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REGULATION

**Individual differences in the phenomenology of mental time travel: The effect of vivid visual
imagery and emotion regulation strategies**

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Abstract

It has been claimed that the ability to remember the past and the ability to project oneself into the future are intimately related. We sought support for this proposition by examining whether individual differences in dimensions that have been shown to affect memory for past events similarly influence the experience of projecting oneself into the future. We found that individuals with a higher capacity for visual imagery experienced more visual and other sensory details both when remembering past events and when imagining future events. In addition, individuals who habitually use suppression to regulate their emotions experienced fewer sensory, contextual, and emotional details when representing both past and future events, while the use of reappraisal had no effect on either kind of events. These findings are consistent with the view that mental time travel into the past and into the future relies on similar mechanisms.

Individual differences in the phenomenology of mental time travel: The effect of vivid visual imagery and emotion regulation strategies

As humans, we frequently engage in “mental time travel,” remembering our past experiences and projecting ourselves into possible future events (Suddendorf & Corballis, 1997; Wheeler, Stuss, & Tulving, 1997). When traveling backwards in time, we may remember an event with considerable detail, for instance by “seeing” in our mind the location where the event took place and the persons and objects that were present, remembering what we thought during that event, feeling what we felt, and so forth. These details give us the subjective experience of mentally reliving a past event—a feeling of “warmth and intimacy” as William James wrote (James, 1890)—which is the hallmark of episodic memory (Tulving, 2002; Wheeler et al., 1997). This subjective experience has been intensely investigated in recent years, by asking people to rate the phenomenal characteristics of their memories (e.g., Johnson, Foley, Suengas, & Raye, 1988; Rubin, Schrauf, & Greenberg, 2003) or to report their states of awareness during memory retrieval (e.g., Gardiner, 1988; Tulving, 1985). By contrast, surprisingly few studies have examined the subjective experience associated with projecting oneself forward in time to pre-experience an event, or what has been called “episodic future thinking” (Atance & O’Neill, 2001).

Suddendorf and Corballis (1997; see also Suddendorf & Busby, 2003, 2005) argued that mental time travel into the future and into the past may employ very similar mechanisms. Memories for past events are transient mental representations constructed from specific sensory-perceptual details, as well as more general semantic knowledge (e.g., Conway & Pleydell-Pearce, 2000). Similarly, imagining future events involves combining some basic elements (e.g., actors, objects, and actions), some of which are extrapolations from past events while others come from

general semantic knowledge, to generate potential scenarios. In addition, mental time travel, whether it be into the past or the future, crucially involves the notion of experiencing the self in time or what Tulving calls “autonoetic” consciousness, which is “the kind of consciousness that mediates an individual’s awareness of his or her existence and identity in subjective time extending from the personal past through the present to the personal future” (Tulving, 1985, p. 1). Data that are consistent with these propositions can be summarized as follows. First, developmental research suggests that episodic memory and episodic future thinking emerge approximately at the same time (around age three to four; Atance & O’Neill, 2005; Levine, 2004; Suddendorf & Busby, 2005). Second, patients with brain damage who are unable to recall their personal past typically have difficulties in imagining possible future experiences (Klein, Loftus, & Kihlstrom, 2002; Tulving, 1985). Third, some neuroimaging data suggest that common cerebral bases might underlie thinking about the future and past (Okuda et al., 2003). Finally, the factors that influence the phenomenal characteristics associated with remembering, such as the emotional valence of the events and their temporal distance from the present, have similar effects on the phenomenal characteristics associated with projecting oneself into the future (D’Argembeau & Van der Linden, 2004).

