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Neural Mechanisms Associated with Semantic and Basic Self-Oriented Memory Processes
Interact to Modulate Self-Esteem

Rachel C. Amey^{1*}, Jordan B. Leitner², Mengting Liu³, and Chad E. Forbes¹

¹Department of Psychological and Brain Sciences, University of Delaware, Newark, Delaware, United States of America

²Department of Psychology, University of California Berkeley, Berkeley, California, United States of America

³Neuroimaging and Informatics Institute, University of Southern California, Los Angeles, California, United States of America

*Corresponding Author:

Rachel C. Amey
email: ramey@psych.udel.edu

41

42 **Abstract**

43 Individuals constantly encounter feedback from others and process this feedback in
44 various ways to maintain positive situational state self-esteem (SSE) in relation to semantic-
45 based or trait self-esteem (TSE). Individuals may utilize a data-driven, or episodic-based process
46 that encodes positive, but not negative, self-relevant information automatically, or employ a
47 semantic-driven process that manipulates encoded negative feedback post-hoc. It's unclear,
48 however, how these processes work either alone or in concert while individuals receive positive
49 and negative feedback to modulate feedback encoding and subsequent SSE. Utilizing neural
50 regions associated with semantic self-oriented and basic encoding processes (mPFC and PCC
51 respectively), and time-frequency and Granger causality analyses to assess mPFC and PCC
52 interactions, this study examined how encoding of positive and negative self-relevant feedback
53 modulated individuals' post-task SSE in relation to their TSE while continuous EEG was
54 recorded. Among those with higher levels of TSE, the encoding of positive or negative feedback
55 was not associated with SSE. Rather, higher SSE was associated with mPFC activity to all
56 feedback and higher TSE. The relationship between TSE and SSE was moderated by mPFC-PCC
57 communication such that increases in mPFC-PCC communication led to SSE levels that were
58 consistent with TSE levels. Furthermore, Granger causality analyses indicated that individuals
59 exhibited higher SSE to the extent mPFC influenced PCC in response to positive and negative
60 feedback. Findings highlight the dynamic interplay between semantic self-oriented and basic
61 encoding processes that modulate SSE in relation to TSE, to maintain more positive global self-
62 perceptions in the moment and over time.

63 **Introduction**

64
65 Individuals appear inherently motivated to maintain positive self-esteem (SE), an integral
66 aspect of the self-concept [1] and utilize different mechanisms to bolster SE in the face of
67 positive and negative self-relevant feedback [2]. Individuals may initially attend to and encode
68 both positive and negative feedback and then manipulate negative feedback post-hoc in a manner
69 that maintains high SE [3], or they may encode positive feedback more deeply while processing
70 negative feedback at a shallower level, to bias SE in a more positive manner in the aggregate [4].
71 These self-protection mechanisms suggest a dynamic interplay between more semantic driven
72 self-oriented and basic memory encoding processes. Yet given that many of these findings are
73 based on self-report measures collected long after feedback is received, it's unclear how and to
74 what extent positive and negative self-relevant information is encoded and processed by
75 individuals on-line in relation to more semantic-based trait SE (TSE) to maintain positive state
76 SE (SSE) in the moment. Employing a social neuroscience approach, the current study examined
77 how individuals encoded positive and negative self-relevant feedback on-line, while they were
78 exposed to said feedback, and how semantic and episodic-based interactions inspired by self-
79 protection mechanisms ultimately modulated post-task SSE in relation to TSE. Findings provide
80 evidence for a dynamic interplay between semantic and episodic-based encoding processes that
81 modulates SSE in relation to TSE to maintain more positive global self-perceptions accordingly.

82 **Social feedback is processed via interactions between semantic self-** 83 **oriented and basic memory encoding processes**

84 The self-concept is comprised of both abstract information relevant to general self-
85 knowledge (e.g., self-attributes, attitudes and beliefs), or semantic knowledge, and concrete

86 information about past experiences and behaviors, or episodic knowledge [5]. SE, the subjective
87 feelings of one's self and abilities, has been identified as an integral aspect of the self-concept
88 [1], and likely a product of semantic and episodic self-knowledge. SE theoretically should be
89 affected by positive or negative self-relevant information, which often comes in the form of
90 social feedback. This feedback is essential for evaluating whether situational perceptions are
91 consistent with global perceptions of the self. Prominent theoretical frameworks contradict this
92 assumption. They indicate that individuals have an innate desire to maintain more positive SE in
93 the aggregate [6, 2]. This suggests a potential dynamic interplay between self-based semantic
94 and episodic memory processes. Influential theories pertinent to SE maintenance, including
95 mnemonic neglect, positive tropism, and sociometer theory, support this conjecture. Among other
96 things, they argue that situational or SSE may be dependent on self-relevant feedback being
97 processed *post-hoc* in ways that make it consistent with more semantic-based positive global
98 perceptions of the self (or TSE). It has also been argued that SSE may be dependent of feedback
99 received *in the moment* in the form of episodic memory-based encoding biases, depending on the
100 valence of the feedback.

101 For instance, according to principles of mnemonic neglect, given inherent motivations to
102 maintain more positive levels of SE, when individuals encounter positive or negative self-
103 relevant feedback, they utilize basic episodic memory encoding processes to automatically attend
104 to and encode positive information accurately. Negative information, however, is processed at a
105 shallower level [4]. This provides a means for negative self-relevant information to be readily
106 degraded over time and remain distinct from the stored positive self-concept, facilitating positive
107 self-perceptions and SSE in the moment that exist regardless of TSE levels [7].

108 Conversely, sociometer theory suggests that individuals integrate self-relevant feedback
109 into their self-concept based on situational fluctuations in SSE. When individuals experience
110 initial reductions in SSE they may accurately attend to both positive and negative social feedback
111 via episodic memory-based encoding processes to accurately detect group inclusion and restore
112 SSE [3]. That is, SE serves as a “sociometer” that detects the extent to which one feels included
113 in a valued group. These feelings of exclusion prompt efforts to restore perceptions of inclusion.
114 Sociometer theory also suggests this process may be modulated by TSE. According to Leary, an
115 individual’s “sociometer” may be calibrated differently depending on whether they have high or
116 low TSE. Whereas individuals with low TSE generally feel as though they tend to be rejected,
117 those with higher TSE feel as though they tend to be accepted. As such, individuals with higher
118 TSE may have higher SSE regardless of the type of feedback they are given. This suggests that
119 semantic-based TSE may modulate basic episodic encoding processes involved in on-line
120 conceptualizations of the self, regardless of feedback valence, to maintain SSE in relation to
121 TSE.

