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Gender identity better than sex explains individual differences in episodic and semantic components of autobiographical memory and future thinking

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ABSTRACT

A recently tested hypothesis suggests that inter-individual differences in episodic autobiographical memory (EAM) are better explained by individual identification of typical features of a gender identity than by sex. This study aimed to test this hypothesis by investigating sex and gender related differences not only in EAM but also during retrieval of more abstract self-knowledge (i.e., semantic autobiographical memory, SAM, and conceptual self, CS), and considering past and future perspectives. No sex-related differences were identified, but regardless of the sex, feminine gender identity was associated with clear differences in emotional aspects that were expressed in both episodic and more abstract forms of AM, and in the past and future perspectives, while masculine gender identity was associated with limited effects. In conclusion, our results support the hypothesis that inter-individual differences in AM are better explained by gender identity than by sex, extending this assumption to both episodic and semantic forms of AM and future thinking.

1. Introduction

Today, beyond physical characteristics, growing evidence shows that women and men differ significantly in their cognitive and neurobiological mechanisms (Andreano & Cahill, 2009; Halpern, 2013; Sherwin, 1996; Wassell, Rogers, Felmingam, Bryant, & Pearson, 2015). For instance, many studies reported a male advantage in spatial processing and a feminine advantage in verbal tasks, although it appears that sex-related differences in cognition may well extend beyond this simple opposition, especially in the field of memory (for a review see Andreano & Cahill, 2009). From a biological perspective, sex-related hormonal differences are known to affect cognition and especially memory (Sherwin, 1996; Wassell et al., 2015). Being a man or a woman is an important part of who we are and who we will be in that belonging to one sex provides a legion of autobiographical and general information and expectations about our behavior, preferences and social roles (Garcia-Falgueras, 2014).

Autobiographical memory (AM) contributes to the sense of identity in that it contains a set of information about oneself, stored at different levels of abstraction, which allows self-definition: I was, I am and I will be (Conway, 2001; Klein & Gangi, 2010; Martinelli,

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Anssens, Sperduti, & Piolino, 2013a; Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012; Singer, Rexhaj, & Baddeley, 2007). Thus, different components of AM, underpinned by different neural correlates (Martinelli, Sperduti, & Piolino, 2013c), are distinguished:

- *Episodic autobiographical memory (EAM)* that allows the recollection experience of a memory associated with autonoetic consciousness (Tulving, 2005), i.e., the feeling of traveling through time to relive or re-experience a unique personal event, lasting less than 24 h and recollecting details related to the context and the occurrence of this event (spatio-temporal context, perceptions, emotions, thoughts);
- *Semantic autobiographical memory* (SAM), which refers to recalling factual information about oneself without the recollection of the encoding context, and gives rise to a sense of familiarity which is referred to as noetic consciousness (Tulving, 2005) or the recall of general events, i.e., repeated or extended in time including information about lifetime periods, which are not associated with a sense of reliving the occurrence of a specific event;
- *Conceptual self* (CS) corresponds to the most abstract and summarized representations of oneself including personality traits, beliefs, images and attitudes that define us and underlie our sense of identity. Its role is crucial in supervising generative search strategies of memories, e.g., EAMs via SAMs, generally in coherence with the current-self and a positive self-image, by means of facilitation and inhibition processes (Conway, 2005; Conway, Singer, & Tagini, 2004).

These different levels of representations are therefore intimately linked, and they are not only at stake to remember and know the remote and recent personal past, but also to pre-experience and conceive one's personal future (Abram, Picard, Navarro, & Piolino, 2014; Rathbone, Conway, & Moulin, 2011). Some memories of the past, especially those from adolescence and young adulthood, are particularly crucial for the construction and the maintenance of the sense of identity (Fitzgerald, 1996; Piolino, Desgranges, Benali, & Eustache, 2002; Piolino et al., 2006). Moreover, future-oriented thinking, including affective forecasting, episodic simulation and autobiographical planning, has a strong adaptive value in our daily life since it allows individuals to plan their future actions, helps them to foresee, set goals and represent what is yet to come (Szpunar, Spreng, & Schacter, 2014).

Several studies that have investigated sex-related differences in EAM showed a female advantage that extends not only to the amount of details recollected or speed or number of evocations, but also during the investigation of the content of autobiographical accounts of personal memories. Women seem to report more details (Grysman & Hudson, 2013; Niedźwieńska, 2003), particularly emotional ones (Cross & Madson, 1997; Davis, 1999; Fujita, Diener, & Sandvik, 1991), remember more specific events than men in a limited testing time and recollect memories more quickly in response to cues (Canli, Desmond, Zhao, & Gabrieli, 2002; Davis, 1999). In the same vein, women also show greater specificity for imagined future events (Wang, Hou, Tang, & Wiprovnick, 2011). By analyzing the narratives' content, sex-related differences in the description of internal states were also evidenced in that women include more elaborations about mental states and especially about emotions in their stories than men (Fivush, Bohanek, Zaman, & Grapin, 2012). Women's memories have thus more meaning from a personal point of view, are endowed with more information about other people and reflect a greater sense of connexion with others (Grysman & Hudson, 2013). They report events concurring with their self-images as closer to the present than men and dissonant events as more distant in the past (Grysman, 2014). Nevertheless, Grysman and Hudson (2013) also noted in their literature review that the expression of these differences could be context dependent in that some instructions such as encouraging recollection of highly relevant memories for oneself (e.g., self-defining memories or memories of decisive events in the participant's life) seem to eliminate sex differences in EAM. Moreover, it could explain the fact that several studies failed to find sex differences in EAM (Piefke, Weiss, Markowitsch, & Fink, 2005; St. Jacques, Conway, & Cabeza, 2011). In addition, no research has directly investigated sex-related differences in general and abstract forms of AM such as SAM (extended in time or repeated events) and CS (abstract self-knowledge). However, some authors (Fuentes & Desrocher, 2013; Grysman, 2016) examined sex-related differences in the production of semantic and episodic details when recollecting EAMs, i.e., external details relative to the context of the event but which refer to general knowledge, e.g., names of friends present, and internal details specific to the episode, e.g., specific perceptual or emotional details of the event, respectively (for the detailed scoring procedure, see Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Their findings suggested a female advantage in the production of episodic details but not of semantic details.

In order to explain these sex-related differences, some research argues in favour of the *cognitive style hypothesis* (i.e., women differ from men in cognitive strategies how they encode, remember or think about their personal experiences, Seidlitz & Diener, 1998). For instance, Fuentes and Desrocher (2013) showed that women remembered more episodic information in comparison to men in the cued recall condition while no sex difference was observed in the free recall condition. These results were interpreted as sex differences in EAM that could originate at the time of encoding, in that women may encode more detailed representations of life events (Cahill & van Stegeren, 2003), thus allowing them to recall a larger amount of additional information when presented with cues in a high retrieval support condition. However, differences in retrieval strategies identified in laboratory tasks (with spatial processes favored in men and verbal ones in women, Halpern, 2013), could also explain these differences in EAM retrieval (Piefke et al., 2005; St. Jacques et al., 2011). According to the *affect intensity hypothesis* (i.e., women benefit from a mnemonic advantage in everyday life because they experience events more intensely and thus remember them more intensely and more often than men, Fujita et al., 1991), Bloise and Johnson (2007) have shown that sex-related differences regarding emotions were mediated by emotional sensitivity, which is particularly interesting in that this result suggests a possible link between the focus of women on emotion and their mnemonic advantage. The reported female advantage could be related not to sex but to their focus on emotion as a factor differentiating participant performances and that tends to be more prevalent among women than men. Thus, this hypothesis assumes that if women are more attentive to emotions than men, this means that attention processes toward emotion could explain their better recall

of emotional information. However, this hypothesis does not entirely explain the female advantage because when general instructions required participants to focus on emotionally neutral information, the female advantage persisted. Finally, the *socialization hypothesis* postulates that early interactions with others and especially with parents when AM skills are under development, contribute to the fact that girls place more emphasis on early relationships with others while boys develop more aspects of personal success and strength in their roles in a group (for review see, Grysman & Hudson, 2013). This hypothesis comes from the observation that autobiographical narratives of parents and especially mothers are more sophisticated and emotionally expressive concerning their daughters than their sons in the first years of life, while girls have more sophisticated memories and are more emotionally expressive than boys (Reese & Fivush, 1993; Reese, Haden, & Fivush, 1996; Reese, Jack, & White, 2010). Better EAM retrieval in women could result from these characteristics of female socialization, for instance women may be socialized to engage in more repetitions and to provide more elaboration about their past through parent-child remembering practices.

