J. Behav. Ther. & Exp. Psychiat. 52 (2016) 166–170

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Twice the negativity bias and half the positivity offset: Evaluative responses to emotional information in depression

Jackie K. Gollan [a, *], Denada Hoxha [a, 1], Kallio Hunnicutt-Ferguson [a, 1], Catherine J. Norris [b, 2], Laina Rosebrock [a, 1], Lindsey Sankin [a, 1], John Cacioppo [c, 3]

[a] Northwestern University Feinberg School of Medicine, Chicago, IL, USA
[b] Swarthmore College, PA, USA
[c] University of Chicago, IL, USA

ARTICLE INFO

Article history:
Received 11 June 2014
Received in revised form
11 September 2015
Accepted 12 September 2015
Available online 26 September 2015

Keywords:
Major depression
IAPS
Negativity bias
Positivity offset
Positive valence
Negative valence

ABSTRACT

Background and objectives: Humans have the dual capacity to assign a slightly pleasant valence to neutral stimuli (the positivity offset) to encourage approach behaviors, as well as to assign a higher negative valence to unpleasant images relative to the positive valence to equally arousing and extreme pleasant images (the negativity bias) to facilitate defensive strategies. We conducted an experimental psychopathology study to examine the extent to which the negativity bias and the positivity offset differ in participants with and without major depression..

Method: Forty-one depressed and thirty-six healthy participants were evaluated using a structured clinical interview for DSM-IV Axis I disorders, questionnaires, and a computerized task designed to measure implicit affective responses to unpleasant, neutral, and pleasant stimuli.

Results: The negativity bias was significantly higher and the positivity offset was significantly lower in depressed relative to healthy participants..

Limitations: Entry criteria enrolling medication-free participants with minimal DSM-IV comorbidity may limit generalizability of the findings.

Conclusions: This study advances our understanding of the positive and negative valence systems in depression, highlighting the irregularities in the positive valence system..

Continued accurate interpretation of emotional information is essential for guiding humans towards safety and resources (Lang, Nelson, & Collins, 1990; Phaf, Mohr, Rotteveel, & Wicherts, 2014). Our affect system should be finely attuned to assess emotional information accurately with greater interest and attention to unpleasant relative to pleasant information to ensure survival from threatening scenarios (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). However, depression may influence the function of the affect system, as captured by the results from experimental paradigms of standardized images designed to elicit affective evaluations in valence units (CSEA-NIMH, 1999; Lang, Bradley, & Cuthbert, 1999). Specifically, results have shown that depressed participants issue valence ratings that are significant higher and lower than healthy controls (Bylsma, Morris, & Rottenberg, 2008; Roiser, Elliott, & Sahakian, 2012), suggesting that evaluative responses to emotional stimuli may be associated with depressive illness beyond the effects of medication and health problems (Harmer, Heinzen, O'Sullivan, Ayres, & Cowen, 2008; Wardle & de Wit, 2012).

This study investigates the applicability of the Evaluative Space Model (ESM; Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Cacioppo & Berntson, 1994; Cacioppo, Gardner, & Berntson, 1997,

* Corresponding author. Northwestern University Feinberg School of Medicine, Department of Psychiatry and Behavioral Sciences, 676 North St Clair Street, Suite 1000, Chicago IL 60613, USA.

E-mail addresses: j-gollan@northwestern.edu (J.K. Gollan), dhoxha@luc.edu (D. Hoxha), kalliohf@gmail.com (K. Hunnicutt-Ferguson), cnorris2@swarthmore.edu (C.J. Norris), lainaerosebrock@gmail.com (L. Rosebrock), lsankin@gmail.com (L. Sankin), cacioppo@uchicago.edu (J. Cacioppo).

[1] Northwestern University Feinberg School of Medicine, Department of Psychiatry and Behavioral Sciences, 676 North St Clair Street, Suite 1000, Chicago IL 60611, USA.

[2] Department of Psychology, Papazian 314, Swarthmore College, USA.

