COGNITION AND EMOTION
2012, 26 (2), 341–350

Psychology Press
Taylor & Francis Group

BRIEF REPORT

The effects of optimism and pessimism on updating emotional information in working memory

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In the present study we elucidate the emotional and executive control interactions that might underlie optimism and pessimism. Participants completed a self-report measure of optimism/pessimism and performed an emotion faces categorisation task and an emotion n-back task in which they indicated whether each of a series of faces had the same or a different emotional expression (happy, sad, neutral) as the face presented two trials before. Trials were structured to measure latency to update emotional content in working memory (WM). More pessimistic individuals formed connections among positive stimuli, and broke connections among positive and sad stimuli, in WM more slowly than did less pessimistic individuals; levels of optimism/pessimism did not affect the rate with which individuals formed and broke connections among neutral representations in WM. It appears, therefore, that levels of pessimism are related to specific affective cognitive mechanisms in WM that may be involved in emotion regulation.

Keywords: Optimism; Pessimism; Working memory; Emotion; Updating; N-back.

There is substantial evidence that dispositional optimism, a generalised expectancy for positive future outcomes (Scheier & Carver, 1988), is related to better psychological adjustment; conversely, pessimism is associated with poorer outcomes (Segerstrom, Taylor, Kemeny, & Fahey, 1998; Solberg Nes & Segerstrom, 2006). Researchers have begun to examine the cognitive processes that might underlie these relations (e.g., Ashby, Isen, & Turken, 1999). For example, it is possible that optimism is related to attention and information processing and, thus, influences early stages of emotion processing and self-regulation. In this context, Segerstrom (2001) used an emotion Stroop task to examine the relation between optimism and automatic information processing. Segerstrom found that whereas pessimistic persons showed interference for negative words, optimistic

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This research was supported by National Institute of Mental Health Grant MH59259 awarded to IHG. The authors thank Christian Waugh for his assistance with data analysis.

http://www.psypress.com/cogemotion http://dx.doi.org/10.1080/02699931.2011.574110

individuals exhibited interference for both positive and negative words, suggesting that optimism is characterised by an information-processing style that includes adaptive reframing.

The present study extends this research by examining executive processes in working memory (WM) that might underlie the relation between optimism and pessimism and affective regulation. WM is a limited-capacity system that provides temporary access to a select set of representations in the service of current cognitive processes (Miyake & Shah, 1999). The ability to update and fluidly connect and disconnect information in WM to form concepts is a critical component of emotion regulation. People continually process large amounts of information and, in order to perform a task or pursue goals, they must be able to rapidly update the contents of WM and form connections among relevant representations. The organisation of information within WM and the modification of representations in WM as a function on new input are especially critical for emotion regulation. Information encountered in the environment and processed in WM is elaborated, activating related representations from the environment and from long-term memory that may interact with and alter existing representations in WM (Dudai, 2002). Therefore, levels of optimism or pessimism may affect emotion regulation by influencing the updating process that mediates the formation and disconnection of associations among representations in WM.

The present study was designed to test this formulation. Participants completed a measure of optimism/pessimism and performed an emotion 2-back task in which they had to indicate whether each of a series of faces had the same or a different emotional (sad, happy, neutral) expression as the expression on the face presented two trials before. Participants also performed a categorisation task with the same stimuli to assess their latencies to perceive and categorise emotional facial expressions. Trials were structured to measure the ability to effectively update emotional content in WM, that is, the ability to form and break connections among affective material in WM, thereby activating and deactivating larger emotional concepts (like "happy"). Previous research using this paradigm has found aberrant updating biases in depressed individuals that may impair their ability to regulate negative affect (Levens & Gotlib, 2010). Given the inverse relation between optimism and depression, we predicted that more optimistic individuals would connect with happy, and disconnect from sad, stimuli in WM more quickly than they would connect with and disconnect from neutral stimuli.

