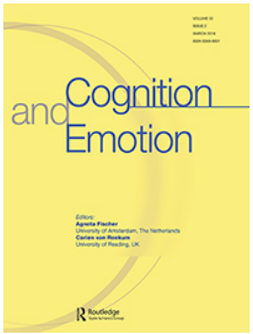

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Cognition and Emotion

ISSN: 0269-9931 (Print) 1464-0600 (Online) Journal homepage: http://www.tandfonline.com/loi/pcem20

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To cite this article: Iliane Houle, Frederick L. Philippe, Serge Lecours & Josiane Roulez (2018) Networks of self-defining memories as a contributing factor to emotional openness, Cognition and Emotion, 32:2, 363-370, DOI: 10.1080/02699931.2017.1284045

To link to this article: https://doi.org/10.1080/02699931.2017.1284045

Published online: 06 Feb 2017.

COGNITION AND EMOTION, 2018
VOL. 32, NO. 2, 363–370
https://doi.org/10.1080/02699931.2017.1284045

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BRIEF ARTICLE

Networks of self-defining memories as a contributing factor to emotional openness

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ABSTRACT

Emotional openness is characterised by a capacity to tolerate threatening self-relevant material and an interest towards new emotional situations. We investigated how specific networks of memories could be an important contributing factor to emotional openness. At Phase 1, participants completed measures of personality traits and emotional intelligence, described a self-defining memory, provided other memories associated with it, and rated the valence of each of their memories. A score assessing the complexity of this memory network, comprising the number of memories reported and their valence diversity, was created. Two weeks later, in laboratory, participants watched an anxiety-inducing film and took part in an interview assessing their emotional openness to the film. They completed a cognitive task before and after the film to measure ego depletion. Controlling for traits and emotional intelligence, memory network complexity was positively associated with emotional openness and negatively with ego depletion. The mental organisation of self-defining memories thus appears to be a critical factor contributing to emotional openness.

ARTICLE HISTORY
Received 5 July 2016
Revised 9 January 2017
Accepted 12 January 2017

KEYWORDS
Self-defining memories; emotional openness; memory network; ego depletion

Emotional openness is characterised by a capacity to tolerate threatening self-relevant material, such as negative emotions (Hart, Shaver, & Goldenberg, 2005), and by an interest towards new emotional situations. It facilitates the integration and the organisation of both negative and positive aspects of new experiences in the self (Weinstein, Deci, & Ryan, 2011), as well as the expression, communication, and regulation of emotion (Weinstein & Hodgins, 2009). Emotional openness has been found to be positively associated with important outcomes, such as cognitive elaboration and complexity, non-avoidance of emotions (Lecours, Philippe, Arseneault, Boucher, & Ahoundova, 2013), and better mental health (e.g. Cramer, 1998). Although certain defences are not necessarily maladaptive or conducive to psychological symptoms, those that prevent emotional openness are typically associated with lower interpersonal abilities and reduced psychological growth (e.g. Beaulieu-Pelletier, Bouchard, & Philippe, 2013). For instance, suppression, which consists in inhibiting one's subjective experience and expression of an emotion, can be useful at short term, but it has also been found to significantly hinder social functioning over time (e.g. Srivastava, Tamir, McGonigal, John, & Gross, 2009).

Emotional openness appears to be an important capacity, but one for which the operating processes are almost unknown. While certain individual characteristics, such as traits like emotional intelligence, are expected to be related to emotional openness (Mayer & Salovey, 1995), traits do not reveal the processes through which people appraise situations as threatening or not, so as to open or defend themselves to the emotionality of the situation.[1] Based on recent contributions in the field of autobiographical memories (e.g. Demblon & D'Argembeau, 2016; Philippe, Koestner, Beaulieu-Pelletier, Lecours, & Lekes, 2012), we suggest that the organisation of memories in the memory system may be associated with emotional openness and operate as a key contributing factor to it.

