Networks of prospective thoughts: The organizational role of emotion and its impact on well-being

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Abstract

Recent research has shown that many prospective thoughts are organized in networks of related events, but the relational dimensions that contribute to the formation of such networks are not fully understood. Here we investigated the organizational role of emotion by using cues of different valence for eliciting event networks. We found that manipulating the emotional valence of cues influenced the characteristics of events within networks, and that members of a network were more similar to each other on affective components than they were to members of other networks. Furthermore, a substantial proportion of events within networks were part of thematic clusters and cluster membership significantly modulated the impact of represented events on current well-being, in part through an intensification of the emotion felt when thinking about these events. These findings demonstrate that emotion contributes to the organization of future thoughts in networks that can affect people's well-being.

Introduction

The ability to envision one's personal future is an important aspect of human cognition that has recently become a topic of extensive research in various fields of psychology and neuroscience (D'Argembeau, 2012; Schacter et al., 2012; Suddendorf & Corballis, 2007; Szpunar, 2010). Several lines of evidence converge to show that such future-oriented thinking involves the retrieval of various information from episodic and semantic memory, and their flexible combination into coherent event representations (Schacter et al., 2012; Szpunar, 2010). Furthermore, recent studies have shown that many imagined future events are organized in broader event networks that link a set of thematically and causally related events (D'Argembeau & Demblon, 2012; Demblon & D'Argembeau, 2014). The relational dimensions that contribute to the formation of future event networks, however, are not fully understood. The purpose of the present study is to investigate the organizational role of emotion and its possible impact on people's sense of well-being.

There is substantial evidence that emotion is an important dimension for organizing information in the cognitive system. For example, people, objects, and events that evoke the same kind of emotional responses may be categorized together even though they do not have any semantic link (e.g., Niedenthal, Halberstadt, & Innes-Ker, 1999; Castelli & Lanza, 2011). Recent research suggests that emotion also plays such an organizational role in autobiographical memory. Philippe and colleagues have indeed demonstrated that when an emotional memory is retrieved, its emotional components are activated along and spread an activation to other related memories, thus resulting in a network of emotional memories that are similar in valence and intensity (Philippe, Lecours, & Beaulieu-Pelletier, 2009; Philippe et al., 2011, 2012).

This organization of autobiographical memories in emotional networks has important consequences on people's emotional experiences. Networks of emotional memories that are triggered by certain situations influence appraisal processes and contribute to one's current emotional response (Philippe et al., 2009, 2011). For example, a situation evoking loss might trigger a network of specific memories characterized by loss-related features, and these memories have predictive value with respect to people's depressive emotions in the situation (Philippe et al., 2011). Information about goal-affective components such as levels of need satisfaction appears to be particularly critical in determining the emotional impact of memory networks. Self-determination theory (Deci & Ryan, 2000) proposes that humans have an overarching goal of growth, which is expressed through the pursuit of fulfillment of three

psychological needs: autonomy (the need to feel volitional and authentic in one's actions), competence (the need to feel effective and efficacious), and relatedness (the need to feel connected and to care for others and be cared for by others in turn). Emotional memory networks are associated with particular need-satisfying or need-thwarting representations with respect to these three psychological needs, and research has shown that such need satisfaction information is an active ingredient that influences people's emotional responses and well-being (Philippe et al., 2011, 2012).

Like memories for past events, many imagined future events are imbued with emotional value, referring either to positive situations that we would like to achieve or negative situations that we would rather avoid (D'Argembeau, Renaud, & Van der Linden, 2011). However, the extent to which such emotional anticipations are also organized in networks of related events is currently unknown. The main purpose of the present study is to address this question and to investigate whether the organizational role of emotion is similar for memories and future thoughts. If emotion contributes to organize imagined future events in networks, manipulating the valence of the event used for cueing an event network should significantly influence the characteristics (e.g., the valence) of produced events; furthermore, members of a network should be more similar to each other, on emotional valence and related goal-affective components (e.g., levels of need satisfaction), than they should be to members of other networks. To test these hypotheses, we compared the characteristics of networks of memories and future thoughts that were cued by positive and negative events.

