SELF AND MEMORY: A MULTIDISCIPLINARY DEBATE

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SELF AND MEMORY: A MULTIDISCIPLINARY DEBATE

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Editorial: Self and Memory: A Multidisciplinary Debate

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Editorial on the Research Topic

Self and Memory: A Multidisciplinary Debate

BACKGROUND

There is no consensus about the definition of autobiographical memory and its contribution to our sense of self. Along the lines of Hoerl (2007), we organized the research topic by distinguishing three strands of theorizing which vary according to how they construe the relationship between autobiographical memory and the notions of episodic memory and self.

Autobiographical memory can be defined in terms of episodic memory, where the latter includes a reference to the self. As Tulving puts it, "episodic memory differs from other forms of memory in that its operations require a self. It is the self that engages in the mental activity that is referred to as mental time travel: there can be no travel without a traveler" (Tulving, 2005, pp. 14–15; emphasis added). Once this reference to a traveling self is built into the notion of episodic memory, a further step may be taken by construing such notion in terms of the phenomenological construct of prereflective self-consciousness. This path is taken, for example, by Prebble et al. (2013) who proposed a framework for the study of sense of self and autobiographical memory where an immediate and automatic sense of being the subject of experience (pre-reflective self-experience) is seen as the precondition for episodic autobiographical memory, which in turn—in virtue of its features of autonoetic consciousness and mental time travel—is a prerequisite for experiencing unity in our subjective experience of selfhood across time (phenomenological continuity). Thus episodic remembering makes it possible the unification of the self as a single entity that persists across time (diachronic unity) by conveying "the inherent 'mineness' of the original experience into the present moment" (Prebble et al., 2013, pp. 818–819). In contrast, semantic continuity is a form of continuity that is not experiential but knowledge-based (the knowledge that the self exists over time), mediated by semantic autobiographical memory which enables us to construct life narratives.

Other models, however, view episodic memory as "only one possible aspect or instance" of autobiographical memory (Hoerl, 2007 , p. 637, note 4). For example, Conway (2005) argues that episodic memories are experience-near sensory-perceptual-conceptual-affective summary features of short-time slices of experience, which are durably retained only if they have been embedded in autobiographical knowledge structures; otherwise, they are rapidly forgotten. Within what Conway terms "the self-memory system," therefore, the notion of autobiographical memory is no longer defined in terms of episodic memory; only conceptual organization of episodic memories within the self-memory system transforms them into autobiographical memory and allows them to play a role in constructing and maintaining a coherent, stable mental representation of the self (the conceptual self) over time.

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In this perspective, in contrast to Tulving's assumption that remembering past events serves to establish the sense of continuity of our self over time by virtue of a specific phenomenal quality (i.e., the immediate feeling that "I" experienced the remembered event), Conway proposes the opposite: it is the conceptual self (the present Me) that selects and also distorts personal memories so as to increase the sense of personal continuity. As a consequence, self-continuity is not "provided by the identity of the remembering I, but by the perceived similarity of the present and past Me" (Habermas and Köber, 2015, p. 153)

A third approach, well represented by Katherine Nelson's work, takes autobiographical memory as a subclass of episodic memories which involve a reference to the self, which is viewed however from a social interactionist standpoint (see, e.g., Nelson, 1996). The sense of self in time originates then from social-communicative interactions, and especially from sharing memory narrative which progressively lead children to rationalize memories of their experiences in autobiographical terms. Thus, Nelson meritoriously stresses more than other authors the role of relationships in constituting a sense of self, placing herself in the wake of an important and heterogeneous tradition going back (with different accents) to Vygotsky and, in the infant research and clinical domain, to the object relation and attachment theories.

On the backdrop of these three theoretical perspectives, the present research topic called interdisciplinary contributions concerning the relationship between autobiographical memory and the self, and notably their functional and dysfunctional interactions. What follows is an overview of the contributions that this research topic includes. It is divided into four sections with headers that describe the subthemes of the issue.

MODELING THE LINK BETWEEN AUTOBIOGRAPHICAL MEMORY AND SENSE OF SELF

Tippett et al. build on their aforementioned model of the relationship between autobiographical memory and the self, making the hypothesis that diachronic unity (i.e., the belief that, despite changes, we are the same person across the lifespan) rests on phenomenological continuity (i.e., the experience of remembering the self over time during episodic recall). When phenomenological continuity is disrupted, however, diachronic unity can still be supported by semantic memory, which enables us to construct narratives from which semantic continuity emerges.

The hypothesis was tested in a study involving patients with mild-to-moderate probable Alzheimer's Disease (AD) and with amnestic mild cognitive impairment (aMCI), two conditions where episodic memory deficits disrupt phenomenological continuity. This alone should not lead to deterioration in diachronic unity, provided that semantic continuity is well-preserved; but if semantic continuity is also altered both in AD and aMCI, there should be an associated deterioration in diachronic unity. The latter was measured through a self-persistence interview (beliefs about self-persistence, explanations for stability/change); semantic continuity was assessed measuring autobiographical reasoning (connections between one's conceptual self and the events of one's life) and (temporal, thematic, and causal) coherence of narratives.

The findings in both aMCI and AD groups confirm the hypothesis that intact semantic continuity is sufficient to support diachronic unity. In the aMCI group, the quality of life narratives was largely preserved, as were measures of self-persistence, indicating that even when the continuity afforded by phenomenological re-experiencing is disrupted, semantic continuity is sufficient to support diachronic unity. However, the findings from the AD group indicate a more complex relationship between diachronic unity and semantic continuity than originally proposed in Prebble et al. (2013). For these findings reveal a divergence between two aspects of diachronic unity: the AD and aMCI groups did not differ from health controls in their beliefs about their persistence over time, but patients with AD showed deterioration in their ability to construct a sophisticated justification for their persistence across time. The authors suggest that in the AD group diminished life narratives that retain features of cultural life scripts are sufficient for strong subjective beliefs of self-persistence, but not for sophisticated explanations about persistence. Better semantic continuity, with the ability to weave high-quality life narratives, may scaffold the capacity to understand and explain one's diachronic unity, but this produces less certainty about their self-persistence.

Wheeler and Gabbert adopt Tulving's notion of episodic memory as a specialized subcategory of memory relating to the conscious recall of personally experienced events. Then they usefully emphasize the distinction between a self-generated cue and a self-referent cue—the former represents the critical properties of a target memory; the latter acts as a cue relating to an aspect of the self. On this background, they provide the first overview of the research work that showed that self-generated cues represent an effective and viable mnemonic technique which can aid recall in a variety of settings.

The authors also theoretically contribute to this research area by speculating on the memory mechanisms that lead to the improvement of memory through self-generated cues. Three mechanisms seem able to explain the effectiveness of self-generated cues. (1) Spreading activation models which view information in long-term memory as being represented by a network of associated concepts. It is possible to recall a given item from memory by recalling other information associated with the target; this is made possible through the process of activation spreading through the network. (2) The principles of encoding-specificity (or encoding-retrieval specificity), i.e., the idea that retrieval cues are effective only to the extent that information within the memory cue is also contained within the target memory trace created at the time of encoding. (3) Cue distinctiveness (or an absence of cue overload) which refers to whether a cue is uniquely associated with a target memory—if a cue is linked to multiple memory traces (and so is "overloaded"), then it becomes more difficult for that cue to activate the current target trace. The authors conclude by suggesting that self-generated cues represent a promising development in episodic memory domains.

Vanderveren et al. shift the focus to memory specificity and memory coherence, two characteristics of autobiographical memory that have been related to psychological well-being and the occurrence of psychopathology. To make a first attempt at a theoretical integration of memory specificity and memory coherence, the authors situate them within the Self-Memory System (SMS). Concerning memory specificity, people suffering from depression or PTSD are reported to experience specific difficulties retrieving episodes and tend to overgeneralise memories. Their semantically (rather than episodically) structured memory impedes time traveling and social life and, consequently, self-regulation—thus predisposing to further suffering. Nonetheless, the whole overgeneralisation literature can be traced back to Williams and Broadbent's Autobiographical Memory Test (AMT), which attested specific difficulties to retrieve personal memories cued by emotion words. In AMT episodic memories are circumscribed by time (no more than one day). Conversely, in SMS episodic memories are defined by event-specific information, which is a unity given by a continuity given by perceptual episodes not necessarily coincident with AMT's temporal slot; this discrepancy raises the problem of understanding what AMT actually measures.

Coherent memories are also associated to well-being. Coherence allows the construction of a unified meaning, which in turn promotes a sense of self-continuity. It is also a precondition for self-regulation, to the extent that it allows a subsumption of an event under a meaningful history. Nevertheless, some theoretical problems still remain unresolved, mostly concerning what relevant dimensions of coherence exactly are: temporal, causal, or thematic coherence? Or a mix of the three? Moreover, the prevalence of cross-sectional studies still leaves unanswered the developmental question: is memory incoherence a genuine predictor of psychopathology; or is rather one of its side effects?

The authors conclude by pointing out that the whole research on memory would beneficiate from a more unified view on specificity and coherence. More iterated models, such as SMS, do not consider the two as separate dimensions, but rather point out to their interconnectedness. Far from neglecting some peculiarities, such as episodic amnesia leaving largely preserving coherence, the authors still recommend further research from a more integrated prospective. With its emphasis on the interconnectedness between current personal goals (supervising coherence), episodic, perceptually vivid traces and long-term memories, SMS is in best position for this scientific new deal.

AUTOBIOGRAPHICAL MEMORY, LIFE NARRATIVES, AND THE CONSTRUCTION OF SELF-IDENTITY

Marchetti et al. focus on adolescence in the development of an adult self, arguing that much more attention should be devoted to the role of body, against a tradition that puts at the forefront the integration of the psychic and the social. Indeed, according to the authors, the body is from birth (and even from the uterus) a constructive, and expressive vehicle of the self.

In order to understand how the body supports the construction of the identity in adolescence, the authors suggest using the method of analyzing what happens when something goes wrong, on the assumption that adolescents choose the body to express their discomfort, for instance, through self-injury. On this background, the authors' main thesis is that the capacity to mentalize represents a critical forerunner of the adolescent's perception of the physical self, insofar as the body is a carrier of implicit memories. Hence, troubles with mentalization in the child involve repercussions both on the child's behavior and the adolescent's psychic integrity. Violence against the physical self (in adolescence) could be an answer to the necessity of a change or an elimination of parts of a self- constructed in infancy and embedded in a bodily, implicit memory.

Finally, the authors point out the importance, particularly in adolescence, of taking into account one's own body in relation to others' bodies (and others' minds): relationships do not develop only on the basis of a meeting of minds but also—and perhaps primarily and at a deeper implicit level—on recognition and synchronization dynamics, which are, according to the authors, bodily grounded.

Rollo et al. represent the social interactionist standpoint by combining two lines of research: the former on the different ways in which mothers reminisce about shared past experiences with their children, the latter on mothers' use of mental state talk during conversations.

Research indicates that mothers vary in the way in which they reminisce about shared past experiences with their children: "elaborative" or "narrative" mothers show a highly elaborative reminiscing style characterized by long and detailed conversations about the past, interpretation of events and actions in terms of intentions and mental states, frequent references to the autobiographical experiences of their children; "repetitive" or "paradigmatic" mothers, on the other hand, show a less elaborative style, talk less frequently and in less detail about the shared past, focus on labeling objects, and specifying their relations with superordinate categories, or on repeating the exact content of a previous utterance. Children whose mothers are more elaborative during reminiscing seem to develop more sophisticated autobiographical memory skills, such that they tell more detailed and coherent narratives about their personal past.

Besides narrative styles, a large body of research point to the conclusion that the frequency with which mothers use mental state talk (Mental State Language, MSL) during conversations is positively and significantly associated with children's performance in theory-of-mind tasks and the development of their psychological lexicon.

Given this background, the authors sought to put together these two strands of research by examining the relation between narrative styles and the use of MSL in maternal conversations during joint picture-book reading. The results (i) confirmed the validity of the distinction between Narrative and Paradigmatic communicative styles; and indicated that (ii) maternal narrative styles changed as a function of children's age (the mothers of 4-year-old children were more narrative than paradigmatic, whereas the opposite pattern occurred for the mothers of 5- and 6-year-old children); (iii) the use of communicative terms was

significantly more frequent for narrative than for paradigmatic mothers, and decreased with children's age; (iv) mothers adapted the referents of their MSL to the children's age (the mothers of younger children referred their MSL more frequently to the book characters, then to themselves or to the child, and lastly to the dyad). Taken together, these results support the idea that mothers adapt their narrative styles and MSL input to the growing abilities of their children—as the latter develop and refine their interaction skills, they move from a narrative to a paradigmatic way of systematizing the reality around them –, thus contributing to the development of sociocognitive understanding.

Veglia and Di Fini explore the universe of personal life-narrations, taken as one of the privileged locus where people try to attribute meanings and look for cohesion and hierarchical order of internal and external information. Their analysis considered different literary genres as well as clinical narrative. Starting from an evolutionary perspective, they postulate the existence of a biological disposition to identify as fundamental six Life Themes: Love, Personal Value, Power, Justice, Truth, and Freedom, laying beyond the apparent, superficial multiplicity of narrations. Interestingly (but not surprisingly, given the evolutionary perspective adopted), a Leitmotif of Life Themes is their relational, interpersonal nature.

The authors delve into the analysis of the role of interpersonal relationships—notably, autobiographical memories related to attachment figures—in personal narrative construction. Most narratives, indeed, are co-created, maintained and revised within the attachment context: parental and domestic relationships during infancy, wider contexts from later childhood on.

While confirming, along with the existent literature, that since childhood secure attachment is related to narrations rich of cooperating caregivers, the authors attest that clinical narrations are characterized by a poor integration due to a rigid or, alternatively, confused exploitation of life themes ("arrested narratives," "unbounded narratives," "under narration," "denarrations"). Starting from this analysis, they suggest that a deeper comprehension of life themes in psychological suffering could help to improve clinical success.

Using the three axes presence/absence of positive or negative narrative occasions, high/low integration, and control of/sharing the theme, the authors identify areas of well-being and, conversely, area of distress, together with important indications concerning the nature of the suffering. This schema, which is co-constructed and shared with the patient and founds a solid therapeutic alliance, gives the therapist a precious tool for envisage and reinterpret together with the patient crucial junctions of her life story, concerning internal, psychological aspects as well as interpersonal relationships.

Beyond its specific, clinical point, the main interest of the paper is its amenability to profitably dialogue and enrich other classical reflections on narrative, such as Dan McAdams' thesis of central nuclei in life stories and John Bruner's perspective on narrative genres.

Rathbone and Moulin introduce the construct of self-image. One component of the Self-Memory-System is the "conceptual self" which is made up of self-images and self-beliefs. Self-images are "I am" statements which are frequently used in psychological research as a measure of identity, as primes in experimental tasks, and as cues to elicit autobiographical memories.

The authors present a descriptive study investigating self-images in adults aged 17 to 88. Participants were presented with an online questionnaire (Study 2) and paper questionnaires/tasks completed in participants' own homes (Study 1) or in the lab (Studies 3, 4, and 5). All participants were asked to generate a set of between 4 and 20 "I am" statements to describe long-term and enduring aspects of their identity. The aim of the paper is to present a database of self-image norms, focusing on people's identity statements.

According to the authors semantic facts about the self may be useful to scaffold narrative continuity and reflect the multi-faceted nature of the self and they are a powerful tool for examining differences in how identity is constructed.

Results revealed that the most commonly generated category of self-image was a social role: Friend followed by Student, Sports player, and Occupation. The less commonly generated category was Articulate and Caring. The highest frequency traits were Happy, Optimistic, and Friendly. Negative self-images (Lazy, Worry, Pessimistic) were also generated multiple times. The youngest self-image category generated was Maths (e.g., "ok at maths") and the oldest was Serious (e.g., "serious minded"). The most frequently cited self-images for females aged 60–70 was Mother.

Lavazza is concerned with the modulation and potentiation of memory and their relationship with personal identity. In fact, several neuroethicists have recently addressed the use of new possible tools to erase or mitigate negative personal memories. After giving an outline of the state of the art of research in this domain, the author discusses the ethical status of these practices and shows how this can be differently assessed according to different views of the self. In this respect, he takes as being very important the distinction between (partially) normative theories of the self (such as John Bruner's and Marya Schechtman's narrative theories), and purely naturalistic theories of the self (e.g., Peter Carruthers).

The artificial alteration of identity will be taken ethically unacceptable only on those conceptions and models of personal identity and self-according to which these act as reference points also for a wider set of values. For instance, some authors complained that chemical alteration of one's memory might lead to non-authentic choices. The idea is that the choice must be in line with the "true" self, to the extent that this latter notion makes sense.

Narrativist theories are inclined to put in question the idea of a strong self, in virtue of their insistence of the continuously tentative character of personal identity. Narratives write and rewrite life stories incessantly. By contrast, neurobiological theories of the self-promote a strong idea of the self, for they identify the psychic healthy state in a neurobiological condition. Use of drugs aims at maintaining this condition. Hence, Lavazza seems point here to a contradiction: use of molecules to modulate memories is ethically (more) allowed if one endorses a weak notion of the self, but neurobiological approaches to the self are committed to a strong notion of the self.

TRAUMA AND DISRUPTION OF AUTOBIOGRAPHICAL MEMORY

Hart et al. aim at assessing the relationship between neuropsychological functioning (notably, working memory and cognitive flexibility), Post-traumatic Stress Disorders (PTSD), and trauma centrality, i.e., the extent to which a traumatic event is taken as central to one's identity and a turning point in the story of our life. To this empirical research based on a cross-sectional design took place 41 Iran and Afghanistan veterans. Although some features of the study (small and full masculine sample, use of on-line neuropsychological test) suggest further investigation, a correlation emerges. While a growing body of empirical research has already well-established the association between, on the one side, PTSD symptoms and trauma centrality, and, on the other side, neuropsychological disorders and PTSD, the possible correlation between neuropsychological functions and trauma centrality is the main focus of this study.

Beyond replicating the solid data attesting the other correlations, the present research shows that lower levels of working memory and (even if results only approach significance) cognitive flexibility are associated with trauma centrality (ceteris paribus, i.e., when measures of depression and PTSD are controlled). However, the results, which are coherent with the well-known overgeneralization of memories in traumatized people, cannot shed light on the direction-of-causality question, as cross-sectional studies assess all the variables at the same time.

Typically, cognitive deficits are unidirectionally taken to affect trauma centrality and, more generally, identity; but things could be more complex and interwoven, as suggested by Conway's work. In his Self-Memory System Conway postulates a strict, continuous and bidirectional relationship between long term mnemonic structures and the working self, i.e., the hierarchical structure containing currently active personal goals. In this theoretical framework, deficits in working representations affect long term self-structures, conceived both as episodic memories and normative, semantic self-structures. Working self constantly mediates between the opposite requirements of internal coherence and correspondence to reality, allowing only the "right kind" of new acquired information to be stored in long-term memory. SMS postulates also the opposite causal direction, suggesting that permanent structures of the self-influence current decisions taken by the working self. As well shown in Conway et al. (2004), structures of personality—in their Bowlbian perspective, internal working models—not only are modulated by, but also modulate working self's functioning.

Carletto et al. view Post-Traumatic Stress Disorders (PTSD) as the crucial disorder to investigate autobiographical memory. They present Eye Movement Desensitization and Reprocessing (EMDR) as the therapeutic technique able to re-elaborate non-integrated memories and to consolidate new memories into the already existing semantic links, promoting the insertion of traumatic but no longer disturbing memory in a coherent and adaptive autobiography.

PTSD is a disorder that develops in some people who have experienced a shocking, scary, or dangerous event. People who have PTSD may feel stressed or frightened even when they are not in danger. The diagnosis include at least one re-experiencing symptom (e.g., flashbacks—reliving the trauma over and over, including physical symptoms like a racing heart or sweating, bad dreams, frightening thoughts), at least one avoidance symptom (e.g. staying away from places, events, or objects that are reminders of the traumatic experience, avoiding thoughts or feelings related to the traumatic event), at least two arousal and reactivity symptoms (e.g., being easily startled, feeling tense or "on edge," having difficulty sleeping, having angry outbursts), at least two cognition and mood symptoms (e.g. trouble remembering key features of the traumatic event, negative thoughts about oneself or the world, distorted feelings like guilt or blame, loss of interest in enjoyable activities).

Traumatic memories are encoded differently than memories of ordinary events, in multisensory fragments that traumatized people cannot integrate in a structured narrative. From a neurobiological point of view, during extreme stressful situation amygdalar synapses are potentiated and this saturate all amygdalar alpha-amino-3-hydroxy-5-methyl-4-isoxazole (AMPA) receptors-bindings sites. Consequently, in the hippocampus the recorded emotional memory trace cannot be merged with the cognitive memory trace and the fragments of emotionally charged memories remain trapped in the limbic system and cannot be transferred to the cortical areas, where a further processing and integration into already existing networks should take place. Therefore, non-processed emotional memories remain trapped and unchanged at subcortical level without contextual integration, causing in some cases PTSD symptoms.

If memories are adequately processed, PTSD symptoms can be mitigated and memories integrated. EMDR is the psychological treatment for PTSD presented by authors. The key aspect is the use of Alternate Bilateral Stimulations (ABS) such as eye movements (EMs).

Authors describe how EMDR works during the PTSD treatment from a neurobiological point of view, mentioning the same mechanism involved in sleep for memory consolidation, arguing also for a potential role for cerebellum in the processes involved in trauma.