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Autobiographical memories are constantly used to appraise novel situations. First, situations that match the content of a memory of a past event will trigger that memory. Second, memories are organised into networks and clusters in the memory system, as a function of similar or shared themes, surface features (same location), and emotion (Demblon & D'Argembeau, 2016; Philippe et al., 2012). Consequently, whenever a memory is activated, other memories that are associated with it are also triggered. The content of this entire memory network is then used to appraise the situation that triggered it (e.g. Philippe, Lecours, & Beaulieu-Pelletier, 2009). This process is thought to proceed mostly unconsciously (Conway & Pleydell-Pearce, 2000).

Since the content of memory networks are used to appraise situations, the quality of these networks should have an important impact on emotional openness. The activation of a memory integrated into a large network comprising several memories, notably memories of distinct emotionality, should provide access to diverse alternatives about how to appraise and act in the situation that triggered that memory network. This should facilitate the person's scope of anticipation of the possible consequences of experiencing emotions, thus increasing her/his emotional openness. Conversely, networks of memories comprising few memories or memories that include only one emotional tonality (all positive or all negative), should provide people with few alternatives on how to interpret situations, and therefore result in a rigid and non-nuanced appraisal of situations, which should prevent emotional openness. Greater emotional openness could also, in turn, help forge more complex and diversified memory networks, which would further increase emotional openness in an upward spiral.

Research has shown that there are important individual differences in the way people's memory system is typically organised, and that this has important consequences for emotional openness. Notably, self-defining memories, that is, memories that are highly significant for people, linked to their current goals and concerns, and that people frequently think about, appear to be a window into people's memory system, in terms of the way memories are typically organised in that system. Indeed, characteristics of these memories typically reflect a level of people's identity and general functioning (Singer & Salovey, 1993), and they are more likely to organise themselves in networks based on meaningful themes (Demblon & D'Argembeau, 2016). Moreover, self-defining memories are often representative of other memories in the memory system, and characteristics of distinct self-defining memories have been found to correlate with each other (Blagov & Singer, 2004).

There is empirical evidence suggesting that the general organisation of self-defining memories could be associated with emotional openness. Blagov and Singer (2004) have shown that the number of specific self-defining memories reported by participants was negatively related to defensive functioning, thus supporting the existence of an association between the number of memories composing a network and emotional openness. Another study (Philippe et al., 2009) has found that the number of networked memories linked to a negative self-defining memory and the positive intensity of these networked memories were positively associated with adaptive emotion regulation mechanisms and psychological resilience. This suggests that networks of self-defining memories can represent a window into how memories are typically organised in people's memory system, and that the quality of these networks, in terms of being extended and diversified, should be associated with emotional openness.

The present study

The purpose of the present study was to investigate how the mental organisation of self-defining memories into networks could be associated with emotional openness to a specific emotion, namely anxiety.[2] Participants completed self-report scales assessing personality traits and emotional intelligence, as they represent individual characteristics that have been frequently related to emotional openness, although not empirically (e.g. Matthews, Roberts, & Zeidner, 2004). Participants described a self-defining memory and other memories associated with it and rated the valence characterising each memory.

Two weeks later, they watched an anxiety-inducing film clip in laboratory. Two markers of emotional openness towards this induction were used. First, participants were asked to complete a cognitive task before and after the film clip. Self-regulation research (e.g. Baumeister, Bratslavsky, Muraven, & Tice, 1998) posits that efforts put at modulating one's degree of emotional openness requires self-control, which leaves fewer cognitive resources to exert self-control again, therefore leading to a poorer performance on a subsequent task – a state of ego depletion. For instance, studies showed that participants who were

instructed to suppress their emotional reactions during an upsetting film had a lower performance at a subsequent cognitive task than participants who were not instructed to suppress or deny their emotions (e.g. Baumeister et al., 1998). This suggests that a state of ego depletion at a cognitive task following an emotional induction could be used as a marker of emotional openness. Second, participants took part in a short semi-structured interview, in which they were asked to describe their emotional experience from the film. Judges rated participants' level of emotional openness to the film clip, thus providing an observer-rated measure of emotional openness based on verbal behaviour.

