AFFECTIVE WORKING MEMORY IN DEPRSSION

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Abstract

Depressed individuals show a wide range of difficulties in executive functioning (incl. working memory), which can be a significant burden on everyday mental processes. Theoretical models of depression have proposed these difficulties to be especially pronounced in affective contexts. However, evidence investigating affective working memory capacity (WMC) in depressed individuals has shown mixed results. The pre-registered study used a complex span task, the Affective Picture Span Paradigm (APSP), which has been shown to be sensitive to difficulties with WMC in affective relative to neutral contexts in other clinical groups to explore affective WMC in clinical depression. Affective WMC was compared between individuals with current depression (n = 25), individuals in remission from depression (n = 25), and healthy controls (n = 30). The results showed that overall, WMC was more impaired in the context of negative distractor images, relative to neutral images. Furthermore, those with a lifetime history of depression (individuals with current depression and individuals remitted from depression), performed worse on the APSP, compared to healthy controls. However, there was no support for the greater disruption of WMC in affective compared to neutral contexts in those with a lifetime history of depression. These findings' implications for current models of depression are discussed.

Keywords: working memory capacity, emotion, depression, complex span, imagery

Cognitive impairments are core characteristics frequently observed in depressed individuals (Rock et al., 2014; Snyder, 2013), often persisting in patients remitted from depression (Bhalla et al. 2006; Bora et al. 2013; Hasselbalch, et al., 2011; Reppermund et al. 2009). These difficulties contribute to the maintenance of depressive states, by limiting the cognitive resources available to engage in adaptive emotion regulatory processes (Tanovic & Joorman, 2015). Specifically, working memory capacity (WMC) has been proposed to be central to maintaining emotion regulatory goals and holding affective information in mind when it is helpful to an individuals' current goals, while ignoring it when affective distractors are detrimental to these goals (Schweizer et al., 2019). Understanding affective WMC in depression is important as it may pose a promising target for interventions.

Cognitive impairments in patients with major depressive disorder (MDD) have been attributed to dysfunctions in the central executive component of working memory (WM) (Baddley, 2003) and the frontoparietal control network that subserves higher order cognition (Nee et al., 2013). That is, depressed individuals tend to allocate processing resources towards affective information, which consumes the limited cognitive resources available in the central executive system, thus reducing WMC to perform other cognitive operations. Studies investigating the impact of affective information on WMC have used complex span tasks, which are thought to reflect a natural representation of everyday difficulties experienced by individuals suffering from emotional disorders (Schweizer & Dalgleish, 2011, 2016). Specifically, complex span tasks require individuals to simultaneously engage in two tasks competing for shared cognitive resources. An example of a complex span task is the reading span task (Daneman & Carpenter, 1980). This task requires individuals to make a semantic judgement about a sentence, whilst maintaining an unrelated word presented at the end of the sentence in WM for later recall. Using a modified affective reading span task, we showed that the affective enhancement effect observed in healthy individuals was preserved

in depressed individuals (Schweizer et al., 2018). Specifically, depressed individuals showed better for words following affective compared to neutral sentences. Other studies, however, have shown emotion impairment effects using similar variants of the reading span task (Garrison & Schmeichel, 2019; Hubbard et al., 2016a, 2016b). Whilst research using simple span and *n*-back tasks have failed to show differential effects of affective relative stimuli on WM accuracy in depression, some have shown effects on reaction time (Berman et al., 2011; Bertocci et al., 2012; Foland-Ross et al., 2013; Joormann et al., 2011; Tavitian et al., 2014; Yoon, LeMoult, & Joormann, 2014). Therefore, the current study conducted a pre-registered investigation of affective WMC in individuals with depression, in remission from depression, and healthy controls using a complex span task including a perceptual operation component that has been shown to be sensitive in clinical groups (Schweizer & Dalgleish, 2016).