122 Findings from mnemonic neglect and sociometer theory allude to a dynamic interplay
123 between semantic and episodic-based encoding processes in response to positive and negative
124 self-relevant feedback during on-line conceptualizations of SSE. Evidence for this potential
125 interplay is informed by an additional theory referred to as positive tropism [8]. According to
126 principles of positive tropism, processing of self-relevant information consists of two phases.
127 Consistent with mnemonic neglect, during the first episodic-based phase of evaluation (or the
128 “positive tropism” phase) motivations to maintain SE result in individuals exhibiting an
129 attentional and encoding bias towards positive self-relevant information specifically. During the
130 second stage of information processing, initial information is compared to TSE. Here, positivity

131 biases can be overridden, possibly using more self-oriented semantic processes, if they are
132 inconsistent with TSE [9]. That is, with enough time, semantic-based processes may override
133 basic encoding positivity biases in attention and encoding, suggesting episodic and semantic
134 processes dynamically interact to maintain SSE levels that are consistent with TSE.

135 Episodic and semantic self-oriented processes thus likely dynamically interact early and
136 often during processing of positive and negative social feedback to influence SSE in relation to
137 TSE. Given that past studies have largely relied on behavioral and self-report measures, it is
138 unclear how exactly these interactions occur. Semantic knowledge about the self may bias how
139 social feedback is encoded or later recalled (and vice versa), but the assessment of self-related
140 measures before or after receiving social feedback ultimately masks how these processes
141 interact. Neuroscience methodologies provide a means to examine this critical time.

142 **Activity between and within PCC and mPFC can index episodic and** 143 **semantic interactions in relation to trait and SSE**

144 One way to gain insight into the role that self-based episodic and semantic memory
145 processes play in biasing encoding of feedback and subsequent SSE is to examine activity within
146 and between neural regions that instantiate encoding (i.e., episodic) and global self-oriented (i.e.,
147 semantic) processes on-line, while individuals are exposed to positive or negative feedback. Past
148 research has identified a collection of brain regions integral for basic encoding processes
149 including the hippocampus, lateral aspects of temporal cortex, medial and lateral aspects of
150 prefrontal cortex, and the precuneus/posterior cingulate cortex [10]. Of interest to the current
151 study (given its EEG-accessible location in the cortex), the precuneus/posterior cingulate cortex
152 (PCC) has been identified as integral for processes such as attentional allocation, and episodic

153 memory encoding and consolidation [11, 12]. PCC has also been shown to integrate new
154 information in to autobiographical memories during self-reflection [13]. Critically, numerous
155 meta-analyses [10, 14], as well as the fMRI meta-analytic software Neurosynth, highlight an
156 integral role for PCC in basic episodic memory processes among hundreds of studies (e.g., a
157 search for the term “episodic memory” in Neurosynth yielded significant PCC activation, z-
158 score=4.28 among 270 studies) [15].

159 Conversely, medial prefrontal cortex (mPFC) is considered a hub for semantic based self-
160 oriented processing, including global self-perceptions [16, 17], self-monitoring, the evaluation of
161 one's direct and reflected self-knowledge [18, 19] and self-esteem. In fact, mPFC has been
162 identified as a potential “neural sociometer” that plays a direct role in SE modulation [20]. mPFC
163 activity has also been correlated with individual differences in SSE and biased perceptions of
164 social feedback estimates, suggesting mPFC may be a hub for the integration of real time
165 feedback with TSE during on-line conceptualizations of SSE [21].

166 Given the role these two regions play in basic episodic and semantic processing,
167 assessing communication between PCC and mPFC could provide insight in to the degree to
168 which these processes interact during encoding of social feedback and conceptualizations of
169 SSE. Indeed, PCC and mPFC are exclusively recruited (along with other regions in the medial
170 temporal lobe network like the hippocampus) during self-related processes such as
171 autobiographical memory reconstruction and prospection [14, 22], suggesting an intimate
172 relationship between the two with respect to self-maintenance processes in general. Importantly,
173 establishing the temporal directionality of this relationship could provide further insight in to the
174 nature of these interactions. If a given measure of neural activity in mPFC at one time point
175 predicts a given measure of neural activity in PCC at a subsequent time point, this could be

176 indicative of a more semantic-based processing mechanism, whereas the converse could
177 represent a given outcome was driven by more episodic memory encoding processes. Examining
178 these measures of neural function in relation to encoding of information associated with social
179 feedback, SSE, and TSE thus provides a means to clarify the role that episodic and semantic
180 processes play in encoding of social feedback and subsequent SSE.

181 **Study overview and hypotheses**

182 The current study placed individuals in a context where they received positive and
183 negative social feedback (other supposed students accepting or rejecting them) and then assessed
184 the degree to which individuals encoded information associated with positive or negative
185 feedback (faces of supposed students that accepted or rejected them) while continuous EEG
186 activity was recorded. Individuals then completed SSE measures and a memory test for
187 previously seen faces (as well as lures; unseen faces). Activity within neural regions (measured
188 via power analyses), communication between neural regions (measured via phase locking
189 analyses), and the directionality of this communication (measured via Granger causality
190 analyses) in response to social feedback provided a means to assess the relationship between
191 semantic-based processes, episodic-based feedback encoding, and SSE. Based on mnemonic
192 neglect and positive tropism, individuals should exhibit greater memory accuracy for faces
193 associated with positive, as compared to negative feedback. Memory accuracy for positive
194 feedback should be associated with higher SSE. Neurally, greater PCC activity to positive
195 feedback should predict higher memory accuracy for positive feedback and higher levels of SSE
196 in comparison to negative feedback. Based on sociometer theory, individuals may initially
197 encode positive and negative feedback, however, encoding accuracy and PCC activity would not

198 correlate with TSE or SSE. There should only be a relationship between mPFC activity and SE,
199 regardless of feedback encoding and valence.

200 If these processes interact, more nuanced relationships would be expected. One
201 possibility is that PCC is involved in accurately encoding self-relevant feedback in general
202 (regardless of valence). The effect of feedback encoding on SSE however, is contingent on the
203 degree to which semantic self-oriented processes (i.e., TSE, instantiated by mPFC) become
204 involved to manipulate encoded information to maintain TSE. PCC-mPFC interactions may
205 modulate SSE such that greater mPFC involvement (higher levels of PCC-mPFC
206 communication) is associated with decreased memory accuracy for social feedback and higher
207 levels of SSE. Directionality of this communication could provide further evidence of the
208 influence that semantic (increased connectivity stemming from mPFC to PCC during feedback
209 encoding) and episodic processes (increased connectivity stemming from PCC to mPFC during
210 feedback encoding) have on global conceptualizations of the self in relation to on-line encoding
211 of positive and negative feedback.