[3] The University of Chicago, Department of Psychology, 5848 South University Avenue, Chicago, IL 60637, USA.

http://dx.doi.org/10.1016/j.jbtep.2015.09.005
0005-7916/

1999) to depressed individuals as they evaluate emotional visual stimuli, a research area that has yet to be studied. The ESM proposes that the affect system is characterized by two separable and asymmetric responses to affective stimuli. The first dimension, the positivity offset, represents the propensity of the affect system to attribute subtle positivity to neutral information (Boucher & Osgood, 1969; Cacioppo et al., 1997). Research reports show that the default neutral emotional state is slightly positive, stable over time, and regained quickly after unpleasant events (Diener & Diener, 1996; Gilbert, Pinel, Wilson, Blumberg, & Wheatley, 1998).

The second dimension of the affect system, the negativity bias, is the assignment of higher negative valence to unpleasant information as compared to the positive valence assigned to pleasant information, when controlling for the arousal and extremity of the images. Experimental studies have shown that unpleasant stimuli evoke more pronounced and rapid automatic responses than equally extreme and arousing pleasant stimuli (Cacioppo et al., 1997; Delplanque, Silvert, Hot, & Sequeira, 2005; Huang & Luo, 2009; Kisley, Wood, & Burrows, 2007). Furthermore, the negativity bias has been associated with physiological indices, including a larger late positive potential (LPP, Ito & Cacioppo, 2005; Ito, Larsen, Smith, & Cacioppo, 1998; Smith et al., 2006), increased corrugator activity (Neta, Norris, & Whalen, 2009), and increased neural activation of the left inferior frontal gyrus (Gollan et al,. 2015). Finally, the negativity bias has been generalized across different modalities (e.g., visual, auditory) and stimuli types (e.g., pictures, words; Norris, Larsen, Crawford, & Cacioppo, 2011; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009).

Given preferential processing of unpleasant information when attention resources are inadequate, as commonly observed among depressed individuals (Huang & Luo, 2009), depressed relative to healthy individuals may show a higher negativity bias. However, because the negativity bias is evoked early in the stream of information processing (Lang et al., 1990), depressed individuals may not show irregularities in the negativity bias (Dong, Zhou, Zhao, & Lu, 2011). Additionally, a low positivity offset may reflect a functional irregularity of the positive valence system when viewing neutral information, suggesting the individual's difficulty in generating positive affect, experiencing weaker positive affect when activated, or trouble sustaining positive affect once generated (Forbes & Dahl, 2005).

The objective of this study was to compare the extent to which depressed and healthy adults differ in their positivity offset and negativity bias, as defined by the ESM, when exposed to unpleasant, neutral, and pleasant images. Based on the findings suggesting heightened preferential processing of unpleasant images, we hypothesized that relative to healthy controls, depressed participants would show a significantly higher negativity bias and a significantly lower positivity offset.

1. Method

1.1. Participants

Forty-one participants with a primary diagnosis of major depression using the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; APA. DSM-IV, 2000) and scores ≥24 on the Inventory of Depressive Symptomatology-Clinician Rated (IDS-C; Rush et al., 1986) were enrolled into a behavioral treatment trial (16 weeks of Behavioral Activation) at Northwestern University's Feinberg School of Medicine in Chicago, Illinois. An additional 36 participants with no lifetime psychiatric symptoms and scores ≤11 on the IDS-C were enrolled. This study was approved by the ethics committees and informed consent was provided by all participants. Data collection occurred between 5/2009 and 7/2011.

The majority of the total sample was female ($n = 46$, 59.7%), with a mean age of 35 years ($SD = 13$ y, range = 19–49 y), and with about half having obtained college degrees ($n = 33$, 43%). Demographic information is provided on Table 1. Differences were observed in Hispanic ethnicity between groups.

Inclusion criteria specified participants between ages 18 and 65 years, medically healthy, medication-free, and with no medication washout. Exclusion criteria included lifetime bipolar disorder, psychosis, obsessive-compulsive disorder, substance abuse/dependence, and some personality disorders (i.e., borderline, schizoid, schizotypal, antisocial).

1.2. Measures

The *Structured Clinical Interview for the DSM-IV Axis I Disorders, Outpatient Version* (SCID, First, Gibbon et al., 1997) is a semi-structured interview designed to assess *DSM-IV* diagnoses. The SCID has adequate inter-rater reliability with kappa values for modules reported to be between .70 and 1.00 (First, Spitzer, Gibbon, & Williams, 1995, First, Spitzer, et al., 1997). Our evaluators, Ph.D. graduate students, underwent a training program with SCID training tapes (Spitzer, Williams, Gibbon, & First, 1989), formal training, observing and demonstrating SCID competency, and co-rating and reviewing SCID interviews. Our reliability checks of three separate tapes yielded kappa coefficients of .83 for the Mood module and .93 for the Anxiety module.