Another important aim of this study was to further investigate the nature of the relational dimensions that link events within emotional networks and to determine the possible effect of this organizational structure on well-being. Previous studies have shown that the activation of emotional networks has a significant impact on current affect and well-being (Philippe et al., 2009, 2012), but the extent to which this influence depends on the kind of relations that link events within networks remains unknown. Some event networks are formed on the basis of thematic, causal, and temporal relationships between events, whereas other networks are solely based on more surface features, such as the persons or location shared across events (Brown & Schopflocher, 1998; D'Argembeau & Demblon, 2012). Networks of memories and future thoughts that are formed on the basis of higher-order themes or causal sequences are referred to as "event clusters" (Brown & Schopflocher, 1998) and include events that are organized in the form of "mini-stories," also referred to as general events (Conway & Pleydell-Pearce, 2000). Such higher-order knowledge may convey an overarching meaning to represented events that

exceeds the meaning attributed to each event taken in isolation. Consequently, the organization of events in clusters may amplify the emotion evoked when thinking about these events, and in turn impact one's current sense of well-being to a larger extent.

Method

In accordance with journal policy, we certify that we report below how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Participants. Thirty-three young adults, mainly students at the University of Liège, took part in the study. One participant was excluded because he did not follow the instructions correctly (i.e., the valence of one cueing event did not correspond to the instructions given), leaving thirty-two participants in the analyses (16 females; ranging in age from 18 to 29 years; $M = 25$ years, $SD = 2.4$ years). The sample size was estimated a priori using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) in order to achieve 80% power, considering an alpha error of .05 and a medium within-subject effect size.

Materials and procedure. Before starting the event network task, participants' current affective state was assessed using the Positive and Negative Affective Scale (PANAS) (Watson, Clark, & Tellegen, 1988; French adaptation by Gaudreau, Sanchez, & Blondin, 2006). These scales were administered in order to control for the possible influence of participants' current affective state on our measure of interest (i.e., ratings of well-being impact of memories and future thoughts). Cronbach's alphas were 0.79 for the positive scale and 0.85 for the negative scale in the current sample.

Participants were then instructed to produce four autobiographical event networks that varied according to the emotional valence and temporal orientation of the cueing event; the task was derived from Philippe et al. (2009, 2011, 2012) and adapted for future events. For each network, participants first had to remember or imagine a specific event (i.e., a particular event occurring in a specific place at a specific time, and lasting a few minutes or hours) that served as cueing event. Depending on the condition, it was specified that this event should be a past event that induced a positive emotion when it happened, a past event that induced a negative emotion when it happened, a future event that would induce a positive emotion if it happened,

or a future event that would induce a negative emotion if it happened. Participants wrote a brief description of this event.

Participants were then asked to think about the cueing event and to mention whether other past or future events that were directly or indirectly linked to this event spontaneously came to mind. It was emphasized that they were not required to produce as many events as possible but simply to report any event that spontaneously came to mind, provided that it referred to a specific event. The instructions did not restrict the number of events that could be reported. For each network, participants were allowed to report both past and future events, and there was no instruction about the valence of events such that participants were free to produce positive, negative or neutral events. In short, there was no constraint regarding the type of event produced (except in terms of specificity), such that participants were free to report any event that spontaneously came to mind. They wrote a brief description of all events (referred to as the cued events). The order of presentation of the four kinds of networks (i.e., networks initiated by a positive past event, a negative past event, a positive future event, and a negative future event) was counterbalanced across participants.

