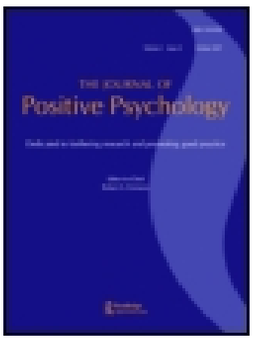

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Resilience facilitates positive emotionality and integration of negative memories in need satisfying memory networks: An experimental study

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ABSTRACT

Resilience has been associated with the capacity to experience positive emotions in the midst of negative life events or following the recall of such events. Apparently, resilient people are able to self-generate those positive emotions because they tend to integrate and associate such past negative life events with other positive past events in memory networks. However, study designs on resilience have remained either cross-sectional or longitudinal. The causal effect of resilience on these outcomes remains to be shown as a third variable or unknown factor could be at play. In this study, we used a resilience intervention from a self-help clinical program to induce resilience and compared this condition against Jacobson type relaxation and neutral music background. Results showed that the resilience intervention increased positive emotionality following the recall of a negative self-defining memory and facilitated the integration of that memory within more positive and need satisfying memory networks.

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Resilience; positive emotionality; memory networks; need satisfaction; self-help program

Resilience has often been associated with the capacity to experience positive emotions in the midst of negative life events (Fredrickson, Tugade, Waugh, & Larkin, 2003) and when thinking back to negative events (Tugade & Fredrickson, 2004). Research has also shown that resilient people are able to self-generate those positive emotions because they tend to integrate and associate past negative life events with other positive past events within memory networks (Philippe, Lecours, & Beaulieu-Pelletier, 2009). However, there is to our knowledge no experimental demonstration confirming that resilience causes these outcomes. Past studies, either cross-sectional or longitudinal, have typically assessed resilience as a trait. There is therefore no certitude that there is not a third variable that is driving this effect (other individual differences or still unknown factors). There is thus a need to ascertain that resilience does cause these outcomes, thereby deepening our understanding of the psychological processes of resilience. The present study will examine these causal effects at the short-term level by manipulating resilience processes using a self-help intervention.

Resilience has been frequently shown to lead to experiences of positive emotions amidst negative events and stress (Block & Kremen, 1996; Klohnen, 1996; Ong, Bergeman, Bisconti, & Wallace, 2006). For instance, Fredrickson et al. (2003) showed that trait resilience predicted increases in positive emotions experienced after the 9/11 attacks on the United States. This experience of positive emotions is essential and has been shown to facilitate coping and faster cardiovascular recovery in face of stress in laboratory studies (Tugade & Fredrickson, 2004). However, resilience is not only about facing stressful events. It is also about living despite having experienced adverse events and, sometimes, traumatic ones. These events do not only have an effect after their experience. They continue having repetitive effects over time through the memory of these events (Philippe & Bernard-Desrosiers, 2017). Recent memory research suggests that it is not as much the frequency of negative events experienced that can hinder mental health, as how the memories of these events are recalled and organized in the memory system (e.g. Philippe, Koestner, Beaulieu-Pelletier, & Lecours, 2011). Two characteristics of memories are expected to promote resilience from past negative events: their experiential component and their organization in networks.

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Need satisfaction in memories as a key experiential component

The experiential component of a memory represents (although not necessarily fully corresponding to it) what the person has experienced during the initial event (Conway, 2009; Wheeler, Stuss, & Tulving, 1997). One important experiential component of memories is the level of need satisfaction experienced during the event of the memory (Philippe, Koestner, Lecours, Beaulieu-Pelletier, & Bois, 2011). According to self-determination theory (Deci & Ryan, 2000), three psychological needs are fundamental to human well-being and growth: autonomy, competence, and relatedness. Autonomy refers to the need to feel volitional and authentic in one's actions. Competence is defined as the need to feel effective and efficacious. Relatedness refers to the need to feel connected, to care for others, and to be cared for by others in turn. The satisfaction of these needs have been found to contribute to well-being and growth in various contexts (Milyavskaya et al., 2009) and across cultures (Tay & Diener, 2011), whereas the thwarting of these needs have been shown to hinder well-being and psychological adjustment (see Deci & Ryan, 2000). Given their constant and pervasive function in people's lives, it is not surprising that research has also found that those needs are a core characteristic of what people remember from past events kept in memories (Philippe, Bouizegarene, Guilbault, Rajotte, & Houle, 2015; Philippe, Koestner, Lecours et al., 2011). Moreover, research has underscored that need satisfaction in memories, as opposed to need thwarting, positively predicts well-being and growth (Philippe, Koestner, Beaulieu-Pelletier, Lecours, & Lekes, 2012; Philippe, Koestner, & Lekes, 2013). The presence of narrative themes similar to need satisfaction in memory descriptions, such as agency (Adler, Skalina, & McAdams, 2008), communion (Bauer & McAdams, 2004), or intrinsic themes (Bauer, McAdams, & Sakaeda, 2005) were also found to correlate with well-being. In addition, those interpretations of need satisfaction and need thwarting are tightly related to the memory to which they pertain and correlate weakly with measures of need satisfaction in other memories or with person-level variables, such as traits and perceptions of need satisfaction in life in general (e.g. 'I feel competent in my life' as opposed to 'During this event, I felt competent' as assessed for a memory) (Philippe et al., 2012).

