Supplemental Information for

SPONTANEOUS THOUGHT DYNAMICS AS A SIGNATURE OF POSITIVE AND NEGATIVE AFFECTIVITY

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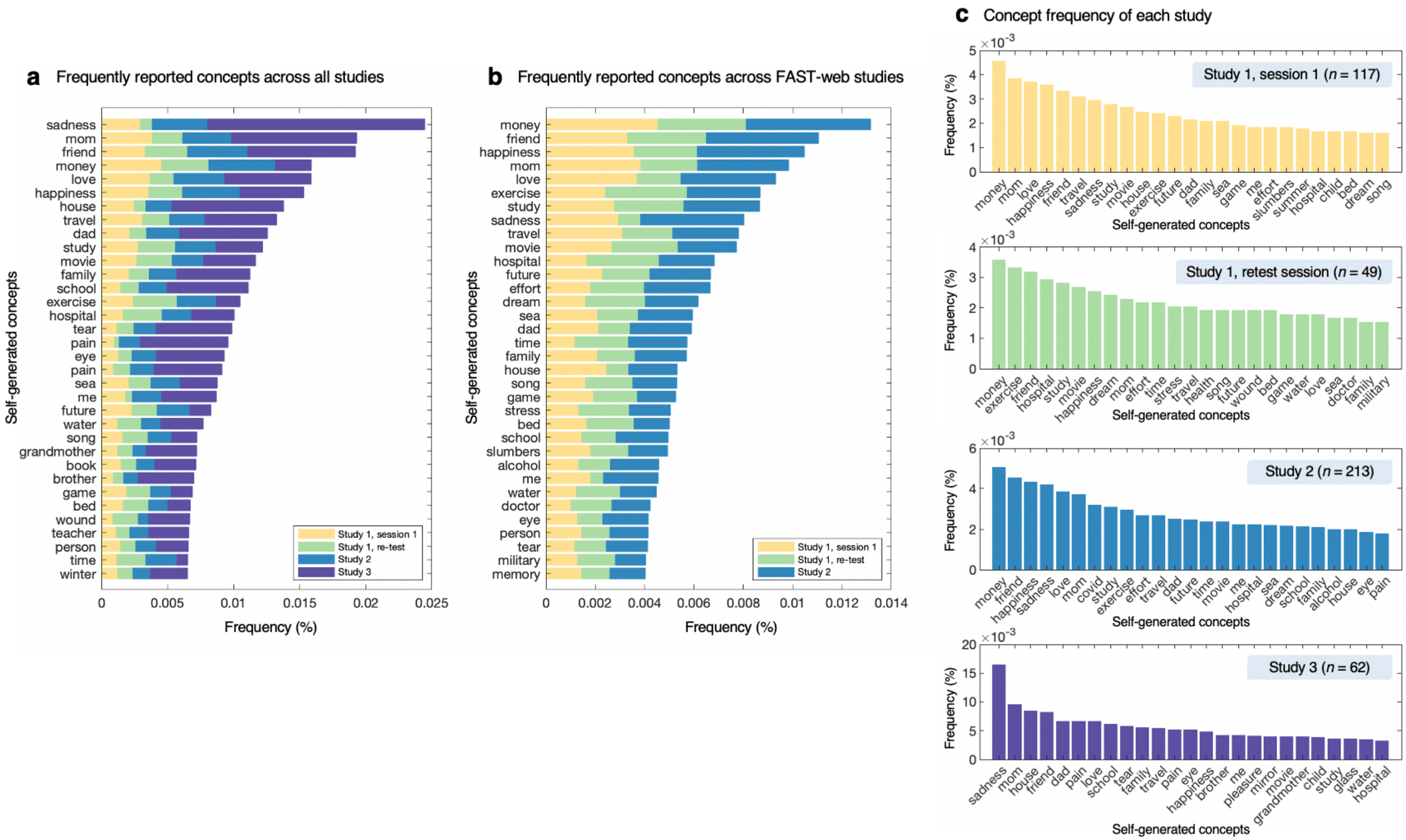
This PDF file includes:

