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Brief article

Executive well-being: Updating of positive stimuli in working memory is associated with subjective well-being

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ABSTRACT

A growing literature shows that the ability to control affective information in working memory (WM) plays an important role in emotional functioning. Whereas most studies have focused on executive processes relating to emotion dysregulation and mood disorders, few, if any, have looked at such processes in association with happiness. In this study, we examined whether the ability to update positive and negative stimuli in WM (assessed with an affective *n*-back task) is related to the cognitive and affective components of subjective well-being. Participants who were better at retaining and updating specifically positive (not negative) information in WM displayed higher levels of life satisfaction and affect balance, both at the trait level and in daily life. These results suggest that effective updating of positive information in WM may underlie happy people's ability to maintain and further enhance positive thoughts and emotions.

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1. Introduction

During the last decade, a burgeoning literature has emerged showing that the ability to control emotional information in working memory (WM) is related to emotional functioning. Specifically, deficits in executive functioning have been related to impaired emotion regulation skills, and appear to be risk factors for the development and maintenance of mood disorder (Joormann, Yoon, & Zetsche, 2007). Based on this research, it is not unreasonable to extrapolate that more adaptive forms of executive processing may contribute to the flipside of mood disorder and emotional dysfunctioning. Yet, few studies, if any, have examined executive functioning processes underlying subjective well-being (SWB). Such work is important since studying psychopathology is not necessarily informative for understanding cognitive processes involved in human flourishing. Indeed, what determines the absence of mental disorder does not imply attainment of SWB (Seligman, Parks, & Steen, 2004).

1.1. Updating in working memory and emotional functioning

WM is a limited capacity system, which temporarily stores and processes relevant information before feeding it into and out of long-term memory (Baddeley, 2003). Given that various internal and external information continually competes for access, executive functions play the important role of regulating which information is actively maintained in WM (Miyake et al., 2000). A crucial function is played by the process of updating, which requires coding incoming relevant information, and appropriately modifying the contents in WM to accommodate such information (Miyake et al., 2000; Morris & Jones, 1990).

It has become increasingly clear that the operation of executive functions (such as updating) on emotional information is central to emotional functioning and regulation.

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For instance, certain forms of emotion regulation require focusing on or inhibiting specific emotionally-laden information in WM (Levens & Gotlib 2010). Consequently, biases or impairments in WM functioning have been related to various forms of emotion dysregulation and maladjustment. For instance, depressed individuals have difficulties replacing previously relevant sad stimuli in their WM with happy or neutral stimuli (Levens & Gotlib, 2010), and they also exhibit deficiencies in manipulating negative information in WM (Joormann, Levens, & Gotlib, 2011). Moreover, depression is associated with difficulties disengaging from sad stimuli, and facilitation of disengagement from happy stimuli (Levens & Gotlib, 2010).

1.2. Subjective well-being

SWB involves both cognitive and affective components: evaluating one's life positively (life satisfaction), and experiencing relatively more positive than negative emotions (affect balance), respectively (Diener, 2000; Schimmack, 2003; Suh, Diener, Oishi, & Triandis, 1998). People with high levels of SWB tend to display several positive biases (Abbe, Tkach, & Lyubomirsky, 2003; Lyubomirsky, 2001) like encoding relatively more positive than negative events into memory (Seidlitz & Diener, 1993), perceiving and interpreting life circumstances in positive ways (Lyubomirsky & Tucker, 1998), and being less sensitive to negative feedback (Lyubomirsky & Ross, 1997; Lyubomirsky, Tucker, & Kasri, 2001). Although SWB appears to be associated with more positive cognitive content, the specific ways in which people with high levels of SWB process positive information in WM remain unexplored.