The *Structured Clinical Interview for DSM-IV Axis II Disorders Questionnaire* (SCID-II; First, Gibbon et al., 1997) is a 47-item self-report screen used to exclude participants who endorse symptoms of borderline, schizoid, schizotypal, antisocial personality disorders.

The *Inventory of Depressive Symptomatology – Clinician-Rated* (IDS-C; Rush, Carmody, & Reimitz, 2000; Rush et al., 1986; Rush et al., 2003) is a 30-item measure that assesses *DSM-IV* symptoms of depression. The inter-rater reliability estimate from this study was .87. We chose the IDS rather than other clinician scales because of its strong psychometric data and free access (Rush et al., 1986, 2003).

The *Inventory of Depressive Symptomatology - Self-Rated* (IDS-SR; Rush et al., 1986, 2003) is a 30-item measure of depression severity. Convergent validity with the IDS-C in our sample was strong with correlations of .964 at pre-treatment and .910 at post-treatment.

The *Implicit Affect Task* (Norris et al., 2011) is a computer-based task that presents color pictures from the International Affective Picture System (IAPS; CSEA-NIMH, 1999; Lang et al., 1999), during which participants issue valence ratings while viewing emotional images. Images were equally split into three categories each of 80 images, based on their normative valence ratings: pleasant, neutral, and unpleasant.[4] Participants were informed that they would see pictures of varied emotional content and that they should view each picture for the full presentation period. Images were presented in one of two pre-determined pseudo-random orders (counterbalanced across participants) during both assessments. Each trial consisted of a 0.5 s baseline period, 4 s image presentation period, and a self-paced rating period. A fixation point appeared at the center of the screen during the baseline period, which was replaced by the image centered on the screen during the presentation period. Participants indicated their positive and negative responses to each picture using the Evaluative Space Grid (ESG), a 5 (0 = *not at all* to 4 = *extremely positive*) x 5 (0 = *not at all* to 4 = *extremely negative*) matrix (Larsen et al., 2009), with positive valence reflected on the horizontal axis and negative valence on the

[4] The picture numbers for IAPS stimuli are available upon request.

Table 1
Baseline characteristics of participants (N = 77).

Baseline characteristics		MDD (n = 41)	Healthy (n = 36)	Full sample (N = 77)	Test statistics
		Frequency n(%)	Frequency n(%)	Frequency n(%)	
Sex	Male	15 (36.6)	16 (44.4)	31 (40.3)	χ^2 (1) = .49, p = .48
	Female	26 (63.4)	20 (55.6)	46 (59.7)	
Ethnicity	Hispanic	4 (9.8)	2 (5.6)	6 (7.8)	χ^2 (1) = .47, p = .49
Race	American Indian	0	0	0	χ^2 (2) = 2.7, p = .33
	Asian	0	0	0	
	Native Hawaiian	0	0	0	
	African American	13 (31.7)	11 (30.6)	24 (31.2)	
	Caucasian	23 (56.1)	19 (52.8)	42 (54.5)	
	Other (Indian)	1 (2.4)	4 (11.1)	5 (6.5)	
Education	High School	2 (7.3)	2 (3.6)	5 (6.5)	χ^2 (3) = 3.86, p = .27
	Partial College	17 (41.5)	15 (41.7)	32 (41.6)	
	University Grad	15 (36.6)	18 (50.0)	33 (42.9)	
	Grad School	6 (14.6)	1 (2.8)	7 (9.1)	
Work	Unemployed	15 (36.6)	6 (16.7)	21 (27.3)	χ^2 (3) = 7.7, p = .05
	Employed	19 (46.3)	20 (55.6)	39 (50.6)	
	Full-Time Student	7 (17.1)	6 (16.7)	13 (16.9)	
	Retired	0 (0.0)	4 (11.1)	4 (5.2)	
Marital	Never Married	31 (75.6)	24 (66.7)	55 (71.4)	χ^2 (4) = 4.8, p = .31
	Married	2 (4.9)	7 (19.4)	9 (11.7)	
	Separated	1 (2.4)	0 (0.0)	1 (1.3)	
	Divorced	6 (14.6)	4 (11.1)	10 (13)	
	Common Law	1 (2.4)	1 (2.8)	2 (2.6)	
Age (M, (SD))		36 (12)	35 (14)	35 (13)	F (1,76) = .11, p = .74

Note. MDD = Major Depressive Disorder.

vertical axis. Participants were instructed to move the mouse to one of the 25 cells in the 5 x 5 matrix to indicate the intensity of their positive and negative responses. Positivity offset was calculated as the difference between the mean positive ratings and mean negative ratings of neutral images. Negativity bias was calculated as the difference in the mean negative valence ratings of very unpleasant images minus the positive valence ratings of very pleasant images (Norris et al., 2011).