Next, participants had to assess various dimensions of each cueing and cued event that had been produced: the emotion felt when thinking about the event (from -3 = *very negative* to 3 = *very positive,* with 0 = *neutral*), the extent to which the event came to mind in the form of visual images (from 1 = *not at all* to 7 = *very much*), and the extent to which the event came to mind in the form of words (from 1 = *not at all* to 7 = *very much*). Nine questions explored the level of need satisfaction of the three psychological needs derived from self-determination theory (Deci & Ryan, 2000): autonomy (e.g. "I felt/will feel that I can be myself"), competence (e.g. "I felt/will feel skillful or capable"), and relatedness (e.g. "I felt/will feel that I get along well with one or more people"); participants rated their degree of agreement with each statement (from -3 = *strongly disagree* to 3 = *strongly agree,* with 0 = *do not agree nor disagree or not applicable*) when thinking about how they felt when the past event happened or would feel if the future event happened. A last question asked participants whether thinking about the event influenced their current well-being (from -3 = *strongly disagree* to 3 = *strongly agree,* with 0 = *do not agree or disagree*). The questions assessing need satisfaction and impact on current well-being were obtained from Philippe et al. (2012) and adapted to assess experiences associated with the imagination of future events.

Finally, the relational dimensions that linked events within each network were assessed. Specifically, participants were asked, for each network, to identify events that 1) shared common people, 2) shared a common location, 3) shared a common activity, 4) were causally related, 5) were nested in one another, 6) were related to a same broader event, 7) corresponded to a same project or to steps allowing the achievement of a goal, and 8) shared a common theme. For each question, participants were asked to identify which (if any) events within the network were linked according to the specified relational dimension. Except for questions 7 (goal) and 8 (theme), these questions were adapted from the work of Brown and colleagues (Brown & Schopflocher, 1998). Following these authors, events were considered to be members of a cluster when participants indicated that they were causally related, members of the same broader event, or nested within one another. Thus, we considered the presence of a cluster when participants identified two or more events of a same network as linked by at least one of the three dimensions assessed in questions 4, 5, and 6.

Results

Characteristics of event networks

The characteristics of event networks are shown in Table 1, as a function of the emotional valence and temporal orientation of the cueing event. For each characteristic, differences across networks were investigated using a two-way (valence by temporal orientation) repeated measures ANOVA (see Table 1). We first examined whether the number of events and the proportion of past events reported per network varied as a function of the emotional valence and temporal orientation of the cueing event. For the number of events, the main effect of valence and the main effect of temporal orientation were both significant, showing that networks included more events when they were cued by past compared to future events and by positive compared to negative events; the interaction between valence and temporal orientation was not significant. For the proportion of past events included in a network, we found a significant main effect of temporal orientation, showing that the proportion of past events was higher when the cue was a past rather than a future event.

Table 1: Characteristics of networks as a function of the emotional valence and temporal orientation of the cueing event.

	PP	NP	PF	NF	Time period of the cue			Valence of the cue			Interaction		
	M (SD)	M (SD)	M (SD)	M (SD)	$F(1,31)$	p	η_p^2	$F(1,31)$	p	η_p^2	$F(1,31)$	p	η_p^2
Number of events	4.50 (1.61)	4.19 (1.75)	4.19 (1.33)	3.75 (1.46)	**4.65**	**.038**	**.130**	**6.06**	**.019**	**.164**	0.12	.735	.004
Prop. of past events	.76 (.18)	.78 (.18)	.46 (.19)	.46 (.17)	**96.30**	**<.001**	**.756**	0.11	.740	.004	0.01	.923	.0003
Prop. of pos. events	.86 (.20)	.23 (.22)	.78 (.25)	.25 (.27)	0.72	.403	.023	**124.97**	**<.001**	**.801**	1.60	.215	.049
Prop. of neg. events	.11 (.18)	.69 (.27)	.17 (.23)	.72 (.29)	1.85	.184	.056	**123.99**	**<.001**	**.800**	0.19	.666	.006
Emotion	1.79 (0.93)	-1.15 (1.07)	1.42 (1.09)	-1.10 (1.33)	1.09	.305	.034	**110.93**	**<.001**	**.781**	1.55	.223	.047
Need satisfaction	1.50 (0.69)	0.16 (0.86)	1.12 (0.61)	0.01 (0.99)	**9.05**	**.005**	**.226**	**68.59**	**<.001**	**.689**	1.07	.309	.033
Well-being	0.93 (1.50)	0.50 (1.42)	0.71 (1.32)	0.25 (1.61)	1.61	.214	.049	**4.25**	**.047**	**.121**	0.01	.938	.0002
Visual images	5.88 (0.89)	5.53 (0.98)	5.71 (1.08)	5.22 (1.13)	3.38	.075	.098	**8.72**	**.006**	**.219**	0.51	.481	.016
Words	2.76 (1.63)	3.24 (1.58)	2.58 (1.47)	2.99 (1.59)	1.57	.219	.048	**8.13**	**.007**	**.208**	0.04	.843	.001