Memories also keep having repetitive effects over time as a function of the level of need satisfaction or need thwarting characterizing them. Whenever a person thinks about a particular memory or that environmental cues match the content of a memory, this memory is reactivated (Conway & Loveday, 2015; Conway & Pleydell-Pearce, 2000). Research has shown that reactivations of need thwarting memories, intentionally or by subtle and non-consciously perceived cues, have immediate effects that disturb mood and well-being, whereas reactivations of need satisfying memories increase positive mood and well-being (Houle & Philippe, 2017; Philippe & Bernard-Desrosiers, 2017; Philippe et al., 2012). Relatedly, a certain type of memories that are frequently recalled and activated, self-defining memories (Singer & Salovey, 1993), were found to be extremely influential (Blagov & Singer, 2004). These memories are central to people's identity as they tend to reflect people's concerns and self-images and are often linked to other memories. Over time, potentially through their frequent activations, these memories have been shown to significantly alter well-being and adjustment in important life spheres as a function of the level of need satisfaction or need thwarting characterizing these memories (Philippe et al., 2012, 2013). Overall, need satisfaction and need thwarting appears to be a critical characteristic of memories with a great influence on mood and well-being.

Networks of memories

The way memories are organized in the memory system can also facilitate resilience. Memories tend to associate with each other based on common features and themes (Anderson, 1984; Brown & Schopflocher, 1998; Christianson & Engelberg, 1999). Research has shown that networks of memories are often formed based on the contiguity of memory elements, such as similar events (Brown & Schopflocher, 1998), themes (Kemp, Burt, & Malinen, 2009), or emotion (Demblon & D'Argembeau, 2016). Consequently, when a negative episodic memory is triggered, other memories to which it is linked become active, as activation spreads across the links (Anderson, 1984; Bower, 1981; Christianson & Engelberg, 1999). According to the emotional memory network theory (Philippe et al., 2009), two properties of the network can serve essential emotion regulation and resilience functions: the number of networked memories composing the network and their need satisfying or thwarting nature. When an episodic memory characterized by need thwarting is triggered, if this memory is associated with a network of other memories of higher need satisfaction levels, these networked memories can temper the impact of the activated need thwarting memory. Similarly, a greater number of networked memories characterized by need satisfaction will have a greater tempering effect than fewer need satisfying networked memories.

In consequence, the capacity to integrate need thwarting memories in a more need satisfying memory network composed of many memories can be an important factor facilitating resilience. Indeed, resilient people have been

shown to integrate negative events into more positive and need satisfying memory networks (Philippe et al., 2009). Therefore, whenever they experience a novel situation that triggers a negative and need thwarting memory from their past, associated networked memories are triggered as well. The greater number and need-satisfying nature of these networked memories then help alleviate the negativity of the main need thwarting memory activated, thereby allowing resilient people to experience positive emotions in the midst of the novel situation or when thinking back to their need thwarting memory.

The present research

The purpose of the present research was to use an experimental intervention of resilience following the recall of a negative self-defining memory and examine its causal effect on the experience of positive emotionality and the capacity to integrate that memory in a more need satisfying memory network. The resilience intervention used was taken from a supervised self-help intervention, Positive Mental Training (Dobbin, Maxwell, & Elton, 2009), which consists of recorded instructions of mindful relaxation, breathing retraining, visualization of positive events and suggestions of resilience, set against a background of neutral (modal) music. This program previously demonstrated significant reductions in clinical depression (Dobbin et al., 2009; Koeser, Dobbin, Ross, & McCrone, 2013). We used one specific audio track from this program, a track containing suggestions of traits, mindsets, and actions characteristic of resilience, such as self-control, hardiness, taking on challenges, experiencing growth as result of difficulties, strong personality, high self-esteem, trust in abilities, being energetic, and positive meaning finding (Block & Kremen, 1996; Klohnen, 1996; Tugade & Fredrickson, 2004). We reasoned that this track would be effective in inducing a mental state of resilience that could reveal the causal effect of resilience processes on the experience of positive emotionality amidst the recall of a negative event and on the integration of such an event in more need satisfying memory networks. This specific track was therefore used in the current study to induce resilience processes and was compared against tracks of Jacobson type relaxation and a track of music only.