1.3. Procedure

Participants from each group were recruited from the same community locations via advertisements and the internet. Participants were screened by phone to ensure eligibility, and then invited to the laboratory for two assessments separated by one week. During the first assessment, participants provided informed consent, passed a toxicology urine screen, and completed the clinical interview and self-report questionnaires. During the second assessment, participants were asked to sign another consent form, take a second toxicology urine screen, and undergo a 25 min psychophysiology assessment (Gollan et al., 2014). Thereafter, depressed participants were enrolled into 16 weeks of BA treatment, and healthy participants were tracked prospectively for 16 weeks. Participants returned at Weeks 8 and 16 to complete the assessment battery again. Gollan et al., (2015) describe the main treatment response findings. At the end of the project, all patients were compensated and debriefed.

1.4. Analytic plan

We conducted tests of differences of demographic and clinical characteristics using Analysis of Variance (ANOVA) for continuous variables and Chi-square tests of independence for categorical variables. In the presence of small or empty cells in the tests of categorical variables, the Chi-square test was replaced by Fisher's exact test. Analyses were 2-tailed at the .05 level of significance. We used an ANOVA to test group difference between the negativity bias and the positivity offset.

2. Results

2.1. Demographic and clinical characteristics

Chi-square analyses showed the depressed group was more likely to be Hispanic and showed a trend towards greater unemployment, No other demographic characteristics were significant (Table 1). Table 2 presents the clinical characteristics by group and the F test to examine group differences. As expected, significant differences were evident on pre-treatment depression severity between depressed and healthy groups.

2.2. Group differences in affective reactivity

Healthy participants exhibited a significantly lower negativity bias (M = 0.18, SD = .55, SE = 0.08, 95% CI: 0.01, 0.34) than depressed participants (M = 0.45, SD = .45, SE = 0.07, 95% CI: 0.29, 0.60), F (1, 75) = 5.4, p = 0.02, η^2 = .07. Moreover, healthy participants showed significantly higher positivity offset (M = .61, SD = .55, SE = 0.08, 95% CI: 0.44, 0.76) compared with the depressed participants (M = 0.30, SD = 0.41, SE = 0.07, 95% CI: 0.15, 0.45), F (1, 75) = 7.69, p = 0.02, η^2 = .09. Finally, when examining valence ratings reported in each group, healthy participants evaluated pleasant (F (1, 75) = 5.18, p < .05) and neutral (F (1, 75) = 7.69, p < .01) stimuli as more positive relative to depressed participants.

Table 2
Clinical characteristics.

Measure	MDD (n = 41)		HV (n = 36)		F (df)	p	$N2$
	M	SD	M	SD			
IDS-C	33.83	7.63	2.19	2.57	F (1, 75) = 562.58	p < .01	.88
IDS-SR	33.93	9.06	3.11	2.94	F (1, 75) = 380.88	p < .01	.84

Note: IDS-C = Inventory of Depressive Symptomatology, Clinician Rated; IDS-SR = Inventory of Depressive Symptomatology, Self-Rated.

3. Discussion

This experimental psychopathology study investigated group differences in the negativity bias and the positivity offset between depressed and healthy adults. Consistent with our hypothesis, negativity bias was higher and positivity offset was lower in depressed relative to healthy participants. In our sample of healthy participants, the negativity bias and positivity offset scores were similar with the results of previous tests of the ESM model, suggesting that there is a definable and replicable function of the positive valence system when individuals are psychiatrically healthy (Cacioppo et al., 2000; Ito & Cacioppo, 2005; Norris et al., 2011). However, our results suggest that there is imbalance of the affective asymmetries when a person experiences clinical depression. Though this is the first demonstration of a skewed asymmetry, our results align with prior research that depressed individuals show an increased reactivity to unpleasant relative to pleasant information (Canli et al., 2004; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002). However, our results do not align with findings from a meta-analysis showing a small effect size for lower emotional reactivity to unpleasant stimuli in depressed participants compared to normal controls (Bylsma et al., 2008), and with results of lower regional activation of the amygdala in response to fear compared with neutral stimuli in depressed relative to healthy participants (Drevets, 2001).