Note: Column headings define the nature of the cueing event. PP = positive past event; NP = negative past event; PF = positive future event; NF = negative future event. Significant main effects and interactions are indicated in bold.

Networks that were cued by a positive event included a higher proportion of positive events (i.e., events receiving a rating > 0 on the emotion rating scale), whereas networks that were cued by a negative event included a higher proportion of negative events (i.e., events receiving a rating < 0 on the emotion rating scale); furthermore, the average valence of events within a network was significantly higher when cued by a positive compared to a negative event (Table 1). To further investigate the potential role of emotional valence in organizing event networks, we examined the proportion of total variance in valence ratings that can be attributed to differences between networks. A multilevel model (with events as level 1 unit, networks as level 2 unit, and participants as level 3 unit) showed that 44% of the total variance in valence ratings can be attributed to differences between networks; a likelihood ratio (LR) test indicated that this part of variance that was due to differences between networks was significantly different from 0 (LR = 117.43, $p < .001$). This indicates that events within networks were more similar to each other on emotional valence than they were to events of other networks, suggesting that emotion is an important dimension that links events within networks.

Following Philippe et al. (2012), we computed an index of need satisfaction by averaging the nine questions about autonomy, competence, and relatedness needs.[1] We found that psychological needs were judged to be more satisfied for networks that were cued by positive rather than negative events and for networks that were cued by past rather than future events. There was significant variation between networks on levels of need satisfaction (38% of the total variance in need satisfaction was due to differences between networks; LR = 75.49, $p < .001$), showing that events within networks were more similar to each other than they were to events of other networks. This indicates a substantial consistency within each event network in terms of need satisfaction.

The impact of represented events on current well-being was judged as being significantly higher for networks that were cued by positive rather than negative events. The representational format of events was also affected by the valence of the cueing event, with

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[1] A three-level confirmatory factor analysis (with events as level 1 unit, networks as level 2 unit and participants as level 3 unit) revealed good fit indices for a three factor model (one factor per need) and for a second order factor, indicating the possibility to average all three needs (CFI = .97, RMSEA = .053, SRMR = .045). Since we did not have specific hypotheses regarding possible dissociations between the three kinds of need, we thus averaged all questions for subsequent analyses.

ratings of visual imagery being higher when the cueing event was positive and ratings of inner speech being higher when the cueing event was negative.

With regard to the relational dimensions that linked events within networks, we first examined the proportion of events that were part of event clusters. Following Brown and Schopflocher (1998), events were considered to be part of a cluster if the participant indicated that they were causally related, members of the same broader event, or nested within one another. Participants reported from 0 to 2 clusters per network. As can be seen from Table 2, the proportion of events that were part of a cluster ranged between 50 and 66%, on average, and did not significantly differ between the four types of networks. The proportions of events sharing the same theme and sharing a common element (i.e., a person, location, or action) were noticeably high, with no significant difference between networks. Finally, we found a main effect of valence for the proportion of events that were related to the same project or goal, showing a higher proportion of goal-related events when the network was cued with a positive rather than a negative event.

Table 2: Relational dimensions linking events within networks.