This social hypothesis emphasizes the importance of social attitudes, roles and expectations in predicting sex-differences in AM in keeping with the fact that social stereotypes are known to affect cognition (e.g., the stereotype threat phenomenon, Wraga, Helt, Jacobs, & Sullivan, 2007). Sex identity is one of the earliest social categories of which children become aware through social valuations based on gender stereotypes (e.g., 'women are more emotionally expressive than men', Leynes, Crawford, Radebaugh, & Taranto, 2013). In adults, the more prominent gender identity stereotypes are in one's self-representation, the more stereotype threats will create an expectation and the more performances will be marked by sex-related effects (Schmader, 2002). Therefore, gender identity could be as important in explaining male and female differences in AM as sex per se. Gender identity refers to the trend for individuals to adopt the typical behaviors of a gender and to the value given to this perceived typicality (Grysman, Fivush, Merrill, & Graci, 2016). This concept attempts to reflect the fact that although most individuals are defined as members of a gender group, the importance given to this category in the representation they have of themselves varies, as does the degree to which they think they conform to gender stereotypes. Studies using this definition of gender identity usually assume that individuals who adopt stereotypical traits of a gender are also more motivated to engage in stereotypical activities (Grysman & Fivush, 2016). In addition, this definition of gender identity assumes that masculine and feminine gender identities are independent as Bem (1974) demonstrated that some individuals have high scores on the feminine gender identity scale and low scores on the masculine gender identity scale while others show the reverse pattern of results but also that some individuals have very low or very high scores simultaneously on both scales. Although some studies have revealed sex-related differences in AM, Grysman and Hudson (2013) found in their literature review that the effect sizes were often small and some studies failed to highlight differences related to sex. They therefore suggested that sex as a binary variable (man or women) is not the only way to explain individual differences in AM and that gender identity as a personal identification with gender stereotypes might be more relevant. Accordingly, sex-related differences in EAM may account for the general trend of each sex to identify with the social stereotypes consistent with their biological sex across the population. In order to test this gender identity hypothesis, Grysman's team (2013) initiated a series of studies investigating the role of gender identity in predicting differences in EAM. Although they reported that it is more difficult to identify sex-related differences using subjective rating scales than narrative analyses (Grysman & Hudson, 2013), they were able to demonstrate the effect of gender identity-related differences by using self-reported rating scales, showing that gender identity is a better predictor of interindividual differences than sex (Grysman & Fivush, 2016; Grysman, Merrill, & Fivush, 2017). More precisely, they showed that feminine or masculine stereotype scales (Spence & Helmreich, 1979) predicted the quality and the content of EAMs recalled by participants, regardless of their biological sex (Grysman & Fivush, 2016; Grysman et al., 2016, 2017). Moreover, they even compared sex-related and gender-related differences in AM and concluded that sex-related differences in AM were mediated by identification with stereotypical gender norms (Grysman et al., 2017). In particular, the tendency to adopt feminine gender stereotypes was associated with the performance pattern usually evidenced in women (e.g., memories were more specific, emotional, recalled in a more detailed manner, more vividly), regardless of the sex of participants (Grysman et al., 2016), which suggests that sex-related differences in EAM reflect exposure to cultural norms that can be modulated by gender identity (i.e., individual identification with typical features of a gender). Moreover, masculine gender identity also predicted some characteristics of autobiographical recall, but these effects were variable depending on the kind of memories evoked (e.g., salient or self-defining events; for more information, see Grysman & Fivush, 2016; Grysman et al., 2016). On the whole these findings suggest that the effects of adopting stereotypically female characteristics appear to reflect a general mode of memory processing or recollection independent of the nature of the event reported while the effects of adopting stereotypically male characteristics imply additional elaborations when the context invites participants to select memories that are highly relevant for them (Grysman & Fivush, 2016).

Despite the great interest of these studies, some replications are necessary, especially because the investigations focused only on EAM ignoring the potential existence of gender identity differences in other aspects of AM.

In this study therefore, we aimed to extend the ongoing work of Grysman and collaborators on the investigation of the **effects of sex and gender identity in AM** by investigating the different levels of abstraction of self-related information (i.e., not only EAM but also SAM and CS) and the different time perspectives (i.e., past, present and future).

Our main assumption was that feminine and masculine gender identity would predict greater differences in different kinds of AM than sex.

Regarding EAM, we expected to replicate some literature results, namely that women's memories would be more specific and vivid, experienced with greater emotional intensity, evaluated as more important than those of men and that some of these effects would be better explained by gender identity than by sex. Moreover, as women's memories seem to depend on the temporal distance to the present (see Grysman, 2014), we expected that sex and/or gender identity effects might change with temporal distance in the past (remote versus recent). For women or individuals who identify to feminine stereotypes, memories of the recent past could be more pertinent for supporting a positive self-image than memories of the remote past and therefore may be more important and

positive. Given the similarities in the literature between EAM and episodic future thinking (Addis, Wong, & Schacter, 2007), we expected to extend the results of Wang et al.'s study (2011) that showed greater specificity in women in imagining the future by assuming that sex- and gender-related differences in EAM are similar to those reported during the imagination of potential future personal events.

Although some previous studies (Fuentes & Desrocher, 2013; Grysman, 2016) suggest no sex-related differences in the production of semantic details when recollecting EAMs, the lack of studies investigating sex and gender identity effects when recollecting directly more general and abstract forms of AM (i.e., SAM and CS) precludes any strong assumptions about sex and gender differences in SAM and CS. However, a recent neuroimaging study highlighted that women showed increased activity, compared to men, in areas involved in emotion regulation strategies, when recalling SAMs, suggesting sex-related differences in the processing of emotional aspects of SAMs (Compère et al., 2016). Based on this study's results, we expected differences related to sex or gender identity in more abstract levels of AM, and by extension, in more abstract levels of future thinking.

2. Method

2.1. Participants and procedure

Twenty-one men and twenty women took part in this study. Participant inclusion criteria were: (i) between 18 and 35 years old; (ii) French mother tongue; (iii) no major auditory disorders; (iv) no psychiatric disorder according to the criteria of the DSM-V (Mini-International Neuropsychiatric Interview); (v) no neurological disease; (vi) no drug use or alcohol abuse. Participants were pre-selected on these criteria after responding to online or displayed ads. Half of them were students while the other half were already engaged in their professional career or looking for a job. Subsequently, participants were contacted to schedule an appointment. An assessment of autobiographical memory and future thinking and psychosocial assessments were administered in a quiet room, and took place in a single afternoon session. Autobiographical assessments (see below) were performed in the same order for all participants: first, the present Tennessee Self Concept Scale was carried out, then the verbal autobiographical fluency task, then the 3 I test, then the past and future Tennessee Self Concept Scale, and finally the episodic autobiographical memory and episodic future thinking assessment task (see Fig. 1, for an overview of the concepts investigated in the different tasks). Participants all gave their informed written consent to this protocol which was approved by the ethics committee CPP Ile de France Paris 3.

Table 1 presents the mean and standard deviation per group concerning age and years of education. There was no difference between men and women in age and years of education.

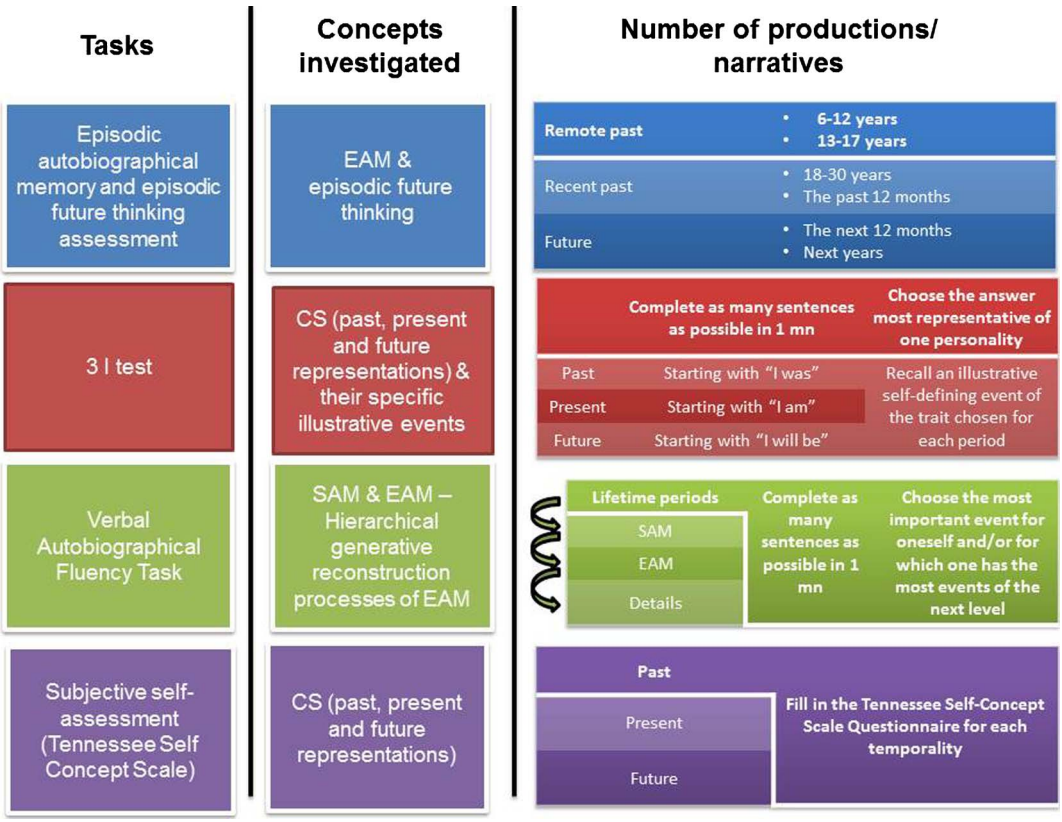

Fig. 1. Overview of the concepts investigated for the different tasks proposed in the protocol.

Table 1
Mean (standard deviation) result per group on the descriptive data of the population, and t tests.

	Participants		Group effect
	Men (n = 21)	Women (n = 20)	
Age	25.29(3.16)	25.15(5.45)	$t(28.29) = 0.09$, $p = .93$, $d = 0.03$
Years of education	15(1.67)	14.42(1.95)	$t(35.88) = 1.03$, $p = .31$, $d = 0.33$
Masculine Bem Sex Role Inventory score	4.72(0.51)	4.25(0.92)	$t(27.76) = 1.94$, $p = .06$, $d = 0.63$
Feminine Bem Sex Role Inventory score	4.77(0.54)	5.06(0.62)	$t(35.59) = -1.56$, $p = .13$, $d = -0.50$

2.2. Gender assessment

The Bem Sex Role Inventory (Bem, 1974; French adaptation, Alain, 1987) consists of 60 self-rated personality related items empirically identified by Bem as associated with gender stereotypes in the North American and European culture. There are 20 masculine items, 20 feminine items, and 20 items that are gender neutral. Ratings are made on a scale ranging from 1 (never true of oneself) to 7 (always true of oneself). The inventory contains two independent scales for the domains of masculinity (M) and femininity (F). The theoretical assumption of this widely used inventory is that both men and women have masculine and feminine gender attributes.