Thus, although this is a relatively new area of research, the existing data are consistent with the view that the ability to remember the past and the ability to project oneself into the future are intimately related. Our goal in this study was to further examine this relationship, focusing specifically on whether certain individual differences affect mental time travel into the past and into the future in the same way. Recent data indicate that some personality dimensions are related to the phenomenology of memory. Rubin and Siegler (2004) found that, of all the domains and facets of personality assessed by the NEO Personality Inventory (Costa & McCrae, 1992), openness to feelings showed by far the strongest relation to the phenomenology of

memory for past events, correlating with measures of belief in the accuracy of memories, sense of recollection, amount of sensory details, and feeling of emotions while remembering. Arguing that the opposite of openness to feelings is the suppression of emotions, Rubin and Siegler related their findings to those of Richards and Gross (2000), who found that people who habitually suppress the expression of their emotions (a) report having a poorer memory for conversations, and (b) recall emotion regulation episodes less well than people with a lower emotion suppression tendency. By contrast, people who habitually regulate their emotions by altering how they think about the situations (i.e., reappraisal) had no better or worse memory than people who do not habitually reappraise (Richards & Gross, 2000). Together, the findings of Rubin and Siegler (2004) and Richards and Gross (2000) thus suggest that the subjective experience associated with remembering past events is affected by individual differences in emotion processing, and particularly the tendency to regulate emotion by means of suppression. Our first goal in this study was to examine whether the subjective experience associated with projecting oneself into the future is also affected by individual differences in the use of emotion regulation strategies.

The second individual difference dimension we were interested in concerns the vividness of visual imagery. Most philosophers and psychologists consider that visual imagery plays a key role in memory for past events (see Brewer, 1996), and neuropsychological data support that claim, by showing that damage to areas known to support visual imagery can, as a secondary consequence, result in an impairment of memory (Conway & Fthenaki, 2000; Greenberg & Rubin, 2003). According to Conway (2001), a crucial function of episodic memory is to keep track of ongoing goal processing, and mental images, especially visual ones, play an important role in representing information about personal goals (Conway, Meares, & Standart, 2004). Episodic future thinking is also closely related to personal goals. Indeed, projecting oneself into

the future involves representing future states of the self that are both related to current goals (i.e., representing episodes of achievement of or failure to achieve personal goals) and plausible with regard to the present state of the self (Atance & O'Neill, 2001). As in the case of memories for past events, it is likely that visual imagery plays an important role in representing future states of the self. If this is the case, individual differences in visual imagery should be related to both episodic memory and episodic future thinking. The second purpose of this study was to examine this proposition.

Method

Participants

One hundred and eight undergraduates at the University of Liège participated in the study. Data from six participants had to be discarded because there were missing values in their questionnaires. The reported results are from the remaining 102 participants (68 of whom were female). Their mean age was 22 years ($SD = 2.8$ years).

Materials and procedure

Participants were tested individually, in two sessions that were separated by a one-week interval. During each session, an initial introduction explained that they would be asked to remember some events that they had personally experienced in the past or to imagine some events that might happen to them in the future. Half of the participants were asked to remember past events during Session 1 and to imagine future events during Session 2, while this order was reversed for the other participants. Detailed written instructions explained that the events participants were to recall or imagine had to be precise and specific (i.e., they had to take place in a specific place at a specific time and they had to last a few minutes or hours but not more than a

day); some examples were provided to illustrate what would or would not be considered as a specific event. For future events, it was also mentioned that the events had to be things that might reasonably happen to them in the future. Participants were asked to remember seven past events and to imagine seven future events from different temporal windows: an event that happened/might happen today, an event that happened yesterday/that might happen tomorrow, an event that happened one week ago/that might happen in one week, an event that happened one month ago/that might happen in one month, an event that happened one year ago/that might happen in one year, an event that happened five years ago/that might happen in five years, and an event that happened ten years ago/that might happen in ten years. For each event, participants were asked to try to remember/imagine the event in as much detail as possible (i.e., remembering/imagining the setting and course of the events, the persons and objects that were/would be present, and so forth) in order to mentally “re-experience” (or “pre-experience”) it. Immediately after having remembered/imagined each event, participants wrote a brief description of the event and rated their subjective experience with 7-point rating scales adapted from the Memory Characteristics Questionnaire (Johnson et al., 1988) and the Autobiographical Memory Questionnaire (Rubin et al., 2003). The rating scales that were used in this study are shown in Table 1 (note that indexes for “autonoetic consciousness,” “other sensory details,” and “spatial context” were computed by averaging responses to two or three items).

