Brief report

Positive facial expressions during retrieval of self-defining memories

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Abstract

This study, for the first time investigates facial expressions during the retrieval of self-defining memories (i.e., vivid and emotionally intense memories of enduring concerns or unresolved conflicts). Participants self-rated the emotional valence of their self-defining memories, while autobiographical retrieval was analyzed with facial analysis software. This software (Facereader) synthesizes the information in facial expression (i.e., cheek, lips, muscles, eyebrow muscles) to describe and categorize facial expressions (i.e., neutral, happy, sad, surprised, angry, scared, and disgusted facial expressions). It was found that participants showed more emotional than neutral facial expressions during the retrieval of self-defining memories. It was also found that participants showed more positive than negative facial expressions during the retrieval of self-defining memories. Interestingly, participants attributed positive valence to the retrieved memories. These findings are the first to demonstrate the consistency between facial expressions and the subjective emotional experience of self-defining memories. These findings provide valuable physiological information about the emotional experience of the past.

Keywords

Autobiographical memory; emotion; facial expressions; facial expressions analysis

1. Introduction

There is a current increase of interest in the relationship between facial expressions and autobiographical memory (i.e., memory of personal experiences or events) that are related to the self [1, 2]. Much of this interest originates in the discovery that autobiographical retrieval can trigger emotional facial expressions. This issue previously been investigated in a study that demonstrated emotional facial expressions during retrieval of emotional autobiographical memories [3]. In that study, participants were invited to recall memories related to emotional cues and retrieval was analyzed with facial analysis software (Facereader). This software applies an algorithm to locate a face in images or videos; it also synthesizes the face by calculating the location of 500 key points and includes the facial texture of the area delineated by these 500 points [4–6]. The software successively classifies facial expressions using an artificial neural network that classifies basic emotions described by Ekman [7, 8] (i.e., neutral, happy, sad, surprised, angry, scared, and disgusted). The software classifies emotional expressions by specifying their facial action units, which typically represent a distinct movement of the face that is isolated from other parts of the face [9, 10].

The evaluation of facial expressions during autobiographical retrieval was also investigated in a study that assessed past and future thinking [11]. In that study, subjects remembered and imagined future personal events. Subjects demonstrated more emotional and fewer neutral facial expressions during imagining the future than

during remembering the past. By describing facial expressions during future thinking, El Haj and Antoine [11] provide physiological evidence on the emotional characteristics of mental time travel into the future [12–16]. The same thing can be said for the evaluation of facial expressions during autobiographical retrieval in general; this evaluation provides valuable physiological information about the emotional experience of the past as this experience has been mainly evaluated with subjective methods (e.g., scales on which participants indicate their emotional state) [17–24].

To provide further insight about emotional facial expressions that may be triggered by autobiographical retrieval, the present study investigates facial expressions during the retrieval of self-defining memories (SDMs). SDMs are important as these memories are highly associated with the self and identity [25, 26]. SDMs refer to those vivid, emotionally intense, and repetitively recalled memories of enduring concerns or unresolved conflicts [27]. According to Conway and Singer [28], these memories help maintain self-consistency and self-coherence, particularly during times of difficult transitions or upheaval. Supporting this assumption, studies have demonstrated the involvement of SDMs in the anticipation of important future events [29], the pursuit of long-term goals [30], development of personality [31], activation of specific self-representations [32], and emotional regulation [31, 33, 34]. At a social level, people frequently describe themselves and their life stories by sharing SDMs with others as this sharing facilitates intimacy and the transmission

of personal experience [35, 36]. Beyond their social-sharing function, SDMs contribute to meaning making and life story integration [25, 36, 37]. In other words, these memories help people establish the meaning of past events and integrate this meaning within the context of their life story [38, 39].