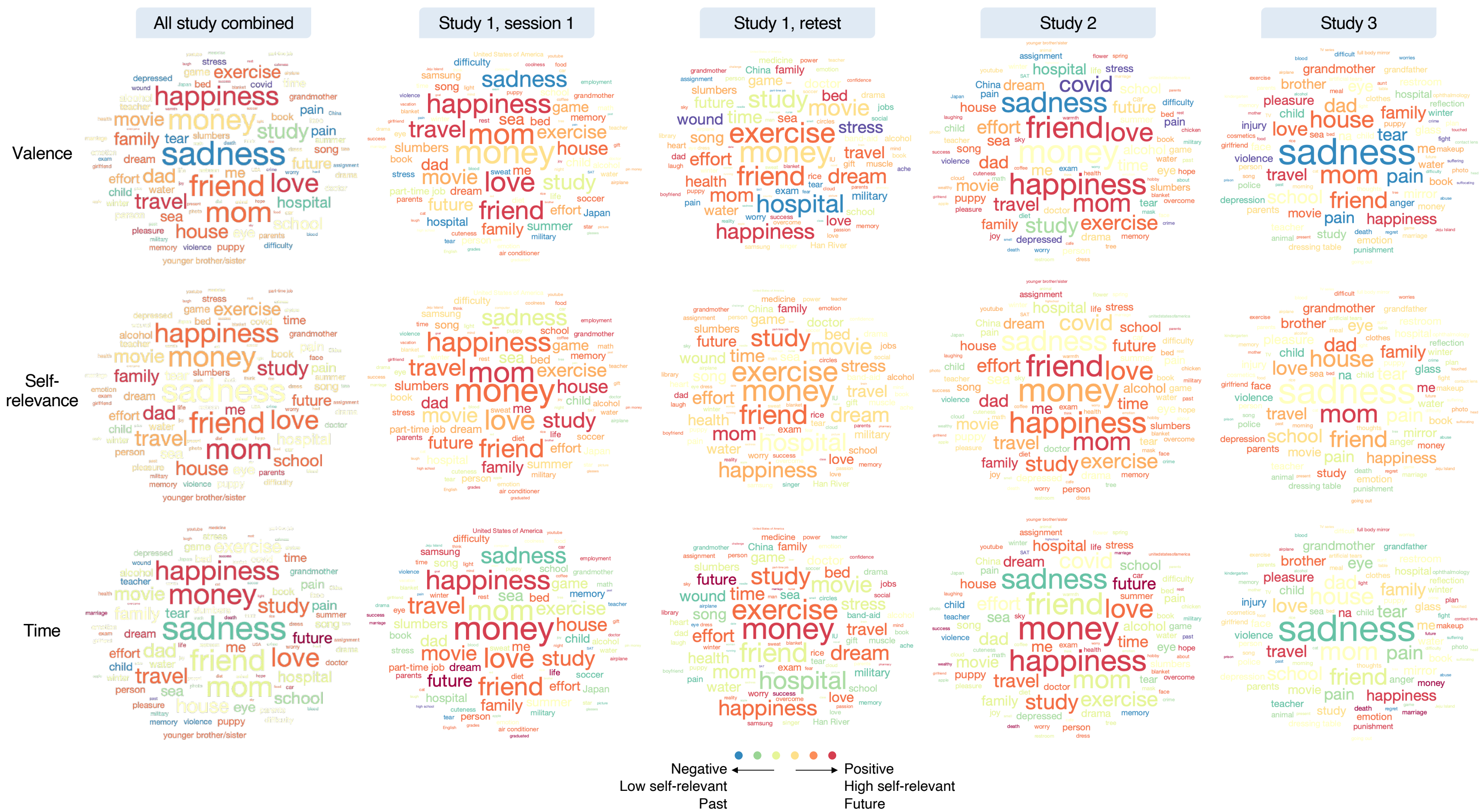
Supplementary Figures. 1 to 8

Supplementary Table 1

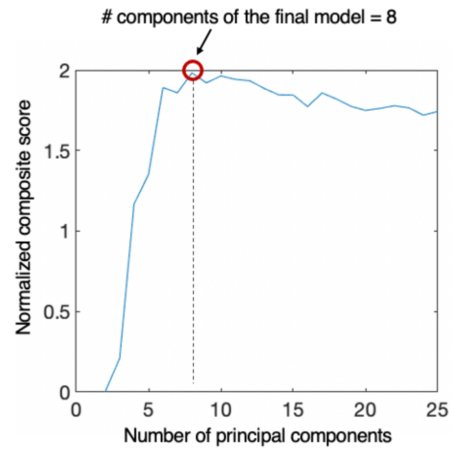
Supplementary Figure 1. Complete FAST response data for a representative participant. The full response data for a participant, the same individual shown in **Fig. 1B**. Participants reported 40 self-generated concepts for each of four different seed words in one session.