Individual differences in vividness of visual imagery were assessed with the Vividness of Visual Imagery Questionnaire (VVIQ), which comprises 16 items referring to different situations that the subject is asked to visualize, rating image vividness on a 5-point scale (Marks, 1973). We used a French version of the VVIQ that has been used in a previous study (Campos, Chiva, & Moreau, 2000) but, as suggested by McKelvie (1995), the numerical values on the 5-point rating scale initially proposed by Marks were reversed, so that higher ratings represent greater

vividness. In the present study, the Cronbach's alpha was .85. Participants also completed the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), which assesses individual differences in the habitual use of two common emotion regulation strategies: cognitive reappraisal (ERQ-R) and expressive suppression (ERQ-S). The ERQ comprises 10 items (6 for the reappraisal scale and 4 for the suppression scale) that are rated on a 7-point scale so that a high score indicates frequent use of reappraisal/suppression. For the purpose of this study, a French adaptation of the ERQ was done using the back-translation method. The two authors and three other psychologists independently translated the ERQ into French and these translations were compared. The five translations were nearly identical; the slight differences were discussed until agreement had been reached. Then, a bilingual translator translated the French ERQ back into English; no semantic differences were noted between the two questionnaire forms. Similarly to Gross and John (2003), an exploratory factor analysis revealed no evidence for a single, general factor; instead, the scree test suggested two factors. These two factors accounted for 53% of the variance, and the maximum loading was found on the correct factor for each item. Also consistent with Gross and John, the ERQ-R and ERQ-S were independent ($r = -.07$). Alphas were .73 and .78 for the ERQ-R and ERQ-S, respectively, which are similar to those reported by Gross and John. The VVIQ significantly correlated with the ERQ-R ($r = .24, p < .05$) but not with the ERQ-S ($r = -.15$).

Results

Content of the events

To give an idea of the content of the events that were remembered and imagined in the present study, we classified the descriptions of events into broad categories. Memories for past events involved episodes at parties (22%), episodes at school (16%), conversations with a relative

or close friend (16%), episodes during leisure activities (12%), romantic episodes (9%), travel (8%), accidents or illnesses (6%), and shopping (5%); 6% of the events could not be classified in these categories. Imagined future events involved episodes related to school or work (24%), episodes at parties (15%), the birth of a child or episodes with a child (12%), episodes during leisure activities (10%), romantic episodes (9%), conversations with a relative or close friend (9%), travel (8%), a move (6%), and shopping (3%); 4% of the events could not be classified in these categories.

Ratings for phenomenal characteristics

For both past and future events, the ratings of the seven events were averaged to provide one value for each phenomenal characteristic for each participant. As can be seen from Table 2, memories for past events contained more visual and other sensory details than representations of future events, were clearer concerning spatial context and temporal information, were formulated to a greater extent in words, were more coherent, and were remembered more with a field perspective. Future events were rated as being more positive and more important than past events. The other rating scales did not differ between past and future events.

Multiple regression analyses were used to assess the influence of individual differences in visual imagery and emotion regulation strategies on the phenomenal characteristics associated with mental time travel into the past and into the future. The independent variables were the scores on the VVIQ, ERQ-R, and ERQ-S, while the dependent variables were the ratings for each phenomenal characteristic. Standardized beta weights and R^2 values are shown in Table 3. For both past and future events, the VVIQ significantly predicted the amount of visual details and other sensory details, indicating that participants with more vivid visual imagery created representations of past and future events that contained more visual and other sensory details. The

VVIQ also predicted the clarity of temporal information for past events while, for future events, it predicted the clarity of spatial context, the feeling of emotions, and the intensity and personal importance of the events.