The functionality of the positive valence dimension may explain our results: The positivity offset and the negativity bias both rely on activation of the positive valence dimension. If this dimension were to be hypoactive, it would elicit higher ratings of unpleasant stimuli relative to pleasant stimuli, and further, suppress ratings of the positive valence dimension with the positivity offset when presented with neutral stimuli. Our results demonstrated that depressed participants evaluated pleasant and neutral stimuli as less positive relative to healthy participants, suggesting the failure of a mechanism in the positive valence system in individuals with depression. This interpretation is consistent with prior findings showing that positive emotional reactivity is lower in depressed individuals (Bylsma et al., 2008) and that depressed participants show an impaired incentive motivation while their aversive motivation remains intact (Canli, Desmond, Zhao, Glover, & Gabrieli, 1998), though not all studies may support this idea (Lautenbacher et al., 1994).

Though this study advances our understanding of the affective asymmetries in depressed adults, there are several limitations worth highlighting. First, this is a preliminary study in which we used an in vivo behavioral task of the negativity bias and the positivity offset that has been tested in several laboratories. Additional testing of the task is required to ensure replication of these results. Second, though the judgment-based task has shown to be stable over time, it is possible that treatment seeking participants respond differently to this task relative to non-treatment seeking depressed individuals. Third, the use of a paradigm designed to measure negativity bias and positivity offset (Norris et al., 2011) along with the affect matrix over a traditional bipolar valence scale strengthens the study, but this task is designed to test the ESM model specifically, and hence, cannot be directly compared with other tasks. Fourth, we enrolled unmedicated participants to constrain the influence of medications on affective responses (Harmer et al., 2008); so our findings may not apply to depressed individuals who use medications. Finally, this study did not have a depressed participants with subsyndromal depression, thus we cannot clarify the nature of the association (e.g., curvilinear vs. linear) between the negativity bias and positivity offset and depressive symptom severity.

Despite the limitations, results suggest irregularities in the positivity offset and negativity in adults with depression. Directions for new research include explicating the association between functional dimensions of depression (e.g., anhedonia) and the affective asymmetries and using neuroimaging techniques to characterize neural mechanisms and functional capacities correlated with these two dimensions of affect.

Acknowledgments

Preparation of this article and the study was supported by Grant R21 1R21MH082133 from the National Institute of Mental Health. Sarah Getch, Ph.D. and Kallio Hunnicutt-Ferguson, Ph.D. served as coordinators. Bjorn Hanson, Ph.D., Angel Buchanan, Ph.D., Shandra Brown, Justin Birnholz, Ph.D., Noah Yulish, Ph.D. conducted phone screens and clinical interviews. Sara Polis conducted physiological assessments. John Stockton, Ph.D. provided programming support.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders*. text revision (4th ed.). Washington, DC: American Psychiatric Association.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. L. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323–370.

Boucher, J., & Osgood, C. E. (1969). The pollyanna hypothesis. *Journal of Verbal Learning and Verbal Behavior, 8*(1), 1–8. http://dx.doi.org/10.1016/S0022-5371(69)80002-2.

Bylsma, L., Morris, B., & Rottenberg, J. (2008). A meta-analyses of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*(4), 676–691. http://dx.doi.org/10.1016/j.cpr.2007.10.001.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: a critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115*(3), 401–423. http://dx.doi.org/10.1037/0033-2909.115.3.401.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In R. Lewis, & J. M. Haviland-Jones (Eds.), *The Handbook of Emotion* (2nd ed., pp. 173–191). New York: Guilford Press.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1997). Beyond bipolar conceptualizations and measures: the case of attitudes and evaluative space. *Personality and Social Psychology Review, 1*(1), 3–25. http://dx.doi.org/10.1207/s15327957pspr0101_2.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: form follows function. *Journal of Personality and Social Psychology, 76*(5), 839–855. http://dx.doi.org/10.1037/0022-3514.76.5.839.