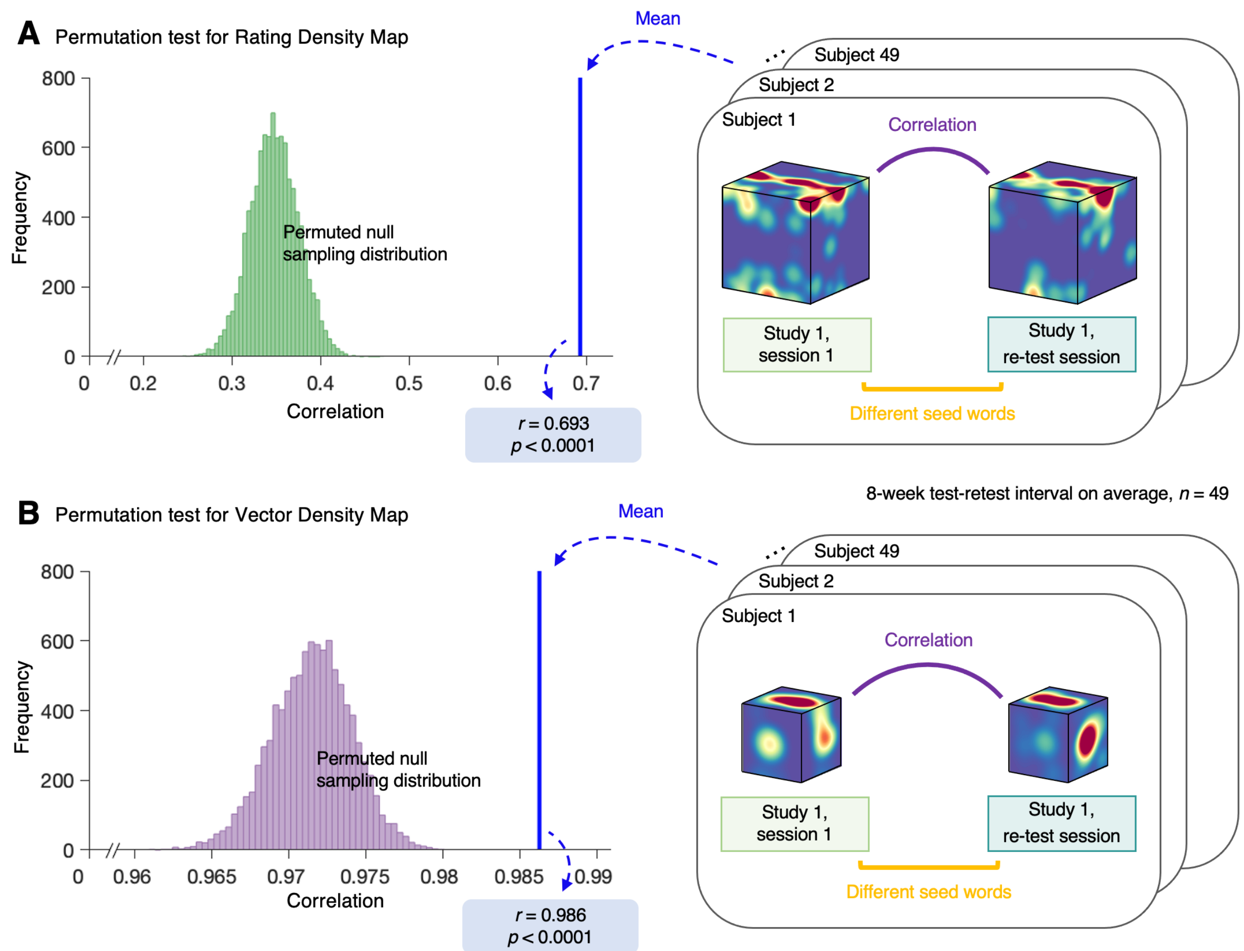
Supplementary Figure 2. Frequency analysis of self-generated concepts across studies. (a) Identification of frequently reported concepts across all studies, with frequency (%) calculated by dividing the count of each concept by the total response count for each study, showing consistency in frequently reported concepts. **(b)** Frequently reported concepts in FAST-web studies (Studies 1 and 2). **(c)** Detailed breakdown of concept frequency for each study.