The importance of SDMs to the self and identity has been illustrated with an integrated model of narrative identity by Singer and Blagov [27], according to whom such memories contribute to the creation of narrative scripts that constitute a stock of "chapters" across one's life story. These assumptions of Singer and Blagov [27] have been supported by studies demonstrating the relationship between compromise of the ability to retrieve SDMs and diminished sense of self and identity in psychiatric [29, 40–44] and neurological [44, 45] populations. Together, SDMs are memories that significantly contribute to the sense of self and identity. By investigation of facial expressions during retrieval of SDMs, this study ought to provide physiological insight into the emotional salience of these kind of memories.

To assess facial expressions that may be triggered by retrieval of SDMs, subjects were invited to retrieve memories that significantly contributed to their life story and identity. Retrieval was video recorded and later analyzed with facial analysis software. Besides this objective evaluation, subjects were invited to evaluate the emotional valence of their memories on a self-rating scale. It was predicted that participants would show more emotional than neutral facial expressions during SDM retrieval.

2. Method

2.1. Subjects

The study included 20 subjects (eight women; M age $= 38.74$ years, $SD = 7.59$) who participated on a voluntary basis and were debriefed following the study. Subjects were native French speakers. Exclusion criteria were a history of neurological, psychiatric, or learning disorders. Informed consent was obtained in accordance with the principles laid down by the Helsinki Declaration.

To measure cognitive function, subjects were assessed using the Montreal Cognitive Assessment, a 30-items cognitive screening tool that screens attention, orientation, language, verbal memory, visuospatial, and executive function. The subjects obtained a mean score of 29.00/30 ($SD = 1.24$).

2.2. Procedures

Subjects were verbally asked to recount five events in their lives. For each event, subjects were instructed: (instructions translated from French to English) "you are invited to remember a specific event in your life, an event that you consider is important to define who you are. In other words, this memory should refer to an event that helps you understand who you are as an individual, this event should be also an event you would share with someone if you wanted that person to understand you in a basic way. The event may be a positive or negative memory, or both; the only important aspect is that it should lead to strong feelings. The memory should be an event that you have thought about many times. It should be also familiar to you like a picture you have looked at a lot or song you have learned by heart". These instructions replicated those provided in prior SDMs research [37, 43], and especially those defined by Singer and Moffitt [46].

Following each memory retrieval, participants were invited to rate its emotional valence on the Self-Assessment Manikin scale, this scale is a nine-point pictorial scale that has been shown to be a valid and reliable assessment of subjective emotional experiences [47]. A score above the level of five points on this scale corresponds to positive valence.

2.3. Facial expression analysis

After obtaining the participant's informed consent, we recorded memory retrieval with an HD camera. We placed the camera in front of the participant and we later analyzed the recording by the FaceReader^{TM} software. For each memory, the software analyzed the memory description to synthesize the face and described the facial expression information (i.e., cheek, lips, muscles, eyebrow muscles). Once the analyses were run, the software described a pie chart representation of the percentage, across all frames, of the following emotions: happy, sad, angry, surprised, scared, disgusted, and neutral. The pie chart also described percentages of unknown states, these state are situations where the face could not be analyzed (e.g., when the participant looked away from the camera).

3. Results

To investigate the hypothesis (i.e., whether SDMs would trigger more emotional than neutral facial expressions), the percentage of total facial emotional expressions (i.e., percentage of the six emotional expressions: happy, sad, angry, surprised, scared, disgusted) were compared with the percentage of neutral expressions during retrieval of SDMs. The percentage of positive (happy and surprised) vs. negative facial expressions (sad, angry, scared, disgusted) were also compared, as this categorization has been proposed by Ekman [8]. The subjective emotional experience of SDMs were also analysed, as rated by the subjects on the Self-Assessment Manikin scale. Non-parametric tests were employed because the subjective evaluation of emotion was scale, and also because of the non-normal distribution of percentage of some facial expressions, the latter determined by Kolmogorov–Smirnov tests. Comparisons were performed using the Wilcoxon signed rank test. The relationship between the subjective emotional evaluation of SDMs and emotional facial expressions were evaluated by regression analysis. For all tests, significance was set at $p \leq 0.05$. Effect sizes were reported for signifcant differences; $d = 0.2$ can be considered a small effect size, $d = 0.5$ represents a medium effect size and $d = 0.8$ refers to a large effect size [48]. Note that Cohen's d was calculated for non-parametric tests following recommendations by Rosenthal and DiMatteo [49], and Ellis [50].