METHOD

Participants

Forty-two undergraduates at a private university (29 females) participated in this study in exchange for credit toward a class requirement. Data from two participants were excluded from analysis because the participants performed the n-back task incorrectly, leaving a final sample of 40 participants (27 female).

Measures

All participants completed the Revised Life Orientation Test (LOT-R; Scheier, Carver, & Bridges, 1994) at the time of testing. This widely used questionnaire consists of optimism and pessimism subscales (three items each, plus four filler items, each rated on a 5-point scale) that have been demonstrated to be dissociable constructs (Scheier et al., 1994, 2001). Total LOT-R scores can range from 6 to 30 (our $M = 22.23$, $SD = 3.5$, range = 14–28, 83% of sample $\geq$ the scale midpoint of 18); optimism and pessimism subscale scores can range from 3 to 15 (optimism: $M = 10.7$, $SD = 2.01$, range = 7–15, 83% of sample ≥ 9; pessimism: $M = 6.6$, $SD = 2.13$, range = 3–11, 90% of sample ≤ 9). To control for the possibility that optimism is related to WM performance through intelligence, Scholastic Assessment Test (SAT) scores were also obtained from each participant at the time of testing.

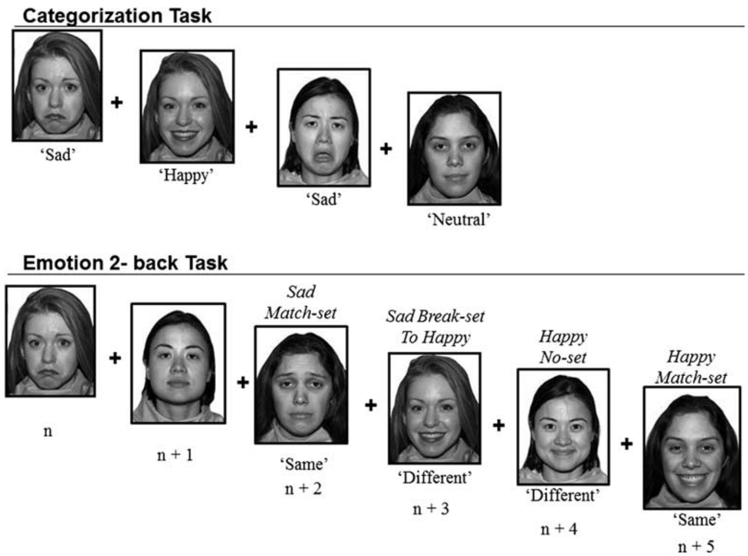

Figure 1. *Examples of categorisation and 2-back emotion tasks with correct responses.*

Stimuli

A total of 138 digital greyscale images of faces from the NimStim Face Set (Tottenham et al., 2009) were used as stimuli: 46 sad faces, 46 happy faces, and 46 neutral or calm faces from 23 different actors (12 female, 11 male). Each emotional expression of each actor was presented approximately four times during the experiment. In the categorisation task, male and female faces were intermixed; in the 2-back task, each trial block contained either only male or only female emotional faces.

Task design

Participants completed a brief demographic questionnaire followed by the LOT-R questionnaire and, finally, the emotion updating task. The emotion updating task consisted of a categorisation task and a 2-back task. Participants performed the categorisation task first, followed immediately by the 2-back task. The experimental procedure was similar for each task. Participants were told that the task measured memory for emotional faces and were instructed how to perform the task both orally and in writing. In both tasks, participants viewed emotional faces presented one at a time for 2 seconds, with an inter-trial-interval of 2.5 seconds. Participants' response and response latency was recorded for each trial.

Categorisation task. The categorisation task consisted of 45 trials, in addition to eight unscored practice trials. Participants viewed three sequences of 15 facial expressions and were asked to indicate whether each face presented in the sequence had a happy, neutral, or sad facial expression (Figure 1a). Participants pressed a key labelled "Happy" if the facial expression was happy, a key labelled "Neut" if the facial expression was neutral, and a key labelled "Sad" if the facial expression was sad. The presentation order of the faces was random.

