Predicting short-term stock fluctuations by using processing fluency. *Proceedings of the National Academy of Science, 103,* 9369-9372.

Barrett, L. F., & Salovey, P. (Eds.) (2002). *The wisdom in feelings.* New York: Guilford.

Blascovich, J., & Mendes, W. B. (2010). Social psychophysiology and embodiment. *Handbook of social psychology*.

Bouton, M.E., Mineka, S. & Barlow, D.H. (2001). A modern learning theory perspective on the etiology of panic disorder. Psychological Review, 108, 4-32.

Cannon, W. B. (1927). The James-Lange theory of emotions: A critical examination and an alternative theory. *American Journal of Psychology, 100*(3-4), 567-586.

Clore, G. L., Wyer, R. S., Dienes, B., Gasper, K., Gohm, C., & Isbell, L. (2001). Affective feelings as feedback: Some cognitive consequences. In L. L. Martin & G. L. Clore (Eds.), *Theories of mood and cognition: A user's handbook* (pp. 27-62). Mahwah, NJ: Erlbaum.

Damasio, A. R. (1994). Descartes' error: Emotion, reason and the human brain. New York: Grosset/Putnam.

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of personality and social psychology*, *30*(4), 510.

Eken, C. et al., (2010). Anxiety and depressive disorders in patients presenting with chest pain to the emergency department: A comparsion between cardiac and non-cardiac origin. *The Journal of Emergency Medicine, 39,* 144–150.

Fleet, R.P., et al. (1996). Panic disorder in emergency department chest pain patients: prevalence, comorbidity, suicidal ideation, and physician recognition. *American Journal of Medicine, 101*, 371-380.

Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition and Emotion, 9*(1), 87-108.

Heinaman, R. (1990). Aristotle and the Mind-Body Problem. *Phronesis*, *35,* 83-102

Hirshleifer, D., & Shumway, T. (2003). Good day sunshine: Stock returns and the weather. *Journal of Finance, 58,* 1009-1032.

Katkin, E.S., Blascovich, J. & Goldband, S. (1981). Empirical assessment of physiological self-perception: Individual and sex differences in the acquisition of heartbeat discrimination. *Journal of Personality and Social Psychology, 40(6)*, 1095-110.

Katon, W. J., Von Korff, M., & Lin, E. (1992). Panic disorder: Relationship to high medical utilization. *The American Journal of Medicine, 92,* 7S-11S.

Kirschbaum, C., Pirke, K. & Hellhammer, D. (1993). The Trier Social Stress Task: A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28.* 76-81.

Lerner, J. S., Goldberg, J. H., & Tetlock, P. E. (1998). Sober second thought: The effects of accountability, anger and authoritarianism on attributions of responsibility. *Personality and Social Psychology Bulletin, 24*(6), 563-574.

Lerner, J.S., Li, Y., Valdesolo, P. & Kassam, K. (2015). *Emotion and decision making Annual Review of Psychology, 66*: In press.

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion*, *5*(2), 175.

National Institute of Mental Health (2014). *Panic Disorders.* Retrieved May 5, 2014 from http://www.nimh.nih.gov/health/topics/panic-disorder/index.shtml

Patti, E., Acosta, J., Chavda, A., Verma, D., Marker, M., Anzisi L. (2007). Prevalence of Anxiety and Depression Among Emergency Department Staff. *New York Medical Journal, 2*. Retrieved from http://newyorkmedicaljournal.org/1/Archives/patti9-07.htm.

Roger, V.L. et al. (2011). Heart disease and stroke statistics---2011 update: a report from the American Heart Association. *Circulation, 123*, e18--209.

Salovey, P., Rothman, A. J., Detweiler, J. B., & Steward, W. T. (2000). Emotional states and physical health. *American Psychologist, 55,* 110-121.

Saper, C. (2002). The Central Autonomic Nervous System: Conscious Physiological Perception and Autonomic Pattern Generation. *Annual Review of Neuroscience, 25*, 433-469

Schachter, S., & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological review*, *69*(5), 379.

Schwarz, N., & Clore, G.L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45,* 513-523.

Schwarz, N., & Clore, G.L. (2003). Mood as information: 20 years later. *Psychological*

Inquiry, 14, 296-303.

Schwarz, N., & Clore, G. L. (2007). Feelings and phenomenal experiences. In A. Kruglanski & E. T. Higgins (eds.), Social psychology. Handbook of basic principles (2nd ed.; pp.385-407). New York: Guilford.

Song, H., & Schwarz, N. (2009). If it's difficult-to-pronounce, it must be risky: Fluency, familiarity, and risk perception. *Psychological Science, 20,* 135-138.

Tversky, A. and Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases, *Science, 185,* 1124-1131

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review, 96*(2), 234-254.

Valins, S. (1966). Cognitive effects of false heart-rate feedback. *Journal of Personality and Social Psychology, 4,* 400-408.

Zillman, D., Katcher, A.H., & Milavsky, B. (1972). Excitation transfer from physical exercise to subsequent aggressive behavior. *Journal of Experimental Social Psychology, 8,* 247-259.

Acknowledgments

Partial funding came from the Fetzer Institute, the Radcliffe Institute for Advanced Study, NIH (MH15750 and MH62376), and NSF (SES082044 and SES0809012). We thank Ellen Yeung, Heidi Stayn, Chris Hsee, William Pirl, Celia Gaertig and Paul Meosky. Correspondence: Christine Ma-Kellams, Department of Psychology, University of La Verne, La Verne, CA 91750; email: cma-kellams@laverne.edu.

Table 1.

Regression results on state negative affect and/or actual heart-rate during stress tasks predicting retrospective estimate of heart-rat, controlling baseline heart-rate

Dependent variable in regressions = Retrospective estimate of heart-rate

Model	Control	Independent Variables		Adjusted R-Square
	Baseline HR	State Negative Affect	Actual HR during stress tasks	
		Study 1: Counting by 7's (N=51)		
1	.40**	.32*	--	.30***
2	.25	--	.47***	.38***
3	.17	.31**	.46***	.46***
		Study 1: Counting by 13's (N=49)		
4	.37**	.27**	--	.24***
5	.07	--	.68***	.50***
6	.03	.22*	.66***	.54***
		Study 2: Speech task (N=120)		
7	.25**	.26**	--	.14***
8	.25*	--	.10	.08**
9	.21*	.25**	.10	.14***
		Study 2: Counting by 13's (N=120)		
10	.28**	.28**	--	.17***

11	.25*	--	.11	.10**
12	.24*	.27**	.06	.16***

* $p < .05$, ** $p < .01$, ***$p < .001$ (all *p*s two-tailed)

Notes. Beta coefficients are standardized.