	PP	NP	PF	NF	Time period of the cue			Valence of the cue			Interaction		
	M (SD)	M (SD)	M (SD)	M (SD)	$F(1,31)$	p	$\eta_p{}^2$	$F(1,31)$	p	$\eta_p{}^2$	$F(1,31)$	p	$\eta_p{}^2$
Event cluster	.54 (.44)	.59 (.35)	.66 (.35)	.50 (.43)	0.04	.832	.001	0.929	.343	.029	2.53	.122	.075
Common elements	.89 (.20)	.86 (.25)	.83 (.27)	.90 (.16)	0.11	.744	.003	0.29	.592	.009	1.67	.206	.051
Same project/goal	.57 (.38)	.30 (.39)	.58 (.37)	.24 (.38)	0.11	.745	.003	**15.96**	**<.001**	**.340**	0.35	.557	.011
Same theme	.92 (.15)	.93 (.19)	.92 (.15)	.87 (.26)	0.92	.345	.029	0.35	.560	.011	0.73	.400	.023

Note: Column headings define the nature of the cueing event. PP = positive past event; NP = negative past event; PF = positive future event; NF = negative future event. Significant main effects and interactions are indicated in bold.

Impact of clustering on current well-being

Our next goal was to investigate whether the organization of events in clusters contributes to the impact of emotional events on current well-being. We first examined whether the current affective state of participants (assessed by the PANAS) influenced their ratings of the impact of events on current well-being. The PANAS scales did not significantly correlate with well-being impact, so they were not considered further (the only correlation that approached statistical significance was between negative affect and well-being impact for networks cued by a negative memory, with $r = 0.32$ and $p = .07$; all other $|rs| < 0.18$, $ps > .34$).

Next, we conducted a multilevel regression analysis (with events as level 1 unit, networks as level 2 unit, and participants as level 3 unit) with current well-being when thinking about the event as dependent variable, and cluster membership as independent variable (coded as a dichotomous variable). Levels of need satisfaction and emotion intensity (corresponding to the absolute value of the emotion rating) associated with each event were also introduced in the model, such that we could investigate whether cluster membership can account for the event impact on current well-being after these variables had been taken into account. We found that each predictor variable made an independent contribution to the prediction of the impact of represented events on current well-being: emotion intensity ($b = 0.440$, $SE = 0.076$, $Z = 5.79$, $p < .001$), need satisfaction ($b = 0.325$, $SE = 0.055$, $Z = 5.91$, $p < .001$), and cluster membership ($b = 0.439$, $SE = 0.152$, $Z = 2.89$, $p = .004$).

The preceding analysis suggests that clustering significantly influences well-being when thinking about events, even after the emotion intensity evoked by the represented events is taken into account. It still remains possible, however, that clustering also impacts well-being through an amplification of the emotion intensity evoked by each event; indeed, a three-level regression analysis revealed that emotion intensity increased with cluster membership ($b = 0.224$, $SE = 0.081$, $Z = 2.77$, $p = .006$). To test this possibility, we conducted a three-level mediation analysis for a 1-1-1 design (i.e., with well-being as dependent variable, clustering as regressor, and emotion intensity as mediator, all measured at level 1) (Preacher, Zyphur, & Zhang, 2010). This analysis revealed a partial mediation, with a significant indirect effect ($b = 0.114$, $SE = 0.047$, $Z = 2.42$, $p = .016$, 95% CI [0.036, 0.191]) as well as a significant direct effect ($b = 0.546$, $SE = 0.161$, $Z = 3.39$, $p = .001$, 95% CI [0.281; 0.811]) of clustering. This suggests that clustering influenced current well-being when thinking about the events in part via an intensification of the emotion evoked by these events.

Discussion

The present findings provide novel evidence that emotion contributes to the organization of prospective thoughts in networks. Manipulating the valence of events used for cueing event networks significantly influenced the characteristics of produced events, notably their emotional valence, level of need satisfaction, and representational format. Most importantly, members of a network were more similar to each other, on emotional valence and related goal-affective components (i.e., need satisfaction), than they were to members of other networks, revealing high affective consistency within networks. These results extend previous work on emotional networks (Philippe et al., 2009, 2011, 2012) by showing that emotion is an important event dimension that links not only autobiographical memories but also prospective thoughts and organizes them in coherent emotional networks.