The two emotion regulation strategies had very different effects on the subjective experience associated with projecting oneself into the past and into the future: while the ERQ-R did not predict any of the phenomenal characteristics, the ERQ-S was negatively related to most of them. For both past and future events, individuals who were high in expressive suppression reported lower ratings for auto-noetic consciousness, visual details, spatial context, feeling emotions, intensity, and the extent to which the events were represented in words. For past events, the ERQ-S also predicted story coherence while, for future events, it predicted other sensory details and temporal information, with participants who were higher in expressive suppression reporting lower ratings in all the cases.

Discussion

Our goal in this study was to examine the relationship between mental time travel into the past and into the future from an individual differences point of view, assessing whether individual differences in visual imagery and emotion regulation strategies affect the phenomenal characteristics associated with memory and with projecting oneself into the future in the same way. The content of the past and future events evoked by the participants involved rather similar domains (school or work, parties, conversations with relatives or friends, romantic relationships, travel), with the exception of the birth of a child or episodes with a child, which were only evoked when imagining the future. Overall, these past and future events formed a rather representative sample of the different kinds of events that characterize human life.

With regard to the phenomenal characteristics associated with mental time travel, we found that participants experienced more visual and other sensory details, more words, a clearer representation of contextual (spatial and temporal) information, a more coherent story, and perceived the event more from a field perspective when remembering past events than when imagining future events. These findings are consistent with a previous study about mental time travel (D'Argembeau & Van der Linden, 2004) and with studies that showed that memories for real events contain more sensory and contextual details than memories for imagined events (e.g., Johnson et al., 1988; McGinnis & Roberts, 1996). In addition, the future events evoked by the participants were rated as being more positive and more important than remembered events, which supports the view that most people have an optimistic bias towards the future (Taylor & Brown, 1988), for instance predicting that they would be more likely than their peers to experience positive events in the future (e.g., having a good job, owning their own home) and less likely to experience negative occurrences (e.g., being fired from a job, divorce; Weinstein, 1980).

Although representations of future events were less detailed than representations of past events, the effects of individual differences in visual imagery and emotion regulation on these two kinds of representations were remarkably similar. For both past and future events, individual differences in the vividness of visual imagery were positively related to the amount of visual and other sensory details experienced while representing the events. In addition, the habitual use of emotion suppression strategies was associated with a decrease in most of the phenomenal characteristics associated with both past and future events, while the use of reappraisal was unrelated to these characteristics. These findings provide new evidence that is consistent with the idea that mental time travel into the past and into the future is intimately related (Atance & O'Neill, 2001; Suddendorf & Corballis, 1997), by showing that individual difference dimensions

that influence the subjective experience associated with remembering past events affect the experience associated with projecting oneself into the future in the same way. In the remainder of the discussion, we consider the specific effects of individual differences in visual imagery and emotion regulation in more detail.

With regard to visual imagery, we found that, when projecting themselves into past and future events, people with a higher capacity for visual imagery experienced not only more visual details but also more details from other sensory modalities and a clearer representation of contextual information (time information for past events and spatial information for future events). As we have already noted, visual imagery seems to play a key role in memory for past events. Visual details can act as cues to activate information from other sensory modalities (Greenberg & Rubin, 2003) and this might explain why individuals who were able to form more vivid visual images also experienced more details from other sensory modalities. In addition, the time of day when a past event occurred is usually not directly stored in memory but is instead reconstructed from the details recalled about the event (Friedman, 1993), and it is likely that more visual information (e.g., about the lighting) facilitates this time reconstruction process.

When projecting themselves into the future, participants with more vivid visual imagery evoked events that were more important and more intense, and they felt more emotions than participants with less vivid visual imagery. As we have already noted, an important function of visual imagery is to represent information about personal goals (Conway et al., 2004). Therefore, it is possible that individuals who are able to form vivid visual images have more information about goals available when representing future events (compared to individuals with less vivid imagery), thereby constructing events that are perceived as more important and that induce more intense emotions. By contrast, this relationship between individual differences in visual imagery and the personal and emotional importance of the events was not observed for past events. A