2.3. Autobiographical memory and future thinking assessment

2.3.1. Episodic autobiographical memory and episodic future thinking assessment

This test took the form of a semi-structured interview that evaluates the ability to experience mentally the phenomenological and contextual details of specific autobiographical events (EAMs) from different temporal perspectives (i.e., remote past to future). This assessment tool is adapted from a test developed and validated by Piolino et al. (2006): the *Test Episodique de Mémoire du Passé Autobiographique (*TEMPau) task. The present version (Temporally Extended-TEMPau) consists in asking participants to retrieve or imagine one specific detailed personal event situated in time and space for each of a number of different lifetime periods covering the remote and recent past and the future: remote past (6–12 years old and 13–17 years old), recent past (the past 12 months and 18–30 years old), and future (the next 12 months and the following years). The order of presentation of periods was randomly proposed. We gave participants a very precise definition of a specific personal event (see Abram et al., 2014; Piolino et al., 2006, for detailed instructions), that is, a unique event lasting less than a day, located precisely in time and space, which can be evoked with factual (people, dialogues and anecdotes) and with phenomenological (feelings, sensations, perceptions, thoughts) details. The time allowed for recall/imagination was unrestricted, but this assessment lasted 1 h and a half on average.

Each recollection or imagination was recorded and scored during the task by the experimenter regarding both free recall and cued recall conditions (see detailed procedure below). The spontaneous event's specificity and details were assessed based on a validated 8-point scoring grid (Piolino, Desgranges, & Eustache, 2009): (i) uniqueness, (ii) short duration (< 24 h), (iii) factual ("what", non spatio-temporal contextual details: who, how, anecdotes), (iv) spatial ("where"), (v) detailed spatial (place and position in the place), (vi) temporal ("when"), (vii) detailed temporal (date and sequence before/after), and viii) phenomenological (thoughts, perceptions, emotions) details, attributing one point to each category of details that was retrieved. If the event did not meet basic criteria (characteristics of uniqueness and short duration (< 24 h)), the participant was encouraged to be more specific and/or if not all the categories were mentioned during the narrative in free recall, the experimenter asked questions directed at the type of missing information to see if these details were available in mind, thus giving a score of free recall and cued recall (max 8 points). For example, if a participant did not mention the place where the event took place in free recall, the examiner asked him to try to complete this information in cued recall. Free recall measured the capacity to spontaneously access a specific event whereas cued recall measured the capacity to improve memory retrieval or imagination under facilitated conditions.

Each recollection or imagination was double-coded regarding the free recall and the cued recall by another expert rater who was blind to the hypotheses of the study. Statistical analyses were performed on the average of the two ratings when the scores differed between raters. The inter-rater reliability calculated with the Intraclass Correlation Coefficient was satisfactory: ICC(1) = 0.82 (CI (95%) = [0.78;0.86], F(224,225) = 10.5, p < .001).

The subjective phenomenological dimensions of the evocation of each event were also investigated by asking participants to use several self-rated scales. Immediately after an event had been evoked, we asked participants more questions about the nature and characteristics of their evocations using four Likert-like scales:

- Emotional valence scale ranging from 1 (very negative event) to 5 (very positive event);
- Emotional intensity scale ranging from 0 (no emotional intensity at all) to 5 (high intensity);
- Importance scale ranging from 0 (not at all self-important) to 5 (very important);
- Visual vividness scale ranging from 0 (no image) to 5 (a lot of images like a movie);

2.3.2. The 3 I test: temporally extended conceptual self and episodic assessment

This adaptation (Duval et al., 2012) of the twenty statements test (Kuhn & Mcpartland, 1954; a well-known conceptual self-

assessment test requiring participants to complete several sentences beginning with "I am") assesses both CS (i.e., trait self-knowledge) and highly related self-relevant event measures illustrative of self-representations from the past, present and future temporalities. For each of these periods (past, present and future), these measures were carried out in two parts and all participants began with the present period but the order of past and future periods was counterbalanced among participants (i.e., present, past, future vs present, future, past).

Part 1 is a fluency task that placed the emphasis on very abstract semantic self-representations: participants had to provide as many statements as possible in one minute, each beginning with "I am" (or "I was" or "I will be"), in order to define and describe their current personal identity (or past identity/way they perceived themselves or their likely future identity) through general self-representations, self- perceptions or self-images.

From this first part, the strength and wealth of self-concept related to the CS (i.e., identity and trait self- knowledge) was calculated on the basis of the number of sentences that had been supplied for each period (Coste et al., 2015; Duval et al., 2012). Moreover, personal importance, valence and emotional intensity associated with the period were assessed through Likert-like scales ranging from 0 or 1 to 5 (similar to those used in the episodic autobiographical memory and episodic future thinking assessment and verbal autobiographical fluency tasks).

In part 2 that explored episodes of personal events illustrative of these abstract semantic self- representations, participants were asked to choose one critical item from their output for the lifetime period under concern (present, past, future) which they considered to be the most representative of their identity (e.g., "I was a hard worker"). They then had to evoke in detail a specific related experience which would help to explain why the selected characteristic was an integral part of their identity (e.g., "I know I was a hard worker at school because I remember a specific math test when I was 10 and I remember how I was stressed out that day.") and assess personal importance, valence and emotional intensity through the Likert-like scales ranging from 0 or 1 to 5. This task was created to evaluate the evocation of self-defining personal events (Duval et al., 2012; Martinelli & Piolino, 2009) from the present, the past and the future from personally relevant cues.

2.3.3. Verbal autobiographical fluency task: different abstraction levels of autobiographical information assessment

This task created by Piolino et al. (2010) assesses the construction of EAM from different types of AM representations in reference to Conway & Pleydell-Pearce's (2000) structural-functional approach, which posits that autobiographical construction is a generative hierarchical process. This paradigm uses a verbal fluency task to test the retrieval of different contents of AM, from semantic to episodic.

Four embedded verbal autobiographical fluencies were used in which the participant was given 1 min to retrieve as many items as possible regarding:

(i) lifetime periods for verbal autobiographical fluency 1 (events that lasted several years, at least 3), for example: "period of life when I lived in that street", "time I was in a relationship with this person", "period of my first job", etc.;
(ii) general events for verbal autobiographical fluency 2 (events that lasted a few days/weeks or repeated events), for example: "dance classes I was following when I was a kid", "Christmas holidays spent with family", "the summer holidays spent doing the harvest", etc.;
(iii) specific events for verbal autobiographical fluency 3 (events that lasted less than one day and were unique, situated in time and space), for example: "Louise's birthday party", "Mylene's wedding reception", "the evening of Patrice's concert", etc.;
(iv) details for verbal autobiographical fluency 4 (sensory-perceptual, affective and cognitive specific details that lasted a few minutes/seconds), remembering for example: "that the cake fell and Pauline screamed"," the smell of caramel", "the way I felt when Jon Snow died", etc.

During the general instructions (see Piolino et al., 2010), participants were told that they had to remember information they had personally experienced, and that the task would begin with a recall of general information (something that had lasted several years, at least 3 years) then "zoom in" step by step to specific details of one specific memory (which had lasted a few minutes/seconds) from this general information. For each verbal autobiographical fluency assessment, the examiner read the specific instructions; participants then had one minute to complete the task. Afterward, the participants had to choose an item (the "critical item") they considered the most detailed and important for themselves, which was then used to perform the next verbal autobiographical fluency. They then performed verbal autobiographical fluency 2 from the critical lifetime period they had selected in verbal autobiographical fluency 1 (e.g. "period of my first job") by producing as many general events as they could, then verbal autobiographical fluency 3 from a critical general event they had selected in verbal autobiographical fluency 2 (e.g. "Christmas holidays spent with family") by producing as many specific events as they could, and finally verbal autobiographical fluency 4 from a critical specific event they selected in verbal autobiographical fluency 3 (e.g. "the evening of Patrice's concert") by producing as many specific details as they could. Details in verbal fluency 4 were classified just after this fluency was achieved with the help of participants. Verbal autobiographical fluencies 1 and 2 were considered as more semantic in nature, whereas verbal autobiographical fluency 3 and especially verbal autobiographical fluency 4 were considered as more episodic.

After each fluency task, participants had also to rate the intensity and the valence of emotion associated with the encoding and the importance of the event on Likert-like scales ranging from 0 or 1 (0 = no emotion, 1 = very negative, 0 = no personal importance, respectively) to 5 (very intense, very positive, high personal importance, respectively).

The scores assigned were the total number of responses for each verbal autobiographical fluency. Each item produced was checked for correct application of the instructions, such as the temporal criterion depending on the verbal autobiographical fluency

level (i.e., several years, several days or months, less than a day, a few seconds or minutes). Moreover, in verbal autobiographical fluency 4, the number of responses was classified as belonging to a category: unique moment, spatial, temporal, perceptive, emotional, thought and other. As we were interested in mechanisms of retrieval in EAM, for each critical item, we calculated three additional scores, considering the intensity and the positive valence of emotion and the personal importance of the event (max. = 5, respectively).