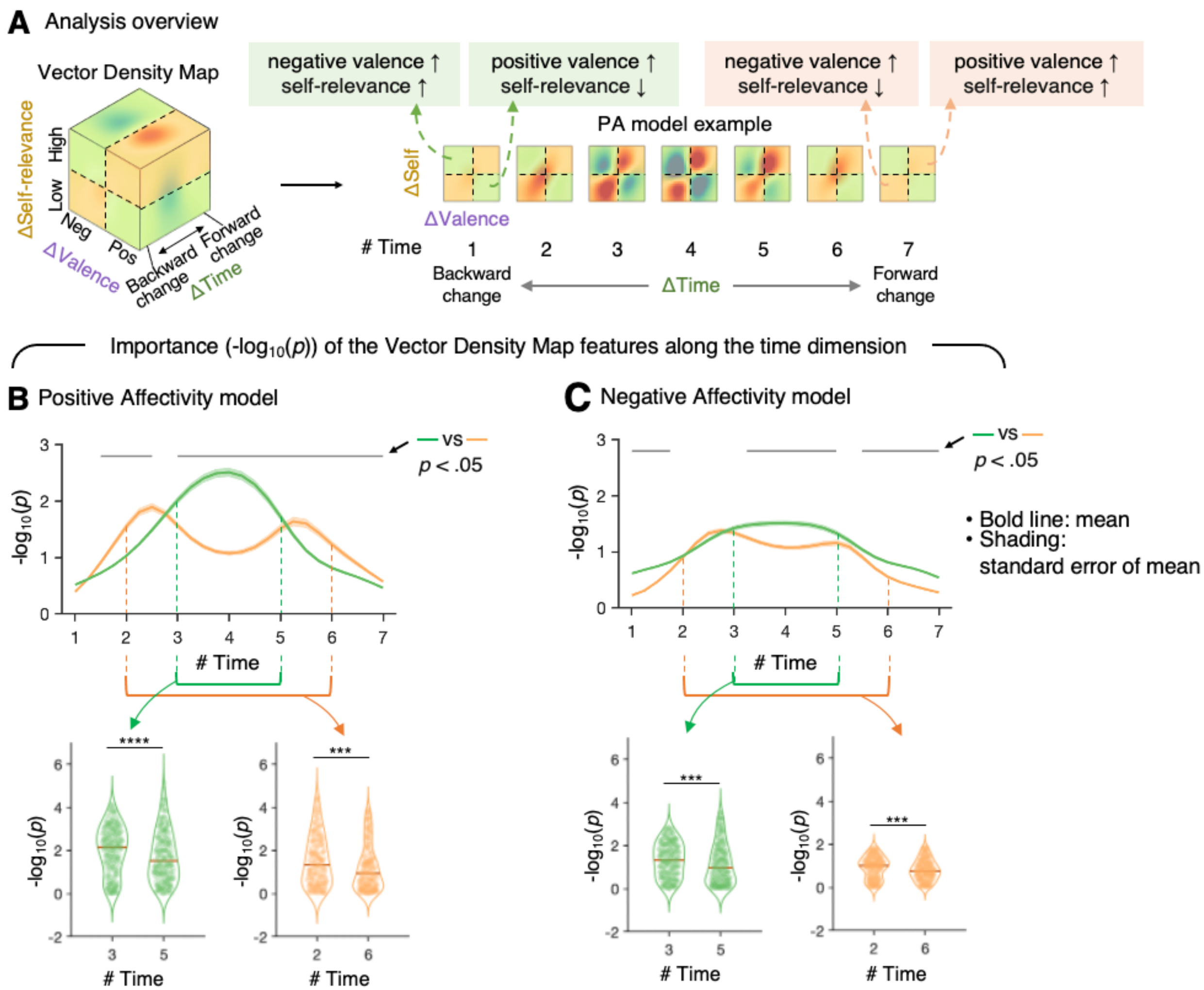
Supplementary Figure 3. Word cloud representation of FAST responses. Word clouds were created from the 100 most frequently reported concepts for each study and all studies combined. The size of each word represents its frequency, while the colors indicate the average rating scores across content dimensions (valence, self-relevance, and time). Rows categorize the different content dimensions, and columns differentiate between individual studies.