The Present Study

The present study used the Affective Picture Span Paradigm (APSP) to measure affective WMC. In line with previous studies (Schweizer & Dalgleish, 2016), we predicted that overall, individuals would remember fewer words when presented in the context of negative distractor images (*valence hypothesis;* see H1a pre-registration, https://osf.io/escdr). Next, we predicted that individuals with a lifetime history of depression would recall fewer words overall compared to never-depressed controls (*depression hypothesis*; H1b). We further hypothesised the main effects of valence and depression to interact, with individuals with a lifetime history of depression performing worse compared to never-depressed individuals on the negative relative to the neutral condition of the APSP (*valence x depression hypothesis;* H1c). Furthermore, we expected depression status to have an effect, with currently depressed individuals remembering the fewest words overall, never-depressed individuals remembering the most words, and individuals in remission from depression

showing intermediate performance (*group hypothesis*; H2a). Finally, we predicted that the effect of group would interact with valence, with the effect of affective relative to neutral distractors being greatest in currently depressed individuals and weakest in never-depressed individuals (*group x valence hypothesis*; H2b).

Method

Participants

Eighty participants (*M* age = 38.99, *SD* = 14.97; 63% females) were recruited from the University of Cambridge, as well as via community advertisements. Participants met study inclusion if they were above 18 years old, fluent in English, had no history of head injury or current neurological disorders, normal or corrected hearing and vision, and if they had a diagnosis of MDD that was not part of bipolar disorder and not due to bereavement.

Participants were recruited from across a range of depressive scores on the BDI-II (Beck et al., 1996) and comprised of individuals with current MDD (*N* = 25), remitted-recurrent MDD (*N* = 25), and never-depressed controls (*N* = 30). As indicated in the pre-registration, the sample size was based on an effect size of having 90% power to detect a group (current MDD, remitted-recurrent MDD, never-depressed) by valence (negative, neutral) interaction as reported in our previous study (Schweizer & Dalgleish, 2016; η_p^2 = 0.19). Groups did not differ in age ($F(2, 77) = 1.33$, $p = .270$), gender ($\chi^2(4)) = 4.80$, $p = .309$) or verbal IQ $F(2, 76) = 1.50$, $p = .229$. In addition, there were no significant differences between groups in education, ethnicity, household income, trait anxiety, or WM as assessed with the Digit Span (all *ps* >.05). As expected, there were significant differences between groups in depressive symptomology ($F(2, 76) = 60.132$, $p = < .005$) and state anxiety ($F(2, 76) = 15.350$, $p <.005$). Data was missing for one participant due to a technical error and nine

participants were excluded in order to match participants based on education and IQ (see update to pre-registration protocol).

Measures

Working memory. Affective WMC was measured with the Affective Picture Span Paradigm (APSP; Schweizer & Dalgleish, 2016). The APSP comprised of two components, a target storage task and an operation task, which were performed simultaneously in the presence of either neutral or negative background images. For the target storage task, participants were required to retain a set of 4-7 words (trial size), presented one word at a time against a background image. Each trial size was presented twice for each valence condition (neutral, negative), resulting in 16 blocks. The valence of the APSP was manipulated by presenting emotionally negative or neutral background images, which were selected from the International Affective Picture System. For the operation task, participants counted shapes (4-6 shapes per trial) that appeared before and after a word was presented. Participants were prompted to accurately enter the number of target shapes that appeared after each trial using the computer keyboard (e.g., 'How many pink squares did you see?'). At the end of each block, participants were instructed to recall as many words as they could remember. The proportion of words recalled correctly were computed for each trial size (4 - 7) and valence (neutral, negative), then proportions were calculated for the neutral and depressed conditions across all trials, irrespective of whether words were recalled in the correct position.

Depression. Depressive symptoms were assessed using Beck's Depression Inventory (BDI-II; Beck et al., 1996), a well-validated measure of affective, cognitive, and physical symptoms of depression (Arnau et al., 2001).

Anxiety. The State-Trait Anxiety Inventory (Spielberger et al., 1983) was used to assess state and trait anxiety (STAI-S/T). Both scales are well-validated with good internal consistency and excellent test-retest reliability.

Verbal IQ. The National Adult Reading Test (NART; Nelson, 1982) was used to assess whether group differences in WMC were due to verbal intelligence.

Procedure

Prior to the study, participants provided written informed consent. Participants then completed a demographic questionnaire followed by the BDI-II, STAI, and NART, before performing on the APSP. The presentation of the neutral and negative conditions of the APSP were counterbalanced. Testing sessions were conducted in a soundproof cubicle on a desktop computer and after completion participants were compensated for their time (£6 per hour).