212 **Materials and methods**

213 **Participants**

214 Forty-five white introductory psychology students (23 male, 22 female) participated for
215 partial course credit. All participants were right handed and had no history of concussions,
216 seizures, or brain damage, and had given consent.

217 **Procedure**

218 The study’s hypotheses were examined using raw data from Leitner et al. (2014) [22]. In
219 that study, participants reported to the lab and were informed that the researchers were ostensibly
220 investigating facial features that promote social interactions. Participants were told that they
221 would be interacting with and receiving feedback from individuals across the country who would
222 view their facial photo on an online social network system. There was no social network and
223 confederate faces were used from the Eberhardt Face Database, Center for Vital Longevity
224 Database [23], MORPH Longitudinal database [24], and from Hehman, Leitner, Deegan and
225 Gaertner (2013) [24]. To corroborate the cover story, participants had their photo taken and were
226 told that it would be uploaded to the social network system. They were then prepared for EEG
227 recording. Next, participants completed the supposed social feedback task (see below) and were
228 led to believe that confederates were deciding in real time whether to accept or reject the
229 participant’s personal profile based on their picture that had just been uploaded to the database.
230 Participants were then given a surprise memory test to measure the extent to which individuals
231 encoded confederate faces that were yoked with either positive or negative social feedback (i.e.,
232 accepted or rejected the participant). Finally, participants completed measures of SSE and were
233 debriefed.

234 **Social feedback task**

235 The social feedback task provided a means to administer adequate amounts of positive
236 and negative social feedback in conjunction with different confederate faces. Each trial began
237 with a fixation cross presented in the middle of the computer screen for 250ms, followed by a
238 confederate face for 2000ms, a black screen for 1000ms, and then feedback indicating whether
239 the confederate accepted them for 2000ms (either “ACCEPT” or “REJECT” was presented in the
240 middle of the screen; Fig 1).

241 **Fig 1. Social feedback task progression.**

242

243 Participants then were asked to indicate whether the confederate accepted or rejected
244 them with a corresponding button press that would advance them to the next trial. Participants
245 were shown 100 faces randomly paired with feedback (50 faces associated with accept feedback,
246 50 faces associated with reject feedback). Confederate gender was always matched to participant
247 gender (e.g., males saw only male confederate faces).

248 **Memory test**

249 Participants were given a surprise memory test consisting of previously seen confederate
250 faces (100 faces; 50 accept, 50 reject) and lures of other confederate faces (50 lures) they had not
251 seen previously. Following the presentation of a confederate face, participants were asked if they
252 had previously seen the confederate on a scale from one to six (where one indicated that they
253 definitely did not see the confederate in the previous task and six indicated that they definitely
254 did see the confederate in the previous task). If participants had been exposed to the confederate
255 during the social feedback task, responses of 4-6 were classified as a hit while responses of 1-3
256 were classified as a miss. Trials that presented confederates with faces that had not been seen in
257 the previous task were classified as a false alarm if the participant responded with a 4-6, and as a
258 correct rejection if the participant responded with a 1-3. To examine participants' sensitivity to
259 faces that were associated with social acceptance vs. rejection feedback, separate d' scores were
260 calculated for faces associated with accept feedback and faces associated with reject feedback.
261 d' , a measure argued to be a more sensitive assessment of memory encoding [25], was derived
262 by subtracting z scores for false alarm rates from z scores for hit rates. Larger d' values indicate
263 better ability to discriminate seen from unseen faces.

264 **TSE and SSE**

265 The Rosenberg SE scale (RSE) [26], was administered during a pretesting session
266 conducted at the beginning of the semester as well as post-experiment to compare trait ($\alpha=.66$)
267 and state ($\alpha=.84$) SE. The RSE scale given during pretesting to assess TSE framed the questions
268 regarding participants' overall feelings while the RSE scale given post task to assess SSE framed
269 the questions regarding how participants felt in the moment. Participants answered 10 questions
270 on a 1-4 scale (where one equaled "strongly disagree" and 4 equaled "strongly agree"). Question
271 answers were averaged together. Final scores ranged from 1 to 4 with higher numbers indicating
272 higher TSE and SSE.

273 **EEG recording**

274 Continuous EEG activity was recorded using an ActiveTwo head cap and the ActiveTwo
275 BioSemi system. Recordings were collected from 64 scalp electrodes. Two electrodes were
276 placed under and on the outer canthus of the right eye to record ocular movements. Data were
277 rereferenced to the original average reference for all analyses off-line and EEG signals were
278 band-pass filtered (.3 to 75 Hz) and stimulus locked to the feedback presentation portion of all
279 trials. EEG signals were stimulus locked to feedback in accordance with previous studies
280 utilizing similar paradigms [23, 29]. All participants' data were scanned for artifacts using
281 BESA's artifact scanning tool and ocular artifacts were corrected via the adaptive algorithm
282 implemented in BESA. All participants included in analyses had at least 10 epochs for all trial
283 conditions.

284 **Source Localization**

285 The goal of this study was not to employ a typical EEG/ERP based approach, which
286 relies on examining evoked activity in response to stimuli within a confined frequency space that
287 collapses across multiple frequency bands and localizing a neural generator for a given ERP of
288 interest. Rather, the current study sought to analyze data in a manner that more closely resembles
289 what fMRI studies typically achieve but with the added benefits afforded to EEG, e.g.,
290 examining electrical activity stemming directly from neural activity on the order of milliseconds
291 as opposed to indexing indirect markers of neural activity consisting of blood flow in a given
292 region on the order of seconds. That is, we sought to analyze both spontaneous and evoked
293 activity within specific neural sources across distinct frequency bands thought to reflect different
294 neural processes (e.g., excitatory compared to inhibitory neural processes). To model
295 spontaneous and evoked neural activity, source and time frequency analyses were conducted
296 with Brain Electromagnetic Source Analysis (BESA) 5.3 software (MEGIS Software GmbH,
297 Grafelfing, Germany); MATLAB was utilized for Granger Causality analyses. BESA source
298 localization utilizes a planted dipole approach in which precise coordinates located in specific
299 neural regions are used, as opposed to regions on the scalp, to parse apart the variance in the
300 EEG signal not unlike a typical principal components analytic (PCA) approach (see Scherg et al.,
301 1990 for mathematical proofs) [30]. The primary difference between the two approaches is that
302 whereas PCA is constrained by the mathematical components of the variance within the data,
303 BESA's approach allows constraints to be based on volume conduction theory and head
304 geometry [30, 31]. This allows one to model principal components as hypothesized sources
305 instead of unique voltage patterns defined by the algorithm. This dipole technique has been cited
306 in notable papers aimed at addressing the inverse problem in EEG source analyses [30, 32] and
307 identifying neural generators of specific ERPs in addition to dipole source localization [33-35].