2-back task. The 2-back task consisted of 280 trials separated into five blocks of 56 trials, in addition to ten unscored practice trials. Face gender was counterbalanced across blocks: participants viewed three blocks of female faces and two blocks of male faces, or two blocks of female faces and three blocks of male faces. Participants were asked to indicate whether the emotional expression of the currently presented face was the same as, or different than, the emotional expression presented two faces earlier. Participants pressed a key labelled "Same" if the facial expression was the same as the expression presented two faces before, or a key labelled "Diff" if the facial expression was different than the expression presented two faces earlier. For each block of trials, for the first two faces presented, participants were told to view the faces without pressing a key; from the third face on, participants were told to respond with the keys "Same" or "Diff" to each face presented, resulting in 54 usable trials per block.

Trial types. By presenting emotional stimuli and asking participants to respond based on the facial expressions of the stimuli, the task assesses the ability to update and form/break connections among representations within an emotional category. Due to the limited capacity of WM, for each trial participants must perceptually process the presented facial expression, add that stimulus to their maintained set of stimuli, discard the facial expression presented three trials earlier that need no longer be maintained, compare the current facial expression to that presented two trials earlier, and then respond. What differs across trials are the valence of the incoming and outgoing stimuli and the cognitive processes involved in comparing the current facial expression with that presented two trials earlier, resulting in three trial types: "match-set" trials, "break-set" trials, and "no-set" trials. For example, on "Same" response, or "*match-set*", trials, participants must match the currently presented facial expression with the one that was presented two trials earlier and, in doing so, must conceptually link the two expressions as members of the same category (see Figure 1b).

Trials requiring a "Different" response involve a different set of cognitive processes. There are two types of "Different" responses, a break-set trial and a no-set trial. A *break-set* trial is a trial that immediately follows a match-set trial: the facial expression presented three trials earlier that must be discarded was one expression in a matched pair. Therefore, to respond to break-set trials, participants must break a set that they endorsed in the preceding trial. Thus, break-set trials assess participants' ability to disconnect two paired valenced stimuli and disengage from the first face to remove it from WM. *No-set* trials, in contrast are "Different" response trials that do not follow a match-set trial. On no-set trials, participants need to determine that no set exists and respond accordingly. Therefore, no-set trials assess participants' ability to integrate a valenced stimulus into WM and assess its relatedness to existing stimuli being held in WM.

As an example, consider the following trial sequence (see Figure 1b): sad face (n), neutral face (n + 1), sad face (n + 2), happy face (n + 3), happy face (n + 4), happy face (n + 5). Participants passively view and remember the faces presented in trials n and n + 1. Trial "n + 2" is a sad match-set trial requiring a "Same" response. Trial "n + 3" is a break-set trial; the correct "Different" response to the currently presented happy face requires participants to "break" the sad category set endorsed in the previous match-set trial by disengaging and removing the sad face "n" from WM. And, finally, Trial "n + 4" is a no-set trial; the current happy face needs to be added to WM and compared against the expression presented two trials earlier. In no-set trials, no previously endorsed happy or sad set needs to be broken to respond, yet the current face may be the same expression as the expression of the preceding trial or the same as an expression recently expelled from WM.[1] Reaction times (RTs) to this type of trial, therefore, capture the ability to integrate

[1] The trial structure in the current study differs from the emotion n-back task used in Levens and Gotlib (2010) in that there are no perseveration trials in the current study. Although the match-set and break-set trials are the same, the no-set trials cannot be compared between the two studies. In the current study, the no-set trial is a 1-back lure, while in the Levens and Gotlib (2010) study, in addition to a 1-back lure, the no-set trial facial expression may also be a 3-back lure. In both studies, the no-set trial is a "Different" response trial in which the participants do not need to break a set of previously paired facial expressions to respond. Thus, while match-set and break-set trials can be compared directly across the two studies, no-set trial reaction times and *z*-scores should be compared with caution.

stimuli into WM and successfully avoid an incorrect response.