Given that self-defining memories are theorised as reflecting people's general memory organisation, we hypothesised that the complexity of the self-defining memory network, as assessed by the number of memories composing that network and by the presence of memories of distinct valence (positive and negative), would be positively associated with emotional openness and negatively with ego depletion, over and above the overall valence of the network. Moreover, giving that memories reflect the mental organisation of specific cognitions and are therefore not traits, we expected these effects to be independent of personality traits and emotional intelligence, thereby showing incremental validity.

Method

We report here how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants and procedures

Based on past research on the effect of networks of episodic memories on diverse outcomes (Philippe et al., 2009, 2012), the expected effect size was anticipated to be between small and medium ($f^2 = .075$). The power analysis suggested a sample size of 107 participants for a multiple regression with seven predictors (power = .80, alpha = .05). Accordingly, a total of 127 students (104 women, 23 men) from a Canadian university were recruited through their university e-mail to participate in a larger study on emotion and well-being, in exchange of a $20 CAN incentive. Their age ranged from 18 to 45 years ($M = 22.51$, SD = 4.79). During Phase 1, participants completed an online questionnaire that assessed their personality traits, emotional intelligence, well-being (not analysed in the present paper), and described their memories. Two weeks later, in laboratory, participants completed a measure of mood and a cognitive task. They completed a short interview about how they typically experience anxiety and joy, which was not analysed in this study. Next, they were asked to watch an anxiety-inducing film clip and, immediately afterwards, they completed the mood measure and cognitive task again. They were finally asked to express their feelings and thoughts about the film clip within a semi-structured interview.

Measures: Phase 1

Personality traits. Traits were measured with the Big Five Inventory (John & Srivastava, 1999). Only openness, neuroticism, and extraversion were considered, as they were the most closely related to the concepts of emotional intelligence and emotional openness. Cronbach's alpha coefficient was .82 for openness, .87 for neuroticism, and .86 for extraversion.

Emotional intelligence. Emotional intelligence was appraised through the Trait Emotional Intelligence Questionnaire (TEIQue; Petrides, 2009). The TEIQue includes 153 items rated on a 7-point Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*). Cronbach's alpha coefficient was .87.

Self-defining memory. Instructions were adapted from previous studies on self-defining memories (Philippe et al., 2012; Singer & Salovey, 1993). Participants were invited to describe:

> A personal memory of an event that is at least one year old which was significant (important) for you. This memory should reflect your identity or who you are and should reveal something about how you perceive yourself generally. Choose a memory that often comes to your mind. This memory can be either positive, negative, or both.

Networked memories. Participants were asked to describe other personal memories directly or indirectly related to the self-defining memory they had just reported. Participants were provided with three textboxes, but were informed that they did not have to use all textboxes and should only report the associated memories that spontaneously came to their mind (maximum of three). This measure was adapted from the event cuing paradigm (Brown & Schopflocher, 1998).

Self-defining memory network overall valence. Participants were asked to rate the valence (–3 = *very*

negative, +3 = *very positive*) of each memory. Valence ratings of the self-defining memory and networked memories were averaged to create an index representing the self-defining memory network overall valence, as done in past studies (e.g. Philippe et al., 2012).

Self-defining memory network complexity. The total number of memories reported was first calculated. All participants reported a self-defining memory, but not all participants were able to retrieve networked memories. Therefore, this score could range from 1 to 4. Second**,** a dichotomous variable was created to assess the presence or absence of diversity in the valence of the memories reported. A score of 1 was attributed to participants who reported either only positive or negative memories in their network, and a score of 2 was attributed to participants who described both positive and negative memories. Those two memory network components were significantly correlated to each other ($r = .30$, $p < .01$). A score of complexity of the memory network was computed by multiplying the number of memories reported (from 1 to 4) and the network valence's diversity (1 or 2). This score could range from 1 to 8. Participants who reported many memories, from both positive and negative valence, had a higher score (memory network of greater complexity). Participants who reported a small number of memories, from only positive or negative valence, had a lower score (memory network of lower complexity).

