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The heart of the story: Peripheral physiology during narrative exposure predicts charitable giving

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ABSTRACT

Emotionally laden narratives are often used as persuasive appeals by charitable organizations. Physiological responses to a narrative may explain why some people respond to an appeal while others do not. In this study we tested whether autonomic and hormonal activity during a narrative predict subsequent narrative influence via charitable giving. Participants viewed a brief story of a father's experience with his 2-year-old son who has terminal cancer. After the story, participants were presented with an opportunity to donate some of their study earnings to a related charity. Measures derived from cardiac and electrodermal activity, including HF-HRV, significantly predicted donor status. Time-series GARCH models of physiology during the narrative further differentiated donors from non-donors. Moreover, cardiac activity and experienced concern were found to covary from moment-to-moment across the narrative. Our findings indicate that the physiological response to a stimulus, herein a narrative, can predict influence as indexed by stimulus-related behavior.

1. Introduction

Can bodily states predict costly behavior? The brain exerts control on the body via neural (autonomic) and hormonal (neuroendocrine) systems (Janig, 2003). Likewise, these systems relay information about bodily states (the "internal environment") back to the brain. Neural states as people are processing information can be observed without intruding on the experience of process itself (Falk et al., 2010), and have been associated with objective influence outcomes (Falk, Berkman, & Lieberman, 2012). In this research we examine how reactivity in these peripheral systems can predict whether someone will behaviorally respond to a related stimulus.

Recent work has associated the neuroactive hormones adrenocorticotropin hormone (ACTH) and oxytocin (OT) with cognitive (attention) and affective engagement (empathic concern) while viewing public service announcements (Lin, Grewal, Morin, Johnson, & Zak, 2013).[1] ACTH has long been affiliated with attention toward environmental stimuli (e.g., Born, Fehm, & Voigt, 1986). Other steroidal hormones are linked to social behaviors. For instance, cortisol is hypothesized to motivate action in response to the factors in the environment (see Dickerson & Kemeny, 2004), including social stimuli (Rahe, Rubin, & Gunderson, 1972). Testosterone has been shown respond to social challenges (Bos, Panksepp, Bluthe, & van Honk, 2012) and in the absence of social threats increases prosocial behavior (Boksem et al., 2013).

An extensive research suggests that both sympathetic and parasympathetic systems are indicative of attention and affective engagement. People are more likely to attend to stimuli eliciting sympathetic arousal (see Boucsein, 2012; Kensinger, 2004; MacLeod & Mathews, 2004). Activity in both sympathetic and parasympathetic systems, via electrodermal and cardiac activity, has been shown to occur in response to emotional stories (Eisenberg, Fabes et al., 1988; Eisenberg, Schaller et al., 1988; Eisenberg et al., 1991). A key component of the parasympathetic nervous system, the vagus nerve, is proposed to be central to the mammalian "social-engagement system" (Porges, 2007). Whereas resting vagal activity is associated with affective experiences,

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[1] Unlike with Lin et al. (2013), we were unable to include oxytocin in our analysis as we encountered a substantial proportion of missing data due to the assay process. The remaining data had such large between- and within-subject variation that they were not included in the analyses.

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notably empathic concern (e.g., Oveis et al., 2009), changes in vagal activity (reactivity) are used as situational indicators of vagal control (Beauchaine, 2001).