3.1. SDMs trigger more emotional than neutral expressions

The percentages of emotional and neutral facial expressions during retrieval of SDMs are described in Fig. 1. Analysis revealed that subjects showed more emotional (i.e., happy + sad + angry + surprised + scared + disgusted $= 52.60$, $SD = 17.27$) than neutral ($M = 39.05, SD = 20.63$) facial expressions during retrieval of SDMs ($Z = 2.13, p < 0.05$, Cohen's $d = 1.08$). Also that participants were more positive (i.e., happy + surprised facial expressions $= 33.45$, $SD = 12.67$) than negative (sad + angry + scared + disgusted $= 19.15$, $SD = 18.81$) for facial expression during retrieval of SDMs ($Z = -3.52, p < 0.001$, Cohen's $d = 2.55$). Subjects also showed more happy than sad ($Z = -3.49, p < 0.001$, Cohen's $d = 2.49$), angry ($Z = -3.55, p < 0.001$, Cohen's $d = 2.61$), scared

($Z = -3.74$, $p < 0.001$, Cohen's $d = 3.05$), or disgusted ($Z = -3.61$, $p < 0.001$, Cohen's $d = 2.73$) facial expressions during retrieval of SDMs. The were also more surprised than sad ($Z = -3.38$, $p < 0.001$, Cohen's $d = 2.30$), angry ($Z = -3.57$, $p < 0.001$, Cohen's $d = 2.62$), scared ($Z = -3.72$, $p < 0.001$, Cohen's $d = 1.53$), or disgusted ($Z = -3.58$, $p < 0.001$, Cohen's $d = 2.67$) by facial expression during retrieval of SDMs. All other comparisons were not significant ($p > 0.10$).

3.2. SDMs trigger positive subjective experience

The mean rating of SDMs for the Self-Assessment Manikin scale was 5.95 points ($SD = 2.05$). This rating was significantly higher than the neutral level of the scale (i.e., five points) ($Z = 2.08$, $p < 0.05$, Cohen's $d = 1.05$). Therefore, the mean subjective rating of retrieved SDMs corresponded to a positive evaluation.
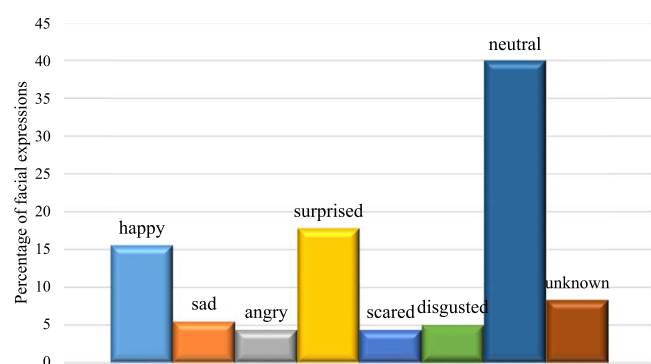

Fig. 1. Facial expressions during retrieval of self-defining memories. *Note.* The state "unknown" refers to situations in which the face could not be modelled.
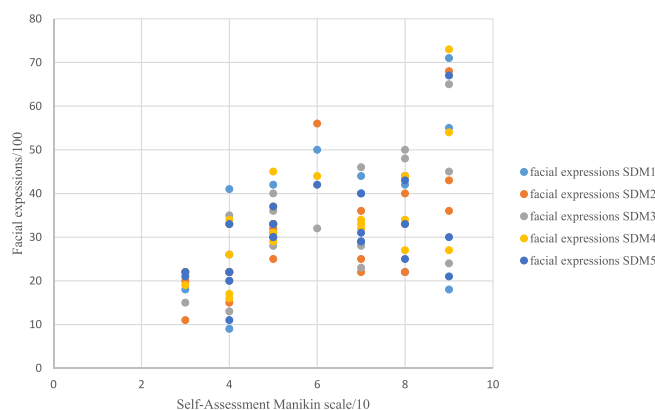

Fig. 2. Regression plot, illustrating the relationship between the subjective emotional experience of self-defining memories (SDMs), as rated by the participants on the Self-Assessment Manikin scale, and positive emotional facial expressions during retrieval of each SDM.