1.3. The present study

The present study investigates whether SWB is associated with the ability to update positive information in WM. Specifically, we examined the association between performance on an affective *n*-back task with life satisfaction and affect balance both at the trait level and in daily life. We predicted that happier participants would be better at updating positive information. This reasoning is consistent with previous research showing that happy people have a tendency to recall and interpret events positively (Lyubomirsky, 2001). This bias towards positive content may be associated with their ability to retain and efficiently update positive material in WM despite other information competing for attention. Moreover, these hypotheses are informed by studies on mood disorders. For example, studies have shown that the ability to update negative emotional information in WM is related to sustained negative affect and depression (Levens & Gotlib, 2010). In addition, because depression is associated with updating and SWB is known to be negatively correlated with depression, it will also be important to examine the relationship between updating of emotional stimuli and SWB while controlling for depression.

Although it has been shown that SWB is associated with positive biases (Abbe et al., 2003; Lyubomirsky, 2001), little is known about how specific cognitive processes, such as updating, relate to SWB. Given the growing literature on executive functioning and psychopathology, demonstrating that SWB is related to better updating for positive information is important for understanding the mechanisms associated with human happiness, beyond what is revealed by studies on psychopathology.

2. Method

2.1. Participants

One hundred participants were selected from a pool of 439 undergraduates to represent a wide and balanced range of depression scores based on a pre-screening measure of the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). One participant withdrew early and four participants were excluded from data analyses (due to equipment malfunction, $n = 3$, poor compliance, $n = 1$) leaving a final sample of 95 participants (59 women, $M_{age} = 19.06$, $SD_{age} = 1.28$).

2.2. Materials

2.2.1. Depression

The CES-D was used to measure level of depressive symptomatology. Participants respond to questions about how often they felt a certain depressive symptom in the past week, ranging from 0 (*rarely or none of the time*) to 3 (*most or all of the time*).

2.2.2. Subjective well-being

SWB was measured using two trait questionnaires and experience sampling. Life satisfaction, the cognitive component of SWB, was measured with the 5-item Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), which asks participants to provide an overall evaluation of their lives on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Affect balance, the affective component of SWB (Suh et al., 1998), was calculated as the difference between the positive and negative affect scales of the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), which asks participants to rate how much they generally experience 10 positive and 10 negative feelings using a scale from 1 (*not at all*) to 5 (*extremely*).

Affect balance was also assessed in daily life using experience sampling. Using palmtops programmed to beep 10 times/day for 7 days, participants recorded their experiences of positive and negative emotions during their normal daily activities. At each beep, participants responded to six items (randomized at each beep) measuring their current feelings of happiness, relaxation, sadness, anxiety, dysphoria, and anger on a continuous slider scale from 1 (*not at all*) to 100 (*very much*). On average, participants responded to 91.5% ($SD = 6.2$) of the programmed beeps. After averaging across negative and positive emotions at each beep, mean positive and negative emotion scores were calculated for each participant, and subtracted to form an affect balance score (Schimmack, 2003). Descriptives of the depression and SWB measures are presented in Table 1.

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Table 1
Descriptive statistics of the different variables used in the study.

Variables	*M*	*SD*	Reliability	Possible range	Actual range
Depression	.73	.48	.91[a]	0.00 to 3.00	0.00 to 2.45
SWB					
Trait					
Life satisfaction	4.60	1.25	.83[a]	1.00 to 7.00	1.80 to 7.00
Affect balance	1.28	0.96	–[b]	−5.00 to 5.00	−1.60 to 3.40
Daily life					
Affect balance	41.61	21.56	–[c]	−100.00 to 100.00	−30.47 to 89.82
n-back task					
Accuracy					
neg–neg–neg	.66	.23	.64[d]	0.00 to 1.00	0.00 to 1.00
neg–pos–neg	.55	.22	.64[d]	0.00 to 1.00	0.08 to 1.00
pos–pos–pos	.68	.20	.56[d]	0.00 to 1.00	0.10 to 1.00
pos–neg–pos	.72	.20	.62[d]	0.00 to 1.00	0.08 to 1.00
Response time (in ms)					
neg–neg–neg	1089.57	334.33	.72[e]	200.00 to 3000.00	267.00 to 2074.49
neg–pos–neg	1126.13	273.61	.81[e]	200.00 to 3000.00	291.50 to 1763.88
pos–pos–pos	1001.21	296.59	.85[e]	200.00 to 3000.00	242.00 to 2008.49
pos–neg–pos	1047.95	291.62	.73[e]	200.00 to 3000.00	334.67 to 1766.33