308 This a priori hypothesis-driven source localization approach consists of the following
309 steps: 1) electrode space is transformed into a reference free source space. 2) Dipole sources
310 specific to a region of interest are fitted in both orientation and location to best model current
311 flow in a given dipole, independent of other dipoles. 3) This source space is then transformed in
312 to time-frequency space, providing a means to essentially model oscillations in a specific
313 frequency band within a specific source that is theoretically independent of oscillatory activity in
314 other sources. Again, much like the PCA approach, but in this case the principal components are
315 sources with specific coordinates identified in accordance with our hypotheses as opposed to
316 principal components comprised of spatially unique voltage patterns located at the scalp.

317 Given that prior knowledge of a neural system of interest can be utilized to constrain
318 spatial parameters of a source model [36], our goal was to model and isolate time-frequency
319 activity in sources of interest while also accounting for typical artifacts present in any EEG study
320 (e.g., eye blinks) as well as basic cognitive and perceptual processes that are likely active during
321 any basic cognitive task. Furthermore, because of the social nature of our task, it is possible that
322 other social cognitive processes, e.g., attribution/theory of mind processes, were evoked but
323 irrelevant to study hypotheses as well. Thus, to account for basic visual and perceptual processes
324 like eye movements and eye blinks, multiple sources were initially planted in the left and right
325 eyes, bilateral occipital cortices, and bilateral cerebellum in accordance with previous literature
326 [23, 37]. Dipoles were also planted in regions associated with social interactions and social
327 feedback [38], including the right Temporal Parietal Junction (TPJ, mental state representation,
328 [39, 40]), bilateral Superior Temporal Sulci (STS, social perception, [41, 42]), and Anterior
329 Cingulate Cortex (ACC, social rejection [29, 43]). Final dipoles were then placed in mPFC and
330 PCC in accordance with study hypotheses.

331 Coordinates for social cognitive processes and hypothesized ROIs were taken from
332 various meta-analyses and relevant works of interest (rTPJ: [44]; right and left STS: [45,46]
333 ACC: [47]; PCC: [13, 48]; mPFC: [20, 44, 49]. These coordinates were then verified using
334 Neurosynth meta analyses to locate the most appropriate talairach coordinates for the model [15].
335 All sources are plotted in Fig 2 and the corresponding Talaraich coordinates are shown in Table
336 1. The dipoles from these sources were converted into regional sources with three orientations,
337 each of which was analyzed as a separate dipole. This source model accounted for 98% of the
338 total variance in the EEG signal; no other dipoles could be planted to account for the other 2% in
339 the model. While a model with this many sources in any given brain region would likely account
340 for 98% of the variance, it's important to note that by applying the approach outlined here, much
341 like a PCA approach and standard fMRI region of interest analysis, we are essentially applying a
342 spatial filter to our data that allows us to examine spontaneous and evoked activity in specific
343 frequency bands at specific points in time in specific ROIs that are theoretically independent of
344 time-frequency activity in other neural regions that are not of interest to the study (i.e., noise).
345 That is, our source model optimized prior knowledge of neural systems to accurately extract
346 signal from theoretically driven ROIs [36].

347 **Fig 2. Source model.**

348 **Table 1: Coordinates for ROIs**

<u>Source</u>	<u>x</u>	<u>y</u>	<u>z</u>
Medial Prefrontal Cortex (mPFC)	-6	-49	-13
Posterior Cingulate Cortex (PCC)	-2	-56	11
Left Superior Temporal Sulcus (LSTS)	-55	-17	-10
Right Superior Temporal Sulcus (RSTS)	49	-5	-13
Anterior Cingulate Cortex	-6	23	38
Right Temporal Parietal Junction (rTPJ)	54	-49	19

Left eye	-26	60	-29
Right Eye	26	60	-29
Left Occipital	-34	-78	28
Right Occipital	34	-78	28
Left Cerebellum	-32	-59	-25
Right Cerebellum	32	-59	-25

349

350 Finally, to validate the source model, a multiple source probe scan (MSPS) was
351 performed in BESA in accordance with past studies using similar techniques [37, 50]. The
352 MSPS model displayed activity around all sources in the source model, suggesting that our
353 source model was an adequate representation of the EEG data.

354 **Time-frequency analysis**

355 Using the source model above, EEG data were then transformed into time-frequency space using
356 complex demodulation [51] within BESA 5.3. Samples were taken from frequencies ranging
357 from 4 to 50Hz in 2-Hz increments. Theta frequencies were operationalized as 4-8 Hz, alpha as
358 8-12Hz, beta as 12-30Hz, and gamma as 30-50Hz [52]. Samples were taken from a -500 to
359 1500ms epoch in 25ms steps. Epochs of interest were extracted from stimulus presentation (0
360 ms) to 500 ms post-stimulus, specifically from accepting feedback, rejecting feedback, and all
361 feedback presentations (collapsing across accepting and rejecting feedback). This epoch length
362 was chosen for several reasons. One, epochs of 500ms typically helps avoid contaminating the
363 results with edge artifacts. Two, by using a longer time segment it is possible to have better
364 frequency precision and resolution. With a time period of 500ms, two cycles of the lowest
365 frequency of interest (500ms for a 4-Hz oscillation) can be extracted while still capturing higher-
366 frequency activity accurately [53]. Larger time windows are also less susceptible to muscle
367 artifacts, outliers, and other non-brain interference [54].

368 Phase locking values were obtained for all frequencies above by calculating the
369 correlation of two normalized spectral density functions [55]. All phase-locking analyses used
370 mPFC source as the source reference given its important role in self-related processing. Power
371 was calculated by obtaining the instantaneous envelope amplitude of each source from the model
372 as a function of frequency and latency, following the procedures of past literature [55, 56]. The
373 absolute power in each source with respect to the baseline was then averaged over all trials.

374 **Time-variant Granger causality**

375 To gain insight in to how self-oriented memory processes interacted, be they basic
376 encoding processes influencing self-oriented processes (PCC to mPFC directionality) or self-
377 oriented processes influencing basic encoding processes (mPFC to PCC directionality), Granger
378 causality (GC) analyses were conducted to assess the directionality of the mPFC and PCC time
379 series. GC is an analytic approach used to quantify the existence and direction of causal
380 influence of time series neural activity from multiple regions. In this study, linear regressive
381 predictive models were first used to calculate independent time series for mPFC and PCC. Time
382 series from either PCC or mPFC were then incorporated into the other using multi-regressive
383 models. If one region has a causal influence on another then the predictive ability of the model
384 should be improved when incorporating the time series from that neural source. See
385 supplemental materials for full mathematical description of the models. In this study, time-
386 variant GC was utilized over a period of 0-500ms post stimulus presentation and more positive
387 GC values represent mPFC activity influencing PCC activity to a greater degree while more
388 negative values indicate PCC activity better predicts mPFC activity.