3.3. Facial expressions predict subjective experience

Relationship between the subjective emotional evaluation of SDMs and emotional facial expressions was investigated by regression analysis. The dependent variable was the mean rating on the Self-Assessment Manikin scale whereas the predictor variables were the positive emotional score of the Facereader (i.e., the sum of happy and surprised facial expressions) for each SDM, therefore five predictor variables (corresponding to five SDMs) were entered simultaneously for regression analysis. Analysis showed that the positive emotional score of the Facereader software significantly contributed to the score on the Self-Assessment Manikin scale, accounting for 36.60% ($p < 0.05$) of its variance (see Fig. 2).

4. Discussion

Facial expression during retrieval of SDMs were investigated. Facial analyses software made it possible to show that the facial expressions of subjects were more emotional than neutral, as well as more positive than negative during SDMs retrieval. It was also found that the subjective experience of SDMs was positive, as rated by subjects on the Self-Assessment Manikin scale. These findings demonstrate the consistency between facial expression and emotional subjective experience of SDMs.

Investigators have long recognized the intimate connection between SDMs and the construction of identity [25, 26]. Research has emphasized the centrality of such memories to the functioning of identity, viewing them as a window into the development of identity and evolution of individual identity [25, 36, 37, 39]. Research has also emphasized the emotional intensity, vividness, and linkages to other memories [31, 33, 34], as well as the centrality of SDMs for self-images, self-understanding, and unresolved conflicts or enduring concerns [28]. SDMs are believed to reflect the dominant concerns in an individual's present life situation and, in moments of uncertainty, they serve as a landmark to remind the individual of his/her identity [25]. Interestingly, emotions associated with self-defining memories were found to be related with changes in personality, well-being, and professional performance [31]. Together, these findings highlight the centrality of SDMs to identity and personality, as well as the centrality of emotion to SDMs. The emotional characteristic of SDMs was observed in this study as data demonstrated emotional facial expressions during retrieval of these memories. The emotional facial expressions, as observed during retrieval of SDMs, can be interpreted in light of a theoretical assumption according to which SDMs are believed to have the power to evoke physiological states similar to those experienced in the encoded events [31]. In other words, emotional facial expressions, as observed in this study during retrieval of SDMs, can be considered as reflecting the affective and motivational content of the encoded events. Alternatively, these expressions can be considered as reflecting emotional regulation during retrieval of SDMs.

Besides demonstrating more emotional than neutral facial expressions during the retrieval of SDMs, findings demonstrated more positive than negative expressions during this retrieval, as well as more positive than neutral subjective evaluation of these memories. These findings mirror a study by Wood and Conway [34] who found positive evaluation of SDMs. More specifically, Wood and Conway [34] observed that, for negative SDMs, participants reported less negative and more positive emotion compared to how they recalled feeling at the time, and the same thing was observed for positive SDMs. Therefore, SDMs seem to trigger a positive emotional state, at least in subjects without psychiatric or neurological disorders. From this perspective, people would presumably describe less negative emotion during retrieval of SDMs because meaning making, a core characteristic of SDMs, involves an assumption of evolution