Because of the critical cognitive process required, we categorised break-set trials according to the *emotional expression of the set that participants must break* in order to respond, rather than by the facial expression of the current trial to which participants are responding; this categorisation yielded happy, sad, and neutral break-set trials. Calculating RTs for break-set trials, therefore, required that "Different" response RTs be averaged across specific trial types. The sad break-set RT, for example, is the mean RT to respond "Different" to a trial in which a happy or neutral face is presented following a sad match-set trial. In contrast, match-set, and no-set trials were categorised based on the current facial expression to which participants were responding.

Statistical analysis. RTs and responses were recorded for each trial, and a mean RT and accuracy rate was calculated for correct trials for each trial type in the categorisation and 2-back tasks. Outlier trials, i.e., responses with RTs greater than 2.5 standard deviations from the mean, were excluded from analysis (Howell, 2002). For each participant we computed a LOT-R, optimism subscale, and pessimism subscale score, the number of incorrect-response and no-response (i.e., missed) trials, and mean RTs for each trial type in the categorisation and 2-back tasks. All scores from the LOT-R were standardised for all statistical analyses.

To control for possible effects of optimism on baseline RTs, RTs for all trial types were converted to z-scores, as suggested by Faust, Balota, Spieler, and Ferraro (1999), who presented data suggesting that RTs can be linearly related across groups (in this case, low and high optimism/pessimism), leading to additive interactions in which the slower group produces larger experimental effects. Therefore, trial type RTs were converted to z-scores by subtracting each participant's trial type RT mean from his/her overall RT mean and dividing by the standard deviation of the trial type mean. We conducted separate z-score transformations on the categorisation and 2-back RTs.

To examine the effect of optimism on cognitive functioning, we first conducted repeated-measures regression General Linear Models (GLM) with Emotion (happy, neutral, sad) as a repeated measure and LOT-R and SAT scores[2] as continuous independent variables on the categorisation task accuracy levels and z-score transformed RTs. Second, to isolate the more complex updating and linking processes required in the emotion 2-back task, we conducted repeated-measure regression GLMs, with Emotion (happy, neutral, sad) as a repeated measure and LOT-R and SAT scores as continuous independent variables, on match-set, break-set, and no-set accuracy levels and RTs. Significant main effects and interactions involving LOT-R and SAT scores were followed up with simple slope regression analyses. In addition, to determine whether the optimism or pessimism subscales were driving significant LOT-R main effects or interactions, we also conducted post hoc simple slope regression analyses using optimism and pessimism subscale scores. The effect size η (eta) is given for all reported effects. Accuracy and RT means and standard deviations for each trial type in each task are presented in Table 1.

RESULTS

Categorisation accuracy analysis

In the categorisation task, participants responded to all trials. The categorisation task repeated-measures GLM yielded a significant main effect

[2] To examine whether intelligence, as assessed by SAT scores, influences the relation between optimism and the ability to update and rapidly connect and disconnect emotional representations in WM, SAT scores were included in all GLM analyses (as a standardised continuous independent variable) and follow-up regression analyses. Moreover, LOT-R score, optimism and pessimism subscale scores, and SAT score were not significantly intercorrelated, *all* ps $> .1$, further suggesting that the relations among LOT-R, pessimism, and emotion updating found in the present study are not due to lower-pessimism participants being more or less intelligent than are their higher-pessimism counterparts.

Table 1. *Categorisation and 2-back trial type mean reaction times, accuracy rates, and simple slope regressions with LOT-R, Optimism and Pessimism subscales, and SAT scores*