tentative explanation for this difference between past and future events regarding the relationship between visual imagery and personal/emotional importance might be that people place more importance on future goals than on past goals (the former being more useful to guide current behaviors), so that the influence of visual imagery might be easier to detect for future events. The finding that future events were perceived as being more important than past events is consistent with this interpretation, although further research is needed in order to examine this issue in more detail. More generally, since the tasks we used to assess mental time travel into the past and into the future both involved imagining a specific event, it could be argued that this imagery component shared by both tasks underlies the similar effects of visual imagery ability on representations of past and future events. However, it is difficult to explain the difference between past and future events regarding the relationship between visual imagery ability and the personal/emotional importance of the events exclusively based on the imagery component of the tasks. This suggests that other aspects had an influence, such as the time component.

As for the effects of emotion regulation, our findings extend previous studies (Richards & Gross, 2000; Rubin & Siegler, 2004) by showing that individual differences in suppression affect not only the phenomenology of memory for past events but also the phenomenology associated with mental time travel into the future. By contrast, individual differences in reappraisal did not affect either the subjective experience associated with remembering past events (which is also consistent with the findings of Richards and Gross) or the experience associated with projecting oneself into the future. According to Richards and Gross (2000; see also Richards, 2004), the effect of suppression on memory for past events results from attentional resources being diverted away from ongoing events in order to continuously control one's own emotional responses, thereby decreasing the extent to which individuals are able to encode the details of the events in memory. How can this interpretation be applied to the effect of suppression on episodic future

thinking? We see three possibilities. A first explanation can be drawn from encoding differences. Indeed, considering that representations of future events are constructed by assembling elements that are mainly extrapolations from past events (Suddendorf & Corballis, 1997), individuals who habitually use suppression, and who have therefore encoded fewer details about past events in memory, should not only remember their past experiences in less detail, but also construct less detailed representations of their future. A second (not incompatible) possibility is that suppression is engaged during retrieval, so that it uses resources and decreases the extent to which individuals are able to access detailed information about the events. Remembered and mentally anticipated events can produce emotional responses similar to real events (e.g., Damasio et al., 2000), which may in turn trigger emotion regulation processes. Whenever this is the case, individuals who habitually use suppression to regulate their emotions would have fewer cognitive resources available to access detailed sensory and contextual information to reconstruct past events and imagine future events.

A third explanation might be that individuals who habitually use suppression have developed a specific cognitive style that forces them to avoid constructing overly detailed representations of past and future events, in order to avoid experiencing strong emotions. Our finding that individuals who were high in suppression were less emotionally engaged when projecting themselves into past and future events might be interpreted as a clue to such a cognitive style. However, the present data clearly do not provide definitive evidence regarding the exact processes that are involved in the influence of suppression on mental time travel, so future studies should be conducted to examine the three hypotheses we have proposed. In addition, such studies should also explore whether the influence of suppression on ratings for phenomenal characteristics associated with mental time travel is not simply related to concerns

about self-presentation or self-disclosure, as these concerns have been found to correlate with suppression (see Gross & John, 2003).

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Table 1

Rating scales used to assess the phenomenal characteristics associated with remembering/imagining past and future events