of memory appraisal (i.e., of improved regulation of memory over time). Additionally, learning lessons or finding benefits from negative memories would presumably lead people to experience more positive emotions about the memory. According to this assumption, one study has demonstrated that life narratives trigger a transformation from negative to positive affect rather than vice versa [51]. This phenomenon of "making things better" mirrors the more general notion of redemption sequences in the life story and research about "happy endings" to negative events [52], "fading affect bias", i.e., that fading is greater for unpleasant emotions than for pleasant emotions associated with autobiographical events [53, 54] and the "wisdom of experience", i.e., wisdom to transform negative events to positive life situations, a phenomenon especially observed in adulthood [55, 56]. Another characteristic of SDMs that may be responsible for their positive valence is social sharing. As mentioned in the introduction, people frequently describe themselves and their life stories by sharing SDMs [35, 36]. When memories, especially positive ones, are shared with others, people tend to experience a positive experience that is above the original experience [57]. Together, the positive characteristics of SDMs, as observed in this study, can be attributed to meaning making (i.e., reflecting on the positive outcomes of a negative event) and/or to social sharing.

It is suggested that the positive emotional facial expressions, as observed in subjects during retrieval of SDMs, can be attributed to the retrieval of the original emotional experience and/or to the emotional regulation of the retrieved memories. The prevalence of positive emotional expressions, as reported for this study, can also be compared with a study assessing these expressions during future thinking [58]. That study found higher emotional, as well as higher positive facial expressions, during future than during past thinking; these findings mirror the picturesque accounts of future thinking. According to this perspective, people tend to imagine the future by setting new goals with the expectation that they will succeed [59, 60].

To further understand the variations of facial expressions during retrieval of SDMs, and memory retrieval in general, it would be of interest to assess these expressions according to emotional regulation during retrieval. As explained here, emotional reactions during retrieval may depend on how people reflect on the outcomes of their memories or even on how they define these outcomes according to their current goals are self-representations (e.g., a memory of a failure is more likely to be considered as a less positive if retrieved during a current achievement than during a current failure). Therefore, it would be of interest to investigate facial expressions during memory retrieval according to emotional regulation profiles. For instance, one may expect fewer emotional facial expressions in people experiencing emotional avoidance. Also, individuals high in agency (i.e., assertive individuals with propensity for mastery and power) may demonstrate highly emotional expressions during memory retrieval. An individual's underlying emotional motive may influence facial expression during memory retrieval. This assumption can be tested for specific personality characteristics. For instance, because intrapersonal self-regulatory processes of a narcissist tend to maintain artificially high self-esteem, their memories are likely to be saturated with specific facial expressions (e.g., contempt) than non-narcissist individuals. Beyond the personality structure, it would be of interest to assess facial expressions during retrieval of autobiographical memories in psychiatric populations. For instance, patients with depressions may demonstrate more negative than positive expressions during retrieval, which may correspond to the negative emotion valence of autobiographical retrieval in depression [61]. In addition, because SDMs tend to be negative in alcohol-dependence [40–42], it would be of interest whether retrieval of these memories would trigger negative emotional facial expressions.

As mentioned in the Introduction, the Facereader software relies on an artificial neural network to map 500 facial points of reference (on the input layer) onto a pre-set list of basic emotions described by Ekman [7, 8]. However, although the model of Ekman provides a comprehensive description of basic emotional categories, there is a wide variety of emotional states that fall outside of this description. This assumption can be supported by many theories suggesting that emotional experiences extend beyond Ekman's list of basic emotions [62, 63]. Therefore, although classification by Facereader provides a description of basic-emotional categories, facial expressions during memory retrieval can be better understood if assessed with software dealing with complex emotions. Regardless of this issue, results demonstrated high levels of "surprised" states during memory retrieval. These high levels can be attributed to the fact that, prior to the retrieval instructions, subjects were informed that the study was designed to investigate facial expressions during memory retrieval and no mention was made of the self-defining nature of the memories probed for. Therefore, participants might be surprised when asked to retrieve personal memories, and more specifically, Self-related highly personal ones. Another possibility is that participants were surprised by their ability to share personal memories or even by the content of their memories.