	Regression beta values													
	Raw data		LOT-R score			Optimism subscale score			Pessimism subscale score			*SAT score*		
DV	*RT*	*Accuracy*	*RT*	*z-score*	*Acc*	*RT*	*z-score*	*Acc*	*RT*	*z-score*	*Acc*	*RT*	*z-score*	*Acc*
Categorisation														
Happy	762 (113)	0.97 (0.05)	0.14	0.14	−0.05	0.13	0.07	0.13	−0.09	−0.16	0.10	0.24	0.22	−0.05
Neutral	924 (151)	0.90 (0.08)	0.01	0.01	0.02	0.19	−0.05	0.03	−0.14	−0.03	−0.04	0.11	0.17	−0.15
Sad	860 (133)	0.92 (0.09)	−0.10	−0.10	−0.14	0.20	−0.01	−0.17	−0.02	0.12	0.02	−0.17	−0.27	0.26
Match-set														
Happy	959 (188)	0.94 (0.05)	−0.43**	−0.36*	0.13	−0.12	−0.12	0.08	0.39*	0.40**	−0.14	−0.14	−0.18	0.32*
Neutral	1136 (176)	0.92 (0.09)	−0.12	0.12	−0.07	−0.04	0.00	0.08	0.18	−0.02	0.07	−0.05	0.00	0.38*
Sad	1166 (170)	0.90 (0.09)	−0.14	0.01	−0.08	−0.07	−0.09	0.00	0.10	−0.06	0.05	−0.01	0.06	0.57**
Break-set														
Happy	1163 (204)	0.93 (0.5)	−0.33*	−0.42*	−0.11	−0.11	−0.19	0.04	0.27	0.33*	−0.07	−0.04	0.03	0.22
Neutral	1135 (187)	0.95 (0.07)	−0.16	0.21	−0.19	0.02	0.27	−0.04	0.12	−0.19	0.04	−0.11	−0.18	0.22
Sad	1187 (194)	0.96 (0.05)	−0.26	−0.10	−0.14	−0.04	−0.02	0.23	0.27	0.34*	0.00	0.02	0.25	0.29
No-set														
Happy	1326 (203)	0.93 (0.1)	0.02	0.26	0.01	0.02	0.01	0.06	−0.14	−0.37*	0.18	−0.05	0.07	0.37*
Neutral	1348 (236)	0.94 (0.8)	0.01	0.25	−0.13	0.11	0.18	−0.13	0.03	−0.12	0.27	−0.05	0.00	0.09
Sad	1318 (229)	0.96 (0.7)	−0.05	0.06	0.12	0.04	−0.02	−0.02	−0.10	−0.27	0.19	−0.13	−0.11	0.10

Note: Standard deviations shown in parentheses. RT = reaction time; *$p < .05$; **$p < .01$.

of Emotion, $F(2, 74) = 8.95$, $p < .001$, $\eta^2 = .199$. Follow-up paired *t*-tests indicate that accuracy rates for categorisation of happy faces were significantly higher than were accuracy rates for neutral, $t(39) = 4.89$, or sad, $t(39) = 3.34$, faces, both *p*s $< .01$. There were no significant main effects or interactions involving LOT-R or SAT scores, all *p*s $> .1$.

Match-set accuracy analysis

In the 2-back task, participants failed to respond to an average of 13 trials ($SD = 13$; range = 0–52, all trial types combined). The match-set repeated-measure GLM yielded a significant main effects of Emotion, $F(2, 74) = 8.4$, $p < .01$, $\eta^2 = .19$, and SAT score, $F(1, 39) = 13.1$, $p < .001$, $\eta^2 = .267$. Follow-up paired *t*-tests indicate that accuracy for sad match-set trials was significantly lower than was accuracy for happy, $t(40) = 3.36$, and neutral, $t(40) = 2.47$, match-set trials, both *p*s $< .05$. To examine the main effect for SAT score, we conducted a linear regression on match-set accuracy and SAT scores. This analysis indicated that individuals with higher SAT scores had higher match-set trial accuracy, $\beta = 0.517$, $p < .001$.

Break-set accuracy analysis

The break-set repeated-measure GLM yielded a significant main effect of Emotion, $F(2, 74) = 3.74$, $p < .05$, $\eta^2 = .094$. Follow-up paired *t*-tests indicate that accuracy for sad break-set trials was significantly higher than was accuracy for happy break-set accuracy trials, $t(40) = 2.63$, $p < .05$. No other effects were statistically significant, all *p*s $> .05$.