Canli, T., Desmond, J. E., Zhao, Z., Glover, G., & Gabrieli, J. D. (1998). Hemispheric asymmetry for emotional stimuli detected with fMRI. *Neuroreport, 5*(14), 3233–3239. http://dx.doi.org/10.1097/00001756-199810050-00019.

Canli, T., Sivers, H., Thomason, M. E., Whitfield-Gabrieli, S., Gabrieli, J. D., & Gotlib, I. H. (2004). Brain activation to emotional words in depressed vs. healthy subjects. *NeuroReport, 15*, 2585–2588. http://dx.doi.org/10.1097/00001756-200412030-00005.

Center for the Study of Emotion and Attention (CSEA-NIMH). (1999). *The international affective picture system*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Delplanque, S., Silvert, L., Hot, P., & Sequeira, H. (2005). Event-related P3a and P3b in response to unpredictable emotional stimuli. *Biological Psychology, 68*, 107–120. http://dx.doi.org/10.1016/j.biopsycho.2004.04.006.

Diener, E., & Diener, C. (1996). Most people are happy. *Psychological Science, 7*(3), 181–185.

Dong, G., Zhou, H., Zhao, X., & Lu, Q. (2011). Early negativity bias occurring prior to experiencing emotion. *Journal of Psychophysiology, 25*(1), 9–17. http://dx.doi.org/10.1027/0269-8803.

Drevet, W. C. (2001). Neuroimaging and neuropathological studies of depression: implications for the cognitive-emotional features of mood disorders. *Current Opinion on Neurobiology, 11*(2), 240–249.

First, M. B., Gibbon, M., & Spitzer, R. (1997). *Structured clinical interview for DSM-IV Axis II personality disorders*. Washington, DC: American Psychiatric Press.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. (1995). *Structured clinical interview for the DSM-IV Axis I disorders (SCID-I/P, version 2)*. New York: Biometrics Research Department, New York State Psychiatric Institute.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1997). *User's guide for the structured clinical interview for DSM-IV Axis I disorders*. Washington, DC: American Psychiatric Press.

Forbes, E. E., & Dahl, R. E. (2005). Neural systems of positive affect: relevance to understanding child and adolescent depression. *Development and Psychopathology, 17*(3), 827–850.

Gilbert, D. T., Pinel, E. C., Wilson, T. D., Blumberg, S. J., & Wheatley, T. (1998). Immune neglect: a source of durability bias in affective forecasting. *Journal of*

Personality and Social Psychology, 75(3), 617–638. http://dx.doi.org/10.1037//0022-3514.75.3.617.

Gollan, J. K., Connolly, M., Buchanan, A., Hoxha, D., Rosebrock, L., Cacioppo, J., et al. (2015). Neural substrates of negativity bias in women with and without major depression. *Biological Psychology, 109*, 184–191. http://dx.doi.org/10.1016/j.biopsycho.2015.06.003.

Gollan, J. K., Hoxha, D., Chihade, D., Pflieger, M. E., Rosebrock, L., & Cacioppo, J. T. (2014). Frontal alpha asymmetry before and after behavioral activation treatment for depression. *Biological Psychology, 99*, 198–208. http://dx.doi.org/10.1016/j.biopsycho.2014.03.003.

Harmer, C. J., Heinzen, J., O'Sullivan, U., Ayres, R. A., & Cowen, P. J. (2008). Dissociable effects of acute antidepressant drug administration on subjective and emotional processing measures in healthy volunteers. *Psychopharmacology, 199*, 495–502. http://dx.doi.org/10.1007/s00213-007-1058-7.

Huang, Y. X., & Luo, Y. J. (2009). Temporal course of emotional negativity bias: an ERP study. *Neuroscience Letters, 398*, 91–96. http://dx.doi.org/10.1016/j.neulet.2005.12.074.

Ito, T. A., & Cacioppo, J. T. (2005). Variations on a human universal: individual differences in positivity offset and negativity bias. *Cognition and Emotion, 19*, 1–26. http://dx.doi.org/10.1080/02699930441000120.

Ito, T. A., Larsen, J. T., Smith, N. K., & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: the negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology, 75*, 887–900. http://dx.doi.org/10.1037/0022-3514.75.4.887.