Measures: Phase 2

Anxiety. The Positive and Negative Affects Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was used to measure emotions. Participants rated how they were feeling at the present moment, on a 5-point Likert scale (1 = *very slightly or not at all,* 5 = *extremely*). Two measurement moments were used: (1) at the beginning of Phase 2 and (2) right after the film induction. In this study, we were particularly interested in the level of anxiety participants would experience following the film induction. Thus, an anxiety subscale comprising five items (i.e. anxious, nervous, frightened, agitated, and fearful) was computed. Alphas were .76 at Time 1 and .87 at Time 2.

Film induction. Participants watched an anxiety-inducing film excerpt from *The Silence of the Lambs* (Saxon, Utt, Bozman, & Demme, 1991), lasting 3.29 minutes. The film scene was the basement chase, which has been shown to successfully induce anxiety (Gross & Levenson, 1995).

Markers of emotional openness

Verbal behaviour of emotional openness. The experimenter conducted a short semi-structured interview with the participants regarding their emotional experience during the film. Participants were asked "How did you feel during the film?" and could answer the question freely. They were then prompted to add to their response with questions such as "What else can you tell about your emotional reaction to this film clip?" and "Do you feel you have told everything about your experience?" Each interview lasted at least five minutes and was recorded. Afterward, the experimenter rated the extent to which the participants demonstrated emotional openness (1 = *not at all*, 9 = *very much*) according to seven criteria (*R* = reverse-coded): "The participant … " (1) "admitted he/she felt anxiety", (2-R) "was defensive, avoided responding to questions", (3-R) "denied his/her feelings", (4-R) "was not interested or motivated to talk about his/her feelings", (5) "was honest about his/her feelings", (6) "showed a complex emotional life", and (7) "showed a rich emotional representation of the film's characters' experience". Emotional openness was calculated by averaging all items' scores, and the Cronbach's alpha coefficient was .87. Those items were used in a previous study (Lecours et al., 2013) to assess emotional openness and were adapted to correspond to anxiety. Based on a factor analysis with Maximum Likelihood and a parallel analysis, it was determined that only one factor should be retained. All seven items showed strong loadings (>.64) on that factor. A second coder also rated 60% of the interviews based on their audio recordings. Interjudge reliability was acceptable (intraclass $r = .65$). The interview transcripts were also analysed using the Linguistic Inquiry and Word Count (Pennebaker, Booth, Boyd, & Francis, 2015), a software that counts specific words in a given text. The number of anxiety-related words used by participants during their interview was correlated to emotional openness ($r = .35$, $p < .001$). The total number of words used by participants was also calculated.

Ego depletion. Ego depletion provided indications of participants' degree of defensiveness towards the film clip. Their performance at a cognitive task that requires self-control was measured before (Time 1) and after (Time 2) the film. The difference in performance between the two tasks provided an indication of the amount of cognitive resources invested by the participants to shield themselves from the anxiety-inducing experience. The cognitive tasks consisted of

two parallel sets of the digit span subtest from (1) the Stanford–Binet Intelligence Scale (Thorndike, Hagen, & Sattler, 1986) and (2) the Wechsler Adult Intelligence Scale – III (WAIS-III: Wechsler, 1997). The Stanford–Binet was always administered before the induction and the WAIS-III after, so that ego depletion scores would be constant across participants and did not reflect the effect of the task administered second. The ego depletion score was the number of sequences correctly reported at Time 1 minus the number reported at Time 2. A positive score was therefore a sign of ego depletion.

Results

Manipulation checks on the anxiety induction

Paired *t*-test between the anxiety subscale of the PANAS at Times 1 and 2 showed a significant increase in anxiety: $t(126) = 5.78$, $p < .001$, $d = .60$. Thus, the movie clip increased anxiety among participants, confirming that the induction of anxiety was successful.