389 **Results**

390 Relationships between trait and SSE

391 Descriptive statistics for all variables in the study are located in Table 2. An initial linear
392 regression analysis regressing SSE on TSE indicated the two variables were correlated, $b=.34$,
393 $t=2.02$, $R^2=.11$, $p=.05$, Fig 3. Higher TSE (collected at the beginning of the semester) was
394 associated with increases in post-task SSE. It is also important to note that all participants had
395 relatively high levels of TSE ($M=3.22$, $SD=.44$, minimum value= 2.4 on a scale of 1-4).

396 **Fig 3. Increases in TSE correlated with increases in post-task SSE.**

397 **Table 2: Descriptive Statistics of Variables in the Main Analyses.**

<u>Variable</u>	<u>N</u>	<u>Mean</u>	<u>Standard Deviation</u>
Trait Self-Esteem	41	3.22	0.44
State Self-Esteem	37	3.45	0.36
Memory Accuracy for Accepting Faces	44	1.56	0.65
Memory Accuracy for Rejecting Faces	44	1.61	0.65
Overall Memory Accuracy for Faces	44	1.60	0.59
PCC Power to all Feedback Theta	43	2005.08	1015.46
PCC Power to all Feedback Alpha	41	596.73	336.95
PCC Power to all Feedback Beta	44	213.59	80.33
PCC Power to all Feedback Gamma	44	109.55	66.23
mPFC Power to all Feedback Theta	41	1274.81	505.42
mPFC Power to all Feedback Alpha	45	240.79	124.97
mPFC Power to all Feedback Beta	41	221.32	180.79
mPFC Power to all Feedback Gamma	40	179.60	148.43
mPFC-PCC Phase Locking to all Feedback Theta	45	0.15	0.05
mPFC-PCC Phase Locking to all Feedback Alpha	44	0.16	0.05
mPFC-PCC Phase Locking to all Feedback Beta	45	0.16	0.05
mPFC-PCC Phase Locking to all Feedback Gamma	44	0.15	0.05
mPFC-PCC Granger Causality	37	0.26	0.01

398

399 Performance on face memory task

400 One sample t-tests were conducted comparing participant's memory accuracy for both
401 accepting and rejecting faces in relation to chance. Both accepting and rejecting faces were
402 significantly different from chance (represented as a d' score of 0; $p's < .001$), suggesting that
403 participants reliably encoded accepting and rejecting faces. An initial 2(Gender: male, female) x
404 2(Face type: accepting, rejecting face) mixed factors ANOVA with repeated measures on the
405 latter variable was then performed on d' scores (memory accuracy) for accepting and rejecting
406 faces to observe if participants remembered accepting or rejecting faces to a greater extent. This
407 analysis yielded no main effects or interactions ($p's > .09$). Thus, participants' memory for faces
408 did not differ as a function of gender or whether faces were associated with accepting or
409 rejecting feedback, providing little behavioral support for mnemonic neglect or positive tropism
410 oriented hypotheses.

411 **Performance on face memory task in relation to trait and SSE**

412 Regression analyses (collapsing across gender of participant) were conducted to assess
413 whether there was any relationship between SSE and memory accuracy for accepting and
414 rejecting faces independently. Separate analyses regressing state and TSE on to d' scores for
415 accepting and rejecting faces indicated no relationships or interactions between these variables
416 ($p's > .20$). These findings provide some initial behavioral support for sociometer theory-oriented
417 hypotheses ([57], study 5) where individuals with higher TSE had higher SSE regardless of
418 whether they accurately encoded who accepted or rejected them during the social feedback task.
419 Encoding confederates who accepted the participant did not predict higher levels of SSE.

420 Initial behavioral analyses provide some evidence for semantic self-oriented processes
421 biasing basic memory encoding, as the extent to which participants encoded confederates who

422 accepted or rejected them had no effect on SSE respectively, whereas TSE did predict SSE. This
423 suggests that the evaluative nature of the experimental context may have prompted more
424 nuanced interactions between basic encoding and semantic self-oriented processes while
425 individuals encountered social feedback. To gain insight into this possibility, the extent to which
426 mPFC and PCC activity elicited during the feedback task was associated with SE or memory
427 accuracy for faces, and whether interactions between these regions ultimately modulated any of
428 these relationships was explored.

429 **MPFC and PCC activity and self-esteem**

430 Given that basic d' analyses indicated individuals did not exhibit a memory bias for
431 accepting or rejecting faces, the remaining analyses collapsed across face type. Analyses specific
432 to accepting and rejecting feedback are located in the supplemental materials. To examine
433 whether MPFC activity was associated with semantic processes, independent linear regression
434 analyses (conducted in all frequency bands for four total models), regressed SSE scores on to
435 mPFC power elicited in response to accept and reject feedback. Because analyses were
436 conducted on four frequency bands, multiple comparisons were controlled for using
437 the Benjamini–Hochberg False Discovery Rate procedure [58], using a q -level of .1 [59-61].
438 These analyses revealed mPFC power was a predictor of SSE in both beta ($b=-.48$, $t=-3.02$,
439 $R^2=.23$, $p<.01$, $SE=.32$) and gamma frequency bands ($b=-.47$, $t=-2.92$, $R^2=.22$, $p<.01$, $SE=.33$).
440 As mPFC power to feedback (both accept and reject) decreased, SSE increased (Fig 4). Theta
441 and alpha frequency bands were not significant (p 's $>.11$). These relationships were not evident
442 when PCC power (across frequency band) elicited during feedback encoding was entered as the
443 predictor (p 's $>.24$), suggesting these relationships were unique to mPFC power. Identical
444 analyses run in all frequency bands (four independent models), regressed mPFC power elicited

445 during the presentation of feedback stimuli onto TSE. These analyses revealed no relationship
446 between TSE and mPFC power in any frequency band (p 's > .20). PCC power also had no
447 relationship with TSE (p 's > .21).