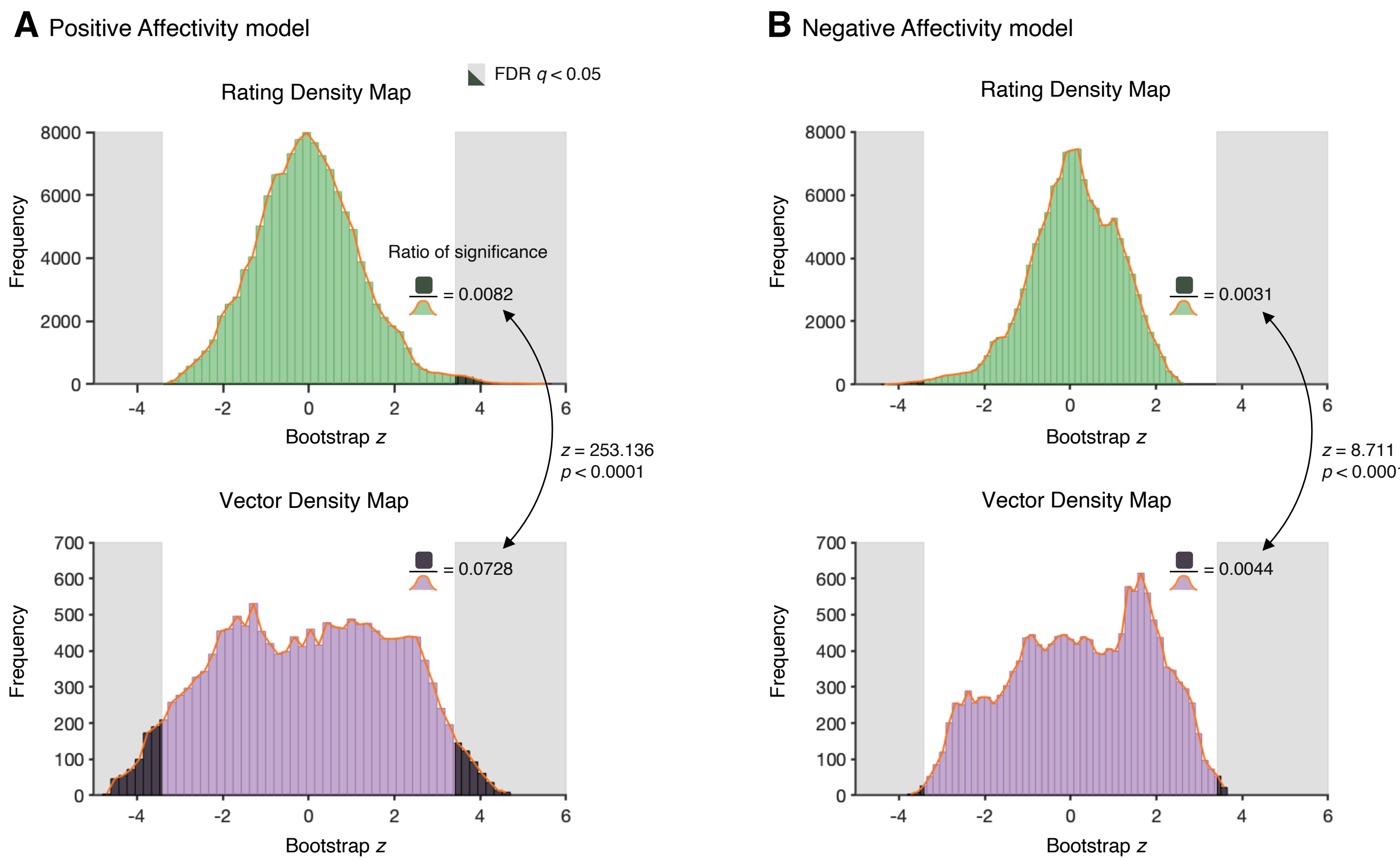
Supplementary Figure 4. Selection of the optimal number of principal components for final models. To determine the ideal number of principal components for our final models, we used Principal Component Regression (PCR) with leave-one-subject-out cross-validation (LOSO-CV). This process was applied to both the PA and NA models using data from Study 1, session 1 (*N* = 117). Performance scores for each model were normalized using the min-max normalization method, scaling them between 0 and 1. By summing these normalized scores, we identified the number of components that produced the highest composite score. The optimal number of principal components selected for the final models was 8.