AUTOBIOGRAPHICAL MEMORY AND PSYCHOTHERAPEUTIC VERSUS PHARMACOLOGICAL TREATMENTS

Mancini and Mancini describe ImRs ("Imagery Rescripting"), a therapeutic technique that aims to reduce the distress associated with negative memories of early aversive experiences. It consists of prompting patients to rescript the autobiographical memory in line with their unmet needs.

The ImRs procedure is based on two steps: (i) change in perspective, from child's one to adult's one; (ii) try to meet the child's unmet needs. The second step requires empathy: empathy on behalf of the adult validates the child's suffering. This makes explicit the rewriting work: the (negative) meaning inferred during childhood (e.g., in attachment relations) is overturned in the recognition of the child's suffering.

ImRs has proven to be effective across several psychopathologies such as depression, social phobia,

obsessive-compulsive disorder, post-traumatic stress disorder, and personality disorders. Yet, the mechanisms through the result is obtained are not properly understood. The hypothesis of the authors is that ImRs acts by reducing the meta-emotional problem, i.e., by reducing the perception of a negative emotion as something problematic and unacceptable. A large literature mentioned by the authors seems to show that the meta-emotional problem could be a trans-diagnostic phenomenon. Yet, since there is still a lack of direct evidence that ImRs reduces the meta-emotional problem, the authors propose an experiment to test their hypothesis.

In sum, the authors argue that ImRs promotes the reduction of symptoms and of negative self-belief both by changing the valence of the aversive autobiographical memory and by reducing their accessibility—both approaches offer a plausible explanation of the observed reduction in negative self-belief. However, they also believe that these approaches are not very accurate in clarifying how the change in self-belief occurs. They suggest establishing a link between the change occurring in the beliefs about one's own emotion and the change occurring in self-belief.

Kalsi et al. present the first neuroimaging meta-analysis which report the changes in functional neural activity as an effect of pre- and post-treatment of psychotherapy versus pharmacological therapy in patients with affective disorders (anxiety and depression).

The main outcome is the inverse effects of cognitive and psychodynamic psychotherapy and antidepressant therapy on the right paracingulate activity. The patients undergoing psychotherapy showed an increase in the right paracingulate activity while pharmacological treatment led to a decrease of activation of this area. The authors conclude that this finding seems to support the recent studies that hypothesize how psychotherapy, through the self-knowledge and the meaning processing, involves a top-down emotional regulation.

What is most remarkable for the Research Topic is that the paracingulate cortex activity seems to be associated with autobiographical memory—as well as with other self-monitoring activities (visual self-recognition, conflict monitoring, verbal self-monitoring, self-generated thoughts) and mentalizing abilities.

CONCLUSION

The main goal of this Research Topic "Self and Memory: A Multidisciplinary Debate" was to offer a snapshot of the growing cognitive, developmental, and clinical psychological literature on the complex relationship between autobiographical memory and the self against the background of the main theoretical approaches in this research area. The final collection of 12 articles does exactly that and provide hints about where this research area is going.

The contributions have all a multidisciplinary character, but some of them focus more on one of the three strands of thinking around self and memory described above (line 17), others focus mostly on issues in the blossoming empirical literature of psychology, psychopathology, and neuroscience of self and memory. More specifically, Tippett et al., Wheeler and Gabbert, and Rathbone and Moulin's papers make the most of Tulving's approach to autobiographical memory; Vanderveren et al., Veglia and Di Fini, and Hart et al.'s contributions build on Conway's perspective; Marchetti et al., Rollo et al., and Lavazza take advantage of Nelson's approach to autobiographical memory. Finally, the contributions of Carletto et al., Mancini and Mancini, and Kalsi et al. focus on clinical issues that cross-cut the three theoretical perspectives—EMDR and Post-Traumatic Stress Disorders; the influence of Imagery Rescripting on the aversive autobiographical memory; neuroimaging data about the effects of pre- and post-treatment of psychotherapy vs. pharmacological therapy.

We hope that the reader will find the collected articles both informative and thought-provoking, and that this Research Topic will serve to stimulate new theoretical debate and empirical research.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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The Persistence of the Self over Time in Mild Cognitive Impairment and Alzheimer's Disease

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Diachronic unity is the belief that, despite changes, we are the same person across the lifespan. We propose that diachronic unity is supported by the experience of remembering the self over time during episodic recall (i.e., phenomenological continuity). However, we also predict that diachronic unity is also possible when episodic memory is impaired, as long as the ability to construct life narratives from semantic memory (i.e., semantic continuity) is intact. To examine this prediction, we investigated diachronic unity in Alzheimer's Disease (AD) and amnestic mild cognitive impairment (aMCI), two conditions characterised by disrupted phenomenological continuity. If semantic continuity is also altered in these conditions, there should be an associated deterioration in diachronic unity. Participants with AD, aMCI, and healthy controls (HC) completed a self-persistence interview measuring diachronic unity (beliefs about self-persistence, explanations for stability/change). Semantic continuity was assessed with a life-story interview measuring autobiographical reasoning (self-event connections), and coherence (temporal/thematic/causal) of narratives. Our results highlight a complex relationship between semantic continuity and diachronic unity and revealed a divergence between two aspects of diachronic unity: AD/aMCI groups did not differ from HC in continuity beliefs, but AD explanations for self-persistence were less sophisticated. Semantic continuity was most impaired in AD: their narratives had fewer self-event connections (vs. HCs) and lower temporal/thematic coherence (vs. HC/aMCI), while both AD/aMCI groups had lower causal coherence. Paradoxically AD participants who scored higher on measures of beliefs in the persistence of the core self, provided less sophisticated explanations for their self-persistence and were less able to explore persistence in their life narratives. These findings support the importance of semantic continuity to diachronic unity, but suggest a more nuanced and multifaceted relationship than originally proposed in our model. In AD, diminished life narratives that retain features of cultural life scripts are sufficient for strong subjective beliefs of self-persistence, but not for sophisticated explanations about persistence. Better semantic continuity, with the ability to weave high-quality life narratives, may scaffold the capacity to understand and explain one's diachronic unity, but this produces less surety about self-persistence.

Keywords: self-persistence, diachronic unity, Alzheimer's disease, amnestic mild cognitive impairment, narrative identity, phenomenological continuity, semantic continuity

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INTRODUCTION

> ***Interviewer:*** *Do you feel that you are the same person now as you were when you were in your early 20s?*
> ***Participant:*** *Yes, oh yes! I don't know, I don't know why. I feel like I'm the same.*
> ***Interviewer:*** *What do you think makes you the same person? How would you explain how one and the same person could act in so many different ways but still be the same person?*
> ***Participant:*** *I feel the same.*
> - Extract from self persistence interview (Participant 010b from AD group, MMSE = 10).

One of the most intriguing aspects of the self is its persistence and unification across time. Known as *diachronic unity* (see Appendix A for a glossary of italicised terms), this does not imply that one is unchanged, but rather expresses a deep conviction that, despite change, one continues to be the same person now as in the past, and will continue to be the same person into the future (Sani, 2008; Klein, 2010; Prebble et al., 2013). Intuitively, *autobiographical memory* (AM) is critical to this experience of diachronic unity. The act of remembering oneself in the past instantly links the present individual to their past self: mentally, emotionally, and experientially. Just as I can know that my current experiences are my own because my subjective experience tags them as such, so too I can know that my episodically remembered past was experienced by "me." This sentiment is clearly articulated in Locke (1964/1970) claim about the relationship between consciousness and identity: "as far as this consciousness can be extended backwards to any past action or thought, so far reaches the identity of that person; it is the same self now it was then; and it is by the same self with this present one that now reflects on it, that that action was done." (p. 181).

Indeed the link between AM and sense of self appears so clear that it is difficult to imagine a theory of diachronic unity that does not incorporate a mnemonic element. Moreover, it has been argued that the experience of continuity is a critical feature of diachronic unity, distinguishing it from synchronic unity (i.e., the unification of self in the present moment) that is supported by short-term memory (Tye, 2003; Rashbrook, 2013). The few studies that have explored people's subjective beliefs about their diachronic unity suggest that a firm sense of persistence across time is fairly ubiquitous both across cultures and across the lifespan (e.g.,Troll and Skaff, 1997; Chandler et al.'s, 2003); they also point to the potentially catastrophic consequences of any deterioration in these beliefs (Chandler et al.'s, 2003; Hsiao et al., 2013). To date, however, there has been little empirical research into the cognitive mechanisms that serve to support diachronic unity, and what role is played by AM. In this paper we report the first systematic exploration of diachronic unity in two groups of individuals with impaired episodic memory: those with amnestic mild cognitive impairment (aMCI) and probable Alzheimer's Disease (AD).

We recently proposed two parallel mechanisms through which AM may serve to support diachronic unity (Prebble et al., 2013; see **Figure 1**). First, remembering one's past experiences—a form of AM known as *episodic memory*—is associated with projecting oneself back into the past to consciously re-experience discrete moments in time (Wheeler et al., 1997; Tulving, 2002; Vandekerckhove and Panksepp, 2009). Known as *autonoetic consciousness,* we have argued this aspect of episodic memory affords a sense of *phenomenological continuity* (Addis and Tippett, 2008; Prebble et al., 2013). A number of single case reports in the clinical literature of densely amnesic individuals support this view (Tulving, 1985; Wilson and Wearing, 1995; Postle, 2009). Patient C.W. provides a striking example; he lacks all episodic memories and constantly reports that he is conscious for the first time: "...this is the first sight I've had, the first taste I've had (sipping his coffee) it's like being dead" (Wilson et al., 2008). Patient C.W. and other cases clearly demonstrate a severe discontinuity of phenomenological experience. Yet there have been few systematic explorations of how these deficits might affect these individuals' subjective beliefs about their diachronic unity (Troll and Skaff, 1997), including their ability to logically account for how and why they remain the same person across time (Chandler et al.'s, 2003).

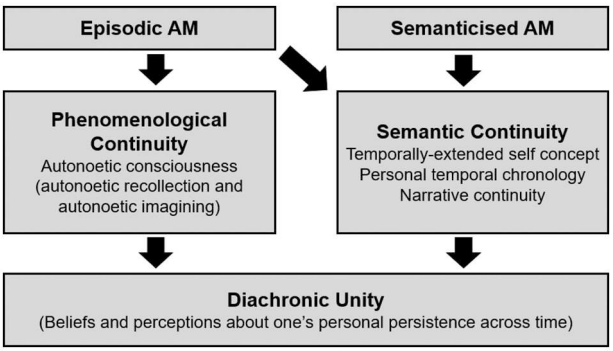

FIGURE 1 | Model of the temporally extended self, showing two autobiographical memory mechanisms for continuity, and their proposed relationship to diachronic unity.

The loss of episodic memory and autonoetic consciousness disrupts phenomenological continuity which in turn impacts subjective beliefs of diachronic unity. However, it is possible that even in the context of disrupted phenomenological continuity, diachronic unity can be supported via a second mechanism: *semantic continuity*. Rather than being experiential, this form of continuity is knowledge-based, mediated by *semantic memory*, an abstract and conceptual type of AM that synthesises large amounts of information (including entire life periods and repeated events) (Conway and Pleydell-Pearce, 2000). Critically, semantic memory enables one to create *narratives*—life stories that explain "who I was and how I came to be who I am" and includes *temporally-extended self-concept* and *personal temporal chronology*—from which semantic continuity emerges (Klein et al., 2003; Piolino et al., 2006; Rathbone et al., 2009). Interestingly the neuropsychological case studies of dense episodic amnesia not only illustrate a severe discontinuity of phenomenological experience, but hint at a form of diachronic unity—a retained belief about their own *self-persistence* (Medved

and Brockmeier, 2008; Postle, 2009; Philippi et al., 2012). While clearly distressed that they are unable to remember their past, they express an appreciation that they *ought* to possess a mnemonic link to the past, which appears to presuppose some notion of themselves as temporally-extended beings. Further, although comments suggest a feeling of being marooned in the present moment (Postle, 2009), their speech and thoughts are not restricted to the present moment as one might expect if one lacked any sense of temporal extension. H.M. not only repeatedly retold the few (semanticised) AMs he had retained (Corkin, 2002), he also expressed emotions that related to his past and his future; anxiety about what might have happened before but could not recall, and concern about how his present actions might impact upon the future. Their words and actions hint at an emotional and behavioural connection to their past and future in the absence of any episodic memories that could provide these links (for a similar model, see Bluck and Liao, 2013). This suggests that although the ability to mentally project oneself into the past may contribute to diachronic unity, it may not be essential.

To examine these proposed mechanisms through which AM may support diachronic unity in the following study we conducted a formal investigation of diachronic unity in two groups with impaired episodic memory and autonoetic consciousness: individuals with aMCI and those with probable early-moderate AD (Rauchs et al., 2007; Addis et al., 2009; Ally et al., 2009; Hudon et al., 2009; Irish et al., 2010). If autonoetic recollection of event memories is essential for diachronic unity, the marked deterioration in episodic memory and autonoetic consciousness in those with AD should lead to a corresponding deterioration in their subjective beliefs about their self-persistence, and to a lesser extent in those with aMCI where impairments of autonetic consciousness are less severe (Hudon et al., 2009). Alternatively, if beliefs about self-persistence have not weakened in these groups, this would provide some evidence that episodic memory, and the phenomenological continuity it affords, is not the sole mechanism supporting diachronic unity. To this end, we examined how aspects of semantic continuity, specifically *narrative identity* and personal temporal chronology, is affected in individuals with aMCI and AD, and how any such deterioration in turn impacts upon diachronic unity. These two groups provide an excellent opportunity to investigate these questions. As noted above, there are consistent findings indicating both deficits in episodic memory and autonoetic consciousness in aMCI and early AD, as well as preserved semantic AM in aMCI (Murphy et al., 2008). In contrast there is divergence in the literature as to whether semantic AM is relatively preserved in early-AD (Gilboa et al., 2005; Martinelli et al., 2013), or showing some evidence of decline (e.g., Addis and Tippett, 2004).

Two main studies have explored diachronic unity, using different approaches to assess subjective beliefs about one's persistence across time. Troll and Skaff (1997) examined beliefs about self-persistence in older adults by asking two simple questions: "In what ways have you always been the same?" and "In what ways have you changed over the years?" They attempted to separate subjective beliefs about whether one's "core self" or essential person was still the same (e.g., "I feel that my essence has always been the same") from perceived changes in the content of self-concept (e.g., characteristics and traits) over time. Beliefs about one's essential person directly captures phenomenological sense of self-persistence, while beliefs about content of self-captures persistence of the self-concept (i.e., temporally-extended self-concept which likely impacts one's beliefs about their diachronic unity.

Chandler et al.'s (2003), in contrast, asked the young people in their study to articulate an explanation for their self-persistence, following an exercise with a fictional character. Participants were first presented with a literary passage involving a character who undergoes considerable personal change (e.g., Jean Valjean in *Les Miserables*), and asked to explain why the character was still the same person by the end of the story. Participants were then asked to reflect on the ways that they had changed throughout their own lives, and explain why they were fundamentally the same person despite these changes.

It is not clear how these two ways of approaching beliefs about diachronic unity might relate. For example, is a logical rationale for one's self persistence necessary in order to sustain a firm belief about one's persistence across time? There is evidence from Chandler et al.'s (2003) work, that in young people, lack of a clear explanation for self-persistence may be associated with suicidal tendencies, suggesting that these aspects of diachronic unity may be linked.

In this study, we combined both approaches to create a comprehensive *self-persistence interview* that assesses diachronic unity. The general aim of the interview was to guide participants to think about, and describe, their subjective beliefs about how they have changed and remained the same over their lives, whether they continue to consider themselves to be the same person, and the reasons underlying these beliefs. Instead of using a fictional story to elicit thoughts about stability and change, we primed participants by having them complete two versions of the Twenty Statements Test (TST; Kuhn and McPartland, 1954), one of which required participants to describe who they are in the present using 20 "I am…" statements, and the other of which asked them to describe who they were in their early 20s. (The results of the two TSTs are not discussed in this paper.) The aim of this method was to provide a concrete point of comparison for the older participants involved in the present study, inviting a direct comparison between their own descriptions of themselves in the present and past, before proceeding to the self-persistence interview. This provided a more direct way to engage our participants, particularly those with AD, in a discussion about diachronic unity.

A proposed contributor to diachronic unity, semantic continuity is characterised by the ability to construct a coherent, meaningful life story out of one's memories that highlights personal temporal chronology. A central assumption of narrative identity theory is that this narrative process is an adaptive ability, possibly through its link to creating sense of continuity (Habermas and Bluck's, 2000; McAdams, 2001). More recent investigations, however, have challenged the uniform benefit of narrative identity, suggesting instead that the benefit of narrative processes like *autobiographical reasoning* may depend on many

complex factors (McLean and Mansfield, 2011; Greenhoot and McLean, 2013; Habermas and Köber, 2014). Nevertheless, if narrative processes are linked to sense of persistence, this suggests that those who are able to construct "better" life narratives should also possess a stronger sense of diachronic unity. To date very little research has examined how narrative identity and autobiographical reasoning may relate to diachronic unity. Habermas and Köber (2015) found that the amount of autobiographical reasoning in the life narratives of healthy adults correlated positively with a sense of self persistence (measured using a four item-scale assessing feeling of familiarity with themselves in the past), but only in those who had experienced serious disruptions in their lives ("biographical disruptions") in the previous 4 years. The authors suggest that narrative identity may be important to self-persistence only when this sense of continuity is challenged in some way (see also Habermas and Köber, 2014).

No studies have yet investigated whether a loss of AM may constitute such a challenge, or whether constructing a life story capable of supporting diachronic unity is even possible in the face of such memory loss. The few studies that have attempted to examine narrative identity in AD suggest that limited narrative abilities may remain even in the face of severe AM deficits (Mills, 1997; Usita et al., 1998; Surr, 2006). Although these studies did not provide any formal analysis of the use of autobiographical reasoning or the global coherence of narratives, their reports provide some hints about how the quality of the narratives may be affected. Surr notes that the majority of their AD participants narrated stories which "integrated the whole of their life from the past to the present…" and appeared to be "...setting their present experiences in the context of their past in order to maintain a sense of self" (Surr, 2006, p. 1727–1728). This description is strikingly similar to descriptions of autobiographical reasoning, providing a tentative suggestion that this capacity may also be preserved to some extent in early stages of the disease.

These studies also touch on some difficulties with the narratives created by those with AD, including an inability to narrate all or part of a life story (Surr, 2006), producing stories that were fragmented and repetitive (Mills, 1997), or that lacked detail in the description of specific events (Usita et al., 1998). Usita et al. found that although the life stories of healthy participants were consistently chronologically ordered and included culturally important life events (e.g., marriage, having children), the stories of those with AD were not. Using Habermas and Bluck's (2000) terminology, these reports seem to suggest that the life stories of those with AD lack temporal coherence and the framework for a cultural concept of biography (i.e., a cultural life script). Another study, however, found that participants with dementia were more likely to include culturally important life events in their stories than healthy adults (Fromholt and Larsen, 1991), suggesting that this important organisational structure for AM may be fairly resilient in AD. As neither of these studies provided any measures of temporal coherence or the cultural life script, it is difficult to assess these conflicting claims.

A goal for the present study was to provide formal measures of semantic continuity by assessing the extent to which narrative processes—autobiographical reasoning and global coherence including personal temporal chronology—are affected in aMCI and AD. More importantly, we aimed to address the relationship of these measures of semantic continuity with diachronic unity. If the quality of the life story, and/or the ability to construct a personal temporal chronology, are indeed important for diachronic unity, those who score higher on measures of global coherence and autobiographical reasoning would also be expected to express more certainty about their persistence across time.

To assess the use of autobiographical reasoning in life stories, we examined self-event connections. Self-event connections involve the creation of connections between one's conceptual self and the events of one's life (Pasupathi and Mansour, 2006; McLean, 2008; McLean and Fournier, 2008). They are suggested to create continuity either by emphasising elements of personal stability over time (stability connections), or by explaining how and why an individual has changed as a result of life events (change connections) (Pasupathi and Mansour, 2006; Pasupathi et al., 2007; McLean, 2008). Autobiographical reasoning was predicted to be particularly crucial for individuals with AD who face significant challenges, or disruptions, with their diagnosis.

We also examined the global coherence of life stories (Habermas and Bluck's, 2000; Habermas, 2011) as a second marker of the quality of semantic continuity. Whereas, autobiographical reasoning involves links made between the self and particular events within the story, global coherence relates to the ability to link and integrate many events into a cohesive whole. Habermas and Bluck's (2000) describe four main elements that contribute to the global coherence of a life narrative. Causal coherence involves explaining how different elements of the story led to, brought about or were dependent upon other elements, including how aspects of the self were affected by events in one's life, and how one's personality contributed to the events that occurred. Thematic coherence is the extent to which a narrative provides interpretive links within the story by identifying higher-level similarities, motifs, and metaphors that provide meaning and cohesion to the story. In addition, global coherence includes two features that facilitate the personal temporal chronology of the narrative. Temporal coherence probes the integrity of personal temporal chronology, specifically the ability to temporally locate, order, and sequence events in relation to each other and within the wider context of one's life. Cultural concept of biography concerns the degree to which one's story incorporates culturally-accepted rules about which elements are important to include in one's life story. These cultural expectations around the life story are suggested to form a cultural life script, which provides the skeletal structure for life stories.

