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BRIEF REPORT

System Justification and Electrophysiological Responses to Feedback: Support for a Positivity Bias

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Conservatives, compared to liberals, are consistently found to exhibit physiological sensitivity to aversive stimuli. However, it remains unknown whether conservatives are also sensitive to salient positively valenced stimuli. We therefore used event-related potentials to determine the relationship between system justification (SJ), a fundamental component of conservative political ideology, and neural processing of negative and positive feedback. Participants ($N = 29$) filled out questionnaire assessments of SJ. Feedback-related negativity (FRN), an event-related potential component thought to index activity in neural regions associated with reward processing, was assessed in response to positive and negative feedback on a time estimation task. A significant interaction was noted between SJ and feedback type in predicting FRN. Simple effects tests suggested that SJ predicted greater FRN in response to positive but not to negative feedback. Conservatives may experience salient positive information with a heightened intensity.

Keywords: feedback-related negativity, system justification, political conservatism, event-related potentials, social neuroscience

A recent review of 60 years of neurobiological, psychophysiological, and psychological studies suggested that political conservatives, compared to liberals, exhibit a "negativity bias," processing negatively valenced information with heightened intensity (Hibbing, Smith, & Alford, in press). This conclusion was based upon findings that conservatives consistently display physiological sensitivity to fear-inducing and disgusting stimuli in a variety of contexts. However, we have recently noted (Tritt, Inzlicht, & Peterson, in press) that further research is needed before it can be concluded that conservatives are sensitive to negative valence per se, rather than arousal more generally. Little happens to be known about how conservatives process motivationally salient, positively valenced information.

We therefore employed event-related potentials (ERPs) to explore the relationship between neural processing of positive and negative feedback and system justification (SJ), a fundamental component of conservative political ideology defined as the endorsement/rationalization of the current social, economic, or political system (Jost & Banaji, 1994). In so doing, we assessed the possibility that conservatives process rewards as well as threats with heightened salience. Through this research, we hoped to gain a better understanding of the neuroaffective correlates of political orientation.

Arousal and Valence Confounded in Political Psychology Research

Political psychology research has tended to confound valence and arousal, which may have led to the potentially premature conclusion that negative valence per se is associated with conservative political beliefs (Tritt et al., in press). Studies that have investigated attentional biases in relation to political orientation have assessed either how individuals process negative compared to neutral information (Dodd

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et al., 2012; Fodor, Wick, Hartsen, & Preve, 2008; Oxley et al., 2008; Smith, Oxley, Hibbing, Alford, & Hibbing, 2011) or the way participants process highly arousing negative compared to positively valenced less arousing information (Carraro, Castelli, & Macchiella, 2011; Dodd et al., 2012; McLean et al., in press), thus confounding the effect of arousal and valence.

Recent neurobiological studies may have similarly been interpreted too narrowly in terms of negative valence rather than arousal. In finding enhanced volume (Kanai, Feilden, Firth, & Rees, 2011) and activity (Schreiber et al., 2013) of the amygdala among conservatives, researchers have assumed greater sensitivity to threat and uncertainty. However, recent evidence has suggested that the amygdala is implicated in detecting a broad range of motivationally relevant stimuli, including positive rewards (e.g., Cunningham & Brosch, 2012). Thus, enhanced amygdala activity/volume may reflect heightened motivational arousal in general, rather than specifically negative valence.

Furthermore, if political conservatism is fundamentally associated with sensitivity to specifically negative valence, then it should be at least somewhat positively correlated with neuroticism, a personality trait that clearly subsumes fear, anxiety, and aversion to uncertainty (e.g., Hirsh & Inzlicht, 2008; Jardine, Martin, Henderson, & Rao, 1984). Many studies have now demonstrated, however, that neuroticism is not linked to political belief in any particular direction or with any real power (e.g., Alford & Hibbing, 2007; Butler, 2000; Carney, Jost, Gosling, & Potter, 2008; Hirsh, DeYoung, Xu, & Peterson, 2010). Not only are conservatives no more neurotic than liberals, but several studies have found that conservatives are actually happier than liberals (e.g., Napier & Jost, 2008; Schlenker, Chambers, & Le, 2012; Taylor, Funk, & Craighill, 2006). This research has suggested that conservatives experience more positive psychological states, including happiness.