448 **Fig 4. mPFC power in the beta band to self-relevant feedback predicts decreases in post-**
449 **task state self-esteem.**

450 A final set of analyses regressing mPFC-PCC phase locking values on to trait and SSE
451 were then conducted to examine whether the interaction between these two regions was affected
452 by trait or SSE accordingly. Interestingly, these analyses yielded a positive relationship between
453 mPFC-PCC phase locking in the theta band and TSE, $b=.36$, $t=2.38$, $R^2=.36$ $p=.02$, Fig 5.
454 Participants exhibited more mPFC-PCC phase locking during feedback encoding to the extent
455 they had higher TSE. No other relationships were evident in the other frequency bands (p 's > .12),
456 or between mPFC-PCC phase locking and SSE (p 's > .51). These analyses provide some evidence
457 that mPFC was associated with more general SE processes compared to PCC alone and that
458 feedback appeared to play little role with respect to mPFC's relationship to SE processes (either
459 SSE or TSE).

460 **Fig 5. Trait self-esteem positively predicts mPFC-PCC phase locking in the theta frequency**
461 **band to self-relevant feedback.**

462 **MPFC and PCC activity and memory accuracy for faces**

463 Separate linear regressions (run in all four frequency bands; four models total) were then
464 conducted that regressed memory accuracy for all face types onto PCC power elicited during
465 feedback encoding. Multiple comparisons were controlled for using the Benjamini-Hochberg
466 False Discovery Rate procedure [58], using a q -level of .1 [59-61]. These analyses revealed that

467 PCC power was a significant predictor of accurate memory encoding in the beta frequency band
468 ($b=.32$, $t=2.16$, $R^2=.10$, $p<.04$, $SE=.57$). As PCC power to all feedback increased, memory
469 accuracy for all faces increased (Fig 6). After controlling for multiple comparisons this analysis
470 did not reach criterion ($p=.034$, FDR cutoff $p=.025$). Nevertheless, given our a priori hypotheses
471 and the large amount of literature supporting this basic finding, we considered these effects to be
472 meaningful. All other frequency bands were not significant ($p's>.11$). These patterns were not
473 evident when mPFC power (in any frequency band) elicited during feedback encoding was
474 entered as the predictor ($p's>.16$).

475 **Fig 6. Increases in PCC power in the beta frequency band to self-relevant feedback**
476 **encoding predicts increases in overall memory accuracy, suggesting an episodic encoding**
477 **process.**

478 Additional regression analyses regressing memory accuracy for all faces on to mPFC-
479 PCC phase locking elicited in response to all feedback revealed a negative relationship in the
480 beta ($b=-.45$, $t=-3.28$, $R^2=.20$, $p<.01$, $SE=.54$) and gamma ($b=-.30$, $t=-2.04$, $R^2=.30$, $p<.05$,
481 $SE=.58$) frequency bands. As mPFC-PCC phase locking to all feedback increased, encoding
482 memory accuracy to all faces decreased. Theta and alpha frequency bands demonstrated no
483 relationship ($p's>.75$). This provides initial evidence that PCC power was associated with basic
484 memory encoding processes, however this relationship was altered when communication
485 between mPFC and PCC were considered.

486 Thus, whereas PCC power was associated with basic memory encoding processes, and
487 mPFC power was associated with self-oriented processes, the communication between the two
488 regions appeared to be associated with SE and encoding accuracy for all feedback in interesting
489 ways; independent analyses for accepting and rejecting feedback are located in the supporting

490 materials. Individuals exhibited greater mPFC-PCC communication in response to both positive
491 and negative feedback to the extent they had higher TSE, and greater communication between
492 these regions was also associated with decreased encoding accuracy of all feedback (Fig 7).
493 These findings are consistent with past research implicating mPFC and PCC as integral for self-
494 related processing and episodic memory recall and provides evidence that interactions between
495 the two regions underscore a dynamic interplay between semantic self-oriented and episodic
496 processes involved in on-line conceptualizations of the self. Analyses for alternative ROIs are
497 found in the supporting materials, only weak relationships were found with SE and memory
498 providing discriminant validity for mPFC and PCC with respect to SE and memory. The nature
499 of this interaction was addressed next. A discussion of the other sources is located within the
500 supplemental results.

501 **Fig 7. Increases in mPFC-PCC phase locking to self-relevant feedback correlates with**
502 **decreased overall memory accuracy, suggesting a semantic influence from the mPFC.**

503 **mPFC-PCC communication moderates the relationship between**
504 **TSE and SSE**

505 Previous literature suggests that TSE may bias encoding of any self-relevant feedback to
506 maintain SSE levels that are consistent with TSE [57]. One way to examine this conjecture is to
507 assess whether on-line communication between mPFC and PCC in response to positive and
508 negative feedback moderated the relationship between TSE and SSE. This possibility was tested
509 via a moderated regression analysis. Moderated regression analyses were tested by deriving
510 unstandardized regression coefficients and 95% bias-corrected confidence intervals (CIs) from
511 10,000 bootstrap estimates using PROCESS ([62]; model 1). TSE was represented as X, SSE

512 was represented as Y, and mPFC-PCC phase locking to feedback in the gamma frequency band
513 was represented as the moderator, M. Because all four frequency bands were tested, multiple
514 comparisons were controlled for using the Benjamini–Hochberg False Discovery Rate procedure
515 [58], using a q-level of .1 [59-61]. Results yielded a main effect for mPFC-PCC phase locking,
516 $b=-21.63$, $t=4.37$, $SE=1.30$, $p=.02$, such that greater communication between mPFC and PCC
517 was associated with higher SSE scores. mPFC-PCC phase locking also moderated the
518 relationship between TSE and SSE ($b=6.90$, $t=2.61$, $SE=2.64$, $p=.014$). Individuals with higher
519 TSE reported higher levels of SSE to the extent that greater mPFC-PCC communication was
520 observed in response to accepting and rejecting faces during the social feedback task (Fig 8).
521 Simple slopes analyses revealed that whereas at lower levels of mPFC-PCC phase locking no
522 relationship was observed between TSE and SSE ($p=.67$), at average and higher levels of phase
523 locking individuals with higher TSE reported higher SSE ($b_{\text{average}}=.31$, $t=2.43$, $p=.0212$;
524 $b_{\text{high}}=.70$, $t=3.41$, $p<.01$). This pattern was also found in other independent models observing the
525 average and high levels of mPFC-PCC phase locking in beta ($b_{\text{average}}=.37$, $t=2.58$, $p<.02$;
526 $b_{\text{high}}=.71$, $t=2.76$, $p<.01$) and alpha frequency bands ($b_{\text{average}}=.33$, $t=2.47$, $p=.02$; $b_{\text{high}}=.60$, $t=3.08$,
527 $p<.01$), and marginally in the theta frequency band ($p=.11$). These results suggest that TSE may
528 influence SSE to the extent that semantic self-knowledge influences basic memory encoding of
529 evaluative social feedback.