In the present study, we aimed to provide the first systematic exploration of sense of diachronic unity in those with aMCI and mild-to-moderate probable AD. By using a range of novel and pre-existing measures of diachronic unity, we sought to examine how these different ways of conceptualising self-persistence might relate, and how they may be differentially affected by memory deterioration in these conditions. More specifically, our model (Prebble et al., 2013) proposes two mechanisms through

which AM may contribute to individuals' subjective beliefs about persistence: phenomenological continuity and semantic continuity. Based on this model, we predicted that although AD (and to a lesser extent aMCI) is characterised by a deterioration in phenomenological continuity associated with episodic memory deficits, this alone should not lead to deterioration in diachronic unity, provided that semantic continuity is well-preserved. The evidence reviewed above, however, indicates that aspects of semantic continuity in AD (particularly narrative processes such as autobiographical reasoning and global coherence including personal temporal chronology) may nevertheless be altered, which should in turn lead to deterioration in diachronic unity.

METHODS

Participants

Patient Groups

The AD and aMCI groups each comprised 15 individuals. Inclusion criteria included formal medical diagnosis of either probable AD or aMCI (Albert et al., 2011; McKhann et al., 2011), fluency in English, no acquired language difficulties preventing communication, and being capable of giving informed consent. Potential participants were excluded if they had a history of major head injury, cerebrovascular disease, neurological abnormality (other than AD/aMCI), alcoholism or drug dependence, psychiatric illness, or prolonged use of psychiatric medication. Participants in the AD group were required to have a dementia severity of mild-to-moderate, with a score of 10 or above (out of 30) on the Mini-Mental State Examination (MMSE; Folstein et al., 1975). Individuals meeting these criteria were identified by clinicians during routine memory clinic appointments (at outpatient memory clinics run through two public hospitals and two private memory clinics in Auckland, New Zealand), and those who expressed an interest in the study were contacted directly by the researcher.

Control Group

The healthy control (HC) group consisted of 25 older adults recruited through advertisements distributed through retirement villages and community groups involving older people. The same exclusion criteria described above also applied to the HC group. In order to screen for undiagnosed dementia, HC participants in the control group were required to have an MMSE score of 25 or greater (Folstein et al., 1975). In addition, any potential participants who described difficulties in memory, appeared forgetful in the interview, or performed poorly on the MMSE memory component, were screened for memory impairment with the Rey Auditory Verbal Learning test (Rey, 1964). Only one participant was excluded on this basis, with performance below age-stratified norms (Strauss et al., 2006).

The demographic characteristics of the three groups are summarised in **Table 1**. The groups did not differ significantly in terms of sex, $\chi^2_{(2)} = 0.69$, $p = 0.71$, age, $F_{(2, 52)} = 1.82$, $p = 0.17$, or years of education, $F_{(2, 52)} = 2.39$, $p = 0.10$. As expected, there was a significant group difference on general cognitive performance (MMSE score), $F_{(2, 18.11)} = 14.65$, $p < 0.001$ (Brown-Forsythe F test for groups with unequal variance), and verbal fluency (Controlled Oral Word Association score), $F_{(2, 52)} = 6.17$, $p = 0.004$. *Post-hoc* Games-Howell tests confirmed that MMSE scores of both memory-impaired groups (AD: $p < 0.001$; aMCI: $p = 0.046$) were significantly lower than the HC group, and the AD group was significantly lower than the aMCI group ($p = 0.002$). The AD group also scored significantly lower than both the HC and aMCI groups ($p \leq 0.01$) on COWA, although the aMCI group did not differ significantly from the HC group ($p = 1.0$).

TABLE 1 | Demographic characteristics of the study participants.

	HC group	aMCI group	AD group
Number	25	15	15
Sex (F/M)	13/12	6/9	8/7
	M (SE)	M (SE)	M (SE)
Age (years)	82.15 (1.51)	78.09 (1.61)	77.7 (2.79)
Range	67–98	64–87	58–95
Education (years)	14.58 (0.54)	13.97 (0.81)	12.6 (0.65)
Range	9–19.5	10–19	7–18.5
MMSE	28.2 (0.26)	26.87 (0.46)*	20.87 (1.42)*
Range	26–30	24–30	10–27
COWA	37.28 (2.43)	37.07 (2.58)	25.6 (2.46)#
Range	20–67	19–51	14–44

M, Mean; SE, Standard Error of the Mean; MMSE, Mini-Mental State Examination; COWA, Controlled Oral Word Association test; HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease.

**Significantly lower than HC group.*

#Significantly lower than HC and aMCI groups.

Measures

Self-persistence Interview

This interview was designed to assess diachronic unity, and incorporated elements from the approaches used by Chandler et al.'s (2003) and Troll and Skaff (1997); note that we have renamed the measures (as indicated by footnotes) to maintain the consistency of the terminology used within the present paper. Responses were transcribed verbatim and the entire self-persistence interview transcripts were analysed when applying each of the separate coding elements described below.

Perceived persistence[1] *(Troll and Skaff, 1997)*

Participants were asked whether they believed that they were still the same person as they were in their early 20s. The yes/no responses to this question were recorded; however some participants responded "yes and no" or "maybe." "Yes" responses were coded "3," "yes and no" and "maybe" responses coded "2," and "no" responses coded "1." For analyses involving a dichotomous variable, mid-way answers were collapsed with the "no" responses. If participants provided an explanation for their answer, this text was transcribed verbatim, and coded as part of the other sections of the interview, as appropriate (see below).

[1]Originally called "perceived continuity" (Troll and Skaff, 1997).

Persistence of the I-self and Me-self*[2] *(Troll and Skaff, 1997)

Participants were next asked how they believed they had changed, and how they believed they had remained the same since they were in their early 20s. An independent coder read through the responses to identify elements that related to the *I-self* (the essential, core self, the underlying essence of who you are, the inner entity; related to beliefs about phenomenological continuity) vs. the *me-self* (the attributes one uses to describe oneself, e.g., traits, attributes, physical and personality descriptions, behaviour, likes and dislikes, values and beliefs; related to beliefs about semantic continuity). The coder then scored each set of responses using two three-point scales (an I-self and a me-self scale) based on a coding method from Troll and Skaff. This method assessed perceptions of change vs. persistence, with higher scores indicating a greater perception of persistence: a score of "1" indicated a perception of fundamental change, "2" indicated some change, and "3" indicated a firm perception of persistence (no change) (see **Table 2**).

Persistence explanation*[3] *(adapted from Chandler et al.'s, 2003)

The last part of the self persistence interview asked participants to explain the reasons why, given the many changes that had taken place in their lives, they still considered themselves to be the same person:

> *What I now want you to do now is to think about the reasons that you consider yourself to be the same person that you were when you were a young adult. What do you think makes you the same person? I want you to explain these reasons. How would you explain how one and the same person could act in so many different ways but still be the same person?*

Responses were coded using a simplified version of Chandler et al. coding scheme that used a five-point scale to grade the complexity or sophistication of the response. Very simple responses (level 1) highlight easily identifiable, surface qualities of the self that have remained the same across time (e.g., particular physical features or simple personality traits) while ignoring or downplaying elements of the self that have changed. More sophisticated answers (which scored higher) are those which integrate ways that the self may have changed while also identifying factors that maintain stability. Persistence explanations scored at the highest levels of sophistication identify a core element of the self which has remained unchanged despite (perhaps considerable) change in more surface attributes (level 4), or demonstrate a meta-awareness of the paradox of persistence by weighing up a number of possible explanations that could account for change and persistence in the self (level 5) (see **Table 3**).

Life Story Interview (Adapted Negele and Habermas, 2010)

This interview elicited a life story which was then assessed for various aspects of semantic continuity. Participants were provided with a very broad initial question, and were then left to tell their story, uninterrupted and in their own words:

> *The main thing I would like to do today is for you to tell me your life story. I would like you to tell me about your whole life, from the time you were born until the present time. You might like to tell me about the most important events in your life and the biggest changes. You can tell me things that someone who doesn't know you might like to know about your life.*

This method (originally used with children) was adapted for use with older adults and AD participants by dividing the story into four chapters: childhood (0–14 years), teenage years and early adulthood (15–25 years), middle adulthood (26–50 years), and late adulthood (51-present). These time periods were selected as a compromise between the need for roughly equal life periods, the need for as few time periods as possible to reduce task demands, and the need to cleanly isolate theoretically important memory periods (e.g., the reminiscence bump). Participants were given 10 min to narrate each chapter. A brief summary of the task instructions along with the relevant life period was placed in front of them while they spoke (e.g., "Please tell me about your childhood: Birth to 14 years old"). If they stopped speaking for longer than 15–20 s, prompts were used to remind them of the task and to elicit more information (e.g., "Is there anything else that you can tell me about that period of your life?") Initial instructions were repeated when necessary. The life stories were coded for a number of markers of narrative identity.

Self-event connections

These were defined as any statement which explicitly connected the narrator's self-concept and the events they are narrating (based on definitions developed by Pasupathi and Mansour (2006) and Pasupathi et al. (2007). Two types of self-event connections were identified. Self-event stability connections suggested a pre-existing quality of the self-explained, or was illustrated by, an event (e.g., "I decided to go overseas because I've always been really adventurous"; "This event shows how persuasive I am"). Self-event change connections explained how and why the narrator had changed as a result of life events (e.g., "After that, I became a lot more wary of other people"). The dependent variable was the number of each type of statement used in the life stories.

Global coherence

This coding protocol was adapted from an original manual developed by Habermas and Diel (2005; see also Habermas and de Silveira, 2008), translated from German and amended by Reese and Suggate (E. Reese, personal communication, May 31, 2010). The coding scheme required a rater to read through the life story, and assess how well it achieved three aspects of global coherence. The temporal coherence score assessed the degree to which the rater could follow when, and in what order, events within the story took place. The causal coherence score assessed the degree to which the rater understood how the narrator had changed throughout their story (in terms of personality, circumstances, or outlook), and how the events in the story explain this change. The thematic coherence score assessed

[2]Originally called the "continuity of the I-self and Me-self" (Troll and Skaff, 1997).
[3]Originally called the "continuity explanation" measure (Chandler et al.'s, 2003).

TABLE 2 | Summary of the coding scheme for the I-self and me-self questions of the self-persistence interview.

Score	I-self persistence subscale	Me-self persistence subscale
1. Fundamental change	Indicates a perception of fundamental change in the core self (e.g., "The person I used to be is no longer there")	Indicates a perception of fundamental change in one's attributes (e.g., "I have changed in so many since I was young – personality, the way I look and act, the people I associate with")
2. Some change	Indicates a perception of some change in the core self or uncertainty about core continuity (e.g., "Not exactly the same person...You're different but the same—it's hard to explain")	Indicates a perception of some change in attributes (e.g., "In my intellectual interests I'm pretty much the same; but I've changed in appearance.")
3. No change	Indicates a firm perception of continuity in the core self (e.g., "I feel my essence has always been the same.")	Indicates a firm perception of stability in attributes. (e.g., "I've always been calm, composed…independent. I'm just the same now.")

Coding scheme adapted from Troll and Skaff (1997).

TABLE 3 | Summary of coding scheme used to score on the persistence explanation question of the self-persistence interview.

Level of sophistication	Description	Examples
Level 1	Response describes simple, surface elements of the self that have not changed, while ignoring aspects that have changed.	I just seem to do the same things. If people talk to me I talk to them, if people need help I help them. Always been the same.
Level 2	Response attempts to engage with the problem that people appear to change by suggesting that apparent changes are in fact aspects of the self that were present from the start but have never been seen until now.	When I was with my ex-husband, it really brought out my angry side. It's still there but now I don't have to be that way so much.
Level 3	Response acknowledges the effects of time as the agent of growth and development of pre-existing traits.	I am the same person, I have just grown. The experiences of my life have brought out a mature version of me.
Level 4	Response attempts to solve the problem of change/continuity by proposing a core, underlying essence of the self which remains unchanged despite change in surface attributes.	Spiritually—your body changes but spiritually you stay the same.
Level 5	Response provides a "meta answer" which indicates that whatever explanation the person may have to the problem of self-continuity is simply one theory among many.	There are many ways you could answer that. I have the same brain. Also, a lot of the attitudes you had when you were little....You remember what you were. This also gives you continuity...Your genes don't change....attitudes stay with you / born in you?

Coding scheme adapted and simplified from Chandler et al.'s (2003).

how well particular elements within the story were linked or positioned in relation to one another. An independent coder rated each life story chapter for each type of coherence, and scored the text on a four-point scale, from 0 (very low coherence) to 3 (very high coherence). Chapter scores were summed to provide a measure of each type of coherence for the life story as a whole.

Cultural life script

Life stories were assessed to determine whether they included cultural life script events. This list of events comprised events identified in at least three studies that had surveyed large numbers of individuals to assess which life events were judged to be important to the life stories of a typical individual (Berntsen and Rubin, 2004; Habermas, 2007; Bohn and Berntsen, 2008; Thomsen and Bernsten, 2008; Rubin et al., 2009; Janssen and Rubin, 2011; Tekcan et al., 2012). A total of 29 event categories met this criterion. Some event categories were slightly tailored for a New Zealand context (e.g., "enter day-care" was amended to "enter day-care, kindergarten or preschool"; "College" was changed to "University or Technical Institute").

Each life story was read by an independent coder to assess whether it contained any mention of each of the event categories on the list (present/absent). It was scored as "present" only if it was a personal event that occurred to the narrator. The total number of event categories mentioned in the life story was tallied, providing a score for the number of cultural life script categories sampled by each participant.

The number of new occurrences of each event category was also counted. Events were counted as new occurrences if they described a new element in the story from within the same life script category (e.g., attending two separate high schools, the birth of successive children). The number of new occurrences was tallied across event categories, providing a score for the number of cultural life script events mentioned by each participant.

Seven events were mentioned so infrequently in the stories that reliability could not be calculated and were therefore removed from the analysis. For each of the remaining 22 event categories, inter-rater agreement for the present/absent ratings across participants was calculated using Cohen's Kappa (see Coding Procedure, below): 4 showed moderate agreement (range:.43 −0.59), 7 showed substantial agreement (range:.64–0.77) and 10 had a near-perfect agreement (range:.82–1.0). The kappa for the most frequently used event (Get a Job/Settle on career) could not be calculated because this event was present in almost every life story, and one coder had not used the "not present" code for any transcripts. Percent agreement between coders was very good (94%), as was the intraclass correlation for the number of occurrences of this event (ICC = 0.96).

Awareness of Memory Deficits

A brief, structured interview was administered to the aMCI and AD groups to assess awareness of memory deficits, based on methods used by Loebel et al. (1990) and Sevush and Leve (1993). The interview consisted of a few simple questions asking whether participants thought they had problems with memory, and whether they suffered from an illness impacting on their memory. Due to time constraints, this brief assessment was favoured over lengthier approaches (see Clare et al., 2005; Souchay, 2007).

Responses were scored on a three-point scale using a scoring method adapted from Sevush and Leve (1993): responses were scored "2" if they suggested a high level of awareness of deficits (i.e., they acknowledged problems with memory and an awareness of its severity); "1" if they indicated some awareness of problems but underestimated the severity (e.g., they acknowledged minor problems, but suggested these were akin to others their age or had always been a problem); and "0" if they showed a complete lack of awareness of memory impairments (e.g., denied any problems). Participants were not required to name their diagnosis correctly in order to score 2, but were required to provide some recognition that their memory problems were greater than the normal aging experience.

Procedures

Coding Procedure

The self-persistence interview, life story interview, and awareness of memory deficit interview were transcribed strict verbatim by a professional transcriber. They were ordered using blind, random numbering for the purposes of coding. A team of independent coders were involved in the coding the various elements of the present study: the self-persistence interview; the life stories for self-event connections, global coherence, and cultural life script. All coders were blind to group membership and, although they were aware of the general topic matter of the study, they were not aware of the hypotheses relating to the coding manuals they were applying. For each separate coding exercise, a single, primary coder was responsible for coding all of the transcripts. Coders were trained to the manuals by one of the authors (S.C.P.), and trial coding exercises were conducted using training examples to ensure that reliability was satisfactory before the transcripts were coded. For the awareness of memory deficits interview coding was completed by one of the authors (S.C.P.) a minimum of 6 months, and in most cases 2 years, following the interviews.

Reliability was established by using a second independent coder for each task, who double coded a random selection of 20% of the transcripts. For ordinal scales and those which generated a frequency count for each participant, the intraclass coefficient was used, while for nominal scales, Cohen's Kappa was used (Cohen, 1960; Landis and Koch, 1977). Reliability statistics for each coding element are set out in **Table 4**.

TABLE 4 | Inter-rater reliability measures for double-coded transcripts.

Self-persistence interview	α	Life story interview	α
I-Self persistence	0.91	Temporal coherence	0.89
Me-self persistence	0.87	Causal coherence	0.88
Persistence explanation	0.96	Thematic coherence	0.75
		Self-event change connection	0.77
		Self-event stability connection	0.83
	α		**Kappa**
Awareness of memory deficits interview	1.0	Cultural life script event categories (present/absent)	Range:0.43–1.0

α = *Cronbach's alpha.*

General Procedure

This study was part of a larger study examining the relationship between AM and sense of self, and thus were embedded in a more extensive procedure. The protocol was approved by the Northern Y Regional Ethics Committee, and carried out in accordance with the recommendations of the Ethical Guidelines for Observational Studies, National Advisory Committee on Health and Disability Support Services Ethics. All subjects gave written informed consent in accordance with the Declaration of Helsinki. Each participant was interviewed twice (each 1.5–2 h including breaks), with sessions held ∼1 week apart.

Session 1 included introducing the study and gaining informed consent, a brief background interview, assessment of awareness of memory deficits, the MMSE, and the life story interview. Session 2 included verbal fluency (COWA), TST (present) and TST (Past), with the self-persistence interview administered after other intervening tasks.

Statistical Analyses

Statistical analyses were carried out using IBM SPSS Statistics 20 for Windows. Frequency data were analysed using Chi-square tests for independence. Analyses involving between and within-group differences were analysed using mixed-factorial Analyses of Variance (ANOVAs). When Mauchly's Test of Sphericity was violated, the Greenhouse-Geisser correction was used. Bonferroni pairwise comparisons were used to test for differences in significant within-subject main effects. For significant group effects, the Games and Howell (1976) *post-hoc* test procedure was used. As three groups were involved in these comparisons, significant interactions involving "group" were broken down using a two-step process. First, to determine which groups contributed to the interaction, either a series of Bonferroni-corrected one-way ANOVAs for each level of the other variable were run or mixed-factorial analyses were computed for each group pairing to determine which pairings contributed to the interaction (HC/aMCI, HC/AD, aMCI/AD). In each instance, the approach which resulted in the fewest comparisons that clarified the nature of the interaction was selected. Second, these omnibus ANOVAs were followed-up using Bonferroni or Games-Howell pairwise comparisons, as appropriate. For one-way ANOVAs where there was unequal variance between the groups, the Brown-Forsythe *F*-statistic was used (Field, 2009). Group differences in relation to ordinal data was assessed using Kruskal-Wallis non-parametric tests,

TABLE 5 | Number (percentage) of participants responding "Yes" or "No" to the perceived persistence question of the self-persistence interview.

	Yes	No
HC group	11 (44%)	14 (56%)
aMCI group	7 (50%)	7 (50%)
AD group	7 (50%)	7 (50%)

HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease.

followed up with pairwise comparisons using Mann-Whitney *U*-tests, correcting for multiple comparisons with a Bonferroni correction. Spearman's rho correlations were calculated for ordinal data. The significance of correlations were determined using a Holm-Bonferroni (sequentially-rejective) procedure (Holm, 1979) to correct for multiple comparisons.

RESULTS

Diachronic Unity: Self Persistence Interview

One participant from each of the AD and aMCI groups was unable to complete the interview due to fatigue, leaving 25 HC, and 14 in each of the AD and aMCI groups.

Perceived Persistence

Table 5 summarises responses to the question of whether they believed that they were still the same person as they were in their early 20s. A chi-square test (combining "yes and no" responses with "no" responses) revealed no significant relationship between group and type of response, $\chi^2_{(2)} = 0.19$, $p = 0.91$.

Persistence of the I-self and Me-self

Participant responses (when asked how they believed they had changed, and how they believed they had remained the same since they were in their early 20s) were separated into aspects which related to persistence of I-self (core) and me-self (traits and characteristics), and rated for whether these responses indicated no, some or fundamental change since their 20s. **Figure 2** displays the distribution of each group in relation to these ratings. The responses of three participants could not be coded in relation to one of the subscales: two participants (one from each of the HC and aMCI groups) provided no information relevant to the I-self subscale, and one participant from the AD group provided no information relevant to the me-self subscale. These participants were excluded from the relevant portion of the analysis.

There was no significant difference between the groups in relation to the ratings for degree of I-self persistence expressed in their responses, $H_{(2)} = 2.34$, $p = 0.31$. There was, however, a significant difference between the groups in relation to the degree of me-self persistence expressed, $H_{(2)} = 6.82$, $p = 0.03$. Pairwise Mann-Whitney *U*-tests (Bonferroni-corrected alpha level set at $p < 0.017$) revealed that the AD group's responses tended to be rated as expressing greater me-self persistence than the responses of the HC group ($p = 0.016$). The degree of me-self persistence expressed in the responses of the aMCI group did not differ significantly from the HC or AD groups (all *p*-values ≤ 0.28).