Given the lack of work examining conservatives' reaction to salient positively valenced stimuli, we conducted a study in which we presented people with both positive and negative feedback and then examined if conservatives responded differently from liberals, exploring whether conservatism is linked with biases of negativity *and* positivity. We examined, in particular, the feedback-related negativity (FRN), an ERP that indexes neural activity in reward-processing brain regions, in response to positive as well as negative feedback.

Feedback-Related Negativity

FRN is an ERP generated in the medial prefrontal cortex, approximately 250–400 ms after receiving positive or negative feedback on a task (e.g., Carlson, Foti, Mujica-Parodi, Harmon-Jones, & Hajcak, 2011; Gehring & Willoughby, 2002; Holroyd & Coles, 2002). FRN has consistently been shown to index the positive versus negative motivational significance of feedback (Hajcak, Moser, Holroyd, & Simons, 2006).

FRN appears to reflect individual differences in emotional processing (e.g., see Santesso et al., 2012). Traditionally, FRN has been thought to gauge decreases in phasic dopamine signals from the basal ganglia that occur during expectation of loss compared to reward (see Bellebaum & Daum, 2008; Hajcak et al., 2006). However, Carlson and colleagues (2011) have recently demonstrated that mesocorticolimbic dopamine structures including the ventral striatum, caudate, amygdala, medial prefrontal cortex, and orbitofrontal cortex were activated during functional magnetic resonance imaging (fMRI) in response to monetary gains compared to losses during completion of a gambling task (Carlson et al., 2011). This activation was paralleled by more positive deflections in FRN amplitude following gains as opposed to losses approximately 250–350 ms postfeedback. FRN, then, may indicate activity in the ventral striatum, caudate, amygdala, medial prefrontal cortex, and orbitalfrontal cortex in response to rewards compared to nonrewards (see also Foti, Weinberg, Dien, & Hajcak, 2011; but see Cohen, Cavanaugh, & Slagter, 2011). Functional MRI data indicating that the medial prefrontal cortex may be more active in response to gain relative to losses (Fujiwara, Tobler, Taira, Iijima, & Tsutsui, 2009; Rogers et al., 2004) and to pleasant versus unpleasant images (Sabatinelli, Bradley, Lang, Costa, & Versace, 2007) appears to support Carlson and colleagues' contention.

Study Overview

If conservatives are in fact characterized by more intense positive experience at a given level of emotional intensity, then they should manifest higher amplitude FRN responses to positive stimuli. If, on the other hand, conservatives are uniquely sensitive to negative, but not positive, arousing stimuli, then they should not exhibit more positive FRN deflections in response to positive stimuli, and they may even show more negative FRN deflections to negative stimuli. The former finding would suggest that conservative political beliefs may be linked to positivity in addition to negativity biases, as suggested by the arousal model put forward by Tritt and colleagues (in press). The latter would cast doubt on that suggestion.

Emotional biases among conservatives are thought to stem from the psychological processes associated with conservative ideology (see Jost, Glaser, Kruglanski, & Sulloway, 2003). We accordingly opted to examine one such psychological process rather than political attitudes per se. In so doing, we assessed a more direct hypothesis about the psychological foundations of conservative ideology. In particular, we assessed SJ, the motive to defend the prevailing sociopolitical system, which is thought to underlie conservative systems of belief (e.g., see Jost & Banaji, 1994; Napier & Jost, 2008).

We moreover chose to employ a nonsocial task, unrelated to political topics, which enabled us to assess individual differences in generalized reward sensitivity. Furthermore, by using standardized positive and negative stimuli that are equal in arousal (feedback), arousal was not confounded with valence.

Method

Participants

Complete electroencephalograph (EEG) data were obtained from 41 individuals in an introductory psychology course participating for course credit. Some were excluded from analyses because of excessive ERP artifacts ($N = 6$). Additionally, one was excluded from analyses because he was deemed to be an outlier based on inspection of scatterplots between scores on the SJ scale and the difference score of FRN between positive and negative feedback types. As well, he obtained outlying scores on the SJ scale (>2 *SD*s above the mean). Finally, some participants ($N = 5$) did not complete all self-report questionnaires. This left a final sample of 29 participants (22 females; mean age = 19.17 years, $SD = 4.79$).

System Justification

Participants completed an eight-item self-report measure of SJ (Kay & Jost, 2003) that includes items such as "Society is set up so that people usually get what they deserve" and "In general, the Canadian political system operates as it should." Responses were scored on 9-point scales ranging from 1 (*strongly disagree*) to 9 (*strongly agree*). The sample mean was 4.57 ($SD = 0.98$). Reliability was good ($\alpha = .76$).