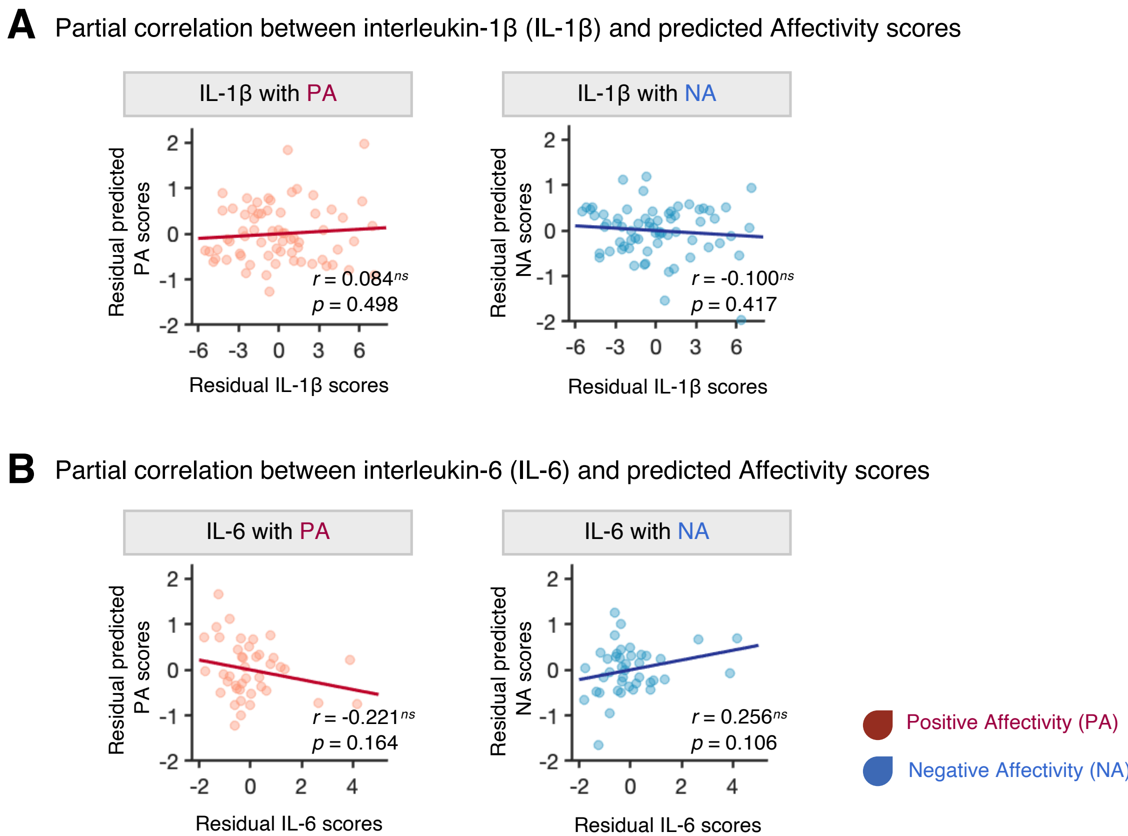
Supplementary Figure 5. Test-retest reliability of density maps. The within-subject reliability of density maps over time was assessed using Study 1 data, with an 8-week interval between sessions ($N = 49$). Different seed words were used for the retest session. **(a)** Test-retest reliability analysis for the rating density map involved permutation tests. The histogram shows the null distribution of mean correlations obtained by randomly shuffling participants 10,000 times. The actual mean test-retest reliability ($r = 0.693$, $p < 0.0001$) is marked by a blue vertical line. **(b)** Test-retest reliability for the vector density map also used permutation tests, yielding a mean reliability of $r = 0.986$ ($p < 0.0001$). These results indicate that dynamic features in both rating and vector density maps remained stable across sessions, even with different seed words.