Emotional openness and ego depletion

Table 1 presents the means, standard deviations, and correlational results of all study variables.[3]

Table 2 presents the results of two hierarchical regression analyses, on emotional openness and ego depletion, conducted to examine the incremental value of the complexity of the self-defining memory network over personality traits (i.e. openness, neuroticism, and extraversion), emotional intelligence, and the memory network overall valence. Performance at the cognitive task at Time 1 was also used as a control measure of general cognitive abilities. This measure has been found to correlate strongly with general intelligence (e.g. Colom, Rebollo, Palacios, Juan-Espinosa, & Kyllonen, 2004). Emotional openness and ego depletion served as dependent variables and were regressed on the three personality traits, emotional intelligence, and performance at the cognitive task at Time 1 at Step 1, on the memory network overall valence at Step 2, and on the memory network complexity at Step 3.

Results at Step 1 revealed that personality traits, emotional intelligence, and the performance at the cognitive task were not associated with emotional openness or ego depletion. At Step 2, the memory network overall valence was also not associated with the dependent variables. However, at Step 3, the self-defining memory network complexity was positively associated with emotional openness, explaining 7% of its variance, $F_{change}(1, 119) = 9.59$, $p < .01$, and was negatively associated with ego depletion, explaining 7% of its variance, $F_{change}(1, 119) = 9.26$, $p < .01$.[4] This suggests that the complexity of a self-defining memory network is associated with emotional openness and ego depletion following an anxiety induction, and this independently of personality traits, general intelligence, emotional intelligence, and the overall valence of the network.

Discussion

Self-defining memories appear to correspond to an adequate representation of people's general organisation of their memory system. Indeed, those memories are specifically elected by people from their autobiographical knowledge base because they are

Table 1. Means, standard deviations, and correlations.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
Emotional openness (1)	6.26	1.59	—										
Ego depletion (2)	1.46	2.52	−.18*	—									
Number of memories (3)	3.31	0.80	.19*	−.21*	—								
SDM network valence diversity (4)	1.53	0.50	.25**	−.25**	.30**	—							
SDM network complexity (5)	5.20	2.30	.29**	−.29**	.70**	.87**	—						
SDM network overall valence (6)	0.43	1.90	−.04	.16	.04	−.01	.02	—					
Emotional intelligence (7)	4.83	0.56	−.02	.02	.13	.02	.09	.47**	—				
Performance at cognitive task, Time 1 (8)	19.54	3.54	−.12	.16	−.10	−.14	−.16	.09	.07	—			
Trait of openness (9)	3.97	0.63	−.10	.02	.15	−.04	.03	.22*	.13	.15	—		
Trait of neuroticism (10)	3.28	0.90	.08	−.08	−.08	.08	.02	−.44**	−.70**	−.05	−.06	—	
Trait of extraversion (11)	3.24	0.82	.05	−.07	.07	.10	.09	.02	.36**	.03	.07	−.15	—
Anxiety, Time 2 (12)	2.22	0.89	.32**	−.01	.11	.07	.13	−.26**	−.12	−.07	−.02	.17	.09

Note: $n = 127$; SDM: Self-defining memory.
*$p < .05$.
**$p < .01$.

Table 2. Hierarchical regressions analysis of personality traits, general intelligence, emotional intelligence, self-defining memory network overall valence, and the self-defining memory network complexity on emotional openness and ego depletion.

	Emotional openness				Ego depletion			
	Model R^2	*B*	95% CI	*β*	Model R^2	*B*	95% CI	*β*
Step 1	.04				.04			
Trait of openness		−.24	[−.69, .22]	−.09		.02	[−.70, .74]	.01
Trait of neuroticism		.29	[−.15, .73]	.17		−.35	[−1.04, .35]	−.12
Trait of extraversion		.08	[−.29, .45]	.04		−.21	[−.80, .38]	−.07
Performance at cognitive task, Time 1		−.05	[−.13, .03]	−.10		.12	[−.01, .24]	.16
Emotional intelligence		.30	[−.46, 1.05]	.10		−.27	[−1.46, .92]	−.06
Step 2	.04				.06			
Self-defining memory network overall valence		.02	[−.16,.19]	.02		.22	[−.05, .50]	.17
Step 3	.11				.13			
Self-defining memory network complexity		.19**	[.07, .31]	.28		−.29**	[−.48, −.10]	−.27