Data analysis

To investigate the first research question, a group (lifetime history of MDD, never-depressed) by valence (neutral, negative) repeated measures mixed-model ANOVA was conducted. Valence was entered as the within-subjects factor and group entered as the between-subjects factor. The lifetime history of MDD group was derived from a combination of individuals with current MDD and remitted-recurrent MDD. This analysis was repeated to investigate the second research question with group (current MDD, remitted-recurrent MDD, never-depressed) as the between-subjects factor and valence (neutral, negative) as the within-subjects factor. All assumptions for the models were met.

Results

In line with the *valence hypothesis* (H1a), there was a significant effect of valence ($F(1, 77) = 5.593$, $p = .021$, $\eta_p^2 = .068$) on WMC, with performance being more impaired in

the context of negative images (*M* = .50, *SD* = .22) relative to neutral images (*M* = .53, *SD* = .21). Supporting the *depression hypothesis* (H1b), there was a significant effect of depression ($F(1, 77) = 6.676$, $p = .012$, $\eta_p^2 = .080$). WMC in participants with a lifetime history of depression was more lower compared to never-depressed participants (Table 1). However, contrary to our *depression x valence hypothesis* (H2c), there was no significant interaction ($F(1, 77) = 1.513$, $p = .222$, $\eta_p^2 = .019$).

Table 1

WM Performance in Participants with a Lifetime History of MDD and Never-depressed Controls

	Never-depressed *n* = 30	Lifetime history of MDD *n* = 49	Total
Neutral *M (SD)*	.61 (.17)	.48 (.21)	.53 (.21)
Negative *M (SD)*	.56 (.19)	.46 (.23)	.50 (.22)

Note. Neutral = proportion of words recalled correctly in the context of neutral images; Negative = proportion of words recalled correctly in the context of negative images; Never-depressed = individuals with no history of MDD; Lifetime history of MDD = combined Current MDD and Remitted MDD groups; Total = total words recalled correctly across neutral and negative trials

The second research question investigated whether performance on the APSP differed in participants with current MDD compared to remitted MDD and never-depressed controls. There was a significant effect of group ($F(2, 76) = 3.298$, $p = .042$, $\eta_p^2 = .080$), in line with

our *group hypothesis* (H2a). Never-depressed participants performed better on the APSP and recalled the most words compared to current MDD participants who recalled the fewest words (Table 2). Finally, again contrary to our *group x valence hypothesis* (H2b), there was no significant interaction ($F(2, 76) = 1.144$, $p = .324$, $\eta_p^2 = .029$).

Table 2

WM Performance in Current MDD, Remitted MDD, and Never-depressed Participants

	Never-depressed *n* = 30	Remitted MDD *n* = 25	Current MDD *n* = 24	Total
Neutral *M (SD)*	.61 (.17)	.47 (.23)	.48 (.20)	.53 (.21)
Negative *M (SD)*	.56 (.19)	.47 (.25)	.45 (.21)	.50 (.22)

Note. Neutral = proportion of words recalled correctly in the context of neutral images; Negative = proportion of words recalled correctly in the context of negative images; Never-depressed = individuals with no history of MDD; Remitted MDD = individuals in remission from MDD; Current MDD = individuals currently suffering from MDD; Total = total words recalled correctly across neutral and negative trials

Operation task performance. To control that the effects were not accounted for by a trade-off between accuracy on the storage versus operation task, the group analyses were repeated with accuracy on the operation task as the outcome. There was a significant difference in accuracy across valence ($F(1, 76) = 7.72$, $p = .007$, $\eta_p^2 = .092$), with higher

accuracy in the neutral condition (*M* = .69, *SD* = .20) relative to the negative condition (*M* = .65, *SD* = .20). However, there was no significant difference on the accuracy of the operation task across groups ($F(2, 76) = .699$, $p = .500$, $\eta_p^2 = .018$) and no significant interaction of *valence x group* ($F(2, 76) = .268$, $p = .765$, $\eta_p^2 = .007$). Furthermore, correlations revealed that accuracy on the operation task was unrelated to WMC (all *ps* > .05), irrespective of whether overall performance was investigated or performance split by valence.