Time Estimation Task

We adopted a paradigm used previously by Oliveira, McDonald, and Goodman (2007) to elicit FRN. While completing this task, participants were asked to press a button when a horizontally moving visual stimulus reached the midpoint of a computer screen. Responses were initially considered correct if they fell within 250 ms of the proper time. The time window of a correct response was decreased by a factor of 0.85 after each correct response and increased by a factor of 1.10 after each incorrect response (although it was never allowed to decrease below 120 ms). This response calibration was done so that, on average, participants would receive an equal number of veridical positive and negative feedback signals.

Participants were informed that they would be awarded four cents for every correct trial and would forfeit the same amount for an incorrect response. In actuality, however, participants received $5 regardless of their performance upon study completion. FRN was stimulus-locked to feedback presentation. Participants completed 200 trials. They were asked to blink as infrequently as possible and instructed to refrain from moving their eyes.

Participants were asked immediately following their response whether they thought that they had responded accurately on a 4-point scale ranging from 1 (*I am certain that my answer was not on time*) to 4 (*I am certain that my answer was on time*). These answers were used to judge whether the feedback that they subsequently received was expected or unexpected. Expectation did not moderate the results. Therefore, we did not analyze expectation as an independent variable but retained it as a covariate, controlling for it in all analyses.

Electrophysiological Recording and Processing

EEG data were recorded using a stretch Lycra cap (Electro-Cap International, Eaton, Ohio) embedded with 32 tin electrodes, with electrodes arranged in the international 10–20 system. Recordings were digitized at 512 Hz using ASA acquisition software (Advanced Neuro Technology B.V., Enschede, the Netherlands) with a digital average of both ears as the reference. EEG data were analyzed with Brain Vision Analyzer 2.0 (Brain Products GmbH, Munich, Germany), corrected for vertical electro-oculogram artifacts (Gratton, Coles, & Donchin, 1983), and digitally filtered offline between 0.1 and 30 Hz (24dB IIR filter). EEG signals were time-locked to the presentation of feedback. Baseline correction was done using the period between −200 and 0 ms before feedback presentation. Artifacts were detected and rejected using an automatic procedure that employed the following criteria: a voltage step of more than 25 μV between sample points, a voltage difference of 150 μV within 150-ms intervals, voltages above 85 μV and below −85 μV, and a maximum voltage difference of less than 0.50 μV within 100-ms intervals. Such intervals were rejected from individual channels in each trial. For each artifact-free trial, an epoch was defined between −200 ms before and 1,000 ms after feedback. These epochs were grand-averaged within their respective feedback stimulus type conditions.

FRNs were calculated for each feedback type: positive and negative. FRN was scored at the midline sites FZ, FCZ, and CZ, which is where this ERP component has been found to be maximally located (e.g., Gehring & Willoughby, 2002; Oliveira et al., 2007; Santesso et al., 2012). Moreover, inspection of topographical maps of the difference scores of EEG activity in response to negative minus positive feedback in the time-window of FRN revealed that FRN seemed most differentiated at these three electrode sites (see Figure 1). FRN was scored as the mean peak between 200 ms and 350 ms following feedback onset, as suggested by Santesso and colleagues (2012). Each participant's average had a minimum of 10 artifact-free feedback trials, a number that has previously been established as appropriate for FRN (Bellebaum & Daum, 2008; see Figure 1 for waveform graph).

Each of our figures depicts the difference wave of FRN in response to negative minus positive stimuli. Difference waves minimize the effect of overlap between FRN and ERP components such as the P3, which may reflect the next peak of the phase-locked theta cycle (see Holroyd & Krigolson, 2007; Holroyd, Pakzad-Vaezi, & Krigolson, 2008; van der Helden, Boksem, & Blom, 2010).

Results

We assessed the effect of feedback type (positive vs. negative), expectation (expected vs. unexpected), electrode (FZ vs. FCZ vs. CZ), and SJ upon FRN amplitudes. In order to account for a mixed design with a continuous predictor, we used multilevel modeling to analyze our data. Our fixed-effects model predicted FRN from an effect-coded feedback type variable (−1 = negative feedback, 1 = positive feedback), an effect-coded expectation variable (−1 = expected feedback, 1 = unexpected feedback), electrode site variable (1 = FZ, 2 = FCZ, 3 = CZ), and mean-centered SJ, as well as the interactions among these variables. We used a variance components covariance matrix to estimate a random intercept for each participant. We calculated semipartial R^2 effect sizes, which estimate the relative variance explained by each predictor (Edwards, Muller, Wolfinger, Qaqish, & Schabenberger, 2008).