One potential shortcoming of this study is the lack of a control condition allowing the comparison of facial expressions during SDMs and an appropriate control situation (e.g., a condition in which participants retrieve a typical autobiographical memory). Regardless of this limitation, our experimental design allowed comparisons of emotional and neutral facial expressions during retrieval of SDMs. Our experimental design also allowed comparison of objective and subjective emotional states during retrieval of SDMs.

By comparing facial expressions during retrieval of SDMs, this study demonstrates how subjective emotions experienced during recollection of highly salient and pertinent memories can be mirrored by emotional facial activity. By doing so, the study serves as a bridge between psychological research on subjective experiences of the past and physiological research on the physical and nervous activity that may be convolved with cognitive processing. it is hoped this study will pave the way to research demonstrating how description of facial activity during memory retrieval can provide insights into the cognitive mechanisms underlying memory construction.

Acknowledgments

Conflict of Interest

All authors declare no conflicts of interest.

References

[1] Conway MA (2005) Memory and the self. *Journal of memory and language* **53(4)**, 594-628.

[2] Rubin DC (2005) A basic-systems approach to autobiographical memory. *Current Directions in Psychological Science* **14(2)**, 79-83.

[3] El Haj M, Antoine P, Nandrino JL (2016) More emotional facial expressions during episodic than during semantic autobiographical retrieval. *Cognitive, Affective, & Behavioral Neuroscience* **16(2)**, 374-381.

[4] Bishop CM (2010) *Neural networks for pattern recognition.* 2nd edn, Oxford University Press.

[5] Den Uyl M, Van Kuilenburg H (2005) The FaceReader: Online facial expression recognition. *Proceedings of Measuring Behavior* **30(2)**, 589-590.

[6] Noldus I (2008) FaceReader 2.0: Technical specifications.

[7] Ekman P (1992) An argument for basic emotions. *Cognition & Emotion* **6(3-4)**, 169-200.

[8] Ekman P (1993) Facial expression and emotion. *American Psychologist* **48(4)**, 384-392.

[9] Friesen E, Ekman P (1978) Facial action coding system: a technique for the measurement of facial movement. Consulting Psychologists, San Francisco.

[10] Ekman P, Rosenberg E, Hager J (1998) Facial action coding system affect interpretation database (FACSAID). http://www.yahoo.com.

[11] El Haj M, Antoine P, Nandrino JL, Gély-Nargeot M-C, Raffard S (2015) Self-defining memories during exposure to music in Alzheimer's disease. *International Psychogeriatrics* **27(10)**, 1719-1730.

[12] Berntsen D, Bohn A (2010) Remembering and forecasting: The relation. *Memory & Cognition* **38(3)**, 265-278.

[13] Berntsen D, Jacobsen AS (2008) Involuntary (spontaneous) mental time travel into the past and future. *Consciousness and cognition* **17(4)**, 1093-1104.

[14] D'Argembeau A, Van der Linden M (2004) Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and cognition* **13(4)**, 844-858.

[15] Newby-Clark IR, Ross M (2003) Conceiving the past and future. *Personality and Social Psychology Bulletin* **29(7)**, 807-818.

[16] Ross M, Newby-Clark IR (1998) Construing the past and future. *Social Cognition* **16(1)**, 133-150.

[17] Comblain C, D'Argembeau A, Van der Linden M (2005) Phenomenal characteristics of autobiographical memories for emotional and neutral events in older and younger adults. *Experimental Aging Research* **31(2)**, 173-189.

[18] Demiray B, Freund AM (2015) Michael Jackson, Bin Laden and I: Functions of positive and negative, public and private flashbulb memories. *Memory* **23(4)**, 487-506.

[19] El Haj M, Gandolphe M-C (2017) Flashbulb memories for Paris attacks in an alcohol-abstinent patient. *Journal System Integrative Neuroscience* **3(2)**, 1-5.

[20] El Haj M, Gandolphe M-C, Wawrziczny E, Antoine P (2016) Flashbulb memories of Paris attacks: Recall of these events and subjective reliving of these memories in a case with Alzheimer disease. *Medicine* **95(46)**.