530 **Fig 8. Individuals with higher trait SE reported higher levels of state SE to the extent that**
531 **greater mPFC-PCC communication was observed in response to accepting and rejecting**
532 **faces during the social feedback task.**

533 **Exploring the contributions of accepting and rejecting feedback**

534 Although behavioral analyses between accepting and rejecting feedback provided data
535 driven reasoning to collapse across feedback type in the main analyses, according to mnemonic
536 neglect, sociometer theory, and positive tropism, accepting and rejecting feedback should be
537 processed differently in the moment to affect the relationship between TSE and SSE. In an
538 exploratory set of analyses, the above moderation was repeated on accepting and rejecting
539 feedback independently to probe for any differences.

540 **mPFC-PCC communication to accepting feedback moderates trait** 541 **and SSE**

542 An initial moderated regression analysis (using PROCESS model 1) examined whether
543 on-line communication between mPFC and PCC in response to positive feedback moderated the
544 relationship between TSE and SSE. TSE was represented as X, SSE was represented as Y, and
545 mPFC-PCC phase locking to accepting feedback in the gamma frequency band was represented
546 as the moderator, M. Because all four frequency bands were tested, multiple comparisons were
547 controlled for using the Benjamini–Hochberg procedure [58], using a q-level of .1 [59-61].
548 Results suggested that the degree of communication between mPFC and PCC towards accepting
549 feedback moderated the relationship between TSE and SSE ($p < .05$, 95%CI [.1528, 10.8457]),
550 however after correcting for multiple comparisons this effect does not remain.

551 **mPFC-PCC communication to rejecting feedback moderates trait** 552 **and SSE**

553 An identical analysis was then conducted utilizing mPFC-PCC communication in
554 response to rejecting feedback (in the gamma frequency band). Results revealed that the degree

555 of communication between mPFC and PCC towards rejecting feedback moderated the
556 relationship between trait and SSE ($p < .01$, 95% CI [2.1768, 12.6248]; Fig 9) to a greater degree
557 than accepting feedback (R^2 change_{accept} = .11; R^2 change_{reject} = .19) and these effects held after
558 correcting for multiple comparisons. Individuals with higher TSE reported higher levels of SSE
559 to the extent that greater mPFC-PCC communication was observed in response to rejecting
560 feedback. Simple slopes analyses revealed that no relationship was observed between TSE and
561 SSE at low levels of phase locking ($p = .62$). For average and high levels of phase locking,
562 however, TSE positively influenced SSE ($b_{\text{average}} = .34$, $t = 2.67$, $p < .02$, 95% CI [.0797, .5960];
563 $b_{\text{high}} = .76$, $t = 3.65$, $p < .01$, 95% CI [.3362, 1.1913]). TSE predicted SSE to the extent mPFC and
564 PCC communicated with one another in response to rejecting feedback. Phase locking in the
565 theta, alpha and beta frequency bands exhibited identical relationships ($p_{\text{theta}} = .09$, $p_{\text{alpha}} < .04$,
566 $p_{\text{beta}} = .05$), however these effects did not survive after multiple comparison corrections. Overall
567 these results provide evidence that exposure to negative feedback drives the relationships
568 between mPFC-PCC communication, TSE and SSE among individuals with higher TSE in
569 general. This suggests self-based semantic processes may play a greater role when high TSE
570 individuals are exposed to negative self-relevant information, possibly reflecting the greater
571 effort that would be required to maintain SSE levels that are consistent with TSE in response to
572 conflicting information. This pattern is consistent with predictions stemming from sociometer
573 theory and positive tropism.

574 **Fig 9. Individuals with higher trait SE reported higher levels of state SE to the extent that**
575 **greater mPFC-PCC communication was observed in response to rejecting faces specifically**
576 **during the social feedback task.**

577 **Evidence for the integral role of semantic self-knowledge in self-**
578 **protective mechanisms**

579 Finally, to determine whether memory accuracy or SSE was driven by more of an
580 influence from semantic self-oriented or basic episodic memory encoding processes, a series of
581 linear regression analyses were conducted utilizing these variables and the product of the time-
582 variant Granger causality (GC) analyses conducted on the mPFC and PCC time series elicited
583 during feedback presentation. Recall that positive GC values represented the degree to which
584 increased activity in mPFC predicted subsequent increases in PCC activity during feedback
585 encoding; higher values indicate a greater influence from mPFC on PCC activity. An initial
586 linear regression analysis regressing SSE onto GC values of mPFC activity predicting PCC
587 activity during feedback encoding revealed that individuals exhibited higher SSE to the extent
588 that mPFC activity predicted PCC activity ($b=18.19$, $p = .03$, $R^2=.13$; Fig 10). This relationship
589 was not evident when memory accuracy was modeled as the outcome ($p>.96$). Thus, SSE scores
590 were dependent in part on the extent to which mPFC activity predicted PCC activity in response
591 to evaluative feedback, suggesting semantic self-oriented processes may bias encoding of
592 evaluative feedback on-line to influence SSE in social evaluative contexts.

593 **Fig 10. State self-esteem scores are dependent to the extent to which mPFC activity**
594 **predicted PCC activity in response to self-relevant feedback, suggesting a semantic**
595 **encoding mechanism.**

596 **Discussion**

597 By examining how brain and behavioral measures associated with semantic-based self-
598 knowledge and episodic encoding processes interact in response to social feedback, findings
599 from the current study inform our understanding of how these processes interact to affect SSE in
600 relation to global self-perceptions and TSE. Consistent with past research identifying mPFC as a
601 hub for self-oriented processes, like SSE and TSE ([16,20]), mPFC activity (power) elicited in
602 response to positive and negative social feedback predicted SSE but not memory accuracy for
603 faces associated with social feedback. Conversely, consistent with previous research citing PCC
604 as an integral component in basic memory encoding [11] PCC activity (power) in response to
605 positive and negative social feedback was associated with increases in memory accuracy for both
606 accepting and rejecting faces, but not trait or SSE (although this effect was slightly less reliable
607 considering multiple comparison corrections). These relationships were not evident in other
608 sources identified in source localization analyses (e.g., TPJ, STS, ACC), providing evidence for
609 discriminant validity among mPFC and PCC with respect to self-based semantic and episodic
610 encoding processes accordingly.