In the omnibus model, we first checked to see if there was a significant interaction between electrode site (FZ, FCZ, CZ) and valence in predicting FRN amplitude. Such an interaction would imply that FRN is maximally located at a specific electrode and that we should be conducting our analyses at that site. We did not find evidence of such an interaction ($b = -0.07$, $SE = 0.28$), $F(1, 302.01) = .07$; $p = .788$, $R^2 < .01$, which suggests that FRN is equally evident across all three electrodes. Electrode site moreover did not interact with SJ to predict FRN ($b = 0.26$, $SE = 0.29$), $F(1, 302.13) = .81$; $p = .368$, $R^2 = .01$. Nor was there a three-way interaction between electrode site, SJ, and valence ($b = 0.19$, $SE = 0.29$), $F(1, 302.01) = .44$; $p = .509$, $R^2 < .01$. A main effect of electrode region was noted ($b = -1.75$, $SE = 0.28$), $F(1, 302.08) = 40.31$; $p = .001$, $R^2 = .12$.

In replication of previous FRN studies (e.g., Hajcak et al., 2006), a main effect of valence was detected ($b = 2.99$, $SE = 0.23$), $F(1, 302.09) = 176.29$; $p = .001$, $R^2 = .37$, whereby the amplitude of FRN was more positive in response to positive ($M = 17.21$ μV, $SD = 7.45$ μV) than negative ($M = 11.37$ μV, $SD = 5.12$ μV) feedback (see Figure 1 for waveform graph). However, a main effect of expectation upon FRN amplitudes was not found ($b = -0.08$, $SE = 0.23$), $F(1, 302.15) = .14$; $p = .714$, $R^2 < .01$. Nor were there significant interactions between valence and expectation ($b = 0.11$, $SE = 0.23$), $F(1, 302.18) = .23$; $p = .632$, $R^2 < .01$, or between expectation and