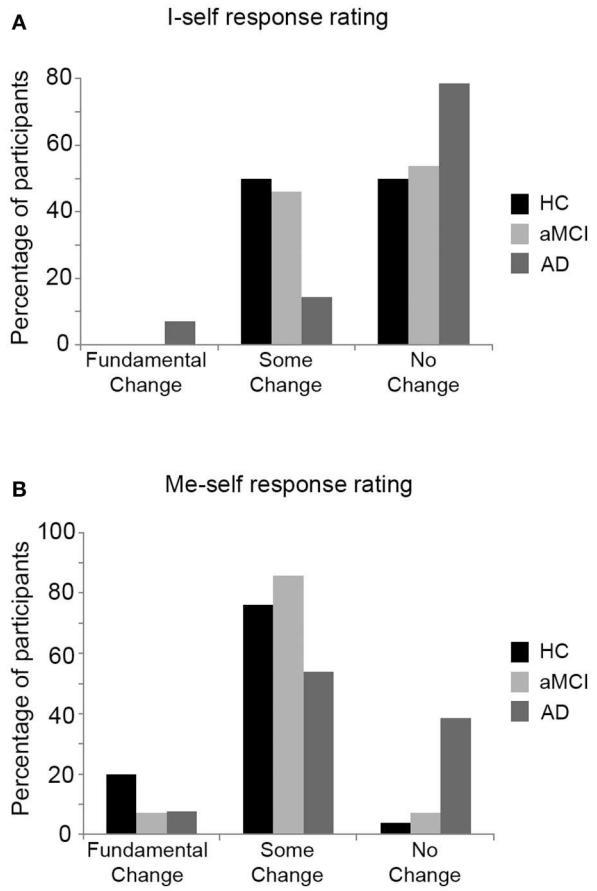

FIGURE 2 | Percentage of participants from each group providing each response type on **(A)** the I-self rating scale, and **(B)** the Me-self rating scale of the self persistence interview. HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease.

Persistence Explanation

The distribution of the level of sophistication of participants' persistence explanations for each group are shown in **Figure 3**. Of the AD group, 50% provided explanations for their persistence that were at the simplest level of sophistication, compared with 16% of the HC group and 14% of the aMCI group. Responses at this simplest level (level 1) focus on simple, surface attributes to account for self persistence while ignoring ways in which the individual may have changed, as illustrated by the following response from a participant in the AD group:

> *If I was walking down the road, and saw someone bashing their dog or kid, I'd stop them. I've always done that. If someone was old and in a wheelchair, I'd help them. Always the same if someone needed help I'd help them.*

In contrast, around 70% of both the HC and aMCI groups provided responses at the highest two levels of sophistication, compared with just 30% of the AD group. Such responses either grappled with the realities of how the individual had changed

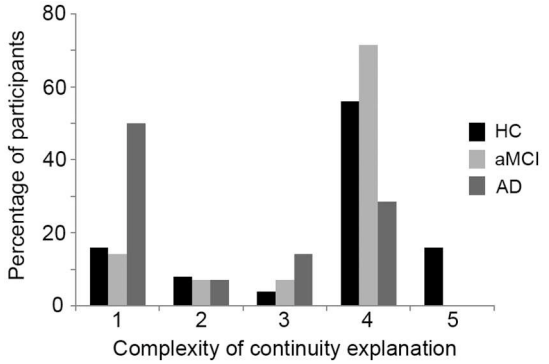

FIGURE 3 | Percentage of participants from each group providing each level of sophistication of response on the persistence explanation. HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease. Scores of 1 represent the lowest level of sophistication, while scores of 5 indicate the highest level of sophistication.

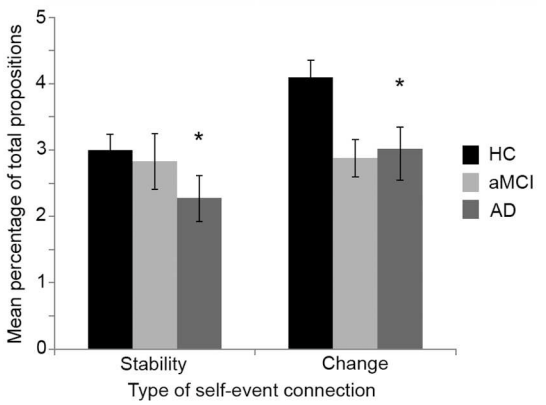

FIGURE 4 | Mean number of self-event connections in the life stories as a percentage of the total number of propositions for each group. HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease. Error bars denote one standard error of the mean. *AD group significantly lower than HC group.

while still identifying some core attributes which accounted for self-persistence (level 4), or weighed up many competing explanations for self-persistence (level 5), as illustrated by the following excerpt from a member of the aMCI group (scored level 4):

> *My experience has increased but my physical self has decreased, aged. My brain problems/memory has changed my outlook. I get depressed sometimes. I am not enjoying looking forward. [My parents]… set standards for me. Not deeply religious, but stronger religious feelings than I had and they brought me up on those standards. And that has been a strong steer for me through my life. Attitudes and values.*

The groups differed significantly in the sophistication of their persistence explanations, $H_{(2)} = 8.8$, $p = 0.01$, with pairwise Mann-Whitney *U*-tests (Bonferroni-corrected alpha level set at $p < 0.017$) confirming that the AD group's persistence explanations were significantly less sophisticated ($Mdn = 1.5$; mean rank = 17.54) than those of the HC group ($Mdn = 4$; mean rank = 31.26; $p = 0.01$). There was also a non-significant trend for the AD group to have lower scores than the aMCI group ($Mdn = 4$; mean rank = 28.86; $p = 0.02$). No significant difference was found in the scores for the aMCI and HC groups ($p = 0.57$).

A possible criticism of this method of assessing diachronic unity is that the task is a very difficult one, and the lower sophistication in the AD group's persistence explanations could relate to more general disease-related deterioration including general cognitive decline, loss of verbal fluency, or lack of insight. However, no significant Spearman's correlations were found between the sophistication of persistence explanation scores and MMSE, COWA, or awareness of memory deficits in the AD group (all *p*-values > 0.12).

Taken together, these analyses indicate that while the AD group demonstrated high confidence in their beliefs about their persistence over time (perceived persistence, I-self persistence, and me-self persistence), their ability to construct a sophisticated justification for their persistence across time was impaired. In fact, Spearman's rho correlations within the AD group revealed a significant negative correlation between the persistence explanation and perceived persistence, $r_s = -0.61$, $p = 0.019$, as well as a marginally-significant negative correlation between the persistence explanation and I-self persistence, $r_s = -0.54$, $p = 0.047$. In other words, those within the AD group who provided more sophisticated explanations for their persistence also tended to express *less* certainty over whether they remained the same person over time. This observation suggests that perceived and I-self (core) persistence may represent different facets of diachronic unity from the persistence explanation.

Semantic Continuity: Life Story Interview

Self-event Connections

All participants completed the life story interview. To compare the amount and type of autobiographical reasoning used in the life stories, a mixed-factorial ANOVA was conducted with life period (childhood, early adulthood, middle adulthood, late adulthood) and type of self-event connection (change, stability) as the within-subjects factors, and group (HC, aMCI, AD) as the between-subjects factor. The dependent variable was the number of self-event connections in each chapter as a percentage of the total number of propositions used in that chapter (see **Figure 4**).

There was a significant main effect for group, $F_{(2, 52)} = 4.7$, $p = 0.01$, with *post-hoc* Games-Howell comparisons showing that the AD group used a significantly lower percentage of self-event connections in their life stories ($M = 5.31$, $SE = 0.52$) compared with the HC group ($M = 7.10$, SE = 0.36; $p = 0.02$). The aMCI group did not differ significantly from either the HC or AD groups ($M = 5.70$, $SE = 0.56$; both *p*-values ≥ 0.16). There was also a significant main effect for type of self-event connection, $F_{(1, 52)} = 5.74$, $p = 0.02$, a larger percentage of change connections ($M = 3.47$, $SE = 0.19$) used than stability connections ($M = 2.76$, $SE = 0.18$). There were no other significant main effects or interactions (all *p*-values ≥ 0.12).

Global Coherence

A mixed ANOVA examined the difference between the groups on the global coherence of their stories, with type of coherence (temporal, causal, thematic) and life period (childhood, early, middle, and late adulthood) as the within-subject factors and group (HC, aMCI, AD) as the between-subject factor. There was a significant main effect for group, $F_{(2, 52)} = 19.64$, $p < 0.001$, with the stories of the AD group rated significantly less coherent than either the HC or aMCI groups (Games-Howell *post-hoc* tests: all p-values < 0.001) while the aMCI and HC groups did not differ ($p = 0.44$). There was also a significant main effect for life period, $F_{(3, 156)} = 1.11$, $p < 0.001$, with the early adulthood period showing greater coherence than other chapters (all p-values < 0.01).

The main effect for type of coherence was also significant, $F_{(2, 104)} = 101.85$, $p < 0.001$, but was modified by a significant interaction between group and type of coherence, $F_{(4, 104)} = 9.00$, $p < 0.001$ (see **Figure 5**). The analysis was rerun for each group pairing, and the interaction remained significant for all three pairs (all p-values ≤ 0.001). Pairwise comparisons showed that the HC and aMCI groups scored higher than the AD group on both temporal and thematic coherence (all p-values ≤ 0.004). In relation to causal coherence, however, both the AD and aMCI groups scored lower than the HC group (both p-values ≤ 0.01). All three groups scored significantly higher on thematic compared with causal or temporal coherence (all p-values < 0.001), but only the aMCI group scored significantly lower on causal than temporal coherence (p-value < 0.001). No other pairwise comparisons were significant ($p = 1.00$). These results indicate that while the AD group scored lower on all forms of coherence, the aMCI group showed a specific deficit in relation to causal coherence.

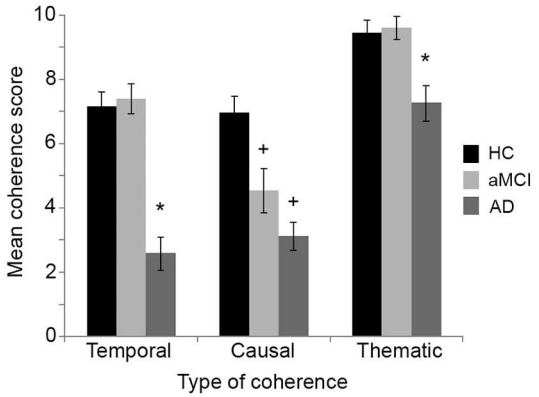

FIGURE 5 | Mean score for each type of coherence (temporal, causal, and thematic) across the whole life story, for each group. HC, Healthy control; aMCI, amnestic Mild Cognitive Impairment; AD, Alzheimer's disease. Errors bars denote one standard error around the mean. *AD significantly lower than HC/aMCI groups; +Significantly lower than HC group.

Cultural Life Script

Separate one-way ANOVAs conducted on the number of cultural life event categories sampled and the total number of cultural life events mentioned in the life story. At a Bonferroni-corrected alpha level (0.025) there was no significant group difference in the number of cultural life script categories sampled, $F_{(2, 32.39)} = 1.89$, $p = 0.17$, or the number of events used in the life stories, $F_{(2, 52)} = 3.41$, $p = 0.04$, although the latter approached significance. When the analyses were rerun using the number of cultural life script events and event categories sampled as a percentage of the total number of propositions used in the life stories, there was no significant difference between the groups on either number of categories sampled, $F_{(2, 25.63)} = 1.38$, $p = 0.27$, or the total number of events used in the life stories, $F_{(2, 27.86)} = 0.80$, $p = 0.46$ (Brown-Forsythe). These findings indicate that the memory-impaired groups did not differ from healthy controls in their use of cultural life script events in their stories.

Diachronic Unity and Semantic Continuity

Next we examined the relationship between measures of diachronic unity and semantic continuity in the AD group as these participants had the most severe memory impairments. Spearman's rho correlations were conducted between three measures from the self-persistence interview (I-self persistence, me-self persistence, persistence explanation) and five measures from the life story interview (the number of self-event stability and change connections used in the life story, and ratings for temporal, causal, and thematic coherence). To control for differences in the length of the life stories, self-event connection measures were percentages of the total number of propositions used in the life story. Five of the 15 correlations were, or approached, significance (Holm-Bonferroni correction, first-level adjusted alpha, $p < 0.003$; second-level adjusted alpha, $p < 0.004$). Two of these were related to perceived persistence: a significant negative correlation with causal coherence, $r_s = -0.84$, $p < 0.001$, and a marginally-significant negative correlation with the number of self-event stability connections, $r_s = -0.62$, $p = 0.02$. In other words, AD participants who produced stories that were more causally coherent and contained higher percentages of self-event connections were also more inclined to state that they were not the same person they were in their early 20s. There was also a consistent pattern of marginally significant positive correlations between the persistence explanation and quality of narrative identity. More sophisticated explanations were associated with the greater use of self-event stability connections, $r_s = 0.72$, $p = 0.004$, and greater temporal, $r_s = 0.58$, $p = 0.03$, and causal coherence, $r_s = 0.54$, $p = 0.049$. This indicates that AD participants with better narrative identity also tended to provide more complex explanations for self-persistence. When the same correlations were conducted within the HC group, as expected there were no significant associations.

DISCUSSION

This study provides one of the first systematic investigations of diachronic unity in memory-impaired older adults. In line with our model of how AM supports diachronic unity (Prebble et al., 2013; **Figure 1**), it is possible that for individuals with

disorders characterised by impaired autonoetic consciousness (Rauchs et al., 2007; Ally et al., 2009; Hudon et al., 2009; Irish et al., 2010), subjective beliefs about their persistence across time (diachronic unity) are maintained, and supported by semantic continuity. We investigated this hypothesis in aMCI and AD by assessing the integrity of, and relationship between, diachronic unity and semantic continuity (narrative processes such as autobiographical reasoning and global coherence including personal temporal chronology).

Diachronic Unity in aMCI and AD

A central finding of this study was that the memory-impaired groups did not differ significantly from healthy older participants in relation to their subjective beliefs about their diachronic unity (i.e., perceived persistence and I-self persistence). About half of healthy and memory-impaired participants expressed strong views that they remained the same person as they were in their early 20s. This finding was accompanied by a preserved sense of persistence of their core essence, which is consistent with qualitative evidence from previous studies that those with memory impairments may nevertheless retain a deep conviction about their persistence across time (Medved and Brockmeier, 2008; Rathbone et al., 2009; Philippi et al., 2012).

Individuals with aMCI provided explanations for their preserved beliefs of persistence that were as sophisticated as those generated by healthy controls, as measured using Chandler et al.'s (2003) continuity explanation. In contrast, in AD these preserved beliefs about diachronic unity were explained in a significantly less sophisticated way than both the HC and aMCI groups. Specifically, half of the AD group provided answers that relied on superficial, surface characteristics to justify stability, while ignoring or downplaying aspects of personal change. Importantly, this difference was not simply related to global cognitive decline or reduced fluency. In contrast to Chandler et al.'s findings with suicidal youth, our results suggest that a coherent and sophisticated rationale for one's persistence is not necessary to maintain a strong inner conviction that you continue to be the same person across time; in memory-impaired older adults even very simple persistence explanations may be sufficient to sustain beliefs about one's diachronic unity.

In fact, for those in the AD group, less sophisticated persistence explanations were associated with *greater* certainty about their diachronic unity (subjective persistence over time, including their core I-self). One possible explanation is that simplistic, "change ignoring" persistence explanations provide a way to support a sense of diachronic unity without needing to grapple with the realities of personal change, focusing instead on superficial aspects of personal consistency, as illustrated by the following response:

> *I can't see myself being very different now. I just am like I am. If people talk to me I'll talk to them. I'm a mother, I help people.... I just seem to do the same things. If people talk to me I talk to them, if people need help I help them. Always been the same.*

Focusing on superficial aspects of consistency may be a useful strategy for maintaining a strong conviction about core persistence in the face of memory loss. The AD group were significantly more likely to emphasise greater persistence in the me-self over time (i.e., traits and characteristics) than healthy controls. A related suggestion has been made by Clare et al. (Clare, 2003, 2004; Naylor and Clare, 2008) in relation to lack of awareness about memory deficits. They suggest that reduced awareness may provide an important strategy for reducing threats to identity for certain individuals. In this study, however, there was no significant correlation between our coarse measure of lack of awareness of memory deficits and the use of more simplistic persistence explanations. It is also possible that the focus on stability rather than change in the responses of the AD group may relate to their memory deficits, and an inability to recollect the nuanced ways they have changed and stayed the same across the lifespan.

Another possible account of these findings is that the perceived persistence and I-self persistence measures used in the present study do not directly assess beliefs about core diachronic unity, but rather assess the level of engagement that a participant has with difficult questions about self-persistence. The direct questions regarding persistence used in the present study (e.g., do you believe you are the same person? In what ways have you changed?) appear to directly address questions about self-persistence, yet someone could respond to these questions in a manner that indicates essential changes to who they are while nevertheless continuing to believe that these changes have occurred to the same, unifying "me." When individuals express less conviction about their core persistence on these measures, for example, by describing themselves as being "a fundamentally different person," this may not be a marker for uncertainty or degradation in their beliefs about core persistence, but rather an indication of intelligent engagement with the enigmatic challenges of diachronic unity. It is difficult to know how to distinguish such an answer from one in which the individual has lost the ability to see themselves as the same unified entity extending across time—a true loss of diachronic unity. In this study those individuals with memory-impairment who indicated doubts about their diachronic unity (thus scoring lower on perceived and I-self persistence), tended to produce more sophisticated explanations for their diachronic unity, which indicates they did engage with the questions about self-persistence. We suggest they may have been attempting to explore the difficult questions of change and persistence over the lifetime at a deep, level, which in turn allowed them to produce sophisticated explanations for the changes they perceived in their fundamental diachronic unity.

These issues indicate that further methodological work is needed to determine how best to assess diachronic unity. In particular, research is needed with groups who are likely to have true disruptions in their subjective beliefs about self-persistence (e.g., suicidal populations, Chandler et al.'s, 2003; Hsiao et al., 2013) in order to determine whether they provide qualitatively different types of answers regarding their diachronic unity.

Semantic Continuity in aMCI and AD

This study revealed that while many aspects of semantic continuity were preserved in aMCI, there were a number

of differences in the semantic continuity of individuals with AD and healthy older adults. First, the life stories of the aMCI group were similar to those of healthy controls in terms of inclusion of cultural life script events, as well as levels of temporal and thematic coherence. In particular, the preservation of temporal coherence indicated that the ability to construct personal temporal chronology is relatively preserved in aMCI. Moreover, aMCI individuals appeared to engage in autobiographical reasoning, although the number of self-event connections they generated was at a level intermediate between that of the healthy control and AD groups (differing significantly from neither group).

Interestingly, however, there was a significant reduction in the causal coherence of the life stories generated by the aMCI group, indicating that they were less able to explain the causal links between events, or between these events and their self-concept. This finding may indicate that causal coherence, at least as it was measured in the present investigation, requires a more complex form of reasoning than the other types of coherence, and is affected earlier in the disease process. Habermas and de Silveira (2008) report that causal coherence develops steeply during adolescence, and is more complex than temporal coherence. Although they suggest that causal coherence is less complex than thematic coherence, and demonstrate that thematic coherence does not steeply increase until after age 16, it is interesting to note that their findings suggest causal coherence is almost absent in the stories of younger children, while a basic level of thematic coherence is present.

Alternatively, it is possible that the impaired causal coherence of the aMCI group may relate to the acute awareness that many possessed about their memory loss, leading to a difference in the way these individuals approached their stories. For example, in attempting to remember all of the details of their stories, they may have focused more deliberately on including important dates and events than on providing any meta-narrative to link the stories together. In addition, the effort of producing these life stories, including trying to remember the events and their temporal order, may have required greater cognitive energy for those with aMCI, leaving less to expend on more complex aspects of the story like causally linking events. Future work could explore the underlying basis of the reduced causal coherence in aMCI groups by using a guided autobiographical reasoning assessment with prompts to elicit these different reasoning processes.

In contrast to the limited change in semantic continuity in the aMCI group, there was a more general reduction in the quality of the narratives produced by the AD group. This included less evidence of autobiographical reasoning, with inclusion of fewer (as well as a lower percentage of) self-event connections about change and stability in their life stories. Moreover, there were reductions in temporal, causal and thematic coherence. These findings indicate that the AD group were making fewer links between the events they included in their stories and their self-concept, and that they were less able to convey the temporal order of events, the causal links between the elements of the story, and the overarching motifs and lessons that wove the story together. It may be that just as episodic memories deteriorate in AD, so too does the ability to link and integrate elements within the story into a coherent narrative.

The present findings also revealed some deterioration in the personal temporal chronology of those with AD. Consistent with reports that the narratives of those with AD may lack chronological ordering (Usita et al., 1998), the life stories of the present AD group were rated as having lower temporal coherence than the stories of the other groups. This was evident despite the provision of a broad temporal structure by dividing the life story into four sequential chapters, indicating deterioration in the ability to convey the absolute and relative temporal ordering of events through their life narratives. While this could relate to difficulties in ordering and sequencing events in the process of story construction, an interesting possibility is that this difficulty reflects a disruption in the temporal organisation of AM itself.