During Phase 1, participants completed online scales of psychological adjustment and described a negative self-defining memory and associated networked memories and rated each memory for need satisfaction. At Phase 2, participants were invited to the lab and were asked to mentally re-experience the event of their negative self-defining memory. They were then randomly assigned to listen to one of the three audio tracks. They subsequently reported their emotions and were asked to describe again networked memories associated with their negative self-defining memory.

We hypothesized that the resilience condition would be more effective than the two other control conditions in increasing positive emotionality after recalling a negative self-defining memory and in facilitating the integration of that memory in a more need satisfying memory network. We did not, however, expect that the ratings of need thwarting of the negative self-defining memory would be reduced over such a short time span. However, the resilience condition should broaden people's cognitive repertoires (Fredrickson, 2001), enabling them to recruit more need satisfying networked memories – as opposed to need thwarting networked memories – in association with their negative self-defining memory. We also examined whether psychological adjustment could act as a moderator. We expected the resilience intervention to be useful to everyone, but hypothesized that it could also be potentially more effective in people presenting lower psychological adjustment. Indeed, people with higher psychological adjustment might already use resilient strategies, in which case the resilience intervention would not contribute additionally.

Method

Participants

A total of 89 undergraduates were recruited from a pool of psychology students at a Canadian university. Six of these participants only completed the measures of Phase 1 and were therefore excluded from the final analyzes. The final sample consisted of 83 participants (70 females, 13 males) with a mean age of $M = 20.30$ years (SD = 1.57 years).

Measures Phase 1

Psychological adjustment

Six scales were used to assess psychological adjustment. A short scale of the Beck Depression Inventory (0- to 3-point scale; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), a short Beck Anxiety Inventory (0- to 3-point scale) measuring the subjective state of anxiety (Osman, Kopper, Barrios, Osman, & Wade, 1997), the 10-item Symptom Checklist (0- to 4-point scale; Rosen et al., 2000, the Perceived Stress Scale (0- to 4-point scale; Cohen, Kamarck, & Mermelstein,1983), the Satisfaction with Life Scale (1-to 7-point scale; Diener, Emmons, Larsen, & Griffin, 1985), and three short subscales (growth, acceptance, and purpose) of the Psychological Wellbeing Scale (1- to 7-point scale; Ryff & Keyes, 1995). All short scales have been used successfully in past research and have displayed adequate evidence of validity and reliability (e.g. Philippe & Bernard-Desrosiers, 2017; Philippe, Koestner, Beaulieu-Pelletier et al., 2011). All

scales were standardized and averaged in an index assessing psychological adjustment with the depression, anxiety, symptoms, and stress scales reverse scored, such that a higher score on this index expressed a high psychological adjustment. Cronbach's alpha coefficient was 0.90 for this index.

Negative self-defining memory

Participants were asked to describe a negative personal self-defining memory (Singer & Salovey, 1993). Instructions were derived from past research (Philippe, Koestner, Beaulieu-Pelletier et al., 2011) and asked the participants:

> "to describe a NEGATIVE personal memory of an event/moment that is at least one year old and that is significant (important) for you. This negative memory should reflect your identity or what you are as a person and should reveal something about how you perceive yourself in general."

Participants were asked to describe their memory in detail, as if they were telling a story to someone.

Networked memories

Following Philippe and colleagues' (2009) procedure, participants were asked to think of other specific personal events that they have experienced in the past that could be linked in one way or another to their negative self-defining memory and to describe them. A maximum of three text boxes were provided to the participants to describe three networked memories. However, they were informed that they did not have to report as many memories but rather write down memories that came spontaneously to mind. Thus, participants were free to recall any number of networked memories, between one and three.