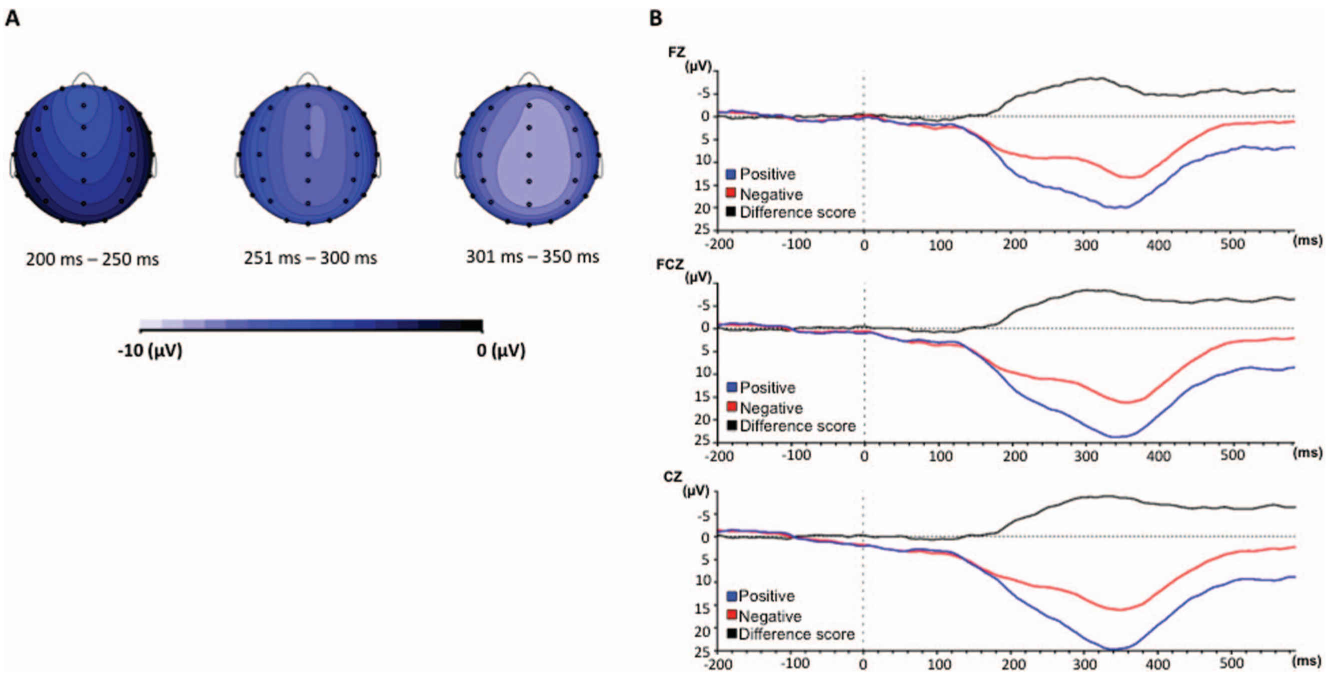

Figure 1. Panel A depicts topographical maps that demonstrate that electrodermal activity was most differentiated by negative and positive stimuli in the time window of feedback-related negativity (FRN), 200–350 ms after stimuli exposure, at fronto-centro electrodes FZ, FCZ, and CZ. Panel B depicts FRN amplitude, evidenced 200–350 ms postexposure in response to positive and negative feedback, and the difference score between negative and positive feedback, at each of these three electrode sites.

SJ (b = 0.39, SE = 0.24), F(1, 302.39) = 2.63; p = .106, R^2 = .01, in predicting FRN.

In regard to SJ, a main effect upon FRN was not found (b = 1.49, SE = 1.15), F(1, 27.08) = 1.69; p = .205, R^2 = .06. However, in support of our main hypothesis, a significant interaction between SJ and feedback type in predicting FRN was noted (b = 0.66, SE = 0.24), F(1, 302.27) = 7.62; p = .006, R^2 = .02. Follow-up simple effects tests were conducted following the methods of Aiken and West (1991), separately assessing whether FRN is more differentiated by feedback type among participants high or low in SJ. We found that FRN was significantly differentiated by feedback type among participants both high (b = 3.62, SE = 0.33), F(1, 302.04) = 122.60; p = .001, R^2 = .29, and low (b = 2.36, SE = 0.32), F(1, 302.33) = 55.79; p = .001, R^2 = .18, in SJ. We then analyzed whether SJ was related to FRN specifically in response to positive or negative feedback types. SJ was not found to be specifically related to negative feedback (b = 0.84, SE = 1.17), F(1, 29.29) = 0.51; p = .480, R^2 = .01, but was associated (a trend) with enhanced FRN in response to positive feedback (b = 2.15, SE = 1.17), F(1, 29.59) = 3.36; p = .077, R^2 = .09. Taken together, it seems that system justifiers displayed more positive FRNs in response to positive feedback (see Figure 2 for waveform graphs and see Figure 3 for scatterplots). This pattern is consistent with the hypothesis that conservatives exhibit increased emotional responsivity to positive stimuli.

We reran all of our analyses without including expectation in our model. This did not alter the significance of any finding.[1]

Discussion

First, our results replicated numerous previous studies of FRN in response to negative compared to positive feedback (e.g., Carlson et al., 2011; Hajcak et al., 2006) and generally demonstrates the usefulness of FRN as a correlative measure of individual differences. Second, the results indicated that individuals who expressed more support for the current sociopolitical system exhibited

[1] Our analyses without controlling for the effect of expectation are as follows: FRN amplitudes were not predicted by interactions between electrode site and valence (b = −0.07, SE = 0.28), F(1, 306.01) = 0.07; p = .793, R^2 < .01; electrode site and SJ (b = 0.26, SE = 0.29), F(1, 306.13) = 0.82; p = .365, R^2 = .01; or electrode site, SJ, and valence (b = 0.19, SE = 0.29), F(1, 306.01) = 0.44; p = .512, R^2 < .01. A main effect was noted for electrode region (b = −1.75, SE = 0.28), F(1, 306.08) = 40.39; p = .001, R^2 = .12. Moreover, in replication of previous FRN studies (e.g., Hajcak et al., 2006), a main effect of valence was detected (b = 3.00, SE = 0.23), F(1, 306.08) = 177.14; p = .001, R^2 = .37. In regard to SJ, a main effect upon FRN was not found (b = 1.49, SE = 1.15), F(1, 27.08) = 1.68, p = .207, R^2 = .06. However, a significant interaction between SJ and feedback type in predicting FRN was noted (b = 0.65, SE = 0.24), F(1, 306.25) = 7.43; p = .007, R^2 = .02. Follow-up simple effects tests revealed that FRN was significantly differentiated by feedback type among participants both high (b = 3.62, SE = 0.33), F(1, 306.03) = 122.64, p = .001, R^2 = .29, and low (b = 2.37, SE = 0.32), F(1, 306.31) = 56.59; p = .001, R^2 = .18, in SJ. SJ was not found to be specifically related to negative feedback (b = 0.84, SE = 1.17), F(1, 29.28) = 0.51; p = .479, R^2 = .01, but was associated (a trend) with enhanced FRN in response to positive feedback (b = 2.14, SE = 1.18), F(1, 29.58) = 3.30; p = .080, R^2 = .09.