[21] Marie-Charlotte G, El Haj M (2016) Flashbulb memories of the Charlie Hebdo attack. *Journal of Psychology and Cognition* **1(1)**.

[22] Gandolphe MC, El Haj M (2017) Flashbulb memories of the Paris attacks. *Scandinavian journal of psychology* **58(3)**, 199-204.

[23] Maki Y, Janssen SM, Uemiya A, Naka M (2013) The phenomenology and temporal distributions of autobiographical memories elicited with emotional and neutral cue words. *Memory* **21(3)**, 286-300.

[24] Schaefer A, Philippot P (2005) Selective effects of emotion on the phenomenal characteristics of autobiographical memories. *Memory* **13(2)**, 148-160.

[25] Blagov PS, Singer JA (2004) Four dimensions of self-defining memories (specificity, meaning, content, and affect) and their relationships to self-restraint, distress, and repressive defensiveness. *Journal of Personality* **72(3)**, 481-511.

[26] Singer J, Rexhaj B, Baddeley J (2007) Older, wiser, and happier? Comparing older adults' and college students' self-defining memories. *Memory* **15(8)**, 886-898.

[27] Singer JA, Blagov P, Berry M, Oost KM (2013) Self-defining memories, scripts, and the life story: Narrative identity in personality and psychotherapy. *Journal of Personality* **81(6)**, 569-582.

[28] Conway MA, Singer JA, Tagini A (2004) The self and autobiographical memory: Correspondence and coherence. *Social Cognition* **22(5: Special issue)**, 491-529.

[29] D'Argembeau A, Lardi C, Van der Linden M (2012) Self-defining future projections: Exploring the identity function of thinking about the future. *Memory* **20(2)**, 110-120.

[30] Moffitt KH, Singer JA (1994) Continulty in the life story: Self-defining memories, affect, and approach/avoidance personal strivings. *Journal of Personality* **62(1)**, 21-43.

[31] Sutin AR, Robins RW (2005) Continuity and correlates of emotions and motives in self-defining memories. *Journal of Personality* **73(3)**, 793-824.

[32] Çili S, Stopa L (2015) The retrieval of self-defining memories is associated with the activation of specific working selves. *Memory* **23(2)**, 233-253.

[33] Lardi C, Ghisletta P, Van der Linden M (2012) What is the Nature of the Self-defining Memories of Repression-prone Individuals? *Self and Identity* **11(4)**, 492-515.

[34] Wood WJ, Conway M (2006) Subjective impact, meaning making, and current and recalled emotions for self-defining memories. *Journal of Personality* **74(3)**, 811-846.

[35] Thorne A, McLean KC (2002) Gendered reminiscence practices and self-definition in late adolescence. *Sex Roles* **46(9-10)**, 267-277.

[36] Thorne A, McLean KC, Lawrence AM (2004) When remembering is not enough: Reflecting on self-defining memories in late adolescence. *Journal of Personality* **72(3)**, 513-542.

[37] Lardi C, D'Argembeau A, Chanal J, Ghisletta P, Van der Linden M (2010) Further characterisation of self-defining memories in young adults: A study of a Swiss sample. *Memory* **18(3)**, 293-309.

[38] Habermas T, de Silveira C (2008) The development of global coherence in life narratives across adolescence: Temporal, causal, and thematic aspects. *Developmental Psychology* **44(3)**, 707.

[39] Habermas T, Diel V, Welzer H (2013) Lifespan trends of autobiographical remembering: Episodicity and search for meaning. *Consciousness and Cognition* **22(3)**, 1061-1073.

[40] Cuervo-Lombard C, Raucher-Chéné D, Barrière S, Van der Linden M, Kaladjian A (2016) Self-defining memories in recently detoxified alcohol-dependent patients. *Psychiatry Research* **246**, 533-538.