2. The present research

The present research examines if reactivity in autonomic and neuroendocrine systems predict whether someone will act in response to a narrative. As our stimulus, we selected a 100-second narrative. Narratives can serve as vehicles for transmitting influence by conveying a desired way to feel, think, or act (Gerrig, 1993). Narratives promote attitude congruence (story-consistent beliefs; e.g., Appel & Richter, 2010; Busselle & Bilandzic, 2009; Green, 2004; Green & Brock, 2000), a positive evaluation of information within the narrative (Escalas, 2004; Paharia, Keinan, Avery, & Schor, 2011), and identification with fictional groups in a story (Gabriel & Young, 2011). Narratives are successful at motivating costly behavior. For instance, character-based appeals are found to be a more effective tool for eliciting donations than an information-based rhetorical appeal (Small & Loewenstein, 2003). A narrative from a charitable organization was selected as it provides a straightforward behavioral outcome measure: a monetary donation. Moreover, a charity narrative permits us to make explicit predictions about the psychological and physiological processes involved in narrative influence. We evaluated whether cardiac vagal control, heart rate (which reflects both sympathetic and vagal influences), and electrodermal activity as people experienced an influential narrative would differ between the responders and non-responders to a subsequent donation appeal. Furthermore, we examined several candidate hormones hypothesized to be associated with attention to the narrative.

3. Method

3.1. Participants and procedure

We recruited 163 participants (68 females) from Claremont colleges and the surrounding community through mass e-mails, posted fliers, and an existing online recruitment pool (ages 18–52, $M = 20.91$, $SD = 5.20$). The general sample size was determined assuming a medium effect size prior to start of data collection. Participant earnings varied with the number of correctly answered post-narrative questions and charitable donations made; maximum possible earnings were $40. Study sessions were conducted at the Center for Neuroeconomics Studies at Claremont Graduate University in Claremont, CA. Claremont Graduate University's Institutional Review Board and the U.S. Army Medical Research and Materiel Command's Office of Research Protections, Human Research Protection Office approved this study.

Prior to consent, participants were informed that the purpose of the study was to investigate what happens in your body when you are exposed to emotional stories. The consent form further informed participants that they would see one of several stories selected by the researchers, though all participants viewed the same story. After obtaining written informed consent, 12 mL of blood was drawn by a qualified phlebotomist from an antecubital vein to establish basal hormone levels and participants were fitted with autonomic physiology sensors. Participants completed a questionnaire that included demographic items and a number of state and trait measures. Once finished, participants were seated privately in a dimly lit room in front of a 15″ MacbookPro© laptop (Apple, Inc.) equipped with headphones. All proceeding tasks, including the donation task, were presented in MATLAB© (Mathworks, Inc.), using the Psychophysics Toolbox extensions (Brainard, 1997).

After a 5-min baseline acquisition period for autonomic nervous system (ANS) measures, participants watched a 100-s video obtained with permission from St. Jude's Children's Research Hospital of a father who has a 2-year-old son who is dying of brain cancer (used previously in Barraza & Zak, 2009). Peripheral nervous system activity was recorded throughout the stimulus. Post-stimulus, participants were asked to rate their emotions using 12 adjectives previously used to assess empathic concern and personal distress (Batson et al., 1997), emotions also believed to be important in narrative experience (Mar, Oatley, Djikic, & Mullin, 2011). Immediately after these ratings, participants received another 12 mL blood draw in an adjacent room. Participants returned to their seats and were asked to answer five questions related to the narrative, earning $5 for each correct answer. These earnings were added to the $15 base participation payment. The earnings task was designed so that participants earned money in the study based on effort rather than receiving a windfall. Questions were made to be simple such that a large majority of participants answered all questions correctly. Participants were next informed that the preceding story was produced by St. Jude's Children's Research Hospital and were given a brief description regarding their activities. The option to donate none, some, or all of their participation earnings to St. Jude's was next presented to participants in private and with a reminder of their anonymity. After the donation decision, participants were privately paid their earnings and dismissed. There was no deception of any kind in this study and donated money was sent to St. Jude's at the conclusion of the study.

3.2. Self-report measures

We employed the Ten-Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003), to assess broad personality dimensions (extraversion, agreeableness, conscientiousness, neuroticism, openness). Item scores ranged from 1 "strongly disagree" to 7 "strongly agree". Each subscale consists of two items; scale scores were computed by averaging the respective item scores. The four subscales in the Interpersonal Reactivity Index (IRI; Davis, 1983) were used to measure empathic personality dimensions (empathic concern, personal distress, perspective-taking, fantasy). Item scores ranged from 1 "does not describe me well" to 7 "describes me very well." Subscales were computed by averaging the seven items per subscale. State negative and positive affect was assessed using the Positive And Negative Affect Schedule (PANAS, Watson et al., 1988). Item scores ranged from 1 "not at all" to 5 "extremely." Positive affect and negative affect subscales were computed by averaging the ten items per subscale.