2.3.4. Subjective self-assessment: temporally extended conceptual self

A subjective self-concept scale was proposed to the participants in order to measure their subjective evaluation of themselves in terms of valence and certainty depending on the time perspective. We used a short version of a scale derived from the Tennessee Self-Concept Scale (Duval, Eustache, & Piolino, 2007; Fitts & Warren, 1996). It is a self-evaluation questionnaire that assesses the qualitative self-description, which is generally based on highly semantic knowledge pertaining to the conceptual self. It consists of 20 descriptive assertions for each of which each participant must indicate to what extent it characterizes them now on a 5-point scale (ranging from always false to always true). Then, in order to compare the current conceptual self to past and future conceptual selves, we asked each participant to complete the same scale from the past and future time perspectives. We calculated the response distribution score and the positivity of self-image score for each time perspective. The response distribution score is based on the number of responses rated 1 and 5 and is considered the "degree of certainty about the way one sees oneself" (Naylor & Clare, 2008) or the degree of "crystallization of the self" (Martinelli et al., 2013b). The positivity of self-image score is used to assess the positive valence of the self-image for 4 different self-categories (personal, social, family and moral).

2.4. Statistical analyses

We analyzed the results in two steps: firstly, we proceeded to model comparison which aimed to determine which variables of interest allowed to explain a part of variance significantly greater than in a basic model and secondly, we conducted the exploration of the linear regression models that were selected in the first step of model comparison.

More precisely, to test our main hypothesis that gender identity explains a larger part of variance than sex, we used linear mixed-effects models and compared six types of models for the main scores of each assessment. We first fitted six full linear fixed effects models in order to see if sex, masculine gender identity or feminine gender identity could explain a significant proportion of variance in the dependent variable (DV).

- Model 1 depended on the experimental design of the relevant task (e.g., for episodic autobiographical memory and episodic future thinking assessment, model 1: DV ~ lifetime period).
- Model 2 corresponds to Model 1 with in addition a modeling of sex as a fixed effect predictor (men-women, e.g., for episodic autobiographical memory and episodic future thinking assessment, Model 2: DV ~ lifetime period * sex),
- Model 3 and Model 4 correspond to Model 1 with a modeling of masculine gender identity as a fixed effect predictor (this variable was treated as a continuous predictor, e.g., for episodic autobiographical memory and episodic future thinking assessment, model 3: DV ~ lifetime period * masculine Bem Sex Role Inventory score) or with a modeling of feminine gender identity as a fixed effect predictor (this variable was treated as a continuous predictor, e.g., for episodic autobiographical memory and episodic future thinking assessment, model 4: DV ~ lifetime period * feminine Bem Sex Role Inventory score). Participants were always entered as random factors.
- Model 5 and Model 6 correspond to Model 1 in order to fit two additional full linear fixed effects models to see if masculine and feminine gender identity would explain a significant proportion of variance when sex is already modeled as a fixed effect predictor: model 5 with masculine gender identity (e.g., for episodic autobiographical memory and episodic future thinking assessment, model 5: DV ~ lifetime period * sex * masculine Bem Sex Role Inventory score) and model 6 with feminine gender identity (e.g., for episodic autobiographical memory and episodic future thinking assessment, model 6: lifetime period * sex * feminine Bem Sex Role Inventory score).

In order to minimize multiple comparisons, we interpreted the results of these models leading to significant results at the threshold defined by applying the Bonferroni correction depending on the number of variables investigated (i.e., $p = .05$/number of variable investigated). We then reported unstandardized beta (B), 95% confidence intervals based on the estimated local curvature of the likelihood surface (Bates, Mächler, Bolker, & Walker, 2014), standardized beta (β) and uncorrected p values of estimates of the fixed effect predictor of models when one variable of interest accounted for a significant part of the DV considered. Standardized beta is considered as a measure of the strength of the relationship between the DV and the predictor, and as such, serves as standardized effect size statistics.

To resume, when adding a variable of interest significantly improved the part of variance explained by model 1 or 2 with the corrected threshold used, we then explored the effects of different factors in the model regardless of the corrected Bonferroni threshold. The parameters of selected models through model comparisons estimated with 95% confidence intervals (CI) are reported in the text, with positive beta values representing a positive predictive relation, and negative beta values representing negative predictive relations. Only the significant results are presented in the text but the results of all the model comparisons are given in Tables 2–5. Moreover, an overview of the main significant results is shown in Fig. 2.

All these analyses were performed using R software (R version 3.2.4 Revised).

3. Results

3.1. Gender assessment: Bem sex role inventory

Table 1 presents the mean and standard deviation per group concerning masculine and feminine Bem Sex Role inventory scores. There was no difference between men and women in age and years of education.

3.2. Episodic autobiographical memory and episodic future thinking assessment

In the episodic autobiographical memory and episodic future thinking assessment (see Appendix A for a table that presents mean and standard deviations for all the sample and per group), an experimental task design was used to define model 1 in which the period of life (i.e., recent past, remote past, future) is a fixed effect predictor. The comparison of the different models is shown in Table 2. Results regarding the specificity score for total (free + cued) recall, valence, importance and vividness are not reported here because comparison of the models did not highlight any significant results for those variables.

3.2.1. Specificity score for free recall

Regarding the specificity score for free recall, there was a significant gain in explaining the variance of this variable when feminine gender identity was added in the base model (model 1). In model 4, the effect of feminine gender identity had a significant effect only in the remote past period B = −0.64, 95% CI [−1.09, −0.19], β. = −0.30, p = .006. In other words, the more participants had a feminine gender identity the less specific they were in free recall in the remote past condition.

3.2.2. Emotional intensity

Regarding the emotional intensity of memories, its variance was significantly better explained when feminine gender identity was added to the base model (model 1). In model 4, the effect of feminine gender identity was significant in the recent past condition, B. = 0.62, 95% CI [0.18, 1.06], β = 0.33, p = .007, and future condition, B. = 0.70, 95% CI [0.26, 1.13], β = 0.38, p = .002. Therefore, the more participants had a feminine gender identity, the more they recollected or imagined intense emotional memories in recent past and future conditions.

3.3. The 3 I test: temporally extended conceptual self and episodic assessment

In the 3 I test (see Appendix B for a table that presents the mean and standard deviations for all the sample and per group), an experimental task design was used to define Model 1 in which the period (i.e., past, present, future) is a fixed effect predictor. The comparison of the different models is shown in Table 3. Results regarding the number of correct responses to fluencies, valence and emotional intensity and importance of lifetime periods, emotional intensity and importance of memories, are not reported here because comparison of the models did not reveal any significant results for those variables.

Table 2
Comparison of mixed-models by likelihood ratio tests to determine which variables best explain the variance in the dependent variables considered in episodic autobiographical memory and episodic future thinking assessment.

Dependent variable	Specificity score for free recall	Specificity score for total recall	Valence	Importance	Emotional intensity	Vividness
Model comparison						
Model 1 vs model 2	$\chi^2(3, N = 41) = 1.35$, $p = .72$	χ^2 (3, $N = 41$) = 2.48, $p = .48$	χ^2 (3, $N = 41$) = 1.89, $p = .60$	χ^2 (3, $N = 41$) = 1.98, $p = .58$	χ^2 (3, $N = 41$) = 1.13, $p = .77$	χ^2 (3, $N = 41$) = 1.83, $p = .61$
Model 1 vs model 3	χ^2 (3, $N = 41$) = 0.69, $p = .87$	χ^2 (3, $N = 41$) = 1.49, $p = .69$	χ^2 (3, $N = 41$) = 3.69, $p = .30$	χ^2 (3, $N = 41$) = 9.97, $p = .02$	χ^2 (3, $N = 41$) = 4.28, $p = .23$	χ^2 (, $N = 41$) = 10.31, $p = .02$
Model 1 vs model 4	**χ^2 (3, $N = 41$) = 12.28, $p = .006$***	χ^2 (3, $N = 41$) = 3.11, $p = .38$	χ^2 (3, $N = 41$) = 5.98, $p = 11$	χ^2 (3, $N = 41$) = 8.29, $p = .04$	**χ^2 (3, $N = 41$) = 13.56, $p = .004$***	χ^2 (3, $N = 41$) = 7.33, $p = .06$
Model 2 vs model 5	χ^2 (6, $N = 41$) = 3.59, $p = .73$	χ^2 (6, $N = 41$) = 1.05, $p = .98$	χ^2 (6, $N = 41$) = 6.74, $p = .35$	χ^2 (6, $N = 41$) = 16.34, $p = .01$	χ^2 (6, $N = 41$) = 4.85, $p = .56$	χ^2 (6, $N = 41$) = 16.67, $p = .01$
Model 2 vs model 6	χ^2 (6, $N = 41$) = 15.31, $p = .02$	χ^2 (6, $N = 41$) = 4.82, $p = .57$	χ^2 (6, $N = 41$) = 6.28, $p = .39$	χ^2 (6, $N = 341$) = 11.23, $p = .08$	χ^2 (6, $N = 41$) = 14.84, $p = .02$	χ^2 (6, $N = 41$) = 8.98, $p = .17$

Model 1 (modeling the episodic autobiographical memory and episodic future thinking assessment experimental plan): DV ~ lifetime period Model 2 (modeling sex differences): DV ~ lifetime period * Sex.
Model 3 (modeling masculine gender identity): DV ~ lifetime period * masculine Bem Sex Role Inventory score.
Model 4 (modeling feminine gender identity): DV ~ lifetime period * feminine Bem Sex Role Inventory score.
Model 5 (modeling sex and masculine gender identity): DV ~ lifetime period * Sex * masculine Bem Sex Role Inventory score.
Model6 (modeling sex and feminine gender identity): DV ~ lifetime period * Sex * feminine Bem Sex Role Inventory score.
DV = dependent variable.
$p < .0083^{*}$, $p < .0017^{**}$, $p < .00017^{***}$ (Bonferroni correction, e.g., $p < .05$/number of variables investigated = 0.05/6 = 0.0083*).

Table 3
Comparison of mixed-models by likelihood ratio tests to determine which variables best explain the variance in the dependent variables considered in the 3I test.