Need satisfaction in memories

After describing all of their memories (self-defining and networked memories), participants were asked to rate the degree of need satisfaction or of need thwarting they experienced at the moment the event of their memory occurred. Participants made their ratings on a 7-point Likert-type scale ranging from −3 (*strongly disagree*) to +3 (*strongly agree*), with 0 representing *do not agree nor disagree or not applicable* – this latter option indicating that both need satisfaction and need thwarting were part of the event or that need satisfaction was not present in the event. They were provided with two items assessing each of the three psychological needs postulated by self-determination theory (i.e. autonomy, competence, and relatedness). Sample items include 'I felt free to do things and to think how I wanted' (autonomy), 'I felt skillful or capable' (competence), and 'I felt connected to one or more people' (relatedness). These items were used in past research (e.g. Philippe, Koestner, Beaulieu-Pelletier et al., 2011) to assess need satisfaction in memories. They were averaged together to form an index of need satisfaction for each memory, separately. Alphas were 0.64 for the self-defining memory and >0.83 for each of the networked memories.

Integration score: Number of need satisfying and need thwarting networked memories.

The number of need satisfying and need thwarting networked memories was calculated. More specifically, networked memories rated >0 in terms of need satisfaction were classified as need satisfying, whereas those rated ≤0 were scored as need thwarting. The number of need thwarting memories was summed and subtracted from the number of need satisfying memories, such that a greater number of need satisfying networked memories as compared to need thwarting networked memories led to a higher integration score. This score takes into account both the number of networked memories reported and their need satisfying vs. need thwarting nature (for similar algorithms, see Philippe et al., 2009, 2012). Since we were specifically interested in how the networked memories could be changed from need thwarting to need satisfying following the intervention (and not just a mere decrease in need thwarting) and in the number of networked memories that would be reported, this algorithm was the most appropriate to test our hypothesis.[1]

Measures Phase 2

Positive emotionality

Participants' positive emotionality was measured using six positive emotional items (amused, content, eager, enthusiastic, happy, interested) used in past research (Tugade & Fredrickson, 2004), six items from the Vitality Scale (Ryan & Frederick, 1997), and six negative emotional items (afraid, angry, anxious, disappointed, disgusted, frustrated). Participants were asked the extent to which they were currently feeling each of the above emotions or the extent to which each statement of the vitality scale was corresponding to how they were currently feeling. Ratings were made on a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*totally*). These scales were completed at the beginning of Phase 2 to obtain a baseline measure (T1: pre-intervention) and again following the experimental manipulation, that is, after listening to one of the three tracks (T2: post-intervention). These three scores were averaged in an index of positive emotionality (with negative emotions reverse scored). Cronbach's alpha coefficient for this index was 0.91 at T1 and 0.86 at T2.

Integration score T2: Need satisfaction in memories and networked memories and number of networked memories

Participants were asked to rate again for need satisfaction the negative self-defining memory they had described

at Phase 1. They were also asked to think of networked memories that seemed to be related to their negative self-defining memory using the same instructions used in Phase 1. They were also told that they could describe the same networked memories they had described one week ago or describe new networked memories that now seemed related to their self-defining memory. They also rated each network memory for need satisfaction. Alphas were 0.70 for the self-defining memory and >0.80 for each of the networked memories. Again, the number of need satisfying and need thwarting networked memories was calculated as explained above.

Intervention conditions

Music condition

The music track consisted of 'in the Dorian mode' by Johan Ovanlee; Dorian modal music is neutral with in neither a minor nor major key so we did not expect mood changes.

Relaxation condition

Against a background of the same music as the music condition, relaxation instructions were given, starting with squeezing the left hand, 'noticing the tension … then when relaxing …. you'll notice … how the relaxation spreads to every part of your entire body and how relaxed your whole body feels' combined with slow diaphragmatic breathing with an experiential focus – 'follow your breath in and follow your breath out, noticing that every time you breathe out you relax more and more, deeper and deeper'.

Resilience condition

The same background music was used. This track suggested at the beginning that the participant will be given pictures and suggestions that will change the way they see themselves, as they listen 'these suggestions and visualizations will sink deeply into your unconscious mind … will give you increased energy, you'll feel more alert, energetic, able to do more, you'll be more effective and resourceful'. There then followed suggestions that the participant will re-appraise an apparently negative situation as explicitly positive (i.e. in an 'increasing positive' fashion where situation is better than before) 'you'll grow as a result of difficulties; you'll experience problems as solutions'. The track concludes with a brief visual activation 'allow yourself to picture yourself in some future situation and see how your increased self-confidence enables you to handle this situation better than you ever have before'. See Appendix 1 for the narratives of each track.

Procedures

The study consisted of two phases. During Phase 1, participants were asked to complete an online questionnaire measuring their psychological adjustment. They were then asked to describe a negative self-defining memory, to rate it for need satisfaction, and to describe networked memories and to rate each networked memory for need satisfaction/thwarting.