[a] Calculated using Cronbach's α.
[b] Cronbach α for trait positive (M = 3.18, SD = .58) and negative affect (M = 1.89, SD = .61) were .82 and .86, respectively. The affect balance at the trait level is the difference score between these two variables.
[c] Reliability for positive (M = 57.26, SD = 13.18, within-subject reliability = .65, between-subject reliability = .97) and negative emotions (M = 15.65, SD = 10.75, within-subject reliability = .66, between-subject reliability = .98) in daily life were calculated following Nezlek (2012). The affect balance in daily life is the difference score between these two variables.
[d] Calculated using *KR*20.
[e] Calculated as Spearman–Brown adjusted split-half correlations.

2.2.3. Affective n-back task

To measure updating of affective information, we adapted Levens and Gotlib's (2010) emotional *n*-back task, replacing facial expressions with affective words as stimuli. This task has been shown to be a valid measure of updating affective content among depressed and non-depressed individuals.

2.2.3.1. Stimuli. A total of 47 positive and 49 negative words (including 23 and 27 nouns, respectively) were selected from the Affective Norms of English Words list (Bradley & Lang, 1999) and translated into Dutch. Words were identified as negative and positive if their valence ratings ranged from 1 to 4 and 6 to 9, respectively, and matched in word length and arousal.

2.2.3.2. Task design. The task consisted of 24 practice trials (not scored) and 96 actual trials separated into four blocks of 24 trials. In each trial, participants viewed a single affective word presented centrally for 500 ms followed by a 2500 ms intertrial interval. Participants were instructed to indicate whether the valence of the current word had the same (match) or different (non-match) valence as the word two trials back by pressing the '1' or '2' key, respectively. For the current study, we only analyzed match trials, which were further subdivided into four conditions: (a) positive targets with same lure valence (pos–pos–pos; 10 trials), (b) positive targets with a different lure valence (pos–neg–pos; 12 trials), (c) negative targets with same lure valence (neg–neg–neg; 10 trials), and (d) negative targets with a different lure valence (neg–pos–neg; 12 trials).

2.2.3.3. Data preparation. Mean accuracy and response times (RTs) for each of the conditions were used as indices of participant's ability to update emotional information. For the RTs, we applied the data preparation procedure of Friedman and Miyake (2004), Faust, Balota, Spieler, and Ferraro (1999). Only correct trials were included in the RT analyses. RT values <200 ms and >3000 ms were eliminated (0.3% of all data points, i.e., 17 of 4356 data points). After examining between-subjects RT distributions for each condition, individuals with a score above or below 3*SD*s from the group mean were replaced with values that were plus or minus 3*SD*s from the mean, respectively (0.5% across participants and conditions, i.e., 2 of 396 data points). Following Levens and Gotlib's (2010) procedure, we converted RTs to *z*-scores for each condition[1] (Faust et al., 1999). Table 1 presents accuracy and RT descriptives per condition.

3. Results

3.1. Correlations between depression and SWB measures

Depression was negatively correlated with all SWB measures (life satisfaction, $r = -.60$, $p < .01$, trait affect balance, $r = -.69$, $p < .01$, daily life affect balance, $r = -.68$, $p < .01$). Life satisfaction correlated positively with both trait affect balance ($r = .73$, $p < .01$) and daily life affect bal-

[1] For RTs, we only performed the analyses on 88 participants because we could not compute the *SD* for at least one condition for seven participants (i.e., they had less than 2 correct responses for at least one condition).