Dependent variable	Number of correct responses to fluencies	Valence of lifetime periods	Emotional intensity of lifetime periods	Importance of lifetime periods	Valence of memories	Emotional intensity of memories	Importance of memories
Model comparison							
Model 1 vs model 2	χ^2 (3, N = 41) = 3.44, p = .33	χ^2 (3, N = 41) = 0.39, p = .94	χ^2 (3, N = 41) = 3.50, p = .32	χ^2 (3, N = 41) = 1.24, p = .74	χ^2 (3, N = 41) = 9.38, p = .02	χ^2 (3, N = 41) = 5.79, p = .12	χ^2 (3, N = 41) = 2.86, p = .41
Model 1 vs model 3	χ^2 (3, N = 41) = 0.43, p = .93	χ^2 (3, N = 41) = 3.76, p = .29	χ^2 (3, N = 41) = 5.44, p = .14	χ^2 (3, N = 41) = 2.23, p = .52	χ^2 (3, N = 41) = 0.80, p = .84	χ^2 (3, N =) = 0.97, p = .81	χ^2 (3, N = 41) = 1.00, p = .80
Model 1 vs model 4	χ^2 (3, N = 41)= 9.41, p = .02	χ^2 (3, N = 41) = 8.90, p = 03	χ^2 (3, N = 41) = 4.15, p = .25	χ^2 (3, N = 41) = 5.40, p = .14	**χ^2 (3, N = 419) = 22.81, p = .000044*****	χ^2 (3, N = 41) = 6.15, p = .10	χ^2 (3, N = 341) = 9.82, p = .02
Model 2 vs model 5	χ^2 (6, N = 41) = 2.56, p = .86	χ^2 (6, N = 41) = 5.59, p = .47	χ^2 (6, N = 41) = 7.73, p = .26	χ^2 (6, N = 41) = 6.43, p = .38	χ^2 (6, N = 41) = 6.90, p = .33	χ^2 (6, N = 41) = 4.31, p = .64	χ^2 (6, N = 41) = 3.29, p = .77
Model 2 vs model 6	χ^2 (6, N = 41) = 10.61, p = .10	χ^2 (6, N = 41) = 16.37, p = .01	χ^2 (6, N = 41) = 6.02, p = .42	χ^2 (6, N = 41) = 10.54, p = .10	**χ^2 (6, N = 41) = 23.16, p = .00075****	χ^2 (6, N = 41) = 5.44, p = .49	χ^2 (6, N = 41) = 14.13, p = .03

Model 1 (modeling of 3 I test experimental plan): DV ~ lifetime period Model 2 (modeling of sex differences): DV ~ lifetime period * Sex.
Model 3 (modeling of masculine gender identity): DV ~ lifetime period * masculine Bem Sex Role Inventory score.
Model 4 (modeling of feminine gender identity): DV ~ lifetime period * feminine Bem Sex Role Inventory score.
Model 5 (modeling sex and masculine gender identity): DV ~ lifetime period * Sex * masculine Bem Sex Role Inventory score.
Model6 (modeling sex and feminine gender identity): DV ~ lifetime period * Sex * feminine Bem Sex Role Inventory score.
DV = dependent variable.
$p < .0071^{*}$, $p < .0014^{**}$, $p < .00014^{***}$ (Bonferroni correction, e.g., $p < .05$/number of variables investigated = 0.05/7 = 0.0071*).

Table 4
Comparison of mixed-models by likelihood ratio tests to determine which variables best explain the variance in the dependent variables considered in the verbal autobiographical fluency task.

Dependent variable	Number of correct responses to nested fluencies (from 1 to 4)	Valence of critical item	Emotional intensity of critical item	Importance of critical item	Number of specific details in verbal autobiographical fluency 4
Model comparison					
Model 1 vs model 2	χ^2 (4, N = 41) = 3.57, p = .47	χ^2 (3, N = 41) = 0.26, p = .97	χ^2 (3, N = 41) = 1.02, p = .80	χ^2 (3, N = 41) = 0.90, p = .83	χ^2 (7, N = 41) = 7.88, p = .34
Model 1 vs model 3	χ^2 (4, N = 41) = 1.95, p = .74	χ^2 (3, N = 41) = 1.36, p = .71	χ^2 (3, N = 41) = 5.32, p = .15	χ^2 (3, N = 41) = 2.83, p = .42	χ^2 (7, N = 41) = 5.77, p = .57
Model 1 vs model 4	χ^2 (4, N = 41) = 1.26, p = .87	χ^2 (3, N = 41) = 2.67, p = .45	**χ^2 (3, N = 41) = 13.13, p = .004***	χ^2 (3, N = 41) = 9.05, p = .03	χ^2 (7, N = 41) = 11.13, p = .13
Model 5 vs model 2	χ^2 (8, N = 41) = 4.79, p = .78	χ^2 (6, N = 41) = 2.78, p = .84	χ^2 (6, N = 41) = 6.64, p = .36	χ^2 (6, N = 41) = 6.20, p = .40	χ^2 (14, N = 41) = 26.12, p = .02
Model 6 vs model 2	χ^2 (8, N = 41) = 6.36, p = .61	χ^2 (6, N = 41) = 14.19, p = .03	χ^2 (6, N = 41) = 16.18, p = .013	**χ^2 (6, N = 41) = 23.17, p = .0007****	**χ^2 (14, N = 41) = 30.36, p = .007***

Model 1 (modeling the verbal autobiographical fluency task experimental plan): DV ~ level of specificity from level 1 to 4 (and for the number of specific details in verbal autobiographical fluency 4 where Model 1: DV ~ types of details).
Model 2 (modeling of sex differences): DV ~ level of specificity * Sex.
Model 3 (modeling of masculine gender identity): DV ~ level of specificity * masculine Bem Sex Role Inventory score.
Model 4 (modeling of feminine gender identity): DV ~ level of specificity * feminine Bem Sex Role Inventory score.
Model 5 (modeling sex and masculine gender identity): DV ~ level of specificity * Sex * masculine Bem Sex Role Inventory score.
Model 6 (modeling sex and feminine gender identity): DV ~ level of specificity * Sex * feminine Bem Sex Role Inventory score.
DV = dependent variable.
$p < 0.01^{*}$, $p < 0.002^{**}$, $p < 0.0002^{***}$ (Bonferroni correction, e.g., $p < .05$/number of variables investigated = 0.05/5 = 0.01^{*}).

3.3.1. Valence of memories

Regarding memories' valence, adding feminine gender identity in models 1 and 2 significantly improved the explanation of the variance. Feminine gender identity reached significance in the past condition, B. = −1.25, 95% CI [−1.86, −0.65], β. = −0.60, p = .0001, and this effect was significant in women, B. = −1.36, 95% CI [−2.14, −0.58], β. = −0.59, p = .002, and in men, B. = −1.21, 95% CI [−2.14, −0.28], β. = −0.58, p = .02 and in the future condition, B. = 0.82, 95% CI [0.24, 1.40], β. = 0.39, p = .007 and this effect was mainly driven by women, B. = 0.88, 95% CI [0.10, 1.67], β. = 0.42, p = .04. In other words, the more participants and especially women had a feminine gender identity, the more they imagined positive future self-defining events, while in the past condition, the more participants had a feminine gender identity, the more negative the self-defining memories recalled were.

3.4. Verbal autobiographical fluency task: different abstraction levels of autobiographical information assessment

In the verbal autobiographical fluency task (see Appendix C for a table that presents means and standard deviations for all the sample and per group), an experimental task design was used to define Model 1 in which the level of specificity of personal information (i.e., lifetime period, general events and specific event and details) is a fixed effect predictor. The comparison of the different models is shown in Table 4. Results regarding the number of correct responses to nested fluencies and valence of critical items are not reported here because comparison of the models did not show any significant results for these variables.

3.4.1. Emotional intensity of critical item

The variance of the critical item's emotional intensity was significantly better explained when feminine gender identity was added to model 1. In model 4, the feminine gender identity effect was significant only in the specific events condition, B. = 0.79, 95% CI [0.29, 1.29], β. = 0.48, p = .003. In other words, the more participants had a feminine gender identity, the more they chose a critical item associated with a high emotional intensity in the specific events condition.

3.4.2. Importance of critical item

The variance of the critical item's importance was significantly better explained when feminine gender identity was added to model 2. The feminine gender identity effect reached significance in model 6 in the general events condition in men, B. = 1.10, 95% CI [0.31, 1.90], β. = 0.55, p = .01, and in the specific events condition in women, B. = 1.33, 95% CI [0.60, 2.06], β. = 0.66, p = .001. In other words, the more participants had a feminine gender identity, the more men chose a critical item that was highly important for them in the general events condition while women seemed to have the same effect but in the specific events condition.

3.4.3. Number of specific details

The variance of the number of specific details was significantly better explained when feminine gender identity was added to model 2. The feminine gender identity effect reached significance in the perceptive category in women, B. = −2.52, 95% CI [−3.64, −1.40], β. = −0.71, p = .00002. In other words, the more participants had a feminine gender identity, the fewer perceptive details women gave.

Table 5
Comparison of mixed-models by likelihood ratio tests to determine which variables best explain the variance in the dependent variables considered in subjective self-assessment.