Despite this, the use of the cultural life script was well-preserved in the life stories of those with AD. Although there was a non-significant trend for those with AD to use fewer cultural life script events, after taking into account the length of their stories, there was no difference between the groups in relation to the number of cultural life script events, or event categories, used. This finding differs from that of Usita et al. (1998), but is consistent with those of Fromholt and Larsen (1991) and suggests that in AD cultural knowledge about the events to include in a life story remains largely intact.

These findings suggest that the organisational structure provided by the cultural life script, and the memories linked to it, may be relatively more resilient than other types of AM, perhaps due to the important socio-cultural function of these memories. This culturally-generated script may play an important role in structuring and organising the last remnants of AM in AD (Berntsen and Rubin, 2004). It is important to note, however, that the measure used in the present study only addressed whether the events were mentioned in the story, and not the detail or accuracy of the stories. It is possible that AD participants retained knowledge about the script (i.e., awareness that a given type of event should be included in their life story) but not any accuracy or detail about the event itself within their own life. The resilience of cultural life script events may also be due to the list of events being weighted to the first half of life, and particularly the early-adulthood "reminiscence bump" period (Berntsen and Rubin, 2004). To assess these possibilities, future investigations should explore the detail and accuracy of the cultural life events included in the stories of those with AD, and whether there is any difference in the recall of cultural life events from different life periods.

Relationship between Semantic Continuity and Diachronic Unity

The present findings suggest a complex relationship between semantic continuity and diachronic unity. There was a consistent pattern of positive, marginally significant correlations between the sophistication of the persistence explanation and the quality of semantic continuity within the AD group, including the greater use of self-event stability connections, and greater temporal and causal coherence of life stories. This finding

provides tentative support for the view that the ability to construct a quality life story, which links one's AMs into a coherent narrative that explains the development of the self across time, is associated with more sophisticated explanations for why one continues to remain the same person. Additional evidence for this notion comes from the aMCI group who had preserved autobiographical reasoning and temporal/thematic coherence of their life stories, and were able to generate persistence explanations as sophisticated as those produced by health controls. When considered together with the disruptions to phenomenological re-experiencing evident in aMCI (Ally et al., 2009; Hudon et al., 2009; Irish et al., 2010), this pattern of findings provides support for our model's prediction that intact semantic continuity is sufficient to support diachronic unity (Prebble et al., 2013).

An intriguing possibility, in line with the present model, is that the association of semantic continuity and diachronic unity reflects a causal relationship: that the ability to weave a high-quality life narrative scaffolds the ability to understand and explain one's persistence across time. The fact that this relationship was present in the AD group, but not the healthy controls is consistent with Habermas and Köber's (2014, 2015) finding and suggestion that autobiographical reasoning may be necessary for reflecting upon, and understanding, diachronic unity only when there are disruptions to self-persistence. A diagnosis of AD, and the accompanying personal and circumstantial changes, may constitute such a disruption. In the face of such disruptions, any deterioration in the ability to weave AM into a coherent narrative may contribute to an impaired ability to understand, at a higher conceptual level, why they remain continuous beings over time.

It is also possible, however, that what may underlie these relationships is cognitive decline in AD which is not directly related to memory, but affects both the construction of quality life narratives and successful engagement in the self-persistence explanation task. However, the loss of sophistication in self-persistence explanation in the AD group was not significantly correlated with general cognitive decline (MMSE) or verbal fluency (COWA), suggesting that other factors were involved. Nevertheless, other more subtle reasoning processes, not captured by simple measures like the MMSE, may be affected. To assess this possibility, future studies could use a control paradigm that requires a similar, but non-self-related reasoning exercise (e.g., explaining the persistence of animals or inanimate objects over time) in order to determine whether it is the ability to engage in such logical reasoning processes that is affected, or whether there are specific deficits in explaining one's own persistence.

Although better semantic continuity was associated with increased sophistication of self-persistence explanation, it was not associated with greater certainty about diachronic unity. On the contrary, in the AD group a significant negative relationship was found between the causal coherence of life stories and certainty about whether they remained the same person. This finding parallels those reported above in relation to phenomenological continuity: better memory performance (in this case, better integration of AM into a life narrative) was associated with more sophisticated explanations about, but less certainty of, self-persistence.

A limitation of the current investigation is its focus on past-facing diachronic unity and continuity. Recent theories have postulated that the adaptive function of the episodic memory system may not relate to reliving the past, but rather in being able to imagine, and therefore plan for, the future (Tulving, 2005; Suddendorf et al., 2009; Tulving and Szpunar, 2009), and neuroscientific work has established a connection between the ability to remember one's past and the projection of oneself forward into the imagined future (Schacter and Addis, 2007; Addis et al., 2008). It may be that the ability to mentally project oneself forward in time, and/or construct a story about the future self, plays a vital role in phenomenological and semantic forms of continuity and thus also diachronic unity.

While research into future thinking has focused primarily on the role of episodic memory, there are studies suggesting that semanticised AM may play an equally important role. Patients with semantic dementia, who have profound semantic memory deficits but largely preserved episodic memory, have been found to be as deficient at imagining personalised future scenarios as individuals with AD, suggesting that semanticised AM may provide the scaffolding that allows episodic memory details to be recombined into novel future scenarios (Irish et al., 2012). There is also evidence that fundamental breakdowns in the sense of semantic continuity in semantic dementia can arise from problems with the ability to mentally project oneself forward in time, and may be associated with suicidal behaviour (Hsiao et al., 2013). This future-facing aspect of continuity and diachronic unity, and its association with semantic and episodic memory ability, is an important area for future investigation.

SUMMARY

This study provides some important insights for our model of how AM supports diachronic unity by examining whether semantic continuity can provide a sense of self persistence in disorders where AM deficits disrupt phenomenological continuity (Prebble et al., 2013). The findings in both aMCI and AD support the predicted importance of semantic continuity to diachronic unity. In aMCI, the quality of life narratives was largely preserved, as were measures of self-persistence, indicating that even when the continuity afforded by phenomenological re-experiencing is disrupted, semantic continuity is sufficient to support diachronic unity. However, the findings from the AD group suggest a more nuanced relationship than was originally proposed in our model. Underlying the complex pattern of findings was a divergence between the two aspects of diachronic unity in the AD group: beliefs about the persistence of the core self over time (i.e., perceived and I-self persistence) vs. the sophistication of persistence explanations. The AD group had maintained the former, but showed deterioration in the latter. Within the AD group, those who scored higher on measures of persistence of the core self also provided less sophisticated explanations for their self-persistence and were less able to use their AM as a vehicle to explore how they came to be the

person they are through their life narratives (i.e., poorer semantic continuity).

These apparently paradoxical findings indicate a multifaceted relation between diachronic unity and semantic continuity in individuals lacking phenomenological continuity as occurs in AD. Those individuals with AD who retain better quality semantic continuity and life narratives, including better autobiographical reasoning and greater global coherence, are able to produce a more complex persistence explanation. This is accompanied by less conviction about the persistence of the core self, without incorporating some degree of fundamental change. Thus, better semantic continuity in individuals with AD may facilitate deep engagement with issues of self-persistence, and this may be reflected both by more sophisticated responses on the persistence explanation, and by responses to questions about diachronic unity that indicate an appreciation of personal change across the lifespan.

A poor quality life narrative that nevertheless contains regular features of a cultural life script, appears to be sufficient for individuals with AD to perceive familiarity with their past and thus maintain strong subjective beliefs of self-persistence over time. Nevertheless, when the connection with one's remembered past is diminished by the combination of poor phenomenological and semantic continuity, this may contribute to a less sophisticated understanding about personal persistence; one which over-emphasises superficial aspects of stability and fails to integrate an understanding of change. Further work is needed to investigate whether this apparent lack of engagement with the paradox of diachronic unity in individuals with AD and diminished semantic continuity is due to an inability to remember personal change, or may serve as an important protective mechanism for the self-persistence of those with AD in the face of tremendous personal change.

AUTHOR CONTRIBUTIONS

LT, SP, and DA conceived of and designed the study. SP collected and analysed the data under the supervision of LT and DA while she was undertaking her PhD. LT and SP drafted the manuscript with input from DA.

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APPENDIX A

Glossary

Autobiographical memory: Memory that is personal in nature in that it involves the self (e.g., personally-experienced events, facts about the self).

Autobiographical reasoning: A narrative process that involves creating connections between different parts of the life story (e.g., events in the past, present, and future) and the self and can emphasise stability or change; this process serves to increase the temporal, causal, and thematic coherence of the life story.

Autonoetic consciousness: The sense of consciously re-experiencing a past event; a critical feature of episodic memory.

Diachronic unity: The unification of the self as a single entity that persists across time; self-persistence.

Episodic memory: A form of autobiographical memory that represents specific events that one experienced in the past.

I-self: the essential, core self, the underlying essence of who you are, the inner entity; related to phenomenological continuity.

Me-self: the attributes one uses to describe oneself, e.g., traits, attributes, physical, and personality descriptions, behaviour, likes and dislikes, values and beliefs; related to beliefs about semantic continuity. *Narrative:* Coherent and meaningful life story that convey "how I was and how I came to be who I am" that highlights the temporally-extended self-concept and personal temporal chronology.

Narrative identity: Sense of identity emergent from the process of constructing a life story.

Phenomenological continuity: The subjective experience of the self-existing over time, arising from episodic remembering and autonoetic consciousness.

Self-persistence: See diachronic unity.

Semantic continuity: The knowledge that the self exists over time; a by-product of the construction of a coherent, temporally-extended narrative.

Semantic memory: An abstract, conceptual form of autobiographical memory that synthesises large amounts of knowledge and facts about the self, including self-concept (e.g., traits, preferences) and knowledge of past experiences, etc.

Temporally-extended self-concept: The self-concept (e.g., trait-self knowledge, preferences, behaviours) in the past, present and future; incorporates change and stability of self-concept.

Personal temporal chronology: The temporal sequence of events experienced in one's life; can be measured by temporal coherence of life narratives.

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REVIEW
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Using Self-Generated Cues to Facilitate Recall: A Narrative Review

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We draw upon the Associative Network model of memory, as well as the principles of encoding-retrieval specificity, and cue distinctiveness, to argue that self-generated cue mnemonics offer an intuitive means of facilitating reliable recall of personally experienced events. The use of a self-generated cue mnemonic allows for the spreading activation nature of memory, whilst also presenting an opportunity to capitalize upon cue distinctiveness. Here, we present the theoretical rationale behind the use of this technique, and highlight the distinction between a self-generated cue and a self-referent cue in autobiographical memory research. We contrast this mnemonic with a similar retrieval technique, Mental Reinstatement of Context, which is recognized as the most effective mnemonic component of the Cognitive Interview. Mental Reinstatement of Context is based upon the principle of encoding-retrieval specificity, whereby the overlap between encoded information and retrieval cue predicts the likelihood of accurate recall. However, it does not incorporate the potential additional benefit of self-generated retrieval cues.

Keywords: retrieval cue, encoding-specificity, spreading activation, cue distinctivness, cue generation, self-generated cue, Mental Reinstatement of Context, encoding-retrieval match

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INTRODUCTION

Being able to reliably recall a personally experienced event is sometimes of critical importance. A good example is when an eyewitness is required during a police investigation to give a complete and accurate account of criminal activity witnessed. In a more everyday context, the recall of personally experienced events can function as a means to understand ourselves and others in the world around us. Through recalling personal memories we can identify who we are as an individual consistent over time, learn from the past, solve current problems, and plan for the future. We can also strengthen social ties and build and maintain intimacy in our relationships through the sharing of stories about past events (Fivush, 2008; Harris et al., 2014).

Successful recall of information from memory is often dependent upon the provision of retrieval cues (see Tulving, 1974 for discussion). Retrieval cues are aspects of an individual's physical and cognitive environment which aid the recall process; they can be explicitly provided at recall, self-generated, or encountered more incidentally through the retrieval context (Pansky et al., 2005). Given the potential importance of accurate recall of personally experienced events outlined above, it is unsurprising that numerous mnemonic techniques have been developed to facilitate this process. The most successful of these build upon established principles of memory, such as the idea that encoding information leaves behind a memory trace comprised of multiple pieces of related information. This means that effective retrieval cues are those which contain a large amount of overlap with encoded information, and that different retrieval cues may facilitate the recall of different items of information (Geiselman et al., 1986).

In the discussion that follows we outline the qualities necessary for a retrieval cue to be effective, and based upon the extant literature, argue that self-generated retrieval cues represent a unique opportunity to maximize each of these qualities. We contrast use of self-generated cues with established context reinstatement techniques, in particular Mental Reinstatement of Context, found principally within the eyewitness domain. Based upon this discussion, we argue that the theory underpinning Mental Reinstatement of Context also supports the effectiveness of self-generated cue mnemonics, and that self-generated cues offer an additional opportunity to capitalize upon the benefit of cue distinctiveness. We close by outlining three memory principles underlying each of these mnemonic techniques: spreading activation, encoding-specificity, and cue distinctiveness. Our aim throughout this review is to consider how existing memory theories might contribute to the beneficial effect of self-generated cues on recall, as demonstrated by the empirical studies outlined, and not to consider alternative explanations of these findings.

DISCUSSION

Episodic Memory

The recall of personally experienced events falls within the domain of episodic memory. Episodic memory, first proposed as a memory system by Tulving (1972), consists of highly detailed sensory information about recent experience. It principally involves recalling the what happened, where, and when of events. As such, episodic memory deals more with personal experience than with general facts about the world and ourselves. It is the 'personally experienced' aspect of episodic memory that distinguishes these memories from semantic memories for more general facts (Tulving, 2001). This concept has been revised by Conway and colleagues to define episodic memory as a system containing highly event-specific, sensory-perceptual details of a recently experienced event. These events usually cover a relatively short-time span, often lasting just minutes or hours (Conway, 2001). It is the high levels of sensory-perceptual detail incorporated into episodic memories that make the re-experiencing of previous events possible through 'mental time travel,' something Tulving argues is likely to be unique to humans (Tulving, 2001, 2002). Tulving (2002) suggests that the episodic memory system is relatively early-deteriorating, and Conway (2001) argues that episodic memories persist on a longer-term basis only when incorporated into autobiographical memory structures (indeed Conway argues that autobiographical memory structures typically consist of one general event, alongside at least one episodic memory). Autobiographical memory, in contrast to the shorter-term, high event specificity of episodic memory, can be taken to be a system of long-term memory containing three levels of specificity: lifetime periods, general events, and event-specific knowledge. It is also generally considered that the self is of central importance to autobiographical memory (Conway and Pleydell-Pearce, 2000). Here, we refer to episodic memory in line with Tulving's (1985) suggestion of episodic memory as a specialized subcategory of memory relating to the conscious recall of personally experienced events. In this sense, episodic memory is both a particular type of encoded information, and a particular type of recollective experience (Tulving, 2002).

Effective Retrieval Cues

A number of key qualities have been suggested as necessary for a retrieval cue to effectively support recall. Good quality retrieval cues often have: (i) constructability (cues generated at encoding can be reliably reproduced at recall); (ii) consistency between encoding and retrieval within a given context (i.e., an effective retrieval cue should be compatible with the memory trace created during encoding and show high cue-target match); (iii) strong associations with the target and the ability to be easily associated with newly learned information; and (iv) bidirectionality of association (the cue recalling target information, and target information recalling the cue). It is also important that retrieval cues are distinctive or discriminable. That is, it should be possible to distinguish cues from one another, and to differentiate the target memories associated with each. If retrieval cues are not recognized as being distinct from one another, then cues are likely to become associated with more information, which in turn reduces the effectiveness of the cue in prompting the recall of target information. This is known as cue overload (Watkins and Watkins, 1975), which leads to slower less accurate recall as a result of a cue (node) containing too many associative links (the fan effect; Anderson, 1983a). In addition, fuzzy trace theory (e.g., Brainerd et al., 1995) suggests that multiple traces are encoded within memory for a single event. In other words, separate memory traces are created which contain either general information about an event (gist traces) or exact details of the same event (verbatim traces). It has been suggested that gist traces are likely to be activated by a wider range of retrieval cues than verbatim traces (Tuckey and Brewer, 2003). This means that more distinct retrieval cues are necessary to access detailed target information (Bellezza and Hoyt, 1992; Tullis and Benjamin, 2015a).

Self-Generated Cues

The self-generation of cues to prompt recall of information at a later date is a relatively natural process; for example, individuals regularly create file names to cue themselves as to the contents, create slides to prompt themselves as to presentation content, or take notes on important information to allow detailed recall in the future (Tullis and Benjamin, 2015b). Generally, it can be expected that individuals should be effective at generating cues to prompt their own future recall. When generating cues ourselves we are able to rely upon rich, unique, personal knowledge to produce cues which are often distinctive, highly associated with the target, and consistent between encoding and retrieval (and therefore stable over time). Research has demonstrated that individuals do not consistently favor any one of these principles over the others when self-generating retrieval cues; instead, they utilize these characteristics flexibly to fit with the current task demands (Tullis and Benjamin, 2015a). For example, when learners are provided with information about the similarity of competing targets (they were made aware that targets were similar to one another) prior to generating their

cues, they focused more on distinguishing between the targets through maximizing cue distinctiveness, and so improved their performance on a recall task (Tullis and Benjamin, 2015a).

Defining a Self-Generated Cue

Research has suggested that the most effective self-generated cues are likely to have been developed with the explicit purpose of cueing later retrieval. This helps individuals to make deliberate choices distinguishing the target from other items stored within memory, rather than merely describing the properties of the target (Tullis and Benjamin, 2015a). In this way, developing self-generated cues can be considered as an active process, resulting in cues which uniquely and functionally represent the critical properties of the target memory (Mäntylä and Nilsson, 1983). For example, when learners were told directly that the cues they generated would be used to guide a future retrieval attempt (mnemonic cues), their cues tended to include more idiosyncratic knowledge and personal experience, were more distinctive, and associated to fewer potential targets, and so facilitated greater levels of recall than cues generated to simply describe the target (Tullis and Benjamin, 2015a). Self-generated cues are likely to include idiosyncratic details based upon the personal context of encoding. They are also likely to make particular use of distinctive aspects of the information to be encoded to distinguish the representation of the target memory from others already stored in memory (Mäntylä, 1986).

As far as we are aware there is no widely agreed definition of a self-generated cue. Here, we refine the definition of a self-generated retrieval cue to mean any detail salient to the individual, and actively generated by the individual themselves, which serves to facilitate more complete retrieval of a target memory, and as such represents the critical properties of the target memory. In defining a self-generated cue, it is also important to distinguish our interpretation of a self-generated cue from other similarly named concepts within the domain of memory research. For example, from the related concept of the generation effect, as well as from self-referent cues commonly found in the autobiographical memory literature. Each of these is treated individually below.

The generation effect or elaborative processing

It has been suggested that information is better recalled when it has been actively and effortfully processed, rather than passively received. This can be considered as a *necessary* but not *sufficient* prerequisite for unique encoding (Slamecka and Graf, 1978; Mäntylä and Nilsson, 1983). Production of unique cues at the encoding stage encourages enhanced encoding of target material. One means of inducing more active unique encoding is to have participants generate the stimuli to-be-recalled for themselves. For example, participants might be given a word with some letters replaced with blanks. This is often presented alongside a strong semantic cue (e.g., *fruit*: a p _ l _). Learners are asked to complete the word, and then to encode this word for later recall (Schmidt, 1991; Laffan et al., 2010). Self-generated stimuli are more accurately recalled than stimuli passively encoded under the same conditions, and this effect persists over a longer retention period. This effect (known as the *generation effect*) holds constant across a range of measures such as cued and uncued recognition, free recall and cued recall, and confidence ratings (Slamecka and Graf, 1978; Mäntylä and Nilsson, 1983; Laffan et al., 2010).

The generation effect can be considered as representing the impact of deeper, semantic, more distinctive encoding strategies (Derwinger et al., 2005). While this potentially works on some of the same principles as our definition of self-generated cues, these two processes are subtly different. In essence, it seems that when a generation effect approach is taken, learners are generally trying to generate the encoding material. In contrast, a self-generated cue in our context is one that is generated by the individual (and so can be as idiosyncratic as necessary) to prompt the recall of encoded material, but does *not* necessarily consist of the target material itself. It is worth noting that some research has found that the generation effect improves memory for target items, but can lead to a reduction in memory for contextual details (Mulligan, 2004; Mulligan et al., 2006). It is not yet known whether self-generated cues might also fail to enhance memory in all contexts.

Self-referent cues

References to 'self-referent cues,' 'self-relevant cues,' or 'personally relevant cues' are not uncommon in the autobiographical memory literature. It has been suggested that there is a strong relationship between the self and memory, and that in particular the self-referencing of autobiographical memories distinguishes them from other types of memory (Conway and Pleydell-Pearce, 2000). In addition, it has been suggested that memory is, at least in part, organized around the concept of the self (see for example Greenwald and Banaji, 1989; Symons and Johnson, 1997). A self-referent cue generally involves processing information in reference to the self. In the simplest terms, this means thinking about oneself during the encoding process (Turk et al., 2015). In doing so the individual associates a piece of to-be-remembered information with a self-relevant item (as in Greenwald and Banaji, 1989). This has been shown to have broader implications for recall, as well as impacting achievment in educational contexts (as in Turk et al., 2015). However, this is somewhat different from the definition of a self-generated cue to (non-autobiographical) retrieval we outlined above. The main distinction being that self-generated cues reflect those that represent critical properties of a target memory, while self-referent cues are those that act as a cue relating to an aspect of the self.