Kisley, M. A., Wood, S., & Burrows, C. L. (2007). Looking at the sunny side of life: age-related change in an event-related potential measure of the negativity bias. *Psychological Science, 18*, 838–843. http://dx.doi.org/10.1111/j.1467-9280.2007.01988.x.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picture system (IAPS): Instruction manual and affective ratings* (Tech. Rep. No. A-4). Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Lang, S. F., Nelson, C. A., & Collins, P. F. (1990). Event-related potentials to emotional and neutral stimuli. *Journal of Clinical and Experimental Neuropsychology, 12*(6), 946–958. http://dx.doi.org/10.1080/01688639008401033.

Larsen, J. T., Norris, C. J., McGraw, A. P., Hawkley, L. C., & Cacioppo, J. T. (2009). The evaluative space grid: a single-item measure of positivity and negativity. *Cognition and Emotion, 23*(3), 453–480. http://dx.doi.org/10.1080/02699930801994054.

Lautenbacher, S., Roscher, S., Strian, D., Fassbender, K., Krumney, K., & Krieg, J. C. (1994). Pain perception in depression: relationships to symptomatology and naloxone-sensitive mechanisms. *Psychosomatic Medicine, 56*, 345–352. http://dx.doi.org/10.1097/00006842-199407000-00010.

Neta, M., Norris, C. J., & Whalen, P. J. (2009). Corrugator muscle responses are associated with individual differences in positivity-negativity bias. *Emotion, 9*, 640–648. http://dx.doi.org/10.1037/a0016819.

Norris, C. J., Larsen, J. T., Crawford, L. E., & Cacioppo, J. T. (2011). Better (or worse) for some than others: individual differences in the positivity offset and negativity bias. *Journal of Research in Personality, 45*(1), 100–111. http://dx.doi.org/10.1016/j.jrp.2010.12.001.

Phaf, R. H., Mohr, S. E., Rotteveel, M., & Wicherts, J. M. (2014). Approach, avoidance, and affect: a meta-analysis of approach-avoidance tendencies in manual reaction time tasks. *Frontiers in Psychology, 5*(378), 1–16. http://dx.doi.org/10.3389/fpsyg.2014.00378.

Roiser, J., Elliott, R., & Sahakian, B. J. (2012). Mood disorders: cognitive mechanisms of treatment in depression. *Neuropsychopharmacology Reviews, 31*, 117–136. http://dx.doi.org/10.1038/npp.2011.183.

Rush, A. J., Carmody, T., & Reimitz, P. E. (2000). The inventory of depressive symptomatology (IDS): clinician (IDS-C) and self-report (IDS-SR) ratings of depressive symptoms. *International Journal of Methods in Psychiatric Research, 9*(2), 45–59. http://dx.doi.org/10.1002/mpr.79.

Rush, A. J., Giles, D. E., Schlesser, M. A., Fulton, C. L., Weissemburger, J., & Burns, C. (1986). The inventory for depressive symptomatology (IDS): preliminary findings. *Psychiatry Research, 18*(1), 65–87. http://dx.doi.org/10.1016/0165-1781(86)90060-0.

Rush, A. J., Trivedi, M., Ibrahim, H., Carmody, T., Arnow, B., Klein, D., et al. (2003). The 16-item quick inventory of depressive symptomatology (IDS), clinician rating (QIDS-C) and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. *Biological Psychiatry, 54*(5), 573–583. http://dx.doi.org/10.1016/S0006-3223(02)01866-8.

Siegle, G. J., Steinhauer, S. R., Thase, M. E., Stenger, V. A., & Carter, C. S. (2002). Can't shake that feeling: fMRI assessment of sustained amygdala activity in response to emotional information in depressed individuals. *Biological Psychiatry, 51*, 693–707.

Smith, N. K., Larsen, J. T., Chartrand, T. L., Cacioppo, J. T., Katafiasz, H. A., & Moran, K. E. (2006). Being bad isn't always good: affective context moderates the attention bias toward negative information. *Journal of Personality and Social Psychology, 90*(2), 210–220. http://dx.doi.org/10.1037/0022-3514.90.2.210.

Spitzer, R. L., Williams, J. B. W., Gibbon, M., & First, M. B. (1989). *DSM-III case book*. Washington, DC: American Psychiatric Press.

Wardle, M. C., & de Wit, H. (2012). Effects of amphetamine on reactivity to emotional stimuli. *Psychopharmacology, 220*(1), 143–153. http://dx.doi.org/10.1007/s00213-011-2498-7.