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ance ($r = .60$, $p < .01$), which were themselves positively correlated ($r = .73$, $p < .01$).

3.2. Analysis of the n-back task

3.2.1. Accuracy

To examine overall accuracy performance in the *n*-back task, a repeated measures ANOVA was conducted on accuracy scores with lure-type (same vs. different) and target-valence (negative vs. positive) as within-subjects factors. This analysis yielded significant main effects of lure-type, $F(1,94) = 5.86$, $p = .02$, $\eta_p^2 = .06$ and target-valence, $F(1,94) = 27.81$, $p < .01$, $\eta_p^2 = .23$, as well as a significant interaction between the two, $F(1,94) = 31.24$, $p < .01$, $\eta_p^2 = .25$. Follow-up tests indicated that when matching negative stimuli, participants had lower accuracy scores when the lure was a different (vs. same) valence from the target, $t(94) = 5.00$, $p < .01$, $d = .52$. However, when matching positive stimuli, participants had lower accuracy scores with lures of the same (vs. different) valence as the target, $t(94) = -1.96$, $p = .05$, $d = -.22$. In addition, participants performed better when matching positive vs. negative stimuli in trials with a different lure valence, $t(94) = 7.66$, $p < .01$, $d = .79$, but not in trials with the same lure valence, $t(94) = 1.02$, $p = .31$, $d = .09$.

3.2.2. Response times

A similar repeated measures ANOVA on *z*-score transformed RTs showed main effects for lure-type, $F(1,87) = 4.22$, $p = .04$, $\eta_p^2 = .05$, and target-valence, $F(1,87) = 15.85$, $p < .01$, $\eta_p^2 = .15$. No interaction effect was found, $F(1,87) = .11$, $p = .74$, $\eta_p^2 = .00$. Participants were faster at positive compared to negative trials, and at trials with lures of the same valence as the target (see Table 1).

3.3. Relationship between n-back performance and SWB measures

3.3.1. Accuracy

We performed a series of ANCOVAs on accuracy scores with lure-type and target-valence as within-subjects factors and each SWB measure as a standardized continuous covariate. Aside from replicating the significant main and interaction effects reported above, critical to our hypothesis, our results indicated significant interactions between target-valence and each of the SWB measures (see Table 2). No other significant interaction effects were found.

Follow-up simple regression analyses, in which accuracy scores in each of the target-valence conditions were regressed onto each SWB measure, showed that participants with better performance in matching positive stimuli scored higher on both the cognitive and affective measures of SWB. Such relationships were not found for matching negative stimuli (see Table 2). In other words, participants who were better at retaining and matching positive information in WM evaluated their life as more satisfying and experienced relatively more positive than negative emotions throughout life.

To determine whether the relationship between SWB and updating of positive stimuli remained after controlling for depression, we conducted an analogous series of ANCOVAs, adding the standardized CES-D score as an additional covariate. Results replicated the significant interactions between target-valence and the various SWB measures, as well as the relationships between SWB and updating of positive stimuli, and not of negative stimuli, in follow-up regression analyses (see Table 2). No other significant interactions or relationships were found, including those involving depression. This implies that even after controlling for depression, SWB was still associated with updating of positive information.

3.3.2. Response times

Similarly, a series of ANCOVAs were performed on *z*-score transformed RTs each including one SWB component as a standardized continuous covariate. Aside from replicating the significant main and interaction effects, there was a marginally significant interaction between target-valence and affect balance at the trait level (see Table 2). Follow-up regression analyses revealed a significant negative relationship between trait affect balance and *z*-score transformed RTs for matching positive stimuli. Moreover, a similar result was found for affect balance in daily life. This suggests that participants who reported a preponderance of positive relative to negative affect (at the trait level and in daily life) were also faster in updating positive stimuli. No other significant interactions were found.