Dependent variable	Response distribution score	Positivity of self-image	Positivity of moral self-image	Positivity of personal self-image	Positivity of family self-image	Positivity of social self-image
Model comparison						
Model 1 vs model 2	χ^2 (3, N = 41) = 3.28, p = .35	χ^2 (3, N = 41) = 3.70, p = .30	χ^2 (3, N = 41) = 2.80, p = .42	χ^2 (3, N = 41) = 1.64, p = .65	χ^2 (3, N = 41) = 3.79, p = .28	χ^2 (3, N = 41) = 2.58, p = .46
Model 1 vs model 3	χ^2 (3, N = 41) = 1.92, p = .59	χ^2 (3, N = 41) = 3.88, p = .27	χ^2 (3, N = 41) = 0.14, p = .99	χ^2 (3, N = 41) = 4.76, p = .19	χ^2 (3, N = 41) = 3.41, p = .33	χ^2 (3, N = 41) = 2.43, p = .49
Model 1 vs model 4	**χ^2 (3, N = 41) = 25.89, p = .00001*****	**χ^2 (3, N = 41) = 14.74, p = .002***	χ^2 (3, N = 41) = 8.34, p = .04	χ^2 (3, N = 41) = 10.53, p = .015	χ^2 (3, N = 41) = 6.61, p = .09	**χ^2 (3, N = 41) = 12.67, p = .005***
Model 2 vs model 5	χ^2 (6, N = 41) = 8.58, p = .20	χ^2 (6, N = 41) = 10.08, p = .12	χ^2 (6, N = 41) = 3.70, p = .72	χ^2 (6, N = 41) = 9.29, p = .16	χ^2 (6, N = 41) = 7.68, p = .26	χ^2 (6, N = 41) = 8.58, p = .20
Model 2 vs model 6	**χ^2 (6, N = 41) = 26.70, p = .00016*****	χ^2 (6, N = 41) = 13.87, p = .03	χ^2 (6, N = 41) = 9.52, p = .14	χ^2 (6, N = 41) = 11.58 p = .07	χ^2 (6, N = 41) = 11.5, p = .07	**χ^2 (6, N = 41) = 20.70, p < .00016*****

Model 1 (modeling of the temporally extended subjective self-assessment plan): DV ~ time period Model 2 (modeling of sex differences): DV ~ time period * Sex.
Model 3 (modeling of masculine gender identity): DV ~ time period * masculine Bem Sex Role Inventory score.
Model 4 (modeling of feminine gender identity): DV ~ time period * feminine Bem Sex Role Inventory score.
Model 5 (modeling sex and masculine gender identity): DV ~ time period * Sex * masculine Bem Sex Role Inventory score.
Model6 (modeling sex and feminine gender identity): DV ~ time period * Sex * feminine Bem Sex Role Inventory score.
DV = dependent variable.
$p < .0083^{*}$, $p < .0017^{**}$, $p < .00017^{***}$ (Bonferroni correction, e.g., $p < .05$/number of variables investigated = 0.05/6 = 0.0083*).

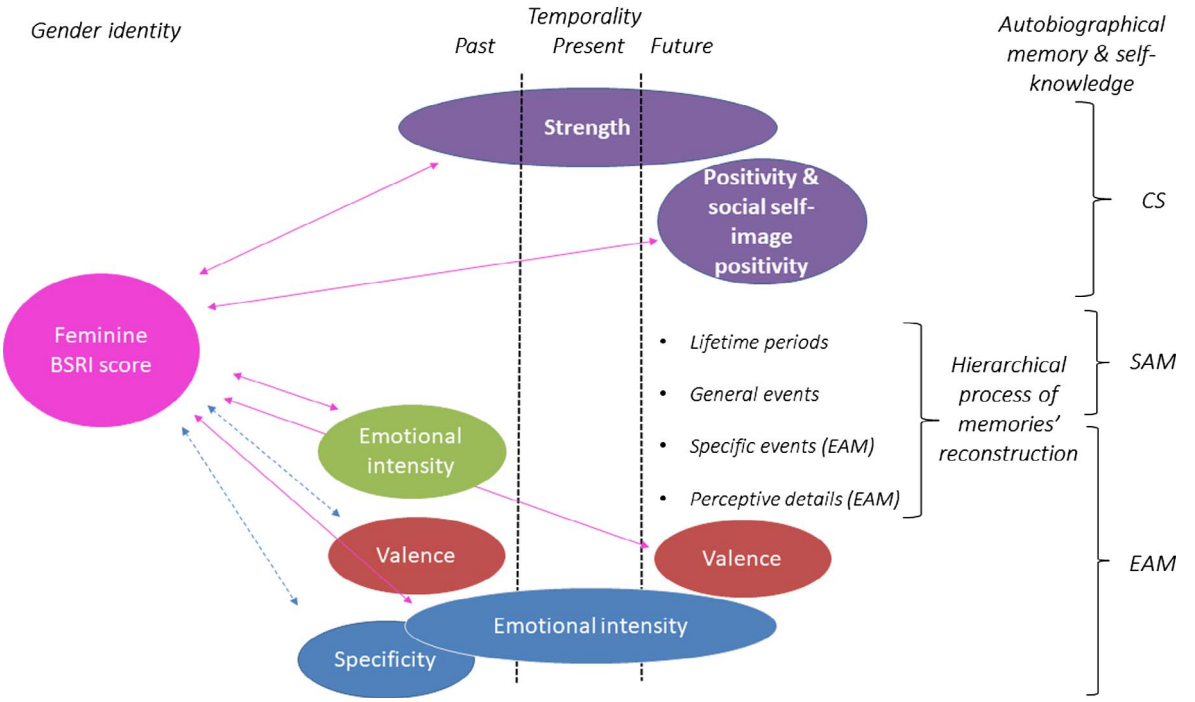

Fig. 2. Overview of the main significant results. The pink and full line arrows indicate a positive relationship between the dependent variable and feminine gender identity and blue and hatched arrows, a negative relationship. The color code is the same as that used for Fig. 1d. Dependent variables framed in violet were obtained from the subjective self-assessment (Tennessee Self-Concept Scale), the one framed in green from the verbal autobiographical fluency task, those framed in red from the 3 I test and those framed in blue from the episodic autobiographical memory and episodic future thinking assessment. CS: conceptual self – EAM: episodic autobiographical memory – SAM: semantic autobiographical memory. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

3.5. Subjective self-assessment: temporally extended conceptual self (past, present and future Tennessee Self Concept Scale)

In the subjective self-assessment (see Appendix D for a table that presents means and standard deviations for all the sample and per group), an experimental task design was used to define Model 1 in which the time period (i.e., past, present and future) is a fixed effect predictor. The comparison of the different models is shown in Table 5. Results regarding the positivity of moral, personal and family self-image, are not reported here because comparison of the models did not show any significant results for those variables.

3.5.1. Response distribution score

The variance of the response distribution score was significantly better explained when feminine gender identity was added to model 1 and to model 2. In model 4, the feminine gender identity effect was significant in the past, B. = 2.60, 95% CI [0.74, 4.46], β. = 0.39, p = .009, present, B. = 2.38, 95% CI [0.50, 4.26], β. = 0.36, p = .02, and future condition, B. = 5.21, 95% CI [3.35, 7.07], β. = 0.78, p = .0000007. In model 6, this effect was significant in the past condition in men, B. = 3.83, 95% CI [0.99, 6.68], β. = 0.57, p = .01, in the present condition in men, B. = 3.73, 95% CI [0.89, 6.57], β. = 0.56, p = .02, in the future condition in men, B. = 5.44, 95% CI [2.60, 8.29], β. = 0.81, p = .0006, and women, B. = 4.99, 95% CI [2.38, 7.60], β. = 0.75, p = .0006. In other words, the more participants had a feminine gender identity, the more they were certain about their self-image from any time perspective. This effect was mainly driven by men in past and present conditions and reached significance for men and women in the future condition.

3.5.2. Identity score or positivity of self-image

The variance of the positivity of self-image score was significantly better explained when feminine gender identity was added to model 1. In model 4, the feminine gender identity effect was significant only in the future condition, B. = 7.95, 95% CI [3.80, 12.09], β. = 0.55, p = .0004, meaning that the more participants had a feminine gender identity, the more positive their self-image in the future was.

3.5.3. The positivity of social self-image

The variance of the positivity of social self-image score was significantly better explained when feminine gender identity was added to models 1 and 2. In model 4, the feminine gender identity effect was significant only in the future condition, B. = 1.81, 95% CI [0.72, 2.90], β. = 0.51, p = .002 and in model 6, this effect only reached significance in women, B. = 1.85, 95% CI [0.31, 3.38], β. = 0.52, p = .03. In other words, the more participants had a feminine gender identity, the more positive their social self-image in the future was; this effect was mainly driven by women.

4. Discussion

This study aimed to extend the recent literature on the effects of sex and gender identity on EAM and to investigate for the first time these effects by considering the different levels of abstraction in AM (i.e., EAM, SAM and CS) and different time perspectives from the past to the future. Overall, the findings confirm our main hypothesis that gender identity predicts greater differences in AM than sex. We will begin by comparing our results with those of the EAM literature before considering our new results for the effects of sex and gender identity on the different aspects of AM.

4.1. Effects of sex and gender identity in episodic autobiographical memory (EAM) and episodic future thinking

Whatever the task used, we did not report sex differences in EAM. Although a female advantage in EAM is frequently highlighted in the literature (Grysman & Hudson, 2013), the lack of sex effect is not novel using either objective scoring (e.g., Compère et al., 2016; Strongman & Kemp, 1991) or self- rating scales (e.g., Piefke et al., 2005; St. Jacques et al., 2011). The fact that numerous experiments have not found sex-related differences is precisely the point used by Grysman and Hudson (2013) to suggest that sex as a binary variable is not the best variable to explain individual differences in AM performance and that gender identity might be more appropriate.