Discussion

The present study investigated the impact of affective information on WMC in depressed individuals. Replicating previous findings in psychologically healthy individuals and individuals with PTSD (Schweizer & Dalgleish, 2016), individuals performed worse on the APSP in the context of negative, relative to neutral distractor images. Furthermore, as predicted, individuals with a lifetime history of depression showed lower overall WMC and recalled fewer words on the APSP, compared to never-depressed individuals. When comparing the groups across depression status, results revealed that in line with our predictions, currently depressed individuals recalled the fewest words whilst never-depressed individuals had the best recall performance. Individuals in remission from depression performed at an intermediate level. However, there was no support for our *depression x valence* hypothesis, with no differences found in WM performance in affective versus neutral contexts between individuals with a lifetime history of depression and never-depressed individuals. The interaction effect remained non-significant when exploring the effect of current depression status (i.e., current, remitted, never-depressed).

The results demonstrate that affective distraction on the ASPS introduced through task-irrelevant background images reliably reduces WMC compared to neutral background

images. This is noteworthy as our meta-analysis of the relevant literature revealed that WM tasks performed in affective compared to neutral contexts (i.e., including affective and neutral stimuli respectively) do not reduce WM performance in health individuals (Schweizer et al., 2019). The dual-task demands of the complex span task (i.e., visuospatial search and word maintenance) completed in the context of task-irrelevant affective versus neutral distraction provide an ecologically-valid analogue of completing higher order mental processes whilst confronted with goal-irrelevant affective information (e.g., feelings, thoughts or memories).

In contrast with our predictions depressive state did not appear to interact with the impact of these affective distractors. That is, while WMC was lower in individuals with a lifetime history of depression compared to never-depressed individuals, the difference in performance was not greater in the affective compared to the neutral condition. This finding suggests that individuals with a history of depression were as able to ignore affective distractors as psychologically healthy individuals. These findings are in contrast with studies that have found valence specific deficits (e.g., Garrison & Schmeichel, 2019; Hubbard et al., 2016a, 2016b). Moreover, meta-analytic evidence showing moderate to large differences between healthy individuals and those with symptoms of depression in attention maintenance toward negative images (Suslow et al., 2020) suggest sustained processing of the aversive background images should interfere with WM encoding and maintenance as well as the operation task in individuals with depression. However, as for WMC there was no evidence of greater impairment on the shape detection operational task in individuals with a lifetime history of depression compared to those who had never been depressed. Two potential accounts of the current findings are: limited affective salience (Pessoa, 2009) and high cognitive load.

The limited affective salience argument is that the negative stimuli included in the current study, generic aversive images, may not have triggered deep self-referential

processing that would take away cognitive resources from the goal-relevant task components in individuals with a history of depression. In support of this account studies that facilitated depth of processing using affective version of the reading span task, which required depressed individuals to read negative sentences and semantically evaluate them, showed reduced recall of unrelated words on these negative trials compared to healthy individuals (Garrison & Schmeichel, 2019; Hubbard et al., 2016a, 2016b). However, a modified version of the reading span task that where the operation component of the task explicitly required self-referential processing of depressogenic sentences derived from the Dysfunctional Attitude Scale (Weissman & Beck, 1978) showed no interaction effect between depressive status and valence. Suggesting that limited affective salience may not, or only partially, account for the lack of an interaction between depression status and valence.

An alternative account for the absence of greater impairment for negative trials in individuals with a lifetime history of depression compared to never depressed individuals is the high cognitive load imposed by the ASPS. The task is made cognitively demanding by simultaneously engaging participants in two mentally challenging tasks. The task demands may have been sufficient to reduce content processing prohibiting any depressogenic rumination about the content of the affective images' content. Research on anxiety has previously shown that high cognitive load can reduce or even eliminate the effects of fear conditioning (Yates et al., 2010) and encoding of highly aversive (trauma-analogue) information (Holmes et al., 2010). Similarly, Hu and Wang (2021) showed that individuals with subthreshold depression showed greater directed forgetting of negative information under conditions of high load. Arguably again limiting more elaborate processing of the negative stimulus material. Together these findings suggest that under high cognitive load individuals with depression appear able to inhibit distraction from goal-irrelevant affective information. Preliminary work suggests that an intervention increasing cognitive load as part

of psychological therapy leads to greater reduction in depressive symptoms compared to a control group that received psychological therapy without added cognitive load (Hu & Wang, 2021).