The Benefit of Self-Generated Cues Over Cues Generated by, or for, Others

It is well-established that strong cue-target relationships, cue distinctiveness, and compatibility between encoding and retrieval are necessary to maximize the effectiveness of a retrieval cue. It is reasonable to assume then that if we are able to capitalize upon each of these principles, then recall performance will be further improved. If this is the case, then allowing individuals to generate their own retrieval cues represents our best opportunity to utilize cues that are unique, and include a high level of cue-target match. Indeed, some researchers have already argued that the high levels of recall demonstrated when the target information shares a unique relationship with the cue become more striking when

the cue is self-generated (Hunt and Smith, 1996). This is not altogether surprising; if effective retrieval cues are both distinctive and compatible with the encoding experience, then it follows naturally that cues are more effective when they are self-generated than other-generated. The 'tester' cannot know what information was most salient to the learner at the time of encoding, nor can they anticipate which aspects of that information are most distinctive to the learner (Mäntylä, 1986). As a result, other-generated cues (i.e., cues that are formulated by someone other than the individual themselves) rely heavily upon more general, semantic, gist-based aspects of the target information, rather than the more specific idiosyncratic episodic details incorporated into self-generated cues. In this sense, other-generated cues can be considered to rely primarily upon associative strength (between cue and target), without the additional benefit of cue distinctiveness and encoding-retrieval match offered by self-generated cues. In support of this, Tullis (2013) highlights that when learners recalled an incorrect target, this response appeared to be driven by the associative strength between the cue and the incorrect response. This suggests that when learners are unable to access specific episodic details for a cue they resort to a 'best guess' based upon associates of the cue provided to them. In other words, when specific episodic details are unavailable, learners fall back upon more general semantic knowledge. This suggests that strong cue-target associations (favored by spreading activation theories of memory) are the backup route to recall, when cue-target overlap and cue distinctiveness fail.

It has been argued that research into self-generated cues makes an important contribution *beyond* the understanding of cue distinctiveness. For example, in examining the use of self-generated cues, we are able to move beyond understanding encoding as the perception and comprehension of an item, to viewing this process as an additional source of potential retrieval cues (Hunt and Smith, 1996). This argument was based primarily around the extraordinary findings of Mäntylä and Nilsson (1988) who showed that given distinctive self-generated verbal cues and a consistent encoding-retrieval environment, recall of unrelated verbal targets is consistently of a high level, even with a long retention interval. This advantage is specific to the producer of the cue, with the cue itself failing to function effectively as a prompt for another individual's recall. In effect, even where two individuals have encoded the same information, they are likely to produce unique retrieval cues, and so benefit exceptionally well from their own cues.

The retrieval benefit of self-generated cues over other-generated cues has been suggested as being linked to the generation process (e.g., through encouraging more active processing of the target memory). However, the research outlined above suggests that this benefit is the result of both the generation *process*, and the generation *context*. The potentially idiosyncratic nature of self-generated cues means that one individual's cues that are given to another individual at test would be unlikely to benefit their performance, even if the same information had been presented at encoding. Despite this, individuals do frequently generate cues to benefit others in naturalistic settings. For example, we might consider how best to prompt an employee to complete a task, or cue one another's memories for shared events when reminiscing with friends (Tullis and Benjamin, 2015b). It is then interesting to examine how asking individuals to generate cues specifically for use *by others* impacts upon the types of cues generated, and the effectiveness of these cues at test. During one such study participants generated cues for themselves and cues for others. At recall, they received another person's cues (this could be a friend or stranger), but never their own self-generated cues. Results suggest friends are able to cue each other more effectively than strangers. However, performance overall improved when participants were provided with cues generated with the knowledge that the cue would be used to support someone else's recall (Andersson and Ronnberg, 1997, Experiment 2).

Tullis and Benjamin (2015b) examined how the quality of a retrieval cue changed when it was generated for use by others rather than use by the self. Participants each generated two cues for each of 60 words. These cues were to be used to support their own later recall attempt, or to aid another learner in recalling the items on the wordlist. The stimulus words were selected as having relevance to the life of college students, and so were considered to offer opportunities for the use of cues based on personal experience. Cues presented at recall were either self or other-generated, and were intended for use by either the self or another individual. In general, cues generated for the self were consistently more idiosyncratic, and so less beneficial when presented to another learner. Consequently, performance was better when participants received an other-generated cue meant for another individual, than an other-generated cue meant for the self. In addition, self-generated cues intended for another individual were no longer as effective in facilitating the originator's recall performance. Although this difference did not reach significance, this does suggest that the benefit of self-generation of the cue is removed when self-generated cues are intended for use by others. This is perhaps as a result of the reliance on more semantic cue-target associations, rather than distinctive, and often idiosyncratic details, of the encoding experience. It can therefore be assumed that the benefit of self-generated cues lies in the inclusion of personal experience and idiosyncratic knowledge to create a distinctive and meaningful cue.

Empirical Tests of Self-Generated Cue Mnemonics

Mäntylä and colleagues were among the first to note the benefit of self-generated cues on recall. Mäntylä and Nilsson (1983) were able to demonstrate strikingly high levels of recall (around 96% of a 30-word list), but only when participants were able to self-generate retrieval cues, and when these same retrieval cues were presented at test. These extraordinarily high levels of recall have been replicated in other contexts. For example, when participants were able to generate three cues at encoding, and then received these cues during an immediate recall test they recalled around 90% of up to 600 words. Performance levels declined slightly when only one self-generated cue was presented at test (to around 50–60%), but self-generated cues consistently resulted in high levels of performance. When other-generated cues were presented performance was particularly low (around 5% given one cue, rising to 17% when three cues were presented;

Mäntylä, 1986). This suggests that the benefit of self-generated cues lie with the inclusion of idiosyncratic details within the cues, resulting in a unique cue which overlaps with few targets. It is then unsurprising, in terms of the encoding-specificity principle of memory, that these cues were only beneficial when they were self-generated (Hunt and Smith, 1996).

The high levels of performance demonstrated by Mäntylä and Nilsson (1983) and Mäntylä (1986) did however decline considerably as the retention interval increased. This decline was suggested as being the result of a decrease in the compatibility of the encoding and retrieval context, stipulated as a requirement of effective recall by the encoding-specificity principle of memory (Mäntylä, 1986). If this is the case then it is possible that that retrieval is impaired because the meaning of a cue is interpreted differently at encoding than at recall, and so consistent use of cues could help to maintain levels of performance. Essentially, reducing *within participant* cue variability for the same target item should reduce the decline in performance. Mäntylä and Nilsson (1988) asked participants to focus in particular on distinctive properties of the target when generating a cue in an attempt to reduce the intrasubject variance (and so make it more likely that the exact same cue will be produced on more than one occasion). They showed that when cues are generated with distinctive features in mind, then the decline in performance over time is much smaller (in comparison to a group who generated their own cues according to personal experience as an appropriate description of the target word) than has been previously suggested (e.g., Mäntylä, 1986). This effect persists throughout a retention interval of up to 6 weeks. This suggests that asking learners to focus specifically on distinctive aspects of the to-be-recalled information during encoding results in self-generated cues which maximize distinctiveness in a way that is unaffected by changes in context (reduced levels of encoding-retrieval match), and in turn ensures that levels of performance are maintained over time (Mäntylä and Nilsson, 1988).

Self-generated cues have also been shown to be effective in recalling more complex stimuli. For example, recall of paragraphs of text has been showed to improve with use of self-generated cues. van Dam et al. (1987) asked participants to study 20 standalone paragraphs in a factual narrative. Recall of the contents of each paragraph was more complete when participants were able to first generate a list of keywords (from memory) that they felt represented the content of each paragraph (i.e., the generated keywords did not have to be present in the paragraph). Interestingly, this was only effective when keyword generation took place *before* the first full recall attempt. When an initial recall of the paragraph contents was attempted, and then the keywords were generated to supplement this attempt, self-generated cues had no impact on the amount recalled.

Furthermore, research has suggested that there is a potential benefit of self-generated cues for those experiencing the beginnings of cognitive decline. For example, use of self-generated cues has been shown to facilitate the recall of a word list in both young adults (aged 20–39) and older adults (aged 70–89). Learners generated cues that were either semantic or phonetic (rhyming) dependent upon the instructions given. A benefit of self-generated cues was shown regardless of the level of processing at which the cue was generated. However, the benefit was more pronounced for older adults, and in particular self-generated semantic cues greatly reduced age-related differences in performance (Sauzéon et al., 2013). The fact that self-generated cues may benefit older adults more than younger adults is particularly striking, and further distinguishes self-generated cues from self-referent cues. For example, while both younger and older adults have been shown to benefit from encoding items to be recalled with reference to the self, research has suggested that older adults benefit less from self-referent processing than younger adults. In particular, it has been suggested that the effectiveness of self-referent encoding varies dependent upon the availability of cognitive resources, and that older adults are more limited in their ability to use this technique flexibly (Gutchess et al., 2007).

In addition, training in the use of a mnemonic, whether this was an established mnemonic or a self-generated strategy, has been shown to improve four-digit number recall of older adults. Older adults were trained using a number-consonant mnemonic (whereby a series of number-consonant pairs are memorized, and a word-phrase generation technique used to memorize number strings) or asked to use a systematic approach during practice sessions to develop an effective strategy for recalling the target digit-strings. The self-generated strategy group were asked to monitor their encoding processes and to make a note of the strategy they adopted to memorize each four-digit number string. For example, in attempting to memorize 2468 participants might enter "my birth year (24), my wife's age (68)," "digit sequence beginning at 2 and adding 2," etc. If participants were unable to think of a specific strategy they might report "repeated the numbers," etc. In this way the participants retrieval strategies, and the reporting of these strategies, was not constrained in any way. Both trained groups outperformed a control (who received no training or practice time) at pre-test and post-test, both with and without cognitive support (cognitive support consisted of the generation of a word cue to prompt recall). Between the two training groups, the mnemonic group showed an improvement in performance from pre-test to post-test, and this improvement was magnified when post-test support was provided. In contrast, the self-generated strategy group showed a (non-significant) improvement from pre-test to post-test without support. This reached significance when post-test support was provided. The fact that both groups showed broadly similar levels of improvement from pre- to post-test is particularly striking when it is considered that the self-generated strategy group received slightly less training than the mnemonic strategy group (Derwinger et al., 2003). The gains in performance made by both the trained groups were also shown to persist after an 8-month delay (Derwinger et al., 2005). This gain persisted for the self-generated strategy group even when cognitive support was removed (the trained mnemonic group in contrast showed a decline in performance at this stage). These findings suggest that cognitive support is less necessary for the benefit of self-generated strategies to be maintained, in comparison to a more cognitively demanding mnemonic technique (Derwinger et al., 2005).

Although self-generated cues and self-generated mnemonic strategies have been used successfully by older adults, it is

important to note that this finding is not as clear cut as might first appear. For example, Mäntylä and Bäckman (1990, Experiment 2) demonstrated that when participants were asked to recall a target word in response to presentation of a cue word self-generated 3 weeks prior, younger adults outperformed older adults. Mäntylä and Bäckman argue that these results reflect an age-related increase in encoding variability. For example, when both younger and older adults were asked to generate properties for target words in two sessions up to 3 weeks apart (with the instruction in the second session to generate properties describing their current interpretation of the target word, rather than trying to recall the descriptions generated in the first session), older adults were less consistent in the properties generated. Older adults also tended to rely on more generic properties, rather than utilizing more distinctive idiosyncratic properties (Mäntylä and Bäckman, 1990, Experiment 1). They suggest that this increase in age-related encoding variability is likely to contribute to the decline in episodic recall performance. Despite this, the potential benefit of self-generated cues in facilitating recall of both younger and older adults is something which merits further research.

Context as a Retrieval Cue

Retrieval cues can also come from the context of an event. The contextual dependence of memory and the benefit that physical or mental reinstatement of encoding conditions at retrieval can have upon recall has long been established in laboratory research (see for example, Smith, 1979). The relationship between memory and context is a natural extension of the encoding-specificity principle of memory (Tulving and Thomson, 1973). In addition, the provision of contextual cues may enhance the completeness of recall through facilitating the spread of activation from accessible items to those not initially accessible (Hershkowitz et al., 2002).

One of the most established and frequently tested context reinstatement techniques is the Mental Reinstatement of Context. This is one of the cognitive mnemonic techniques incorporated into the Cognitive Interview (developed by Fisher et al., 1984). Mental Reinstatement of Context describes the process of guiding the individual to reconstruct an internal representation of the physical context of an event. This generally includes instructions to "reinstate in your mind the context surrounding the event" through considering the layout of the scene, the weather, the people and objects that were nearby, and so on. It is also considers the personal context of the event, through attempting to recall thoughts, feelings, and reactions to the event to-be-recalled (Geiselman et al., 1985). This technique is frequently used within laboratory studies on eyewitness memory. A recent meta-analysis suggested that 100% of the studies conducted using the CI and its variants over the preceding 25 years had incorporated MRC instructions (Memon et al., 2010). It is also noted as being a highly effective recall technique. For example, provision of physical cues from encoding and encouraging mental reinstatement of the context of the event has been suggested to increase the accuracy of identifications in an eyewitness context (Krafka and Penrod, 1985). This process has been shown to result in an increase in the level of detail (although not necessarily the amount of detail) provided in real-world accounts (e.g., Hershkowitz et al., 2002).

The Benefit of Self-Generated Cues Over Context Reinstatement

It has been suggested that the benefits of context-based cues become more apparent only when more effective cues are unavailable, suggesting that the benefit of context-based mnemonic approaches can be overshadowed if individuals are able to provide their own cues (Pansky et al., 2005). One potential means of reinstating context whilst also encouraging the use of an individual's own cues is the Sketch Mental Reinstatement of Context. Developed by Dando et al. (2009, 2011) this technique allows trained interviewers to guide individuals toward using their own contextual cues when recalling a complex event. When using this technique, the witness sketches details of the event to be recalled, describing these aloud as they do so. Use of the Sketch Mental Reinstatement of Context has been suggested as comparable to the standard Mental Reinstatement of Context procedure in terms of both accurate information elicited and overall accuracy. The additional benefit of the Sketch Mental Reinstatement of Context is that it introduces self-generated contextual cues which are likely to be more salient (and so more effective) than contextual cues provided by an interviewer (for example through the standard MRC procedure).

However, even where context reinstatement techniques can be combined with self-generated retrieval cues, there remains problems with the application of these techniques. Context reinstatement techniques such as Mental Reinstatement of Context can be both difficult and time-consuming to implement effectively. For example, trained interviewers report finding Mental Reinstatement of Context (and other Cognitive Interview techniques) cognitively demanding, requiring flexibility, and difficult to incorporate in real world settings (Kebbell et al., 1999; Brown et al., 2008). It should be noted here that the Sketch Mental Reinstatement of Context technique has been suggested to reduce some of these demands, but more research is needed before this can be stated conclusively.

In contrast, the limited work that has investigated the use of self-generated cues in an applied context suggests that they might be preferable to techniques which require greater levels of training. As Derwinger et al. (2005) suggest the ease of use and personal compatibility inherent in self-generated strategies may mean that they are relatively easily incorporated into everyday routine, thus providing practice effects over time. The self-generated cue research described thus far has some applied relevance, but still relies primarily upon fairly artificial stimuli and artificial means of self-generated cue production. The work outlined in the following section begins to take steps to move the use of self-generated cues into a more ecologically valid domain.

When faced with a complex event, particularly one rich in temporal details or involving multiple actors, accurate recall of information becomes a more cognitively demanding task. Interviewee-led cueing methods have begun to appear in an eyewitness domain, and these techniques show undoubtable promise. For example, Hope et al. (2013) demonstrated that use of the timeline technique facilitated retrieval in an eyewitness testimony context. When using this technique individuals are able to delineate a complex event into key stages by placing person description cards and action cards on a physical

cardboard timeline. This allows the interviewee to recall the individuals, actions, and sequences involved in a complex event in a witness-compatible manner (e.g., by beginning at the most salient point of the event). Use of this technique has been shown to facilitate the retrieval of more details than a free recall account alone, with no cost to accuracy. This benefit persists even after a 2-week delay. Furthermore, use of multiple mnemonics, including self-generated cues, during an interview about repeated events (in this case family gatherings) facilitated witness recall, even when the witness judged that they had recalled as much as they were able (and after repeated attempts to keep trying yielded no more information). Results showed an increase in recall of around 70% when using a combination of seven distinct mnemonics than when recalling unaided (Leins et al., 2014). Taken together these findings suggest that self-generated cues may be an intuitive means of facilitating recall in everyday settings.

Theoretical Underpinnings of Self-Generated Cue Mnemonics

The research outlined thus far suggests a clear benefit of the use of self-generated cues on retrieval. We now address the theory underlying this approach. There are three key principles of memory which contribute to explaining the effectiveness of self-generated cues: the spreading activation theory of memory, the encoding-specificity principle of memory, and cue distinctiveness. We outline each of these in turn in the sections that follow, and speculate on how these principles of memory relate to the success of self-generated cues in aiding retrieval.

Spreading Activation Theory of Memory

In attempting to recall information from episodic memory we have to access long-term memory, a relatively slow process in comparison to other human information processing systems (Anderson, 1983a). Spreading activation models view information in long-term memory as being represented by a network of associated concepts. The assumption is then that it is possible to recall a given item from memory by recalling other information associated with the target. This is made possible through the process of activation spreading through the network (Anderson, 1983a; Crestani, 1997).

Memory is generally viewed as a network of interlinked nodes (as in Collins and Loftus, 1975; Anderson, 1983b). Within these networks, units of memory are conceptualized as cognitive units, made up of a node and its associated elements (or key properties of the node). Cognitive units make up the essential units of encoding and retrieval. During encoding, a cognitive unit is formed via a copy in working memory, which is later transferred as a more permanent long-term memory trace (Anderson, 1983b). Associative networks are formed of generic nodes, representing concepts or categories and knowledge about the category member, and episodic nodes, representing specific instances of generic nodes, connected by associative links (Tuckey and Brewer, 2003). There has been some debate around whether cognitive units are limited or unconstrained in terms of the number of linked elements they are able to contain. Irrespective of this, it is likely that memory networks represent a complex structure of links between concepts and associated properties (see Collins and Loftus, 1975; Anderson, 1983b, for examples of opposing views on this issue).

Spreading activation models generally assume that when information is encoded in memory it is also incorporated into a semantic network. In other words, information can be considered as being organized around semantic similarities. If this is the case, then the extent to which any one concept primes activation of another is a function of the number of connections between the two concepts. In other words, as activation spreads between semantically related memories during a recall attempt, the recall of one item often primes the recall of other semantically related items and so on (for further discussion of this assumption and the underlying experimental data see, Collins and Loftus, 1975).

Further support for the assumption of semantic organization of memory networks is shown through the use of category clustering recall techniques. Paulo et al. (2016) examined whether recall of a complex eyewitness event could be improved by asking participants to recall the target event in terms of the person, object, action, and location details of the event. Their results suggest that this category clustering is an effective mnemonic technique. Paulo et al. (2016) suggest that according to Collins and Loftus (1975) spreading activation theory of semantic processing, a key benefit of recalling via semantic (or category) clusters is that this approach gradually allows activation within the network to reach a level which triggers other semantically related information which may not otherwise have been activated and recalled.

Spreading activation models of memory all generally view a memory search as the process of spreading activation from concept nodes along associative links throughout a semantic network until a threshold is reached (Collins and Loftus, 1975). The original spreading activation theory was proposed by Quillian (1962, 1967) who attempted to develop computer simulations of human memory search (see also developments by Collins and Loftus, 1975; Anderson, 1983b). It is generally accepted that a memory cue (sometimes termed a memory probe) triggers a memory search beginning at the node or nodes originally activated by the cue. The activation then spreads to all nodes connected to the initial node, and then to all nodes linked to these first tier activated nodes, and so on (Collins and Loftus, 1975). As activation spreads throughout the network information associated with the sources of activation becomes available (Anderson and Pirolli, 1984). This process is shown in **Figure 1** below. In this example, the cue triggers activation of the black node; this activation then spreads to the three dark gray nodes connected to the initial node (the first tier or spreading activation), and from there the activation continues down all pathways connected to the first tier activated nodes to reach the light gray second tier of activated nodes. Anderson (1983a) suggests that the transmission of activation is bidirectional; as shown in **Figure 1**, nodes can rebound activation back upon nodes which are already activated (e.g., the light gray node outlined in a dashed black line rebounds activation received back to the initially activated node). The level of activation reached by each node begins to decrease as soon as the information contained in the node drops from the focus of

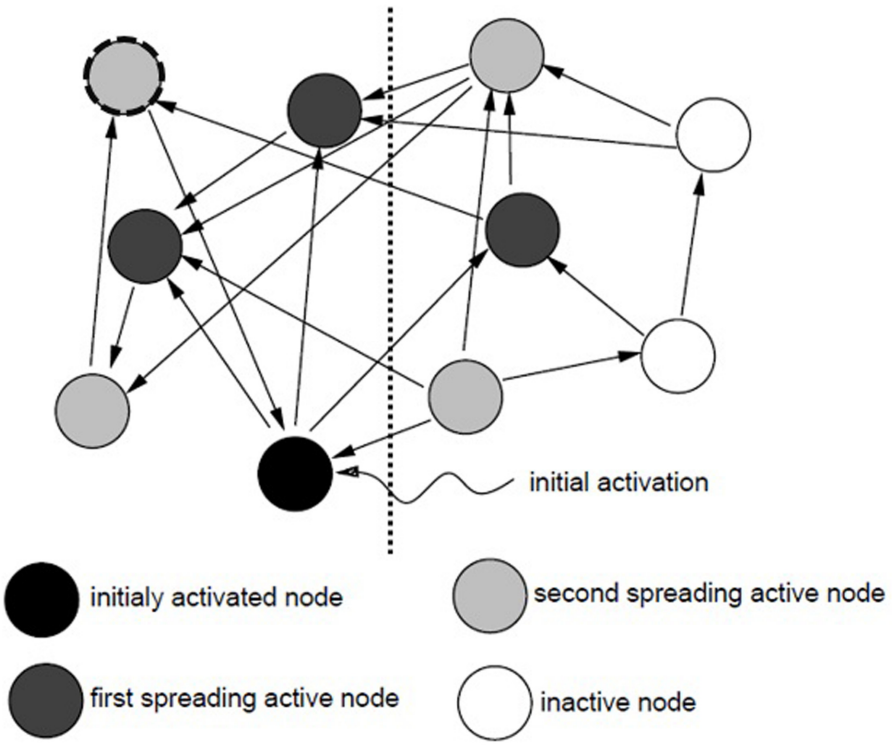

FIGURE 1 | The spread of activation through a memory network (adapted from Crestani, 1997).

attention (Anderson, 1983b) and continues to decrease with the passage of time (Collins and Loftus, 1975).