However, when depression scores were included as a covariate in a series of similar ANCOVAs on *z*-score transformed RTs, no significant main or interaction effects involving SWB or depression remained (see Table 2).[2]

4. Discussion

To our knowledge, the present study is the first to examine whether the ability to update affective information in WM is associated with SWB. As predicted, participants who were more accurate at retaining and updating positive stimuli in WM had higher levels of life satisfaction and experienced relatively more positive than negative emotions as assessed through retrospective self-report and in daily life. Importantly, these results remained after controlling for depression, which implies that the relationship between SWB and updating for positive information goes beyond any effects that depression might have on this relationship. In contrast, our RT results did not show such clear patterns. However, this was not surprising because of the relatively low task accuracy of the current study (range: 55–72%) compared to previous studies (e.g., Levens & Gotlib, 2010; range: 75–90% for match trials). Since RT means are calculated from correct trials, the less accurate people are, the less representative RT means become of

[2] We also performed analyses only with participants who performed above chance-level on the *n*-back ($n = 86$). For accuracy scores, results remained largely similar (with one exception: the interaction between target-valence and trait affect balance did not reach significance). Importantly, participants who had higher accuracy scores for positive targets also had higher scores for SWL ($\beta = .33$, $p < .01$), for affect balance at the trait level ($\beta = .31$, $p < .01$) and in daily life ($\beta = .34$, $p < .01$). No significant relationships were found for negative targets. Results remained even after controlling for depression scores. For RT scores, none of the relationships were significant.

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Table 2
Valence-subjective well-being interactions, and regression analyses predicting updating of affective stimuli by components of SWB.

SWB measures	Valence-SWB interaction				Standardized regression weights			
	Acc		*RT*		Updating of positive stimuli		Updating of negative stimuli	
	F	n_p^2	*F*	n_p^2	*Acc*	*RT*	*Acc*	*RT*
Uncorrected raw scores								
Trait								
Life satisfaction	5.74*	.06	1.84	.02	.27**	−.17	.03	.04
Affect balance	4.19*	.04	3.07†	.03	.24*	−.22*	.03	.06
Daily life								
Affect balance	5.28*	.05	1.04	.01	.28**	−.22*	.05	−.07
Controlling for CESD								
Trait								
Life satisfaction	4.56*	.05	.71	.01	.33**	−.13	.06	.04
Affect balance	3.06†	.03	1.74	.02	.32*	−.22	.08	.06
Daily life								
Affect balance	4.29*	.05	.12	.00	.39**	−.23	.10	−.17

Note: Acc = accuracy; RT = response times.
** $p \leqslant .01$.
* $p < .05$.
† $p < .10$.

the underlying ability. Nonetheless, our current findings clearly demonstrate that happier participants are better, although not necessarily faster, at retaining and matching positive stimuli, beyond what is explained by depression.

The findings of the current study make two important contributions: First, they corroborate and extend previous research on the role of executive functioning in emotional functioning. On one end of the spectrum, research has shown that mood disorders (such as depression) are associated with poorer processing of positive information (e.g., Levens & Gotlib, 2010). Our current study closes the gap on the other end of the spectrum by demonstrating that SWB is associated with better processing of positive information. Second, our findings support Seligman et al.'s (2004) argument that happiness involves not merely the absence of (processes underlying) psychopathology. Indeed, while research shows that mood disorder is characterized mainly by deficits in inhibiting and manipulating negative information (e.g., Joormann et al., 2011), our findings show that better performance in the updating of positive, but not negative, stimuli is associated with higher levels of SWB.