When examining in more detail the nature of the relational dimensions linking events within networks, we found that a substantial proportion of events were part of event clusters (i.e., higher-order themes and causal sequences; Brown & Schopflocher, 1998), thus replicating recent work on the organization of episodic future thoughts (D'Argembeau & Demblon, 2012; Demblon & D'Argembeau, 2014). Furthermore, an important contribution of the present study is to show that clustering was significantly related to the impact of represented events on a person's current sense of well-being. Indeed, we found that events that were part of clusters had a greater impact on current well-being when thinking about the events, even after the effects of need satisfaction and emotion intensity were taken into account. This finding demonstrates that in addition to levels of need satisfaction (see Philippe et al., 2009, 2012), the impact of emotional networks on current well-being depends on the types of relational dimensions linking events to each other. Our mediation analysis further showed that the effect of clustering on current well-being is partly direct and partly mediated by an amplification of the emotion intensity evoked when thinking about the events. Thinking about events that are part of higher-order themes and causal sequences may prompt people to consider the broader meaning and implications of the events, thus amplifying their affective significance beyond the significance attributed to each event considered in isolation.

Another result that deserves further discussion is that the representational format of networked events differed as a function of the valence of the cueing event, with ratings of visual imagery being higher when the cueing event was positive and ratings of inner speech being higher when the cueing event was negative. This finding is in line with previous studies showing

that positive past and future thoughts typically contain more sensory and contextual details than negative ones (e.g., D'Argembeau & Van der Linden, 2004). Such a difference may in part reflect an emotion regulation process aimed at limiting negative affect when contemplating one's personal past and future. Indeed, mental images evoke stronger affective responses than does verbal processing (Holmes & Mathews, 2010), such that people may be more willing to represent positive than negative events using visual imagery, especially when these events have important implications for their self-images (D'Argembeau & Van der Linden, 2008). The decreased use of visual imagery and increased use of inner speech when thinking about negative events might allow one to detach oneself emotionally while still representing information that is potentially useful for guiding future-oriented decisions and behaviors (e.g., possible threats or negative consequences of one's actions).

It should be acknowledged that the present study has some limitations. First, we investigated whether thinking about past and future events impacts current well-being without exploring the direction (positive or negative) of this effect. Second, we assessed the immediate impact of thinking about past and future events, with the aim to better understand what kind of thoughts (e.g., clustered versus non-clustered thoughts) has greater impact on well-being. However, the present study does not allow us to conclude about longer-term modifications of well-being and this is clearly an important issue that deserves further investigation in future studies. Third, it could be argued that the production of event clusters within event networks could in part be an artifact of task instructions (i.e., participants were explicitly asked to report memories and future thoughts that were related to the cueing events). We do not believe that this is the case, however, because the instructions clearly emphasized that participants should only report events that came spontaneously to mind and the kind of relational dimensions linking events was left unspecified; therefore, the fact that reported events were frequently part of clusters (rather than only sharing surface features) cannot be simply explained by experimental demands. Furthermore, recent evidence has shown that people spontaneously report clustered events even when they are not explicitly instructed to produce a set of related events (i.e., during a free generation task), demonstrating that clustering does not simply reflect demands implied by task instructions (Demblon & D'Argembeau, 2014).

Notwithstanding these limitations, the present results may have important implications for understanding the role of prospective thought in psychopathology (Seligman, Railton, Baumeister, & Sripada, 2013). Emotional disorders such as depression and anxiety have been

linked to reduced positive and/or increased negative future thinking (e.g., MacLeod & Byrne, 1996). It would be interesting in future studies to investigate whether, beyond the anticipation of any single emotional experience, the organization of anticipated events in emotional networks differ in various patient populations and to determine whether organizational particularities contribute to the impact of prospective thoughts on patients' well-being.

Acknowledgement

Funding

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