Supplementary Figure 6. Time dimension analysis in the vector density-based predictive models. (a) An additional analysis of the vector density map was conducted to examine the relationship between dynamic changes in the time dimension and both positive and negative affectivity. The three-dimensional vector density map was divided into quadrants based on changes in valence (Δ valence) and self-relevance (Δ self-relevance) between concepts. Diagonally symmetric quadrants (green and orange regions) were combined across the Δ time range. The seven time points correspond to those in **Fig. 4**. **(b)** For the PA model, -log$_{10}$(p) values of the vector density map features along the time dimension were calculated using p-values from bootstrap tests (10,000 iterations), which estimate feature importance. The top section displays $-\log_{10}(p)$ values across time, with the gray line indicating significant time points ($p < 0.05$, paired t-test) in comparisons between two quadrant groups. The colored thick lines represent the average $-\log_{10}(p)$, while the shaded area represents the standard error of the mean (s.e.m.). The bottom section compares backward transitions versus forward transitions in the PA model. The significance shows the results of the paired t-test. **(c)** Identical analyses to those in **(b)** were conducted for the NA model. $^{***}p < 0.001$, $^{****}p < 0.0001$, two-tailed, paired t-test.



Supplementary Figure 7. Proportion of significant features in rating versus vector density maps. To quantitatively compare rating- and vector-based features, we computed the proportion of coordinates identified as significant in bootstrap tests after false discovery rate (FDR) correction ($q < 0.05$). **(a)** For the PA model, the vector density map contained a significantly higher proportion of significant features (7.28%) than the rating density map (0.82%; difference = 6.46%, 95% CI [6.41, 6.51], $z = 253.136$, $p < 0.0001$, binomial test), as indicated in the gray/black area. **(b)** The NA model showed the same pattern, with a higher proportion of significant features in the vector density map compared to the rating density map (0.31%; difference = 0.13%, 95% CI [0.10, 0.16], $z = 8.711$, $p <$ 0.0001, binomial test).



Supplementary Figure 8. Correlation between model responses and inflammatory marker. Partial correlations were computed to examine the relationship between inflammatory markers and model-predicted affectivity scores. **(a)** The correlations between interleukin-1β (IL-1β) levels and predicted PA and NA scores were not significant. **(b)** The correlations between interleukin-6 (IL-6) levels and predicted PA and NA scores were not significant. Covariates included in the analysis were Body Mass Index (BMI), age, gender, tobacco use, and alcohol consumption. Each dot represents a participant ($N = 68$). ^{ns}not significant.

Supplementary Table 1. Factor loadings of self-report questionnaires

Questionnaires	Subscales (if subscales were used)	Study 1, session 1 (*N* = 117)		Study 3 (*N* = 62)	
		Factor 1	Factor 2	Factor 1	Factor 2
		Positive affect	Negative affect	Positive affect	Negative affect
CES-D	-	-0.108	**0.775**	-0.329	**0.667**
PANAS	Positive affect	**0.751**	0.261	**0.939**	0.081
PANAS	Negative affect	0.496	**1.127**	0.264	**0.736**
STAI-T	-	-0.304	**0.663**	-0.249	**0.794**
SIQ	Two representative items (12,22)	-0.403	**0.144**	-	-
RRS	Brooding	-	-	0.060	**0.747**
RRS	Depressive Rumination	-0.110	**0.547**	0.070	**0.814**
LS	-	-0.511	**0.306**	-	-
PWB	Environmental Mastery	**0.436**	-0.192	-	-
PWB	Autonomy	**0.486**	0.081	-	-
PWB	Positive Relations	**0.574**	-0.206	-	-
PWB	Purpose in Life	**0.605**	0.173	-	-
PWB	Personal Growth	**0.649**	0.102	-	-
PWB	Self-acceptance	**0.675**	-0.192	-	-
SWLS	-	**0.545**	-0.138	-	-
MASQ30	General distress	-	-	-0.073	**0.870**
MASQ30	Anhedonic depression[a]	-	-	**0.809**	-0.094
MASQ30	Anxiety arousal	-	-	0.323	**0.571**

Note. Factor analyses were conducted to determine Positive and Negative Affectivity factor scores, which were used as outcome variables in the predictive modeling. Since Study 3 included a different set of self-report questionnaires compared to Studies 1 and 2, two separate factor analyses were performed. The bolded values indicate the higher factor loadings among two factors, clarifying the association of each questionnaire with either positive or negative affectivity. CES-D, Center for Epidemiologic Studies Depression; PANAS, Positive and Negative Affect Schedule; STAI-T, State-Trait Anxiety Inventory-Trait version; SIQ, Suicidal Ideation Questionnaire; RRS, Rumination Response Scale; LS, Loneliness Scale; PWB, Psychological Well-Being scale; SWLS, Satisfaction With Life Scale; MASQ30, 30-item Mood and Anxiety Symptom Questionnaire. [a] reverse coding.