The current study constitutes a significant addition to the discourse about the nature of the affective WMC in individuals with depression. The study was pre-registered and adequately powered to detect an interaction effect based on work using this task in another clinical sample. In line with a growing number of studies (Berman et al., 2011; Bertocci et al., 2012; Foland-Ross et al., 2013; Joormann & Gotlib, 2008; Joormann, Levens, & Gotlib, 2011; Joormann, Nee, Berman, Jonides, & Gotlib, 2010; Ladouceur et al., 2005; Levens & Gotlib, 2009, 2010; Tavitian et al., 2014; Yoon, LeMoult, & Joormann, 2014) the results show no greater impairment in affective compared to neutral contexts in depressed individuals. The mounting evidence suggests that theoretical models on the role of WM in depression need to consider that WM problems in depression are not valence specific. That is, there is a more generic reduction in cognitive capacity in individuals with a lifetime history of depression.

References

Arnau, R. C., Meagher, M. W., Norris, M. P., Bramson, R. (2001). Psychometric evaluation of the Beck Depression Inventory-II with primary care medical patients. *Health Psychology, 20*(2), 112–119. https://doi.org/10.1037/0278-6133.20.2.112

Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience, 4,* 829–839. https://doi.org/10.1038/nrn1201

Beck, A. T., Rush, A. J., Shaw, B. F., & Emery, G. (1979). *Cognitive therapy of depression: A treatment manual.* The Guildford Press.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Manual for the Beck Depression Inventory-II.* Psychological Corporation.

Berman, M. G., Nee, D. E., Casement, M., Kim, H. S., Deldin, P., Kross, E., . . . Jonides, J. (2011). Neural and behavioral effects of interference resolution in depression and rumination. *Cognitive, Affective & Behavioral Neuroscience, 11,* 85–96. https://doi.org/10.3758/s13415-010-0014-x

Bertocci, M. A., Bebko, G. M., Mullin, B. C., Langenecker, S. A., Ladouceur, C. D., Almeida, J. R. C., & Phillips, M. L. (2012). Abnormal anterior cingulate cortical activity during emotional n-back task performance distinguishes bipolar from unipolar depressed females. *Psychological Medicine, 42,* 1417–1428. https://doi.org/10.1017/S003329171100242X

Bhalla, R. K., Butters, M. A., Mulsant, B. H., Begley, A. E., Zmuda, M. D., Schoderbek, B., Pollock, B. G., Reynolds, C. F., & Becker, J. T. (2006). Persistence of neuropsychologic deficits in the remitted state of late-life depression. *American Journal of Geriatric Psychiatry, 14,* 419–427. https://doi.org/10.1097/01.JGP.0000203130.45421.69

Bora, E., Harrison, B. J., Yücel, M., & Pantelis, C. (2013). Cognitive impairment in euthymic major depressive disorder: a meta-analysis. *Psychological Medicine, 43,* 2017–2026. https://doi.org/10.1017/S0033291712002085

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review, 12,* 769–786. https://doi.org/10.3758/BF03196772

Foland-Ross, L. C., Hamilton, J. P., Joormann, J., Berman, M. G., Jonides, J., & Gotlib, I. H. (2013). The neural basis of difficulties disengaging from negative irrelevant material in major depression. *Psychological Science, 24,* 334–344. https://doi.org/10.1177/0956797612457380

Garrison, K. E., & Schmeichel, B. J. (2019). Effects of emotional content on working memory capacity. *Cognition & Emotion,* 33(2), 370-377. https://doi.org/10.1080/02699931.2018.1438989

Hasselbalch, B. J., Knorr, U., & Kessing, L. V. (2011). Cognitive impairment in the remitted state of unipolar depressive disorder: a systematic review. *Journal of Affective Disorders, 134,* 20–31. https://doi.org/10.1016/j.jad.2010.11.011

Hubbard, N. A., Hutchison, J. L., Hambrick, D. Z., & Rypma, B. (2016a). The enduring effects of depressive thoughts on working memory. *Journal of Affective Disorders, 190,* 208–213. https://doi.org/10.1016/j.jad.2015.06.056