611 Importantly, findings from the current study allude to a dynamic interaction between self-
612 based semantic and episodic memory processes with respect to chronic self-perceptions (TSE)
613 and “actual data”, i.e., self-relevant information received in an evaluative context. Moderated
614 regression analyses revealed that individuals with higher TSE exhibited more mPFC-PCC phase
615 locking while being exposed to social feedback. Greater communication between these regions,
616 in turn, predicted a positive relationship between TSE and SSE, which was driven mPFC-PCC
617 communication in response to negative feedback specifically. Highlighting how self-oriented
618 processes can directly influence basic encoding to affect SSE, GC analyses indicated that SSE

619 was higher to the extent mPFC power had a direct, causal influence on PCC power during
620 individuals' exposure to feedback.

621 Consistent with Leary [57], the parameters under which mPFC becomes involved in
622 PCC-based encoding may be influenced by the context and valence of TSE and SSE. According
623 to Leary, individuals with higher chronic TSE maintain higher levels of SSE by assuming they
624 will be accepted in a given context and thus do not attend to any kind of self-relevant feedback in
625 general. This argument is consistent with findings from the current study indicating that when
626 TSE was higher, encoding processes did not exhibit any relationships with SSE; individuals'
627 SSE was consistent with their TSE regardless of whether they were socially rejected or accepted.

628 Although relationships between mPFC-PCC communication to accepting feedback, TSE,
629 and SSE were evident, it was the communication between these regions in response to rejecting
630 feedback that appeared to play a larger role in TSE-based maintenance of SSE. These findings
631 support hypotheses derived from sociometer theory and positive tropism, which suggest that
632 negative feedback may be manipulated post-hoc among high TSE individuals to maintain high
633 SSE accordingly. Results extend the understanding of these mechanisms by suggesting that the
634 influence and nature of basic encoding is predicated on individuals' semantic-based TSE while
635 individuals receive self-oriented feedback. They also provide evidence that actual data is in fact
636 encoded, at least with respect to the PCC, but the dynamic interplay between mPFC and PCC
637 may ultimately bias how this data is factored in to global conceptualizations of SSE, which is
638 something all three theories have not clearly explained or expanded upon to date. Importantly,
639 findings from this study help bridge the gap between past research that primarily examines SSE
640 via pre and post self-report measures independent of what individuals encode in a given context,
641 and social neuroscience studies that did not examine how multiple regions integral for semantic

642 self-knowledge and episodic encoding processes interact and/or directly influence one another to
643 affect SSE with respect to TSE.

644 While no a priori hypotheses were established for specific frequency bands, it's
645 worthwhile to note that different findings appeared to be driven by activity in beta and gamma
646 frequency bands. Whereas analyses focusing on activity within regions typically found effects in
647 the beta and gamma frequency bands, some phase-locking analyses suggested effects were
648 specific to the theta frequency band (although most analyses provided evidence that all
649 frequency bands were trending in the same direction except for the alpha frequency band).
650 Clearly there is still much debate in the literature regarding what exactly different frequency
651 bands correspond to neurally and psychologically, however, findings from this study are rather
652 consistent with current theoretical accounts. Neuronal oscillations are an essential part of the
653 brain's design, suggesting functional relevance for each frequency band [63]. Frequency bands
654 have been associated with different brain states and processing mechanisms including attention
655 and memory [64, 65], and can be characterized by the neural area activated. For instance, higher
656 frequency oscillations have been considered representative of smaller neural networks in a given
657 cycle (i.e., activity within a brain region) while lower frequency oscillations have been
658 considered representative of larger network interactions (i.e., activity between brain regions;
659 [66]). Ultimately all frequency bands have been shown to temporally coexist within the same
660 neural structures, however, as a given neural structure performs operations locally as well as in
661 relation to larger networks. These patterns of oscillations and functional architecture of the brain
662 allow multiple cognitive processes to be carried out at once, possibly in a hierarchical manner
663 [64].

664 Thus, with respect to the findings, analyses confined to activity within a region or driven
665 by a single region (e.g., like those found for mPFC and SE and PCC and memory accuracy)
666 would be expected to yield meaningful results in higher frequency bands such as beta or gamma.
667 Likewise, analyses focusing on activity between regions (e.g., mPFC-PCC phase locking
668 analyses) should yield meaningful results in lower frequency bands like theta, which is consistent
669 with findings from this study.

670 Specific to study limitations, as with any EEG study that utilizes a source localization
671 approach, it is always important to encourage caution with respect to conjectures based on
672 specific regions of the brain given limitations in spatial localization associated with
673 the methodology. Nevertheless, standards practiced in this study, e.g., using a high density EEG
674 array for data collection and restricting sources to outer cortex, have been shown to
675 provide fairly precise measurements of specific brain regions (with EEG regional source voxel
676 clusters around 7 cubic millimeters in size as opposed to 3 cubic millimeters for fMRI; [53]).
677 Given the number of sources present in our model it is also possible that any combination of
678 sources could provide a good representation of the global EEG signal. While true, a theoretical
679 approach was taken in selecting these sources. Prior knowledge of regions integral in social
680 cognition were used to constrain spatial parameters of the model [37]. It is also important to note
681 that only a priori defined mPFC and PCC sources exhibited any hypothesized relationships with
682 behavioral outcomes of interest. No less, these behavioral outcomes map directly onto
683 hypothesized functions of the a priori regions of interest. That is, mPFC activity predicted self-
684 esteem but not memory measures and PCC activity predicted basic memory but not self-
685 esteem measures, providing an element of construct and discriminant validity to our
686 basic findings. MSPS analyses bolstered confidence in source locations by revealing activation

687 around a priori regions as well. Nevertheless, future research should replicate this study utilizing
688 combined EEG–fMRI methodologies to allow for both optimal temporal and spatial resolution to
689 bolster claims accordingly.

690 In summary, findings from this study highlight the parameters under which self-oriented
691 semantic and episodic memory processes interact to modulate SSE in relation to TSE. When
692 TSE is high, mPFC appears to play an integral role in altering how social feedback is recalled,
693 such that memory accuracy for socially accepting and rejecting individuals does not appear to
694 influence the extent to which higher SSE is consistent with higher TSE. This suggests semantic-
695 based TSE modulates the extent to which basic encoding processes are employed in evaluative
696 contexts, with the goal of ultimately maintaining SSE levels that are consistent with TSE levels.
697 Thus, findings provide additional support for theories of self-maintenance that argue for the
698 importance of semantic and episodic processes, but extend upon these theories by suggesting the
699 self-maintenance process is much more dynamic and nuanced than typical self-report measures
700 would suggest.

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876 **Supporting Information**

877 **S1 File. Supporting analyses and results.**

878 **S1 Table. Descriptive statistics for supporting analyses.**

879 **S2 Table. Descriptive statistics for alternative ROIs.**

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