No-set accuracy analysis

Finally, the no-set repeated-measure GLM did not yield any statistically significant main effects or interactions, all *p*s $> .05$.

Categorisation reaction-time analysis

The repeated-measures regression GLM on emotion categorisation RTs yielded a significant main effect of Emotion, $F(2, 74) = 77.76$, $p < .001$, $\eta^2 = .678$; neither the main effects of LOT-R and SAT scores nor their interactions were significant, all *p*s $> .05$. Follow-up tests indicated that participants had significantly faster RTs to categorise happy faces than sad faces, $t(40) = 6.89$, $p < .001$, which were both significantly faster than were RTs to categorise neutral faces, $t(40) = 17.7$, $p < .001$; $t(40) = 4.35$, $p < .001$, respectively.

Match-set reaction-time analysis

The match-set repeated-measures regression GLM yielded a significant main effect of Emotion, $F(2, 74) = 79.09$, $p < .001$, $\eta^2 = .68$, and a significant interaction of Emotion and LOT-R score, $F(2, 74) = 3.16$, $p < .05$, $\eta^2 = .078$; there were no significant main effects or interactions with SAT score. Follow-up tests indicate that participants matched happy stimuli significantly faster than they did neutral stimuli, $t(40) = 9.45$, $p < .001$, both of which they matched faster than they did sad stimuli, $t(40) = 10.66$, $p < .001$; $t(40) = 2.03$, $p < .05$, respectively. To examine the interaction of emotion and LOT-R scores, we conducted multiple simple slope regression analyses on match-set *z*-scores and LOT-R scores, as well as post hoc simple slope regressions analyses with optimism and pessimism subscale scores. These analyses yielded a significant relation between happy match-set *z*-scores and LOT-R, $\beta = -0.358$, $p < .05$, and pessimism subscale, $\beta = 0.401$, $p < .01$, scores; no other regression slopes were significant, *p*s $> .1$ (see Table 1). Thus, the more pessimistic the participants, the more slowly they make connections among happy stimuli in WM.

Break-set reaction-time analysis

The break-set repeated-measures regression GLM also yielded a significant main effect of

Emotion, $F(2,\ 74) = 7.39$, $p < .01$, $\eta^2 = .166$, and a significant interaction of Emotion and Optimism, $F(2,\ 74) = 4.37$, $p < .05$, $\eta^2 = .106$; there were no significant main effects or interactions with SAT score. Follow-up tests indicated that participants break sets of neutral stimuli significantly faster than they do than sets of happy, $t(40) = 2.02$, $p < .05$, and sad stimuli, $t(40) = 3.24$, $p < .01$, respectively. To examine the interaction of emotion and optimism, we conducted multiple simple slope regressions on break-set z-scores and LOT-R, optimism, and pessimism subscale scores (see Table 1). These analyses yielded a significant relation between happy break-set z-scores and LOT-R, $\beta = 0.423$, $p < .01$, and pessimism subscale, $\beta = 0.326$, $p < .05$, scores, as well as a significant relation between sad break-set z-scores and pessimism subscale scores, $\beta = 0.344$, $p < .01$; no other regression slopes were significant, ps $> .1$. Thus, the more pessimistic the participants, the more slowly they break sets of happy and sad stimuli.

No-set reaction time analysis

The no-set repeated-measures regression GLM yielded no significant main effects or interactions for Emotion, Optimism, or SAT scores, all ps $> .05$ (see Table 1).

DISCUSSION

The present study was designed to examine the relations among optimism, pessimism, and the ability to update emotional information in WM, a critical component of emotion processing and regulation. We examined two dependent variables, accuracy and RT, and their relation to optimism and pessimism. We found SAT scores, but not optimism, to be related to accuracy; perhaps not surprisingly, participants with higher SAT scores performed better in pairing stimuli on a 2-back task than did their lower-scoring counterparts. SAT scores are reliable indicators of general intelligence (e.g., Frey & Detterman, 2004). Our finding of a positive correlation between SAT scores and accuracy on the 2-back match-set trials supports research examining the relation between n-back task performance and fluid intelligence (Shelton, Elliott, Hill, Calamia, & Gouvier, 2009), and indicates that this relation is also obtained with emotional stimuli.