Given the correlational nature of this study, conclusions about a causal relationship between SWB and updating of positive information cannot be drawn. It is possible that updating of positive information contribute to happiness; that is, repeated activation of positive information in WM (through updating) makes such information more accessible and less effortful to process over time (Miller & Cohen, 2001). This would then allow more positive thoughts to be retained, resulting in greater SWB. Yet, it is also likely that ability to update positive information is a result of repeated exposure to positive events. Moreover, it is also possible that a third factor may underlie both people's happiness and updating of positive information (e.g., temperament or goals; Diener, 2000). Finally, current mood, which correlates with overall SWB, may also be a contributing factor, although evidence suggests that positive mood may hamper rather than enhance updating ability (Mitchell & Phillips, 2007). Clearly, future research is needed to examine the direction of the relationship between updating of positive information and SWB, and the role of current mood in the updating of valenced information.

The importance of the present study lies in mirroring a growing literature on the cognitive processes involved in mood disorder by providing first evidence that SWB is associated with better ability to maintain positive information in WM. As such, these results have important theoretical and practical implications in understanding the sources of happiness.

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References

Abbe, A., Tkach, C., & Lyubomirsky, S. (2003). The art of living by dispositionally happy people. *Journal of Happiness Studies*, 385–404.
Baddeley, A. (2003). Working memory: Looking back and looking forward. *Neuroscience*, 829–839.
Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEWs): Instruction manual and affective ratings*. Gainesville: University of Florida, Center for Research in Psychophysiology.
Diener, E. (2000). Subjective well-being: The science of happiness and a proposal for a national index. *American Psychologist, 55*, 34–43.
Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment, 49*, 71–75.
Faust, M. E., Balota, D. A., Spieler, D. H., & Ferraro, F. R. (1999). Individual differences in information processing rate and amount: Implications for group differences in response latency. *Psychological Bulletin, 125*, 777–799.
Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General, 133*, 101–135.

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*.

Joormann, J., Yoon, K. L., & Zetsche, U. (2007). Cognitive inhibition in depression. *Applied and Preventive Psychology, 12*, 128–139.

Levens, S. M., & Gotlib, I. H. (2010). Updating positive and negative stimuli in working memory in depression. *Journal of Experimental Psychology: General, 139*, 654–664.

Lyubomirsky, S. (2001). Why are some people happier than others: The role of cognitive and motivational processes in well-being. *American Psychologist, 56*, 239–249.

Lyubomirsky, S., & Ross, L. (1997). Hedonic consequences of social comparison: A contrast of happy and unhappy people. *Journal of Personality and Social Psychology, 73*, 1141–1157.

Lyubomirsky, S., & Tucker, K. L. (1998). Implications of individual differences in subjective happiness for perceiving, interpreting, and thinking about life events. *Motivation and Emotion, 22*, 155–186.

Lyubomirsky, S., Tucker, K. L., & Kasri, F. (2001). Responses to hedonically conflicting social comparisons: Comparing happy and unhappy people. *European Journal of Social Psychology, 31*, 511–535.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*, 167–202.

Mitchell, R. L. C., & Phillips, L. H. (2007). The psychological, neurochemical and functional neuroanatomical mediators of the effects of positive and negative mood on executive functions. *Neuropsychologia, 45*, 617–629.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wagner, T. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100.

Morris, N., & Jones, D. M. (1990). Memory updating in working memory: The role of the central executive. *British Journal of Psychology, 81*, 111–121.

Nezlek, J. (2012). Multilevel modeling analyses of diary-style data. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 357–383). New York: Guilford.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385–401.

Schimmack, U. (2003). Affect measurement in experience sampling research. *Journal of Happiness Studies, 4*, 79–106.

Seidlitz, L., & Diener, E. (1993). Memory for positive versus negative life events: Theories for the differences between happy and unhappy persons. *Journal of Personality and Social Psychology, 64*, 654–664.

Seligman, M. E. P., Parks, A. C., & Steen, T. (2004). A balanced psychology and a full life. *Philosophical Transactions of the Royal Society of London Series B, 359*, 1379–1381.

Suh, E., Diener, E., Oishi, S., & Triandis, H. C. (1998). The shifting basis of life satisfaction judgments across cultures: Emotions versus norms. *Journal of Personality and Social Psychology, 74*, 482–493.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063–1070.

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