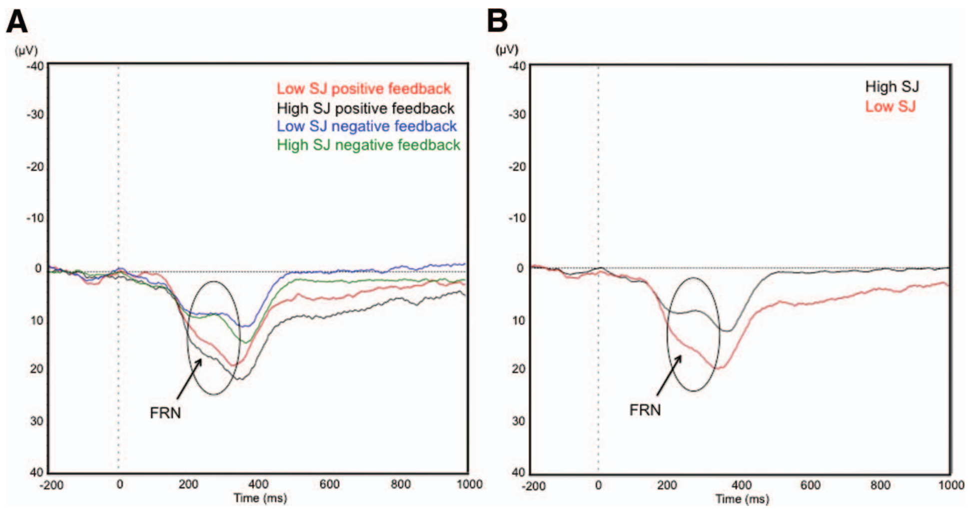

Figure 2. Feedback-related negativity (FRN) amplitude, evidenced 200–350 ms postexposure, averaged across FZ, FCZ, and CZ electrodes, in response to positive and negative feedback (Panel A) and the difference scores between negative and positive feedback (Panel B), for participants with above and below the median scores on the system justification (SJ) scale (Kay & Jost, 2003).

greater sensitivity to positive feedback, indexed by an ERP component thought to reflect neural activity in reward-processing brain regions (see Carlson et al., 2011). This study supports the notion, then, that SJ, a fundamental component of conservative ideology, is associated with a "positivity bias," such that rewarding stimuli are experienced with heightened intensity.

Political Conservatism and Responsivity to Positive Feedback

The fact that system justifiers exhibited heightened reactivity in reward-processing neural regions (see Carlson et al., 2011) suggests that current theories that emphasize the relationship between conservative ideology and aversive states such as uncertainty, threat, and disgust (e.g., see Hibbing et al., in press; Jost et al., 2003, for reviews) may be conceived too narrowly. Our study finding is consistent, on the other hand, with several studies that have found that conservatives are happier than liberals (e.g., Napier & Jost, 2008; Schlenker et al., 2012; Taylor et al., 2006). Indeed, our study may suggest a neural mechanism through which conservatives experience more positive psychological states such as happiness; system justifiers may process positive information with a heightened intensity.

Further experimental study may help establish whether activation of reward-processing systems causes individuals to support the validity of the status quo, or conversely, if priming system-justifying ideologies enhances sensitivity to rewarding stimuli. Either possibility would suggest a novel mechanism through which populations encourage or resist social change.