3.3. Autonomic measures

Cardiac (sampling rate 1 kHz) and electrodermal activity (sampling rate 250 Hz) were collected using a Biopac MP150 data acquisition system and BioNomadix® transmitters and recorded with AcqKnowledge® software version 4.2 (Biopac Inc., Goleta, CA). To measure cardiac activity, participants were fitted with three disposable Ag–AgCl electrocardiogram (ECG) electrodes using a Lead(III) configuration. To measure skin conductance, two disposable Ag–AgCl electrodermal (EDA) electrodes were placed on participants' distal phalanx surfaces of the middle and index fingers of their non-dominant hand. Before placement of EDA electrodes, participants washed hands with non-detergent bar soap.

Following data collection, the data were manually inspected in AcqKnowledge® software version 4.2 (Biopac Inc., Goleta, CA). Skin conductance waveforms were visually inspected for brief periods of signal loss, and data drop-offs shorter than 1 s in length were replaced with averages from adjacent parts of the waveform. Additionally, waveform noise due to experimenter-observed movement was smoothed using mean-value replacement from adjacent parts of the waveform. Next, a 10-Hz low-pass filter was applied to the waveform to remove high-frequency noise (Norris, Larsen, & Cacioppo, 2007), and a square root transformation was applied to adjust for skew inherent to skin conductance data (Dawson, Schell, & Filion, 1989; Figner & Murphy, 2001). After transformations, average skin conductance level (SCL) was extracted for the final 2 min of the baseline and for the 100 s time-span of the narrative. These values were used to calculate percent change in SCL from baseline to the narrative. For time series analyses, 1 s segments of SCL were taken from baseline and narrative stimulus. Non-specific skin conductance responses (NS-SCRs) were identified using a threshold of 0.01 μS, and NS-SCR counts were taken for baseline, and narrative. Following extraction of NS-SCR counts, these values were used to calculate rate of NS-SCRs/min for baseline, narrative, and the three narrative segments.

Cardiac data from 23 participants were excluded due to problems with data collection, thus leaving a total of 141 participants for further analysis. ECG artifacts were manually removed from the data. Data were further passed through the band-pass finite impulse response (FIR) filter, to remove both high- and low-frequency noise, and then smoothed. R-R intervals were identified and extracted from Biopac and imported into Kubios software (http://kubios.uef.fi) for derivation of heart rate variability (HRV) measures, including the high frequency (HF) component as the measure of vagal control. Linear trend components were removed from the data prior to HRV analysis. The HF power was extracted from 0.12 to 0.4 Hz band and then log-transformed as suggested by Lewis, Furman, McCool, and Porges (2012).

3.4. Hormone measures

Three hormones were assessed at baseline and immediately after narrative exposure: adrenocorticotropin hormone (ACTH), cortisol (CORT), and testosterone (T). Sessions were run in the afternoon when diurnal variations in CORT are relatively stable.[2] Two 8-mL, EDTA (ethylenediaminetetraacetic acid) whole-blood tubes and one 8-mL, serum-separator tube were drawn while maintaining a sterile field and using a Vacutainer butterfly needle (BD, Franklin Lakes, NJ, USA) at baseline and post-stimulus. Following the draw, whole-blood tubes were rocked to facilitate mixing

[2] Though each hormone follows a different time course (e.g., de Wied, 1990; Dickerson & Kemeny, 2004; Rowe et al., 1974), we collected blood for assay within 1–5 min of the narrative stimulus conclusion. The collection point was selected given the rapidity of changes in both oxytocin (Fabian et al., 1969) and ACTH (de Wied, 1990).