In accordance with their hypothesis and ours, our analysis has highlighted clear gender identity effects on EAM performances, particularly of feminine gender identity. Indeed, feminine gender identity appeared as a key factor for the specificity of EAMs and their emotional intensity. As shown by the episodic autobiographical memory and episodic future thinking assessment, the more participants tended to adopt stereotypical feminine features, regardless of their sex membership, the less specific they were in the free recall of remote EAMs and the more participants recalled emotionally intense recent EAMs. First, it is interesting to note that feminine gender identity seemed to affect specificity scores in free recall but not the total specificity score (sum of specificity scores of free and cued recalls). This result suggests that these differences may be related to differences in the retrieval strategies used by the participants with a feminine gender identity, which is consistent with the predominant mode of responding and narrating hypothesis argued by Grysman and Hudson (2013). This refers to the fact that interindividual differences in autobiographical memory may not be the consequence of an inability to recall certain details for some individuals but simply of a tendency in the way they are remembered or evoked. Second, Grysman (2014) showed that women report events concurring with their self-images as closer to the present than men and dissonant events as more distant in the past. Therefore, one speculative explanation of our results is that the present effects particularly concerned remote memories that were dissonant with participants' self-image, which might explain why these memories were spontaneously recalled with less specificity, possibly due to inhibition mechanisms in order to preserve the coherence with current self (Conway, 2005; Conway et al., 2004; Sperduti et al., 2013). However, in his study, Grysman (2014) operationalized the consonance or dissonance of memories by using a positive self-relevant personality as a cue, asking some participants to recall memories in which they acted according to the self-descriptive trait (consonant event) while others were asked to write a memory narrative of an event in which they did not act in accordance with that trait (dissonant event). As a consequence, it is very likely that self-dissonant memories in this study are memories of negative valency or at least not projecting a positive image of participants. In the same way, in the 3 I test, the more participants had a feminine gender identity, the more they recalled negative personal events illustrative of their past semantic self-representation (see below, discussion on CS). Therefore, if participants who identify with feminine stereotypes have more self-dissonant, negative or associated with a less positive self-image remote memories, this would explain why inhibition mechanisms induce less specificity in order to preserve coherence with the current self among these participants. Lastly, another argument in favor of the robustness of this result is that it did not appear task dependent because it was replicated in the verbal autobiographical fluency task as feminine gender identity was associated with an enhanced emotional intensity of the chosen critical item in the specific event level and a lower production of specific perceptive details in women. Therefore, while feminine gender identity is usually associated with the recall of more emotionally intense EAMs, it is possible that the recall of less specific memories here is an attempt to reduce the emotional intensity of these memories, since for remote memories, feminine gender identity is associated with less specificity in free recall while for recent memories and future thinking, it is associated with more emotional intensity, in the episodic autobiographical memory and episodic future thinking assessment. Indeed, it has been suggested that the decline in mental imagery for example is an effective strategy to decrease the emotional intensity of a memory (Holland & Kensinger, 2013) and this interpretation is consistent with the fact that these differences were evidenced with free recall specificity scores in the episodic autobiographical memory and episodic future thinking assessment and when time was limited in the verbal autobiographical fluencies task, which suggests that this information can be accessed with cueing but is inhibited during time-limited or free recollection. Interestingly, the gender effect regarding emotional intensity in episodic future thinking mirrored that of EAMs. Indeed, the present study revealed that the more participants tended to adopt a feminine gender identity, the more they imagined future intense emotional events.

The association of feminine gender identity with memories or imagination of greater emotional intensity is consistent with the affect intensity hypothesis according to which women experience and remember life events more intensely than men (Fujita et al., 1991). However, the combination of feminine gender identity with fewer perceptive details was unexpected given the fact that the affect intensity hypothesis attempts to explain the greater specificity in women and that Grysman and Fivush (2016) reported a positive correlation between feminine gender identity and sensory details of specific memories. However, several methodological differences are at stake here. First, in the episodic autobiographical memory and episodic future thinking assessment, we assigned one point for the presence of each category of details for EAM specificity scoring. This means that if some participants gave more sensory details than others, the specificity score did not reflect that specifically. However, this explanation is not valid for the verbal

autobiographical fluency task as each specific detail was considered. Nonetheless, here the participants were limited to one minute to give as many details as possible while in their study, Grysman and Fivush (2016) asked participants to self-assess how rich in sensory details their freely recalled memories were.

Otherwise, our findings did not reveal any significant effect of masculine gender identity, confirming previous findings that masculine gender identity effects are less consistent than those of the feminine gender identity (Grysman & Fivush, 2016) and more context-dependent (Grysman et al., 2016). However, we found an interaction between sex and gender identity that concerned masculine membership using the verbal autobiographical fluency task. This task assessed the construction of EAMs from different types of AM representations which posits that autobiographical construction is a generative hierarchical process (Conway & Pleydell-Pearce, 2000) and allowed us to investigate at which level of this generative process differences related to sex or gender identity would occur. In fact, feminine gender identity in women was associated with choosing an important critical item at the specific events level (verbal autobiographical fluency 3) while in men, this effect was expressed at the level of general events (i.e., repeated or extended in time, verbal autobiographical fluency 2). This result suggests that feminine gender identity related differences take root during the processes of cue generation in the hierarchical reconstruction of EAMs but that the tendency to choose important events during the time course reconstruction of EAMs appears at an earlier stage in men. More generally, the existence of an interaction between sex and gender identity suggests that interindividual differences in autobiographical memory can be explained in part by a source of biological variance (e.g., such as genetics or hormones) and a source of social variance (e.g., such as the influence of culture or gender identity) and that these different sources of variance could have different effects on autobiographical memory performance.

Overall, these results highlight major differences related to the emotional aspects of EAMs associated with feminine gender identity. This appears in agreement with the affect intensity hypothesis according to which women i.e., here participants who have a more feminine gender identity, experience and remember personal events with greater emotional intensity. Moreover, although this result requires replication, it seems that feminine gender identity may sometimes interact with sex and that its effects may vary from men to women.

4.2. *Effects of sex and gender identity in abstract forms of AM and future representations*

Abstract forms of self-knowledge (i.e., CS and SAM), such as EAMs, were not modulated by sex-related differences but showed effects related to gender identity.

The CS investigated by a subjective self-assessment (Tennessee Self Concept Scale) showed that the more participants had a feminine gender identity, the surer they were of their self-images from any time perspective (i.e., I was, I am, I will be). Moreover, the 3 I test indicated that the more participants had a feminine gender identity, the more they recalled negative personal events illustrative of their past semantic self-representation and positive personal events illustrative of their future semantic self-representation. It suggests that at the level of abstract self-representation the capacity to project in a positive future might counteract the effects of a negatively perceived past among participants with a feminine gender identity. As our sample was screened to ensure that our participants did not suffer from mood disorders, the question arises whether this tendency is not a natural trend associated with feminine gender identity to overcome reminiscence of the past which is well known to affect women more than men (Nolen-Hoeksema & Jackson, 2001), and that could become pathological when women are unable to plan for a positive future. Further consideration of different Tennessee Self Concept Scale self-image categories suggests that this positivity in the future comes from the social self-image among these participants, which is consistent with the stereotype that women are more social than men (Bakan, 1966) and with the socialization hypothesis that women are more focused on social relationships (Grysman & Hudson, 2013).

Regarding SAM, which was investigated in the verbal autobiographical fluency task by the first two fluencies that concerned periods of life and general events, the critical items selected in general level events were more important in men with a feminine gender identity. We have already discussed the finding that feminine gender identity was associated with the tendency to choose more meaningful events at the SAM level in men. A previous study investigating differences in fMRI in men and women during EAM and SAM retrieval showed greater activation in SAM in women than in men in the dorsal anterior cingulate cortex and in the left inferior parietal gyrus, which was interpreted as indicating greater cognitive control in order to minimize intense emotional responses in women (Compère et al., 2016). An enhanced establishment of emotion regulation strategies in women at a semantic level might explain why they do not feel the memories chosen in SAM as particularly intense emotionally. However, as this previous study did not investigate the links between these differences and gender identity, it is difficult to know what specific role sex and gender identity have in these cerebral activation differences between men and women and in emotion regulation strategies in general which are known to be less efficient or more effortful in women (Domes et al., 2010; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008).

To summarize, these new findings imply that specific gender differences are rooted at the abstract levels of self- representation and are consistent with Conway's conception of AM which assumes that CS and SAM guide EAM reconstruction (Conway, 2005). Nevertheless, we reported some effect of gender identity that depended on the sex of participants. Thus, it seems at least that feminine gender identity may sometimes interact with sex and that its effect may vary from men to women. Although such an interaction requires replication, the modulation of gender identity by sex raises the possibility that complex interactions between social factors such as gender identity and biological factors such as sex may exist and need further research (e.g., Resnick, Gottesman, & McGue, 1993).