Phase 2 took place one week later. Participants were invited to a lab session and tested in small groups (n = 3 or 4) in a large testing room and seated in such a way that they could not see each other. At T1 (pre-intervention), participants completed the baseline positive emotionality scales. They were then shown the negative self-defining personal memory they had described in Phase 1 and asked to 'Please take about two minutes to read this memory and to remind yourself about this event/moment in detail and how you felt during this event/moment'. Next, the program randomly assigned the participants to listen to one of three audio-recorded tracks. In all three tracks there was an instruction to the participant to sit comfortably and close their eyes. We did not assess mood after the mental re-experience of the negative self-defining memory in order to avoid distracting the participants from this memory induction and because it is already well-established that such an induction clearly reduces positive mood and elevates negative mood (e.g. Baker & Guttfreund, 1993; Houle & Philippe, 2017). Each condition lasted 10 min. After listening to the condition, at T2 (post-intervention), participants were asked to complete the same positive emotionality mood scale again and were asked to rate again on need satisfaction their negative self-defining memory. They were then asked to report networked memories again and to rate them for need satisfaction. Participants were fully debriefed and paid $10 for their participation.[2]

Results

There were no significant differences among the conditions on all Phase 1 measures and on pre-intervention positive emotionality (all Fs < 1.00, ns). Psychological adjustment was positively associated with positive emotionality at T1 (r = 0.39, p < 0.01) and with integration at T1 (r = 0.29, p < 0.01). Positive emotionality at T1 and T2 were positively correlated (r = 0.64, p < 0.01), as well as integration scores at T1 and T2 (r = 0.52, p < 0.01).

Positive emotionality

An ANCOVA was performed on positive emotionality at T2 (post-intervention), conditions as the between-factor, and positive emotionality at T1 (pre-intervention) as covariate. By controlling for positive emotionality at T1, the results of this ANCOVA will show if the conditions instilled a change in positive emotionality.[3] Results revealed a main effect of conditions, F(2, 79) = 3.11, p = 0.05. Planned orthogonal contrasts revealed that the resilience condition resulted

in significantly higher levels of positive emotionality at T2 ($M = 4.87$, SE = 0.11) than the relaxation and music conditions ($M = 4.56$, SE = 0.13), $t(81) = 2.42$, $p < 0.05$, which did not differ against each other, $t(55) = 0.48$, *ns*. See Table 1. Controlling for psychological adjustment or for the level of need satisfaction/thwarting in the self-defining memory did not affect these results. However, there was a marginally significant Conditions X Psychological adjustment interaction, $F(2, 76) = 2.83$, $p = 0.065$. Analysis of this interaction was done using multiple regressions and revealed that for those with a low psychological adjustment (-1 SD), there was a particularly greater increase in positive emotionality in the resilience condition as compared to the two other conditions, $t(81) = 3.44$, $p < 0.05$. The distinction among conditions was smaller for those with a high psychological adjustment (+1 SD), $t(81) = 0.66$, $p = 0.51$.

Further analysis of this result revealed that those in the resilience condition with low psychological adjustment increased their positive emotionality at T2 to the same level ($M = 4.87$, SD = 0.68) as those with high psychological adjustment across the three conditions ($M = 4.88$, SD = 0.75), $t(44) = 0.04$, *ns*. For this reason, people in the resilience condition with low psychological adjustment reported significantly greater positive emotionality at T2 than people with low psychological adjustment in the two other conditions $t(34) = 2.32$, $p < 0.05$ and $t(29) = 1.90$, $p < 0.07$. These results suggest that the resilience condition was particularly effective at increasing positive emotionality in people characterized by lower psychological adjustment. Given the clear positive relationship between psychological adjustment and positive emotionality ($r = 0.39$, $p < 0.01$, in this study), it is noteworthy that participants in the resilience condition reached levels of positive emotionality comparable to those typically experienced by people with high psychological adjustment.

Changes in the networked memories

The same ANCOVA was conducted again, but this time the integration score at T2 (post-intervention) served as the dependent variable and conditions was the between-factor. Integration at T1 (pre-intervention) was entered as a covariate to allow the examination of changes in integration between T1 and T2. There was a significant main effect of conditions, $F(2, 79), = 3.24$, $p < 0.05$. Planned orthogonal contrasts revealed that the resilience condition had a significantly higher integration score at T2 ($M = 1.40$, SE = 0.28) than the relaxation and music conditions ($M = 0.54$, SE = 0.38), $t(81) = 2.53$, $p < 0.05$, which did not differ against each other, $t(55) = 0.19$, *ns*. See Table 1. Controlling for need satisfaction/thwarting in the self-defining memory or psychological adjustment did not alter the result and there was no significant Conditions X Psychological adjustment interaction, $F(2, 76) = 1.14$, $p = 0.33$, suggesting that the resilience condition was helpful in facilitating the integration of the negative self-defining memory for everyone, including those with low or high psychological adjustment.