Figure 1 also depicts the fanning of activation down parallel paths. Activation begins at the initially activated node and continues out along multiple parallel paths. Where an active concept node has links to multiple other nodes (these links are referred to as the fan of the concept), the activation spreads in parallel among these pathways. For example, the level of activation initially received at the source node (in black) splits simultaneously down the three pathways leading to the dark gray first tier activated nodes. Anderson (1983a) argues that nodes have a finite capacity for activation, and so the more paths a node is connected to, the less activation it is able to send down any one path (as the level of activation transmitted out along the path is a function of the amount of activation received minus the total number of paths connected to the node), and so the slower the recall process is. In essence, this means that where the fan effect occurs the amount of activation available for any one pathway decreases, and the time taken to retrieve information increases. The more facts that are linked to a given concept, the longer it takes to recall any one fact associated with that concept (Anderson and Reder, 1999).

Targets are recognized (or recalled) when a threshold level of activation has been reached (Anderson, 1983a). The overall amount of activation a given node receives predicts the amount of time it will take to accurately recall the information contained within that node (Anderson, 1983b). The level of activation that a node receives can be considered as a product of the strength of their associations. Nodes which are more closely or strongly related to the source of activation receive more activation than those which are further removed. In other words, as activation spreads throughout the network, its strength decreases. As Collins and Loftus (1975, p. 411) state "activation is like a signal from a source that is attenuated as it travels outward." In this way, the level of activation of other nodes within the network varies in terms of their degree of association to the source nodes. The activation arriving from multiple sources at a single node will sum. As such, information contained within any given node is processed more quickly when multiple sources spread activation to the target node (Anderson and Pirolli, 1984). Ultimately the level of activation within a given area of the network predicts the speed and accuracy with which information within that area can be recalled (Anderson, 1983b). To illustrate, in **Figure 1** the information stored in nodes to the left of the vertical dotted line is more likely to be recalled quickly and accurately than the information stored in nodes on the right (all else being equal, the activation received by nodes on the left is greater than that received by those on the right). Individuals can also capitalize upon the gathering of activation within specific areas of a network by refocusing activation from the initial node to a more active subnode to enable faster a spread of activation (see Anderson, 1983b for discussion).

Within spreading activation models of memory there has been some debate around which factor ultimately predicts the time taken to recall a target item. It has previously been assumed that the time taken to recall an item is a function of the

amount of time it takes activation to spread throughout the network (Ratcliff and McKoon, 1981). In contrast, Anderson (1983b) suggests that processing time can be explained as the time taken for activation to reach a peak (an asymptotic level of activation). This argument is based primarily on the findings of priming studies (see Anderson, 1983b for discussion), and is a key feature distinguishing Anderson's (1983b) model of spreading activation from other spreading activation models. The strength of individual nodes and their associated links also contributes to understanding of how some nodes reach higher levels of activation sooner than others. One assumption of the fan effect described above is that as a node becomes active, each path from the concept node to its properties is equally activated. However, data suggests that this might not always be the case. As stated above, both Collins and Loftus (1975) and (Anderson, 1983a,b) argue that the strength of the relationship (and so the distance between) a node and the source of activation predicts how much activation that node is likely to receive. As a result, it can be assumed that not all concepts and links are of equal strength (Anderson, 1983a,b). For example, Anderson (1983a) suggests that activation is allocated among competing paths based upon their relative strength. He gives the example of slower response times for two-fan facts studied four times, when an alternative has been studied more frequently, and takes this as the basis for the argument that activation is allocated based upon the relative strength of each possible pathway (see Anderson, 1983a for further discussion).

Proponents of spreading activation theories of memory generally agree that individual nodes vary in strength. A number of explanations as to how this occurs have been put forward. For example, node strength may be predicted by frequency of exposure. When facts about concepts are studied and tested more frequently, the individual nodes containing these facts (and their associated memory traces) become stronger, resulting in faster, more accurate recall. This strengthening effect occurs even when practice sessions occur in quick succession (for further discussion of practice effects see Anderson, 1983b; Tuckey and Brewer, 2003). Anderson (1983b) argues that once formed traces are not lost, but their strength does decrease gradually over time. In this way, Schacter (1999) suggests that spreading activation theories of memory can go some way toward explaining what he refers to as 'the sin of transience,' or gradual forgetting over time. When not bolstered by the strengthening effects that retrieval attempts can have, the associated memory traces begin to gradually weaken, and so to become less accessible over time. On the other hand, Tuckey and Brewer (2003) argue that the strength of associative links is also in part determined by how schema-consistent or inconsistent the items encoded are. For example, aspects of an event that are schema consistent are more likely to be rehearsed and so are more likely to be strongly encoding than those that are schema inconsistent. This is supported by their finding that schema inconsistent information shows greater levels of decay than schema consistent information. Regardless of the reason for their strength, stronger nodes are also able to transmit and receive greater levels of activation, and thus allow more activation to gather in areas of the network containing stronger nodes (Anderson, 1983b). The implication of this for retrieval processes is that the most salient cues are the ones which are most likely to enable fast, accurate retrieval of information.

Spreading activation theory and self-generated cues

Spreading activation theories underpin the effectiveness of retrieval cues based upon a number of key properties. As has been previously discussed, a high-quality retrieval cue generally has a strong association with the target memory, whilst also being able to easily incorporate new related information as necessary. These associations should also be bidirectional, whereby the cue recalls the target information, and the target information recalls the cue (Bellezza and Hoyt, 1992). When the effectiveness of a retrieval cue is described in terms of these properties, then it is clear that the spreading activation theory of memory is of critical importance in explaining successful recall. We suggest that self-generated cues offer the opportunity to maximize the benefit of these properties, and briefly outline how this may be the case below.

It is well-established that recall of one item can prompt further recall of semantically related items (Collins and Loftus, 1975). This occurs through the spread of activation through the associative links of the memory network. When the associative links are stronger, then information is recalled faster and more accurately. For example, when recall of a target word is cued by a word more closely associated with the target then the target is recalled faster, than when the target is cued by a word situated further away in the network (Ratcliff and McKoon, 1981). The benefit of strongly associated semantic clusters has also been demonstrated through category clustering recall. In line with the spreading activation theory, if memory is indeed organized according to semantic similarity, then focusing on and recalling information by semantic cluster is likely to produce enough activation to cue associated items. When individuals are asked to make a second or third recall attempt using category clustering (i.e., attempting to recall further information one semantic category at a time, for example person details, action details, and so on), then recall improves without a cost to accuracy, compared to recall attempts using other established mnemonic techniques such as the change order mnemonic (Paulo et al., 2016). The prime benefit of this approach is that it is relatively intuitive; individuals often spontaneously encode, organize, and recall information in semantic clusters (see Paulo et al., 2016 for further discussion).

Although further research is needed to test these assumptions, we propose that self-generated cues represent a prime opportunity to capitalize upon the semantic organization of memory. In allowing individuals to define their own semantic clusters, we give individuals the opportunity to focus their recall attempts on clusters most compatible with their own encoding of the target material. Self-generated cues also present the opportunity to cue recall using strong associative links. In allowing individuals to generate their own cues we maximize the opportunity to trigger activation from the point most critical to the recall of the target material. For example, by allowing individuals to select their own cues we can capitalize upon the strongest associative links, and minimize the distance in the network between cue and target.

The importance of the bidirectionality of associative links becomes apparent when we consider 'recognition failure'; where associative links do not have bidirectionality, then it is possible that a target memory will not be selected in a recognition context without the associated learned cue or context. Interestingly, this means that individuals may be able to recall details of the target memory given an associated concept that they are not able to provide in a recognition task (Tulving and Thomson, 1973; Wiseman and Tulving, 1976). Similarly, where a cue and target evoke each other with high frequency (e.g., tree cues oak, and vice versa) then the target is recalled more quickly when a cue is provided, than when a cue and target evoke each other with low frequency (e.g., cloth cueing orlon, or vice versa). Importantly, where the cue and target evoke each other with equal frequency then either word can be used to prompt recall of the other (i.e., it doesn't matter which is presented as the cue, and which as the target). In contrast, where there is an imbalance in this strength of association, and so the cue evokes the target at a higher frequency than the inverse (as with seafood-shrimp; seafood evokes the word shrimp at a higher frequency than shrimp does seafood), then reaction time varies significantly dependent upon which word was used to cue which (Collins and Loftus, 1975). This demonstrates the importance of bidirectional relationships. We suggest that if self-generated cues do indeed offer the opportunity to minimize the distance between cue and target within the semantic network, then it is also plausible that they can contribute to maximizing the bidirectionality of associative links.

Encoding-Specificity Principle of Memory

Initially developed by Tulving and colleagues, the encoding-specificity principle of memory (or encoding-retrieval specificity) refers to the idea that retrieval cues are effective only to the extent that information within the memory cue is also contained within the target memory trace created at the time of encoding. As Tulving and Thomson (1973, p. 353) note "what is stored is determined by what is perceived and how it is encoded, and what is stored determines what retrieval cues are effective in providing access to what is stored." Put another way, the encoding-specificity principle of memory takes as its core the idea that it is only possible to retrieve what has been stored in memory, and that the way this information has been encoded and stored governs the ways in which this information can be retrieved (Tulving and Thomson, 1973).

Tulving and Thomson (1973) agreed with the principles of memory outlined in spreading activation theories that: (a) information within memory is stored as a memory trace; (b) a memory trace is a collection of elements, features, or attributes of the encoded information; and (c) that an encoding phase is situated between the perception of an event, and the creation of a memory trace. However, they viewed retrieval as a selective process, relying on a complex interaction between encoded information and features of the retrieval environment (Tulving and Thomson, 1973). Tulving and Thomson (1973) argue that it is well-established that identical information encoded under different conditions can lead to differences in recall and recognition performance. Likewise, the information present at retrieval can greatly influence the recall and recognition of items stored under identical encoding conditions. These findings, as well as more general forgetting, can be explained through encoding-specificity in terms of the accessibility of information in memory; information may not be lost, so much as inaccessible given the cues available at the time of the recall attempt (Brown and Craik, 2000). Together, these ideas suggest that different cues might make different memory traces more accessible than others, which in turn raises the question of what constitutes an effective retrieval cue.

Tulving and Thomson (1973) argue that the spreading activation explanation of differences in recall performance as being caused by differing strengths of memory traces is of little practical value. Tulving and colleagues also suggest that the benefit of a strong cue-target association is likely to be lost if the cue is not also encoded alongside the target information (for further discussion see Tulving and Osler, 1968; Thomson and Tulving, 1970; Tulving and Thomson, 1973). If information is not salient at the time of encoding, then it will not act as an effective memory cue for the target, regardless of how central the cue might be to the target in general terms (Brown and Craik, 2000). In essence, this means that the match between features of recall and features of encoding is more important for a successful retrieval attempt than the strength of the association between the cue and the target information (Roediger and Guynn, 1996; Pansky et al., 2005).

A number of studies have demonstrated support for this concept. For example, across a series of three studies, Thomson and Tulving (1970) demonstrated that when weakly associated cues were encoded alongside target information, then strongly associated cues provided at recall (but not at encoding) did not facilitate retrieval of the target information. In addition, Higham (2002) found strongly associated retrieval cues not presented at encoding produced less correctly recalled information and more incorrect recall than weakly associated cues which had been previously presented at study. Furthermore, Rosenbluth-Mor (2001 cited in Pansky et al., 2005) found that weakly associated cues presented at both encoding and retrieval facilitated recall in comparison to a no cue control, whereas presenting a new (not seen at encoding) weakly associated cue at retrieval impaired performance in comparison to a no cue control. Taken together, these findings demonstrate that mismatch between encoding and retrieval cues impairs recall, rather than the more conventional view that increasing the match improves recall (Pansky et al., 2005). It is, however, important to note that this view is not universally shared by researchers. For example, research has shown that an encoding-retrieval mismatch has a more detrimental effect on those with high working memory capacity than those of low working memory capacity. It has been suggested that this effect is seen because individuals with high working memory capacity are more likely to encode information strategically, and to utilize these strategies at recall, and so experience a decline in performance when their planned strategies are disrupted (Unsworth et al., 2011). In addition, some researchers have found means of improving recall performance using strongly associated cues not presented at the time of encoding (see Higham, 2002, for discussion of this).

It is not the case that the encoding-specificity principle ignores the role that semantic relationships between cues and items to be recalled can play. Rather, this is seen as a part of the cognitive encoding environment. For example, when encoding a wordlist for later recall we can assume that information is encoded about the appearance of a given word in the present context. This might or might not include encoding information about the semantic relationships between wordlist items: if so then another item on the wordlist might constitute an effective retrieval cue, if not then this will not be the case (see Tulving and Thomson, 1973 for empirical support for these claims). In addition, where target words are encoded alongside cue words, there is often an assumption that these cues will reappear at test, and as such the cue word forms part of the context in which the target is encoded. This means that the target memory trace cannot always be readily accessed in a recognition context, where the memory cue provided consists solely of the target word itself without the associated encoding context. This is termed 'recognition failure' (see Wiseman and Tulving, 1976 for further discussion of recognition failure).

It should be noted that the encoding-specificity principle and the spreading activation theory are not necessarily mutually exclusive. Anderson (1983b) argues that the findings of encoding-specificity studies (such as Tulving and Thomson, 1973) can still be incorporated into a spreading activation framework. In particular, when a cue has multiple possible interpretations (e.g., the word 'jam' might be interpreted differently dependent upon whether it is presented alongside the associated word 'raspberry' or 'traffic'), then the encoding context determines which interpretation is encoded (potentially alongside other cues from the encoding context itself). At retrieval, context can then be used to determine the appropriate interpretation to activate, and the activation spreads from this point out into the network. The probability of recall or recognition is therefore higher when the same interpretation is selected at both encoding and retrieval, thus allowing activation to spread directly from the node directly linked to the memory trace and reducing levels of activation sent down pathways linked to alternative interpretations.

Encoding-specificity and self-generated cues

As previously noted, the encoding-specificity principle of memory and spreading activation theory are not mutually exclusive. Context can be used to activate appropriate concepts within memory (Anderson, 1983b), and facilitate the spread of activation through a memory network (Hershkowitz et al., 2002). Research around the generation of cues for the self versus another individual suggests that self-generated cues contain more idiosyncratic episodic details than cues generated by, or for use by, others. The latter tend to contain more generic, semantic details (Mäntylä, 1986; Mäntylä and Nilsson, 1988). Interestingly, cues generated by older adults to cue their own memory also tend to show this same generic focus (Mäntylä and Bäckman, 1990). In addition, when learners recall an incorrect target in response to a self-generated cue this seems to be driven by a strong associative relationship between the cue and the incorrect response (Tullis, 2013). Taken together, these findings suggest that spreading activation can be considered as a 'back-up' route in cue generation, seemingly forming a default option when cognitive resources are low, or when recall via a more efficient means (such as encoding-specificity or cue distinctiveness) has failed. In this sense, spreading activation theory can essentially be viewed as the foundation upon which effective retrieval cues, whether generated by the self or another, can be built, with encoding-specificity and cue distinctiveness providing an additional benefit beyond this default route.

The encoding-specificity principle of memory suggests that good quality retrieval cues have a high level of overlap between encoding and retrieval. This allows cues generated at encoding to be reproduced at retrieval reliably and consistently. These qualities, combined with the benefit of semantic clustering, make for highly effective retrieval techniques. For example, while the category clustering recall technique previously outlined allows recall to be cued using strongly associated semantic clusters, this technique also provides the additional benefit of framing recall in an encoding compatible manner. The same benefit is provided by self-generated cues; indeed, we would suggest that this benefit is magnified in the case of self-generated cues. According to the principle of encoding-retrieval specificity, effective cueing relies on a knowledge of the most salient aspects of information to be recalled. If this is the case then it follows logically that the best cues are generated by the self to guide recall, rather than by an other.

Cue Distinctiveness

Overall, the idea that the same material may be encoded differently in a different cognitive context, resulting in different routes through which to access the information, lies at the heart of the encoding-specificity principle of memory. Yet, Tulving and Thomson (1973) also highlight the influence of other, somewhat indefinable factors. They demonstrate that an additional factor is likely to operate alongside the properties of an encoded item, and that this unknown factor further impacts upon the chance of successful retrieval. As Nairne (2002) states, even when we ensure a *nominal* match between encoding and retrieval (e.g., through use of identical cues), this does not guarantee a *functional* match between the cue and the memory trace for the target item. Therefore, despite the widely accepted beliefs that once encoding has been completed it is the match between encoding and retrieval conditions that is the primary predictor of memory performance, data from memory studies (see Nairne, 2002) suggest that there must be other factors also at play. One candidate which may help to explain the differences in recall performance not captured by encoding-specificity, is cue distinctiveness[1].

Nairne (2002, p. 390) considers the process of remembering to be "an active process of discrimination" during which we use retrieval cues to guide us toward viable retrieval candidates.

[1]It should be noted that some researchers distinguish between the terms 'unique' and 'distinctive' (see Mäntylä and Nilsson, 1983 for discussion of this). While we agree with Mäntylä and Nilsson (1983) that a careful conceptual analysis of these terms is needed, this is beyond the scope of this paper. Therefore, throughout this manuscript we use the terms unique and distinctive interchangeably to describe a retrieval cue which recalls one particular memory at the exclusion of others, and as such can be considered to have diagnostic value.

He argues that although the encoding-specificity principle of memory is of some practical value, its theoretical relevance is limited. The rationale behind this claim is that the relationship between encoding and retrieval is correlational rather than causal. Instead Nairne (2002) argues that cue distinctiveness has a stronger influence on retrieval. Increasing the overlap between encoding and retrieval benefits recall through increasing the probability that distinctive features unique to the target will be utilized. He is not alone in this belief; it has been suggested that a key property of an effective retrieval cue is discriminability (Bellezza and Hoyt, 1992). Retrieval cues which are distinct from each other are more likely to prompt the recall of target information, and more likely to result in the recall of verbatim, rather than gist-based information (Anderson, 1983a; Anderson and Reder, 1999; Tuckey and Brewer, 2003). Cue distinctiveness is based upon similar principles.

Cue distinctiveness (or an absence of cue overload) refers to whether a cue is uniquely associated with a target memory. If a cue is linked to multiple memory traces (and so is 'overloaded'), then it becomes more difficult for that cue to activate the current target trace. This clearly will reduce the effectiveness of the cue in facilitating recall of the target information (Watkins and Watkins, 1975). In other words, a retrieval cue is useful only to the extent that it provides diagnostic information about the occurrence of a target item (Pansky et al., 2005). Cue distinctiveness is also entwined with the encoding process. Encoding information in ways that lead to a more precise memory trace, and in doing so separating one encoding experience from others contained within memory, facilitates recall. Distinctiveness is critical to this process (see Schmidt, 1991, for a review of the distinctiveness literature). When unique elements of an event (those which do not overlap with other events) are encoded, then these elements form a unique identifier for the target event, and so increase the likelihood that it can be discriminated from other events stored in memory. Where this distinct element is available at retrieval then the unique cue reinstates the original memory trace, provided that the context (of the distinctive element) is the same (Hunt and Smith, 1996).

Most researchers currently favor a two-factor account, which accepts that both encoding-retrieval match (encoding-specificity) and cue overload (or cue distinctiveness) combine to influence memory performance. However, Nairne (2002) argues that this approach impedes our ability to make practical predictions about memory performance. He gives an example of trying to recall a target event (E_1) from a series of events (E_2, E_3, and so on). If a participant is cued with an event feature unique to the target event (feature X_1), then this is likely to facilitate recall. However, if the feature used as a cue was present for events one, two, and three (E_1, E_2, E_3), then this cue (feature X_2) loses its diagnostic value, making it more difficult to discriminate the target event memory from other competing event memories. In this case, we can reasonably expect recall performance to decline. In short, memory performance is equal to the match between cue (X_1) and target (E_1) and declines as the number of items associated with cue (X_1) increases (Nairne, 2002). The critical aspect of the cue distinctiveness principle then is that cue-target match is *necessary* but not *sufficient* for accurate retrieval. Nairne (2002) and other advocates of the benefit of cue distinctiveness (e.g., Moscovitch and Craik, 1976) accept that retrieval cues are effective only if they match the memory trace of the target item (as in the encoding-specificity principle of memory), but suggest that diagnostic cues, which specify a single target item and exclude others, are key in predicting recall performance. In other words, if a retrieval cue is specific to the encoded event, then this is more likely to result in accurate recall than a more generic cue, and it is this diagnostic value that is key (Nairne, 2002; Goh and Lu, 2012).