4.3. Limits, conclusion and perspectives

Overall, our results support our main hypothesis that inter-individual differences in AM are better explained by gender identity than by sex in accordance with Grysman and Hudson (2013)'s proposal. In addition, a strength of our study is that, unlike studies that have investigated gender effects up to now, we verified that our participants had no psychiatric or neurological history, thus obviating this potential bias in the pattern of results. Moreover, we extend this assumption to both episodic and semantic forms of AM and future thinking. Furthermore, they also seem to suggest that sex and gender identity may interact so that some effects of gender identity vary depending on participants' sex. Nevertheless, these results need to be replicated, as our sample size was rather small. However, unlike most studies conducted by Grysman's team on this issue that involve online data collection, we performed a thorough neuropsychological assessment of autobiographical memory using standardized tests which involves spending an entire afternoon with each participant. Our methodological choice has limited the number of participants but it ensured that the participants have fully understood the degree of specificity of the self-related information investigated by each test and that the criteria characterizing an episodic or semantic autobiographical memory are stringently applied by asking the participants questions about the nature of the memory when the experimenter has a doubt. Furthermore, as the men and women we studied were young adults and did not differ significantly in their feminine and masculine Bem Sex Role Inventory scores (even if descriptively, men had higher scores of masculine Bem Sex Role Inventory than women and vice versa for feminine Bem Sex Role Inventory scores), it would be important to replicate these findings with older adults since the tendency to adopt gender stereotypes is reduced in young participants (fewer differences in the tendency to adopt feminine stereotypes in men and women aged 18–29 years, as in our sample, than 30–39 years, Grysman et al., 2016). This fact reinforces our contention that sex-related differences in AM are actually related to gender identity. Indeed, since gender identity differences between groups were not significant enough in the present study, and if gender identity differences are responsible for the sex-related differences highlighted by the literature, it makes sense that small differences in gender identity between groups would weaken the expression of sex-related differences but further studies are needed, especially with different age groups to confirm our findings. Nevertheless, the results clearly reveal differences related to the valence and intensity of emotional memories at different levels of self-knowledge abstraction in participants with a feminine gender identity, which supports the affect intensity hypothesis that women remember more emotionally intense memories (Fujita et al., 1991) and the socialization hypothesis that girls learn early to focus on their emotions in their autobiographical narratives (Grysman & Hudson, 2013). Along the same lines, the more participants have a feminine gender identity, the more they tend to adopt stereotypes usually associated with women such as the fact that women are more emotionally expressive than men (Fischer, 2000) and tend to engage in activities to confirm these stereotypes (Grysman & Hudson, 2013; Spencer, Steele, & Quinn, 1999). From a clinical perspective, these results could be particularly relevant in that they might provide new insights into etiologic processes of major depressive (Yao et al., 2014) or anxiety (Stevens & Hamann, 2012) disorders whose prevalence is higher among women in comparison to men, both conditions being characterized by overgeneralization in AM (Liu, Li, Xiao, Yang, & Jiang, 2013; Robinson & Jobson, 2013).

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Appendix A. Means with standard deviations for the dependent variables by time periods in episodic autobiographical memory and episodic future thinking assessment

	Remote past			Recent past			Future		
Sample	All	Men	Women	All	Men	Women	All	Men	Women
Specificity score of free recall***	6.28 ± 0.96	6.49 ± 1.06	5.22 ± 1.36	5.22 ± 1.36	5.22 ± 1.36	6.41 ± 1.00	5.22 ± 1.36	5.11 ± 1.26	5.35 ± 1.46
Specificity score of total recall***	7.45 ± 0.69	7.73 ± 0.46	6.84 ± 1.30	6.84 ± 1.30	6.84 ± 1.30	7.70 ± 0.52	6.84 ± 1.30	6.72 ± 1.33	6.97 ± 1.28
Valence of memories*	3.02 ± 1.27	3.75 ± 1.25	4.33 ± 0.85	4.33 ± 0.85	4.33 ± 0.85	3.84 ± 1.22	4.33 ± 0.85	4.16 ± 0.97	4.51 ± 0.67
Importance of memories**	3.09 ± 1.54	3.67 ± 1.09	4.16 ± 1.06	4.16 ± 1.06	4.16 ± 1.06	3.69 ± 1.16	4.16 ± 1.06	4.08 ± 1.08	4.24 ± 1.06
Emotional intensity of memories**	3.70 ± 1.13	4.03 ± 1.03	4.11 ± 1.03	4.11 ± 1.03	4.11 ± 1.03	4.03 ± 1.07	4.11 ± 1.03	4.00 ± 1.07	4.23 ± 1.00
Vividness of memories**	3.69 ± 0.83	4.29 ± 0.84	3.64 ± 1.03	3.64 ± 1.03	3.64 ± 1.03	4.34 ± 0.80	3.64 ± 1.03	3.53 ± 1.16	3.77 ± 0.88

* *min = 1 − max = 5.*
** *min = 0 − max = 5.*
*** *min = 0 − max = 8.*

Appendix B. Means with standard deviations for the dependent variables by periods in the 3 I test

	Past			Present			Future		
Sample	All	Men	Women	All	Men	Women	All	Men	Women
Number of correct answers	7.43 ± 3.06	9.49 ± 2.59	8.19 ± 2.85	8.19 ± 2.85	8.19 ± 2.85	7.61 ± 2.70	8.19 ± 2.85	7.74 ± 3.00	8.67 ± 2.68
Valence of periods*	3.54 ± 0.87	4.00 ± 0.62	4.24 ± 0.76	4.24 ± 0.76	4.24 ± 0.76	3.61 ± 0.98	4.24 ± 0.76	4.21 ± 0.71	4.28 ± 0.83
Emotional intensity of periods**	3.89 ± 0.84	3.76 ± 0.80	3.84 ± 0.76	3.84 ± 0.76	3.84 ± 0.76	3.94 ± 0.87	3.84 ± 0.76	3.84 ± 0.76	3.83 ± 0.79
Importance of periods**	3.95 ± 0.94	4.46 ± 0.65	4.27 ± 0.90	4.27 ± 0.90	4.27 ± 0.90	3.83 ± 1.04	4.27 ± 0.90	4.32 ± 0.82	4.22 ± 1.00
Valence of memories*	3.17 ± 1.25	3.81 ± 1.13	4.11 ± 1.10	4.11 ± 1.10	4.11 ± 1.10	3.06 ± 1.35	4.11 ± 1.10	3.89 ± 1.29	4.33 ± 0.84
Emotional intensity of memories**	3.67 ± 1.24	3.51 ± 1.41	3.73 ± 1.17	3.73 ± 1.17	3.73 ± 1.17	3.61 ± 1.24	3.73 ± ± 1.17	3.79 ± 1.40	3.67 ± 0.91
Importance of memories**	3.00 ± 1.72	3.43 ± 1.42	4.03 ± 1.21	4.03 ± 1.21	4.03 ± 1.21	2.72 ± 1.60	4.03 ± 1.21	4.05 ± 1.43	4.00 ± 0.97

* *min = 1 − max = 5.*
** *min = 0 − max = 5.*

Appendix C. Means with standard deviations for the dependent variables for the whole sample and per group by verbal autobiographical fluency level in verbal autobiographical fluency task

		Life periods			General events			Specific Events			Specific details		
Sample		All	Men	Women	All	Men	Women	All	Men	Women	All	Men	Women
Number of correct answers		6.86 ± 2.37	6.58 ± 1.57	7.17 ± 3.01	7.59 ± 2.70	8.11 ± 2.28	7.06 ± 3.06	5.54 ± 1.77	5.37 ± 1.71	5.72 ± 1.87	7.62 ± 2.90	7.47 ± 2.89	7.78 ± 2.98
Valence of critical item*		4.14 ± 0.63	4.11 ± 0.46	4.17 ± 0.79	4.22 ± 0.98	4.16 ± 0.90	4.28 ± 1.07	3.81 ± 1.33	3.84 ± 1.26	3.78 ± 4.44			
Emotional intensity of critical item**		4.14 ± 0.71	4.11 ± 0.74	4.17 ± 0.71	3.78 ± 1.13	3.68 ± 1.11	3.89 ± 1.18	4.19 ± 0.97	4.05 ± 0.85	4.33 ± 1.08			
Importance of critical item**		4.49 ± 0.61	4.37 ± 0.60	4.61 ± 0.61	4.05 ± 0.88	4.00 ± 0.88	1.11 ± 0.90	3.14 ± 1.46	3.00 ± 1.37	3.28 ± 1.56			
Number of details	Unique moment										1.00 ± 1.61	0.67 ± 1.14	1.35 ± 1.97
	Spatial										0.49 ± 0.89	0.78 ± 1.11	0.18 ± 0.39
	Temporal										0.23 ± 0.60	0.33 ± 0.77	0.12 ± 0.33
	Perceptive										4.60 ± 2.63	4.39 ± 2.20	4.82 ± 3.07
	Emotional										1.40 ± 1.48	1.00 ± 1.46	1.82 ± 1.42
	Thought										0.57 ± 1.12	0.50 ± 0.99	0.65 ± 1.27
	Other										0.17 ± 0.62	0.22 ± 0.73	0.12 ± 0.49

* *min = 1 − max = 5.*
** *min = 0 − max = 5.*

Appendix D. Means with standard deviations for the dependent variables for the whole sample and per group by time periods of subjective-self assessment (Tennessee Self Concept Scale)

	Past			Present			Future		
Sample	All	Men	Women	All	Men	Women	All	Men	Women
Response Distribution score (max = 21)	9.51 ± 3.85	9.24 ± 3.98	9.78 ± 3.81	9.44 ± 3.97	8.68 ± 3.90	10.29 ± 4.00	10.06 ± 4.24	8.94 ± 4.55	11.11 ± 3.76
Positivity of self-image (max = 105)	84.51 ± 10.20	85.47 ± 7.05	83.61 ± 12.63	88.58 ± 7.36	87.79 ± 5.93	89.47 ± 8.80	90.71 ± 6.75	88.59 ± 7.67	92.72 ± 5.21
Positivity of moral self-image max(max = 20)	15.91 ± 1.93	15.82 ± 2.01	16.00 ± 1.91	16.58 ± 1.27	16.37 ± 1.16	16.82 ± 1.38	17.26 ± 1.44	16.82 ± 1.59	17.67 ± 1.19
Positivity of personal self-image (max = 25)	20.31 ± 3.06	20.59 ± 2.69	20.06 ± 3.42	21.83 ± 1.90	21.79 ± 1.75	21.88 ± 2.12	21.89 ± 1.88	21.53 ± 1.97	22.22 ± 1.77
Positivity of family self-image (max = 20)	16.83 ± 2.80	17.59 ± 1.46	16.11 ± 3.55	17.25 ± 2.36	17.32 ± 1.70	17.18 ± 2.98	17.80 ± 2.04	17.71 ± 2.14	17.89 ± 2.00
Positivity of social self-image (max = 15)	11.77 ± 2.38	11.59 ± 2.40	11.94 ± 2.41	12.16 ± 2.10	12.37 ± 2.31	11.94 ± 1.89	12.66 ± 1.83	12.18 ± 1.81	13.11 ± 1.78

Appendix E. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.concog.2017.11.001.

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