In contrast, the results of the RT analysis indicated that dispositional pessimism interacts with emotional updating: more pessimistic individuals were slower to form connections among positive stimuli and to break connections among positive and sad stimuli in WM than were their less pessimistic counterparts. Furthermore, across levels of LOT-R, participants formed connections among positive representations in WM more quickly than they did among neutral or negative representations, and broke connections among neutral representations more quickly than they did among positive or negative representations.

These results add to a growing literature examining the relation between personality dispositions and cognition. The interactions obtained in the present study between pessimism and the ability to update emotional content in WM suggest that specific cognitive-affective mechanisms underlie the negative thinking and emotion regulation difficulties that characterise pessimistic individuals. As valenced information initially enters WM, it is elaborated, activating related representations from long-term memory that may interact with and alter existing WM representations (Dudai, 2002). Therefore, the slower matching of happy sets of stimuli by pessimistic individuals may contribute to their negative outlook by delaying the formation and elaboration of associations among positive stimuli. Furthermore, the finding that pessimistic individuals are slow to disengage from positive and negative stimuli indicates that once valenced content is in WM, pessimistic individuals find it difficult to remove this material, suggesting that pessimism is also characterised by emotional inflexibility.

The present results also have important implications for our understanding of optimism, pessimism, and the updating of emotional content in WM in the context of the development of psychopathology. Levens and Gotlib (2010) conducted a similar emotion n-back task with depressed and never disordered control participants to examine whether differences in the ability to effectively update emotional content in WM may underlie protective and maladaptive biases that contribute to depression. These investigators found that depressed participants were both slower to break sets of sad stimuli and faster to break sets of happy facial expressions than were healthy control participants who, in contrast, were slower to break sets of happy than neutral or sad stimuli. Depressed individuals were also slower than were controls to match sets of happy stimuli. Levens and Gotlib postulated that these group differences reflect both protective and maladaptive biases in WM that underlie the ability to effectively regulate negative affect.

The results of the current study with optimistic/pessimistic participants were slightly different: pessimistic individuals were slower to match happy stimuli and break sets of happy and sad stimuli than were less pessimistic individuals. While we should be cautious in making comparisons across studies, both depressed and pessimistic participants were slow to match happy and break sad stimulus sets, suggesting that these effects underlie the positive insensitivity and negative thinking common to pessimistic and depressed individuals. These two groups performed differently, however, on happy break-set trials; whereas depressed individuals broke sets of happy stimuli more quickly than did their never-disordered counterparts, pessimistic individuals broke sets of happy stimuli more slowly than did their less pessimistic counterparts, behaving in this instance more like never-disordered participants. This difference in the apparent ease with which pessimistic and depressed persons are able to break positive stimulus sets may represent an important protective attribute that distinguishes these two groups of individuals, and that may prevent high levels of pessimism from leading to depression.

In sum, the present findings support the formulation that personality dispositions are related to attention, information processing, and early stages of self-regulation. Pessimists' slower forming of positive associations and breaking of positive and negative associations in WM would impair their processing of positive stimuli and influence their emotion regulation. The present findings also extend research examining the relation between WM performance and fluid intelligence. The results of this study are important in suggesting that emotion updating biases in WM underlie the affective functioning and difficulties in emotion regulation that characterise pessimistic individuals. Future research should examine more explicitly the links between emotion updating and emotion-regulation strategies such as coping. Investigators should also examine whether pessimism-related differences in updating extend to non-emotional stimuli and, similarly, whether the updating biases that we found in this study are also evident with other emotional stimuli, such as angry faces or threatening pictures.

Manuscript received 16 September 2010
Revised manuscript received 3 January 2011
Manuscript accepted 10 March 2011
First published online 13 June 2011

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