Hubbard, N. A., Hutchison, J. L., Turner, M., Montroy, J., Bowles, R. P., & Rypma, B. (2016b). Depressive thoughts limit working memory capacity in dysphoria. *Cognition and Emotion, 30,* 193–209. https://doi.org/10.1080/02699931.2014.991694

Joormann, J., Levens, S. M., & Gotlib, I. H. (2011). Sticky thoughts: Depression and rumination are associated with difficulties manipulating emotional material in working memory. *Psychological Science, 22,* 979–983. https://doi.org/10.1177/0956797611415539

Joormann, J & Tanovic, E. (2015). Cognitive vulnerability to depression: examining cognitive control and emotion regulation. *Current Opinion in Psychology, 4,* 86-92. https://doi.org/10.1016/j.copsyc.2014.12.006

Nee, D. E., Brown, J. W., Askren, M. K., Berman, M. G., Demiralp, E., Krawitz, A., & Jonides, J. (2013). A meta-analysis of executive components of working memory. *Cerebral Cortex, 23,* 264–282. https://doi.org/10.1093/cercor/bhs007

Nelson, H. E. (1982). National Adult Reading Test (NART): *For the assessment of premorbid intelligence in patients with dementia: Test manual.* NFER-Nelson.

Pessoa, L. (2009). How do emotion and motivation direct executive control? *Trends in Cognitive Sciences, 13,* 160–166. https://doi.org/10.1016/j.tics.2009.01.006

Reppermund, S., Ising, M., Lucae, S., & Zihl, J. (2009). Cognitive impairment in unipolar depression is persistent and non-specific: further evidence for the final common pathway disorder hypothesis. *Psychological Medicine 39,* 603–614. https://doi.org/10.1017/S003329170800411X

Rock, P. L., Roiser, J. P., Riedel1, W. J., & Blackwel, A.D. (2014). Cognitive impairment in depression: a systematic review and meta-analysis. *Psychological Medicine, 44,* 2029–2040. https://doi.org/10.1017/S0033291713002535

Schweizer, S., & Dalgleish, T. (2011). Emotional working memory capacity in posttraumatic stress disorder (PTSD). *Behaviour Research and Therapy, 49,* 498–504. https://doi.org/10.1016/j.brat.2011.05.007

Schweizer, S., & Dalgleish, T. (2016). The impact of affective contexts on working memory capacity in healthy populations and in individuals with PTSD. *Emotion, 16,* 16–23. https://doi.org/10.1037/emo0000072

Schweizer, S., Navrady, L., Breakwell, L., Howard, R. M., Golden, A.-M., Werner-Seidler, A., & Dalgleish, T. (2018). Affective enhancement of working memory is maintained in depression. *Emotion, 18*(1), 127-137. http://dx.doi.org/10.1037/emo0000306

Schweizer, S., Satpute, A. B., Atzil, S., Field, A. P., Hitchcock, C., Black, M., Barrett, L. F., & Dalgleish, T. (2019). The Impact of Affective Information on Working Memory: A Pair of Meta-Analytic Reviews of Behavioral and Neuroimaging Evidence. *Psychological Bulletin.* http://dx.doi.org/10.1037/bul0000193

Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: a meta-analysis and review. *Psychological Bulletin, 139*(1), 81–132. https://doi.org/10.1037/a0028727

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory.* Consulting Psychologists Press.

Tavitian, L. R., Ladouceur, C. D., Nahas, Z., Khater, B., Brent, D. A., & Maalouf, F. T. (2014). Neutral face distractors differentiate performance between depressed and healthy adolescents during an emotional working memory task. *European Child & Adolescent Psychiatry, 23,* 659–667. https://doi.org/10.1007/s00787-013-0492-9

Vuilleumier, P., & Huang, Y.-M. (2009). Emotional attention: Uncovering the mechanisms of affective biases in perception. *Current Directions in Psychological Science, 18,* 148–152. https://www.jstor.org/stable/20696018

Yoon, K. L., LeMoult, J., & Joormann, J. (2014). Updating emotional content in working memory: A depression-specific deficit? *Journal of Behavior Therapy and Experimental Psychiatry, 45,* 368–374. https://doi.org/10.1016/j.jbtep.2014.03.004