Further analyzes revealed that the resilience condition was effective at both increasing the number of need satisfying networked memories, $t(81) = 2.39$, $p < 0.05$, and decreasing the number of need thwarting networked memories, $t(81) = 2.26$, $p < 0.05$.

The same ANCOVA was conducted again, this time looking at change in the need thwarting ratings of the negative self-defining memory. There was no significant effect of conditions, $F(2, 79) = 0.06$, *ns* or interaction between conditions and psychological adjustment, $F(2, 76) = 1.34$, *ns*, thus suggesting that the resilience intervention did not alter the interpretation of the negative self-defining memory, but was effective at integrating that negative memory in a more need satisfying memory network.

Table 1. Means and standard errors of positive emotionality and integration score across experimental conditions.

	Dependent variables	
Conditions	Positive emotionality T2	Integration score T2
Music	4.53 (0.10)	0.51 (0.26)
Relaxation	4.60 (0.11)	0.58 (0.28)
Resilience	4.88 (0.11)	1.40 (0.28)

Note: Means are adjusted after controlling for their respective T1 measure. Standard errors are in parenthesis.

General discussion

The purpose of the present research was to ascertain the causal effect of resilience processes on positive emotionality amidst the recall of a negative event and the capacity to integrate such negative events into need satisfying memory networks. Our findings revealed that a resilience intervention focusing on key characteristics of resilience (e.g. zestful, self-control, growth, hardiness, positive meaning finding, see Block & Kremen, 1996; Klohnen, 1996) was more effective than relaxation or listening to neutral music at increasing participants' positive emotionality following their recall of one of their own negative self-defining memories. More importantly, the results also showed that the resilience condition facilitated the integration of this negative self-defining memory into a more need satisfying memory network.

The capacity to experience positive emotions amidst adversity or following the recall of negative events is a well-established finding (e.g. Fredrickson, 2001; Tugade & Fredrickson, 2004). The present research extends those findings by showing for the first time the causal effect of resilience on positive emotionality following the recall of a negative event. The effect of our resilience intervention

also appears to have been slightly more effective in people with lower psychological adjustment. This tends to suggest that people with higher psychological adjustment are already able to recruit positive emotions and recover to their baseline level after recalling a negative event. However, people with lower psychological adjustment could have more difficulties achieving this and the resilience intervention appears to have eliminated the difference between those with high and low psychological adjustment on this capacity.

A finding that is much less well-established regarding resilience is that resilient people integrate negative events of their lives within more positive and need satisfying memory networks. This has been suggested as an important way in which resilient people can self-generate positive emotions, notably during the experience of negative events or stress (Philippe et al., 2009). In this study, manipulating resilience, using suggestions of various characteristics of resilience, appears to have led people to associate their negative self-defining memory with more need satisfying networked memories. This not only replicates the findings of Philippe et al. (2009) but complements them by showing the causal effect of resilience on this capacity to integrate negative events within positive and need satisfying memory networks.

The organization of memories in positive and need satisfying memory networks has great emotional regulation value and is potentially a mechanism preventing distressing past events from constantly affecting people's well-being and health over time. Whenever a memory is recalled consciously or activated outside of people's awareness (Philippe et al., 2012) it has a clear impact on people's subjective (Baker & Guttfreund, 1993) and physiological responses (Schwartz, Weinberger, & Singer, 1981). Over time, frequent activations of these memories have been shown to have an enduring effect on stable assessments of depressive mood (Philippe, Koestner, Beaulieu-Pelletier et al., 2011) and well-being (Milyavskaya, Philippe, & Koestner, 2013; Philippe et al., 2012). Because networked memories are activated as well whenever a memory is triggered, these networked memories have the power to reduce the deleterious impact of a frequently activated negative memory, thereby acting as an effective regulating mechanism. This suggests that networked memories are a potential avenue for clinical interventions in order to reduce the deleterious effect that negative memories can have on mental health.

The present study showed that it was possible to 'prime' resilience processes and examine their effects upon key outcomes of resilience. However, from a clinical standpoint, it is unknown if a resilience intervention such as the one we used could lead to stable changes. Memories are constantly reconstructed based on the person's actual goals system and therefore, any mindset such as the one induced in the present research can orient the retrieval process toward certain type of memories. Whether the resilience intervention had an effect at the retrieval mechanisms only or also had a deeper influence at the structural level of memory – at the way memories are associated in the self-memory system – remains unknown. However, if the resilience intervention broadened cognitions (Fredrickson, 2001) and increased the capacity to recruit more diverse and more need satisfying network memories, then repetitive inductions of resilience could lead to stable changes in the memory system. If these changes are stable, then thinking back to the negative self-defining memory should lessen its deleterious impact on subjective and physiological well-being, which over time, should lead to improvements in psychological adjustment. Future research will be needed to examine the long-term effect of such interventions.