Political Conservatism and Responsivity to Negative Feedback

We did not find any relationship between SJ and FRN in response to negative stimuli. This seems surprising, given that past research has found that conservatives exhibit enhanced physiological responses to aversive stimuli (see Hibbing et al., in press, for review). We believe that this lack of a finding may be due to the fact that FRN may more accurately reflect reward rather than threat-processing neural activity (Carlson et al., 2011). FRN, consequently, may be more powerfully able to detect individual differences in reward as opposed to threat sensitivity. Thus, this study should likely not be reasonably construed as a test of a negativity bias among conservatives but rather understood as providing partial support for the idea that conservatives might respond more to arousing, positively valenced stimuli than do liberals. To our knowledge, this has never been demonstrated before.

Future study, with larger sample sizes and a wider variety of psychophysiological measures, is needed to further examine these ideas. The fact that we found a relationship between a fundamental aspect of conservative ideology and reward processing does not support a negative valence model of political conservatism, as has recently been suggested by Hibbing and colleagues (in press). Instead, it suggests that conservatism may be driven by arousal.

Alternative Interpretation of FRN

An alternative interpretation of FRN is the Alexander and Brown (2011) predicted response outcome model. According to this model, the medial prefrontal cortex activity that is indexed by FRN reflects the degree of expectedness of an event—regardless of the positive or negative valence of that event. If this is the case, then FRN might be interpreted in terms of the expectedness of positive and negative feedback. We did not find evidence of a main effect of expectation upon FRN amplitudes, nor did we find an interaction between expectation and SJ in predicting FRN, which does not support the Alexander and Brown model or the role of expectation in explaining the relationship between SJ and FRN responses to positive feedback. Nonetheless, this could be due to lack of power in our expectation manipulation. Future studies are needed to further investigate the role of expectation in attentional bias to emotional stimuli among system justifiers.

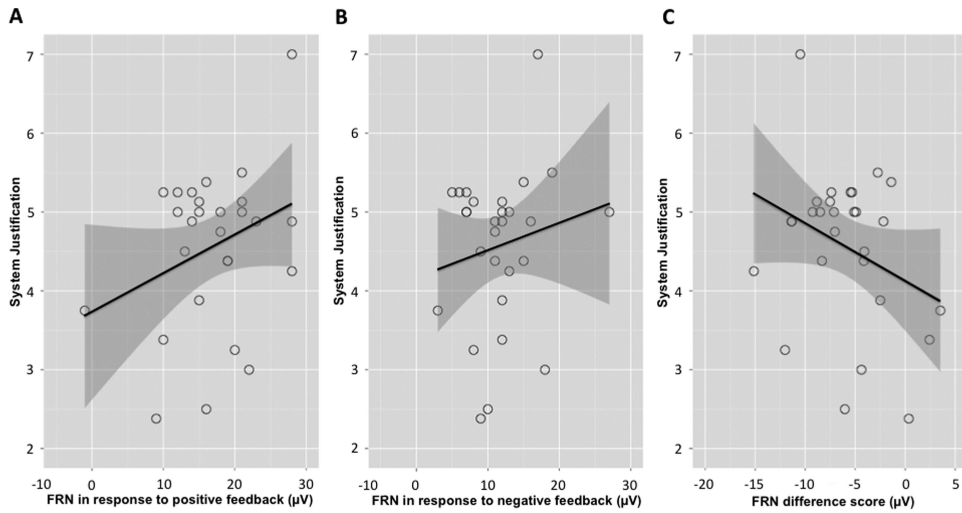

Figure 3. Scatterplots depict the relationship between scores on the system justification scale (Kay & Jost, 2003) and the feedback-related negativity (FRN) amplitude, averaged across electrode sites FZ, FCZ, and CZ and evidenced 200–350 ms postexposure, in response to positive feedback (Panel A), negative feedback (Panel B), and the difference scores between negative and positive feedback (Panel C), with 95% confidence intervals displayed.

Conclusion

The finding that SJ is associated with heightened processing of positive stimuli may enhance understanding of the neuropsychological processes associated with endorsement of the status quo. Increased understanding of the neural and personality processes that motivate maintenance of the status quo, especially in the context of unjust and authoritarian sociopolitical systems, may be a first step to undermining unhealthy stagnation in society.

Our study highlights the necessity for political psychology researchers to be cautious in considering both the arousal and valence of the stimuli that they choose to employ. In order to tease apart which of these is most fundamentally linked to political belief, it will be necessary to conduct studies that manipulate both (see Tritt et al., in press).

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