Note: $n = 127$.
**$p < .01$.

significant and represent their enduring concerns and identity (Conway, Singer, & Tagini, 2004). The capacity to organise these memories into complex networks of memories, comprising many memories from diverse valence, seems to be associated with greater level of emotional openness. Our study is the first, to our knowledge, to suggest that the organisation of self-defining memories in networks can act as an important individual difference contributing to emotional openness. It also extends research on self-defining memories that have shown the extensive predictive value of self-defining memories for several outcomes related to defensiveness and emotion regulation. It is also possible that greater emotional openness contributes in return to create more extended and diverse memory networks. Future research will be needed on this issue.

Our findings also show that memory networks characterised by lower complexity can have important cognitive consequences in the short term, as the complexity of the memory network was negatively associated with a state of ego depletion after watching an emotional film. It would thus appear that defending oneself against one's emotional experience has consumed cognitive resources, which were not available afterward to perform well on a subsequent cognitive task. It is still unclear what are the long-term consequences of such defensiveness. However, we can speculate, based on self-regulation research (Baumeister et al., 1998), that people characterised by a low level of emotional openness who have to evolve in environments where they frequently have to face emotional situations may not be as effective as people who can remain open to their emotional experiences.

An apparently surprising finding is that trait emotional intelligence was not significantly associated with emotional openness or ego depletion. However, if emotional intelligence has been found to be related to other general personality traits (e.g. neuroticism, general emotional regulation abilities), there has been little empirical work investigating how it can predict actual reactions in specific contexts (Matthews et al., 2004). Moreover, general personality traits, like emotional intelligence, represent general action tendencies across situations, but may not be relevant to predict precise behaviours in specific situations. Conversely, memories reflect a particular level of people's personality and identity and are representations of the person contextualised in diverse situations (Conway et al., 2004). Our results suggest that this particular level of personality can be a better predictor of emotional openness in response to a specific emotional situation than more general traits.

This study presents some limitations. First, the measure of emotional openness was based on judges' observed evaluations of participants' verbal behaviour. Future research could also use physiological measures to complement this measurement of emotional openness. Second, we suggested that ego depletion was an indicator of defensiveness and suppression of emotions by participants, as it is theorised by self-regulation research. However, we did not directly measure suppression strategies. Our results therefore only indirectly support that claim. Third, the anxiety induction took place in laboratory and participants' response to the interview might not represent the way they naturally respond to anxiety. Social desirability or demand characteristics might be at play in the present design. Fourth, causal conclusions cannot be drawn from the present study design. Finally, the present findings need to be generalised with caution, as there were more females than

males in our sample, and it was comprising university students.

Notes

1. Emotional openness is a concept that differs from trait openness to experience, which typically refers to individuals who are intellectual, imaginative, independent, and open-minded, not necessarily individuals that are open and tolerant towards emotions and self-threatening material (John & Srivastava, 1999).
2. We assessed anxiety because our target participants were students. Anxiety is a frequently and commonly experienced emotion in this population, and a relevant one as well (Bayram & Bilgel, 2008).
3. As can be seen in Table 1, both the number of memories reported in the network and the diversity of valence were positively associated with emotional openness and negatively correlated to ego depletion, which supports the rationale of their aggregation and our algorithm. It should also be noted that averaging the *z*-scores of both variables or multiplying them leads to very similar results.
4. The same hierarchical regressions were also conducted with only diversity of valence or the number of memories of the network at Step 3. Those two variables were individually positively associated with emotional openness and negatively with ego depletion. However, the combination of those two variables in an index of complexity explained a greater portion of variance. Participants' age and sex were not associated with the dependant variables, and their inclusion did not affect the results significantly. Finally, the number of words used during the interview was also unrelated to emotional openness ($\beta = .07$, *ns*), and all study results remained virtually the same when controlling for this variable.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research was supported by a grant from the Social Sciences and Humanities Research Council of Canada 435-2012-1358 awarded to the second author and by a scholarship from the Social Sciences and Humanities Research Council of Canada awarded to the first author.

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