A number of limitations should be underscored regarding the present research. First, the sample size was a bit small. Consequently, our power was slightly reduced and only medium to large effects could be detected. It remains possible that smaller effects that could not be detected with our analyzes could play a role. Second, we did not use a manipulation check for our resilience intervention. We had several reasons not to do so. A first reason is that the resilience intervention we used is part of a larger self-help program, which has been shown to be effective (Dobbin et al., 2009; Koeser et al., 2013) and the narratives of the track have clear face validity. There is therefore some evidence that this track can tap into resilience processes. A second reason is that it is difficult to determine what would have been an adequate manipulation check for resilience. There exists no situational measure of resilience and it is doubtful that our resilience intervention would have translated into influencing participants' responses to a trait inventory of resilience. A third reason is that we were very careful in the present research to avoid any influence that could have thwarted our intervention, as we were unaware of the strength of our manipulation. As such, we did not measure emotions after the memory recall in order to prevent participants from focusing on this task as an induction and we did not use any manipulation check so as not to prime participants with non-resilience. Indeed, responding to a trait inventory of resilience following the resilience intervention could bring to mind that one does not feel or act in this way very often, which could counteract the resilience induction. Now that there is evidence that the resilience intervention is effective, future research could try to use a manipulation check to further ensure that resilience is actually induced by the audio track. Nevertheless, the intervention we used showed to lead to resilient-like outcomes and this can have important consequences for clinical programs.

Notes

1. Averaging the need satisfaction ratings would lose the information as to whether a memory was only reduced in need thwarting, while still remaining need thwarting, or whether it has changed from need thwarting to need satisfying. Research has shown that need thwarting memories, regardless of their intensity, negatively affect people's well-being. For example, priming a need thwarting memory will immediately reduce situational well-being, regardless of how much need thwarting it is, whereas priming a need satisfying memory will increase well-being (Philippe & Bernard-Desrosiers, 2017; Philippe et al., 2012). As such, the key is not to reduce the intensity of need thwarting memories, since these memories will continue to have deleterious effects, but rather to change those memories from need thwarting to need satisfying (or to elect new need satisfying memories). The present algorithm takes into account this important issue.
2. The Autobiographical Memory Test was also assessed at the end of both Phases 1 and 2, but will not be analyzed in this study.
3. Results were the same using a repeated-measures ANOVA. Although there were no significant ($p < 0.05$) differences among conditions in the means of positive emotionality and integration score at T1, the means were not equal across conditions (e.g. means ranging from 4.49 to 4.71 for positive emotionality at T1). The ANCOVA was therefore initially judged as more adequate than repeated measures to adjust for those pre-intervention unequal means among conditions.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix 1

Relaxation track

Sit or lie down and make yourself as comfortable as possible. In a moment I'll ask you to clench your left hand as hard as you can, take in a deep breath and hold it notice that when you do this the tension in your body especially in your chest and in your left hand and forearm will increase I will then ask you to breathe out, close your eyes, and relax your left hand and you'll notice when you do that how the relaxation spreads to every part of your entire body and how relaxed your whole body feels You can begin now by clenching your left hand as hard as you can, take a deep breath as deep as possible and hold your breath hold your breath notice the tensing in your left hand and chest and breathe out, allowing your eyes to close and relaxing your left hand and your entire body feel how the relaxation spreads throughout your entire body you don't need to make any effort to spread the relaxation just let it come in its own way, breathe calmly and evenly, Concentrate effortlessly on the physical sensations of breathing, the feeling of stretching as you breathe in, and relaxation as you breathe out as you breathe in follow your breath in, as you breathe out follow your breath out, as you breathe in you are aware of your body, as you breathe out you are calming your body, follow your breath in and follow your breath out, noticing that every time you breathe out you relax more and more, deeper and deeper. Now just continue breathing calmly and evenly for a few moments until I speak to you again each time that you breathe out allow yourself to relax even more, allow the relaxation to spread throughout your entire body at its own speed, noticing the pleasurable sensation of heaviness that follows the relaxation.