Characteristic	Brief description of rating scale
Autonoetic consciousness	Average of <i>re-experiencing/pre-experiencing</i> and <i>mental time travel</i>
Re-experiencing/pre-experiencing	While remembering/imagining the event, I feel as though I am reliving/experiencing it: 1 = not at all, 7 = completely
Mental time travel	While remembering/imagining the event, I feel that I travel back/forward to the time when it happened/would happen: 1 = not at all, 7 = completely
Visual details	My memory/representation for this event involves visual details: 1 = none, 7 = a lot
Other sensory details	Average of <i>sounds</i> and <i>smells/tastes</i>
Sounds	My memory/representation for this event involves sounds: 1 = none, 7 = a lot
Smells/tastes	My memory/representation for this event involves smells/tastes: 1 = none, 7 = a lot
Spatial context	Average of <i>location</i> , <i>spatial arrangement of objects</i> , and <i>spatial arrangement of people</i>
Location	My memory/representation for the location where the event takes place is: 1 = not at all clear, 7 = very clear
Spatial arrangement of objects	Relative spatial arrangement of objects in my memory/representation for the event is: 1 = not at all clear, 7 = very clear
Spatial arrangement of people	Relative spatial arrangement of people in my memory/representation for the event is: 1 = not at all clear, 7 = very clear
Temporal information	My memory/representation for the time of day when the event takes place is: 1 = not at all clear, 7 = very clear
Feeling emotions	While remembering/imagining the event, I feel the emotions I felt when the event occurred/would feel if the event occurred: 1 = not at all, 7 = completely
Intensity	When/if this event happened, my emotions were/would be: 1 = not intense, 7 = very intense
Valence	When/if this event happened, my emotions were/would be: -3 = very negative, 0 = neutral, +3 = very positive
Personal importance	This event is important to me (it involves an important theme or episode in my life): 1 = not at all important, 7 = very important
In words	While remembering/imagining the event, it comes to me in words: 1 = not at all, 7 = a lot
Coherent story	While remembering/imagining the event, it comes to me as a coherent story and not as an isolated scene: 1 = not at all, 7 = completely
Visual perspective	A detailed paragraph adapted from Nigro and Neisser (1983) asked participants to report whether they "saw" themselves in their memory (observer perspective) or saw the scene from their own perspective (field perspective): from -3 = entirely looking through my eyes to +3 = entirely observing myself from an outside point of view

Table 2

Means and standard deviations for the ratings of past and future events

	Past events		Future events		<i>t</i> (101)
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Autonoetic consciousness	4.24	1.26	4.38	1.35	-1.41
Visual details	5.92	0.72	5.45	0.87	5.58*
Other sensory details	3.96	1.04	3.36	1.09	6.24*
Spatial context	5.72	0.69	4.41	1.11	12.70*
Temporal information	5.98	0.79	4.73	1.13	11.00*
Feeling emotions	4.80	1.11	4.78	1.16	0.20
Intensity	5.04	0.86	5.00	0.98	0.43
Valence	0.85	0.97	1.46	0.89	-5.93*
Personal importance	4.21	1.15	4.73	1.01	-5.31*
In words	3.70	1.64	3.22	1.46	3.83*
Coherent story	4.94	1.23	4.18	1.33	6.23*
Visual perspective	-0.82	1.55	-0.07	1.58	-5.16*

Note: * $p < .05$.

Table 3

Multiple regression analyses with the measures of visual imagery and emotion regulation strategies

	Past events				Future events			
	R^2	Standardized β			R^2	Standardized β		
		VVIQ	ERQ-R	ERQ-S		VVIQ	ERQ-R	ERQ-S
Autonoetic consciousness	.06	-.01	.11	-.22*	.14	.14	.15	-.27**
Visual details	.13	.26**	-.01	-.22*	.22	.26**	-.06	-.37**
Other sensory details	.12	.23*	.12	-.15	.17	.30**	.07	-.21*
Spatial context	.11	.15	.03	-.27**	.13	.23*	-.05	-.25**
Temporal information	.10	.25*	-.01	-.15	.09	.13	.03	-.24*
Feeling emotions	.11	.03	.13	-.28**	.13	.20*	.13	-.21*
Intensity	.10	.04	.06	-.30**	.12	.23*	.05	-.21*
Valence	.05	.05	-.12	-.19	.06	.19	.03	-.08
Personal importance	.05	.11	-.05	-.17	.13	.30**	-.10	-.18
In words	.05	.07	-.03	-.20*	.07	-.02	-.05	-.26**
Coherent story	.16	.12	.18	-.30**	.10	.19	.09	-.18
Visual perspective	.04	.13	-.09	.18	.04	-.09	-.04	.15

Note: VVIQ = Vividness of Visual Imagery Questionnaire; ERQ-R = Emotion Regulation Questionnaire – Reappraisal scale; ERQ-S = Emotion Regulation Questionnaire – Suppression scale.

* $p < .05$. ** $p < .01$.