[41] Nandrino JL, Gandolphe MC (2017) Characterization of Self-Defining Memories in Individuals with Severe Alcohol Use Disorders After Mid-Term Abstinence: The Impact of the Emotional Valence of Memories. *Alcoholism: Clinical and Experimental Research* **41(8)**, 1484-1491.

[42] Nandrino J-L, Gandolphe M-C, El Haj M (2017) Autobiographical memory compromise in individuals with alcohol use disorders: Towards implications for psychotherapy research. *Drug and Alcohol Dependence* **179**, 61-70.

[43] Raffard S, D'Argembeau A, Lardi C, Bayard S, Boulenger J-P, Boulenger J-P, Van Der Linden M (2009) Exploring self-defining memories in schizophrenia. *Memory* **17(1)**, 26-38.

[44] Raffard S, D'Argembeau A, Lardi C, Bayard S, Boulenger J-P, Van der Linden M (2010) Narrative identity in schizophrenia. *Consciousness and Cognition* **19(1)**, 328-340.

[45] Martinelli P, Anssens A, Sperduti M, Piolino P (2013) The influence of normal aging and Alzheimer's disease in autobiographical memory highly related to the self. *Neuropsychology* **27(1)**, 69.

[46] Singer JA, Moffitt KH (1992) An experimental investigation of specificity and generality in memory narratives. *Imagination, Cognition and Personality* **11(3)**, 233-257.

[47] Bradley MM, Lang PJ (1994) Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry* **25(1)**, 49-59.

[48] Cohen J (1988) Statistical power analysis for the behavioral sciences. *Technometrics* **31(4)**, 499-500.

[49] Rosenthal R, DiMatteo MR (2001) Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology* **52(1)**, 59-82.

[50] Ellis PD (2010) *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results.* Cambridge University Press.

[51] McAdams DP, Reynolds J, Lewis M, Patten AH, Bowman PJ (2001) When bad things turn good and good things turn bad: Sequences of redemption and contamination in life narrative and their relation to psychosocial adaptation in midlife adults and in students. *Personality and Social Psychology Bulletin* **27(4)**, 474-485.

[52] King LA, Scollon CK, Ramsey C, Williams T (2000) Stories of life transition: Subjective well-being and ego development in parents of children with Down Syndrome. *Journal of Research in Personality* **34(4)**, 509-536.

[53] Skowronski J, Gibbons J, Vogl R, Walker WR (2004) The effect of social disclosure on the intensity of affect provoked by autobiographical memories. *Self and Identity* **3(4)**, 285-309.

[54] Walker WR, Skowronski JJ, Thompson CP (2003) Life is pleasant–and memory helps to keep it that way! *Review of General Psychology* **7(2)**, 203.

[55] Bluck S, Glück J (2004) Making things better and learning a lesson: Experiencing wisdom across the lifespan. *Journal of Personality* **72(3)**, 543-572.

[56] Sternberg RJ (1998) A balance theory of wisdom. *Review of General Psychology* **2(4)**, 347.

[57] Langston CA (1994) Capitalizing on and coping with daily-life events: Expressive responses to positive events. *Journal of Personality and Social Psychology* **67(6)**, 1112.

[58] El Haj M, Antoine P, Nandrino JL (2017) Facial expressions triggered by imagining the future. *Journal of Integrative Neuroscience* **16(4)**, 483-492.

[59] Cacioppo JT, Gardner WL (1999) Emotion. *Annual Review of Psychology* **50(1)**, 191-214.

[60] Rasmussen AS, Berntsen D (2013) The reality of the past versus the ideality of the future: Emotional valence and functional differences between past and future mental time travel. *Memory & Cognition* **41(2)**, 187-200.

[61] Williams JMG, Barnhofer T, Crane C, Herman D, Raes F, Watkins E, Dalgleish T (2007) Autobiographical memory specificity and emotional disorder. *Psychological Bulletin* **133(1)**, 122.

[62] Barrett LF (2006) Are emotions natural kinds? *Perspectives on Psychological Science* **1(1)**, 28-58.

[63] Russell JA (1994) Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin* **115(1)**, 102.