Now we're going to help your body relax by noticing each muscle group in the order in which they come, allowing each muscle to relax totally after I name each part, allowing the relaxation to come by itself each time that you breathe out. Start by relaxing your forehead, your eyebrows, and your eyelids which are now lightly and comfortably closed, relaxing your mouth, your tongue, your jaws, allowing your lips to part just a little, allowing the relaxation to move into every muscle in your face allowing the relaxation now to move into the front and the back of your neck, and allowing all the tension in your neck to disappear and be replaced by a feeling of relaxation, relaxing your shoulders and letting that feeling spread down into your arms and into your fingers. Notice the pleasurable sensation of heaviness that follows the relaxation, relaxed and heavy relaxed and heavy allow a pleasurable sensation of heaviness and warmth to spread throughout your entire body, allow your chest and stomach to relax, breathe into your stomach, allow each breath out passively allow your chest and stomach to relax as you continue to breathe out allow the relaxed feeling to go deeper each time you breathe out allow the relaxation to spread down further into your back and into your entire lower body, relaxing your buttocks, thighs, lower legs and feet, allowing your feet to fall out to the side, and noticing how relaxed and heavy your lower legs have become, noting how relaxed your entire body has become, and how, as tensions disappear, your body feels pleasant comfortable and relaxed. Allow the relaxation to increase each time that you breathe out.

Go ahead and relax on your own now for a few minutes. Recognize that you have reached a place that is very special to you that feels good to you. And I'll make contact with you again there shortly. Relax on your own now, each time you breathe out let it take you down to a calm beautiful and restful place.

When you wake up, you will feel relaxed calm and good in every way.

Resilience track

Sit or lie down and make yourself as comfortable as possible, and allow your eyes to close. I'm going to give you a few pictures and suggestions that will help you increase your self confidence, that will help you look at yourself in a more positive way, that will help you to value yourself even more than you already do, that will help you respect yourself more, that will help you to have an even better feeling when you think about yourself. These suggestions and pictures that you receive while you are in this state are going to build up your self image, increase your self confidence, and increase your good feelings about yourself. These pictures and suggestions that you receive will affect the way you think, the way that you feel and the way that you act, they'll change your attitude to yourself and you'll see yourself in a more positive way. Afterwards you'll notice each and every change that is positive and this will make you happy. As you continue to listen to this track relaxing deeply becoming more and more relaxed with every breath out these suggestions and visualisations will sink deeply into your unconscious mind and will remain there and will give you increased energy, you'll feel more alert, energetic able to do more, you'll be more effective and resourceful, you'll be able to take the initiative and better be able to accomplish whatever task you set for yourself, You'll find that your nerves are stronger, that you're emotionally stronger, and that you'll feel more stable, your thoughts will be calmer and clearer, more controlled, more collected and balanced, more filled with satisfaction, and you'll have an easier and easier time focusing and concentrating and paying attention to whatever it is you're doing at that moment, you'll be able to detach your thoughts from issues that are at that moment irrelevant, and you'll have an increased ability to keep concentration and focus in the midst of disturbances. You'll be able to see things exactly the way they are without making difficulties seem larger than they really are, and without losing your sense of perspective. You'll also be able to look at things that happen in a more positive way. You'll discover that there's something positive to be found in everything that happens you'll find that you can never ever fail and you'll be able to learn from your mistakes, you'll experience that you'll grow as a result of difficulties, you'll experience problems as solutions, hindrances as challenges, this means that you'll be able to face the future with a deep feeling of calm assurance and self confidence. You'll be able to look at coming events with a feeling of confidence and positive expectation, you'll be able to stand up for yourself more, You will realize that you too have the right to become angry that you too have the right to be sad, you will realize that your feelings are as important as those of other people. You will more easily express your own ideas, you will realize that your ideas are as important as those of other people, that you are as important a person as anyone else. Every day you will experience an increase of inner safety, inner security, and personal well being, you will become more aware of your resources and your potential, day by day your trust in your own abilities will increase, day by day your feeling of safety and inner security will grow, day by day your self esteem, your self respect and your self confidence will steadily develop. You'll experience that your picture of yourself

and your personal resources will grow more and more and become more and more positive. You can allow yourself to relax on your own now and absorb all this information, let it sink deep down inside you. Allow yourself to picture yourself in some future situation and see how your increased self confidence enables you to handle this situation better than you ever have before. Allow yourself to move into this situation and experience how much better you manage it than you ever have before.

When you wake up you will retain these feelings of calm assurance and inner balance. You'll feel rested and cheerful, you'll know that the suggestions and pictures that you've just received will rest within you and will affect the way of thinking and feeling and acting that you now have at your command. You will feel relaxed calm and good in every way.