Several studies have shown support for cue distinctiveness as a predictor of recall performance. For example, Moscovitch and Craik (1976, Experiments 2 and 3) manipulated the number of targets paired with a cue, and the similarity of this cue to others encoded. Participants encoded questions as cues alongside target words, and were then asked to recall the target words given the question cue. When cues were shared among a set of 10 targets, recall performance was lower than when each target was prompted by a distinct cue question. This is consistent with other research (e.g., Watkins and Watkins, 1975) and with well-documented effects such as the list length effect. However, Moscovitch and Craik's findings suggest that this effect was not universal across all stimuli (for example semantically encoded words, or items associated with a positive response to the cue question). In addition, they noted that recall of rhyme-encoded words showed little decline in response to the shared cue manipulation. They argue that this suggests that there are 'levels' of distinctiveness, and that surface level distinctiveness is of little importance in comparison to more meaningful forms of distinctiveness. In order to test this hypothesis, Goh and Lu (2012), manipulated both encoding-retrieval match and the degree of cue overload in a 2 (overload: high, low) × 2 (encoding-retrieval match: high, low) design. In each condition participants learned a list of word pairs and were later tested on these pairs in a cued recall task. In high encoding-retrieval match conditions participants were provided with the originally encoded cue word, alongside a second cue of the semantic category the target word belonged to. In low encoding-retrieval match conditions, only the originally encoded cue was provided. To manipulate cue overload, Goh and Lu (2012) ensured that the semantic category cue provided at test applied to several (in some cases all) of the words learned at encoding (high cue overload) or was unique to the target word (low cue overload). Goh and Lu's (2012) results suggest that high encoding-retrieval match does not necessarily facilitate recall, showing instead that high encoding-retrieval match improves performance only when cue overload is low (see Brandimonte and Passolunghi, 1994, for similar support of cue-distinctiveness in a prospective memory task).

Cue distinctiveness and self-generated cues

The principles of encoding-specificity and cue distinctiveness can be difficult to disentangle in terms of their contribution to the effectiveness of retrieval cues, and of self-generated cues in particular. It is clear, however, that cue distinctiveness adds to the effectiveness of cues with a high degree of encoding-retrieval overlap. For example, while the effectiveness of a cue which has a high level of overlap with the target, and contains idiosyncratic details about the encoding context can be understood in terms

of encoding-specificity, maintaining this advantage can be seen as a product of cue distinctiveness. In other words, the best retrieval cues are those which emphasize distinctive aspects of the target, resulting in increased consistency with which targets are produced in response to cues over a longer retention interval. Where this consistency is lost, we see increased encoding variability, and poorer memory performance over time (Watkins and Watkins, 1975; Mäntylä and Bäckman, 1990; Anderson and Reder, 1999). Asking learners to focus specifically on distinctive aspects of the to-be-recalled information during encoding results in self-generated cues which maximize distinctiveness in a way that is unaffected by changes in context (reduced levels of encoding-retrieval match), and in turn ensures that levels of performance are maintained over time (Mäntylä and Nilsson, 1988). In addition, the idiosyncratic nature of self-generated cues means that one individual's cues that are given to another individual at test would be unlikely to benefit their performance, even if the same information had been presented at encoding. This additional benefit of cue distinctiveness beyond merely cue-target overlap demonstrates the separate qualities that cue distinctiveness and encoding-specificity bring to effective self-generated cues. Cue distinctiveness is naturally maximized where cues are self-generated. Where individuals generate cues for use by others, they tend to revert back to more general, semantic, gist-based aspects of the target information, rather than the more specific idiosyncratic episodic details incorporated into self-generated cues. In this way, self-generated retrieval cues capitalize upon cue distinctiveness, and so maximize the effectiveness of the cue (Mäntylä, 1986; Hunt and Smith, 1996).

CONCLUSION

Successful recall of information from memory is often dependent upon the provision of retrieval cues. Retrieval cues might form part of the retrieval context, and can be self or other-generated (Pansky et al., 2005). In line with the spreading activation theory of memory, and the principles of encoding-specificity, and cue distinctiveness, effective retrieval cues are often strongly associated with the target item, have a strong cue-target overlap, and differentiate between different items stored within memory (Bellezza and Hoyt, 1992; Tullis and Benjamin, 2015a). Based upon the literature discussed, we argue that if self-generated cues are taken to be cues containing details salient to the individual, and actively generated by the individual themselves, which serve to facilitate more complete retrieval of a target memory, and as such represent the critical properties of the target memory, then it follows logically that self-generated retrieval cues represent our best opportunity to capitalize upon these three principles of memory. In particular, it is in relation to the principle of cue distinctiveness that self-generated cues offer an advantage over other mnemonic techniques (e.g., Mental Reinstatement of Context). While other-generated cues rely heavily upon more general, semantic, gist-based aspects of the target information, self-generated cues are able to incorporate more specific idiosyncratic episodic details to maximize the diagnostic value of a cue (Nairne, 2002). This important when it is considered that the benefits of context-based cues become more apparent only when more effective cues are unavailable. In other words, the benefit of context-based mnemonic approaches can be overshadowed if individuals are able to provide their own cues (Pansky et al., 2005).

Overall, the literature discussed suggests that self-generated cues represent an effective and viable mnemonic technique which can aid recall in a variety of settings. The high level of compatibility of self-generated cues with individual requirements and abilities means they do not require complex training or regular practice to be used effectively. As a result, we suggest that self-generated cues represent a promising development in episodic memory domains. Throughout the preceding discussion we have speculated on the effectiveness of self-generated cues, however, further research is needed to establish the extent of the contribution self-generated cues are able to make to the field. In particular, future research should seek to replicate existing findings on the benefit of self-generated cues, especially in comparison to other mnemonic techniques such as Mental Reinstatement of Context, or category clustering techniques. Future research is also needed to extend current knowledge of the most effective means of self-generating retrieval cues. For example, through establishing the qualities of an effective cue generation technique, and by contrasting existing methods of cue generation. Future research should also seek to establish the boundary conditions of effective self-generated cues. For instance, under what conditions are self-generated cues most effective, or what impact does varying the delay between encoding, cue generation, and recall have upon retrieval. It may also be of interest to investigate whether use of self-generated cues improve item memory, but reduce memory for context as has been shown with the generation effect (Mulligan, 2004; Mulligan et al., 2006). It is also important to establish the potential implications of use of self-generated cues in a variety of settings, for example in eyewitness testimony contexts, educational settings, and during collaborative learning and recall. Throughout this article we have also speculated on how spreading activation theories, the encoding-specificity principle of memory, and cue distinctiveness each contribute to the effectiveness of self-generated cues. While we acknowledge that these principles are often strongly intertwined, we believe that it would be beneficial for future research to address which of the mechanisms outlined contributes most strongly to the success of self-generated cue techniques.

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RW and FG devised the concept of the manuscript. RW drafted the work, and FG critically revised it. The final manuscript was approved by RW and FG.

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The Importance of Memory Specificity and Memory Coherence for the Self: Linking Two Characteristics of Autobiographical Memory

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Autobiographical memory forms a network of memories about personal experiences that defines and supports well-being and effective functioning of the self in various ways. During the last three decades, there have been two characteristics of autobiographical memory that have received special interest regarding their role in psychological well-being and psychopathology, namely memory specificity and memory coherence. Memory specificity refers to the extent to which retrieved autobiographical memories are specific (i.e., memories about a particular experience that happened on a particular day). Difficulty retrieving specific memories interferes with effective functioning of the self and is related to depression and post-traumatic stress disorder. Memory coherence refers to the narrative expression of the overall structure of autobiographical memories. It has likewise been related to psychological well-being and the occurrence of psychopathology. Research on memory specificity and memory coherence has developed as two largely independent research domains, even though they show much overlap. This raises some important theoretical questions. How do these two characteristics of autobiographical memory relate to each other, both theoretically and empirically? Additionally, how can the integration of these two facilitate our understanding of the importance of autobiographical memory for the self? In this article, we give a critical overview of memory specificity and memory coherence and their relation to the self. We link both features of autobiographical memory by describing some important similarities and by formulating hypotheses about how they might relate to each other. By situating both memory specificity and memory coherence within Conway and Pleydell-Pearce's Self-Memory System, we make a first attempt at a theoretical integration. Finally, we suggest some new and exciting research possibilities and explain how both research fields could benefit from integration in future research.

Keywords: autobiographical memory, memory specificity, memory coherence, self, Self-Memory System

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INTRODUCTION

Research has consistently demonstrated the intricate relationship between autobiographical memory and the self. Different features of autobiographical memories contribute to well-being and effective functioning of the self in various ways and some of these memory characteristics show some overlap. In this paper, we will focus on two features of autobiographical memories in particular: memory specificity and memory coherence. Research on these two features developed rather independently throughout the past three decades. This is, in our opinion, quite surprising since there seem to be similarities between both when comparing both literatures. Memory specificity and memory coherence show, for example, similar associations to well-being and psychopathology. They also show a quite similar developmental pathway throughout childhood and adolescence. These similarities make us wonder how they might relate to each other and how they both relate to the self. Integrating both research domains offers, in our opinion, new and exciting possibilities for future research. The goal of this paper is therefore to point out the exciting research possibilities that can come from integrating coherence and specificity and explain why and how both research fields could benefit from such integration in future research. First, we will focus on the relationship between autobiographical memory and the self, after which we will give a brief overview of the literature on memory specificity and memory coherence and how they relate to the self. We will also point to some remaining questions and limitations within both research fields. Then, we will link both features of autobiographical memory by describing some important similarities and by formulating hypotheses about how they might relate to each other. We will make a first attempt at a theoretical integration by positioning both memory specificity and memory coherence within Conway and Pleydell-Pearce's Self-Memory System. Finally, we will suggest some new and exciting research possibilities and we will describe in more detail how integrating both in future research could be beneficial for research on both memory specificity and memory coherence. Throughout this paper, we will refer to Conway and Pleydell-Pearce's Self-Memory System (Conway and Pleydell-Pearce, 2000) to illustrate the reciprocal and intricate relationship between autobiographical memory and the self. Although the Self-Memory System is just one of many available theoretical models, we have chosen this model because it offers an interesting theoretical framework to look at how memory specificity and memory coherence could potentially be integrated.

AUTOBIOGRAPHICAL MEMORY AND THE SELF

Autobiographical memories are memories about personally experienced events that go beyond the mere factual description of the event to include personal beliefs, thoughts, and emotions (Bruner, 1990; Fivush, 2010). Together they form a network of memories called autobiographical memory, which contains personal information that make up a person's unique life story (Fivush et al., 2011). The structure of this integrative network is illustrated in Conway and Pleydell-Pearce's Self-Memory System (Conway and Pleydell-Pearce, 2000; Conway et al., 2004). An individual's personal life story consists of different layers of autobiographical memories that are represented in the autobiographical knowledge base and the episodic memory system: life story schema, lifetime periods, general events, and event-specific knowledge. These categories are ordered in a hierarchy going from general to specific personal information. Life story schema is a mental representation of major components of a person's life and represents the individual's understanding of how one's life story is constructed within the culture one lives in. Lifetime periods represent certain periods in a person's life with a clear beginning and ending that have distinctive thematic features (e.g., my time at the University of Leuven). General events are more specific than lifetime periods and are composed of clusters of repeated events or sequences of related events that share a certain theme (e.g., driving to class in the mornings). Accessing one memory of a general event triggers others that are comprised within the same or related clusters. Finally, event-specific knowledge refers to perceptual and sensory-rich information about single personal experiences (e.g., my thesis defense). Autobiographical memories are retrieved through the consecutive activation of these three categories, with more general information at the top layers triggering related information at the more specific levels (Conway and Pleydell-Pearce, 2000; Conway et al., 2004). Together, the personal information that is stored in these different hierarchical layers represents who we are, were, and can be in the future (Conway, 2005).

Autobiographical memory supports well-being and effective functioning of the self in different ways. Before we describe the role of autobiographical memory for the self in more detail, we will take a closer look at how the self can be conceptualized. In the Self-Memory System of Conway and Pleydell-Pearce, the self is represented by three separate constructs that interact with each other: the working self, the conceptual self and the long-term self (see Conway and Pleydell-Pearce, 2000; Conway et al., 2004). The working self consists of a hierarchy of current personal goals that are thought to guide cognitions, emotions, and behavior toward achieving these goals. Personal experiences are organized and evaluated in function of their correspondence to current goals. The result of this evaluation determines which experiences will be more likely to be encoded and later recalled by favoring personal events that are in accordance to one's goals. The long-term self contains more permanent information about the self that is required for the working self to organize and evaluate personal experiences. One aspect of the long-term self is the conceptual self, which consists of attitudes, values, beliefs, relational schemas etc. Besides the conceptual self, the long-term self also includes the autobiographical knowledge base, which we discussed earlier. The working self, conceptual self, and long-term self interact and by doing so, influence the formation of autobiographical memories.

The previous seems to indicate that autobiographical memory and the self share an intricate and reciprocal relationship. The self mediates the formation of autobiographical memories and

controls their accessibility. Conversely, autobiographical memory serves the self in many different ways (see Bluck and Alea, 2002; Fivush, 2011; or Pillemer, 1992 for a more detailed overview). First of all, autobiographical memories provide a sense of continuity through time for the individual; the idea that one is the same person now as in the past and will be in the future. Even if one changes, these changes are explained and understood through experiences of growth that lead to new perspectives on self. Second, autobiographical memory facilitates the creation and maintenance of a social network through reminiscing with others. Third, memories about past personal experiences guide our current and future behavior. Fourth and final, by constructing memories about negative or stressful experiences and integrating these memories within a broader framework, autobiographical memory facilitates the process of coping with and resolving negative emotions (Fivush, 2011). These self-serving functions of autobiographical memory all contribute to well-being (Fivush, 2011).

Single autobiographical memories consist of different features, like the amount of detail they entail, their emotional intensity, structural characteristics, etc. Research on how specific characteristics of personal memories contribute to well-being enhances our understanding of how autobiographical memory relates to the self. In this paper, we take a closer look at two particular features of autobiographical memories and how they both relate to the self: memory specificity and memory coherence.

MEMORY SPECIFICITY

During the last three decades, one particular characteristic of autobiographical memory, namely memory specificity, has been an important topic of research. Memory specificity is usually operationalized as the ability to retrieve specific personal memories following emotional cue words. For a personal memory to be considered specific, it has to consist of a particular event that happened at a particular time and place and did not last longer than 1 day (Williams and Broadbent, 1986). The whole memory specificity literature can be brought back to a rather coincidental observation by Williams and Broadbent (1986). They found that, compared to a healthy control group, depressed and suicidal individuals showed difficulty retrieving specific personal memories following emotional cue words (a paradigm that is now commonly referred to as the Autobiographical Memory Test or AMT). Instead of retrieving specific memories as instructed, they responded more frequently with overgeneral memories such as categorical memories (i.e., the memory refers to a class of generic events) or extended memories (i.e., the described event lasted longer than 1 day) (Williams and Broadbent, 1986). This phenomenon is referred to as Overgeneral Autobiographical Memory or OGM. When asked to recall a specific memory following the cue-word 'happy,' someone who has a tendency to recall overgeneral memories would say for instance 'Whenever I'm on vacation' instead of giving a more specific answer like 'I felt happy last Saturday night when I went to the movies with my best friend.'

As we mentioned earlier, autobiographical memory serves the self in four different ways; it helps us guide future behavior, form and maintain a social network, create a continuous sense of self and cope with negative emotions and experiences (Pillemer, 1992; Bluck and Alea, 2002; Fivush et al., 2003; Fivush, 2011). These four functions all have been found to relate to psychological and physical well-being (Fivush, 2011). To explain the importance of the specificity of autobiographical memories for the self, we consecutively describe the way memory specificity is involved in these four functions.

Self-Guidance

Memory specificity supports effective functioning of the self by guiding current and future behavior. For instance, when faced with a problem, being able to recall a specific past event facilitates problem solving since knowledge about past solutions can be transferred to the current situation. In other words, being able to recall a specific past experience that is similar to the current situation and the details about how the past situation was dealt with enhances problem solving of the current situation (Evans et al., 1992; Goddard et al., 1996, 1997; Scott et al., 2000; Raes et al., 2005). Difficulty recalling specific memories therefore hinders problem solving. Additionally, difficulty remembering specific past experiences also relates to difficulty picturing specific future events and setting goals for the future (Belcher and Kangas, 2014). Not being able to imagine specific future happenings has been found to evoke feelings of hopelessness (Evans et al., 1992; Williams et al., 1996).

Self-in-Relation

Sharing autobiographical memories with others facilitates the formation and maintenance of a social network. It is assumed that people develop close and intimate relationships with others by sharing specific personal memories (Alea and Bluck, 2003). In order to really get to know someone, sharing specific personal memories is important, since these memories reveal the person's unique life story (e.g., unique adventures or obstacles they encountered throughout their life) (Habermas and Bluck, 2000). By doing this, the individual differentiates oneself from others (Beike et al., 2016). Research has indeed shown that sharing specific personal memories increases intimacy and closeness. People report feeling more intimate to the conservation partner and experiencing a more positive mood after conversations in which specific memories were shared (e.g., Pasupathi and Carstensen, 2003; Alea and Bluck, 2007). This relationship between intimacy and sharing specific memories appears to be bidirectional, since feeling close to someone facilitates sharing specific personal memories. Feelings of intimacy and closeness create a safe context to disclose specific personal information, which in turn increases intimacy (Beike et al., 2016). However, a recent study by Beike et al. (2016) has shown that sharing specific personal memories does not increase intimacy and closeness more than disclosing general personal information does. So, the act of sharing personal information in itself appears to be more important for creating close relationships with others than the nature (specific versus general) of the information.

Self-Identity

Besides guiding future behavior and facilitating social interactions, memory specificity is also involved in creating a stable sense of self. Autobiographical memory represents someone's unique personal history that defines who one is across time. Recalling specific personal experiences plays an important role in creating a continuous sense of self (Bluck and Habermas, 2000), which is considered a crucial developmental task during adolescence (Erikson, 1968; McAdams, 1985). By interpreting, evaluating, and linking together different specific personal experiences that are believed to be significant to understand who one is, a sense of self evolves. This refers to the process of autobiographical reasoning, which facilitates identity development (Bluck and Habermas, 2000; Habermas and Bluck, 2000; Fivush et al., 2011). However, studies directly examining the influence of memory specificity on identity development are rather scarce. It is, nonetheless, reasonable to assume that difficulty recalling specific personal experiences would have an influence on one's sense of self. If someone is unable to recall specific memories that are unique to the person and differentiate oneself from others, it is plausible to assume that this would be associated with a less profound and stable sense of self. Some studies on autobiographical memory in patients with Alzheimer's disease and certain personality disorders seem to support this hypothesis. Alzheimer's disease is for example characterized by deficits in recalling personal memories (including specific memories), which leads to an impaired sense of self and identity (see El Haj et al., 2015). Additionally, there seems to be a negative association between identity confusion and memory specificity in patients with Borderline Personality Disorder (Van den Broeck, 2014), and patients with Dissociative Identity Disorder show signs of overgeneral autobiographical memory as well (Huntjens et al., 2014). Research specifically addressing the influence of overgeneral autobiographical memory on sense of self and identity development would be a valuable addition to these findings.

Self-Regulation

Being able to recall specific personal memories contributes to aspects of psychological well-being and effective functioning of the self, as demonstrated earlier. Additionally, research has shown that overgeneral autobiographical memory contributes to the development of psychological problems like depression and post-traumatic stress disorder (see Sumner et al., 2010 or Williams et al., 2007 for reviews). When individuals experience negative emotions or events, they have to regulate and resolve them in order to move on. If these self-regulatory processes are insufficient or maladaptive, the individual is at risk to develop psychological problems. Different emotion regulation strategies relate to the presence of overgeneral autobiographical memory and can explain the relationship between overgenerality and psychopathology, which we will discuss in more detail later on. First, we take a closer look at the association between overgeneral autobiographical memory and psychopathology.

Research has shown that patients who suffer from depression or PTSD have more difficulty recalling specific memories following emotional cues than healthy controls. More specifically, studies have shown that overgeneral autobiographical memory can predict the course and onset of depression over and above initial depressive symptoms (Sumner et al., 2010). This difficulty retrieving specific memories remains present whilst in remission. In other words, overgeneral memory appears to be a steady characteristic of depressed and formerly depressed individuals (see Williams et al., 2007 or Sumner et al., 2010 for a review). This tendency to recall general rather than specific memories has likewise been observed in individuals suffering from PTSD. Patients who suffer from PTSD show difficulty retrieving specific memories related to the trauma they experienced and over time this difficulty expands to unrelated memories as well (e.g., Kuyken and Brewin, 1995; Williams et al., 2007). Additionally, overgeneral autobiographical memory is able to predict PTSD diagnosis following a traumatic experience (Kleim and Ehlers, 2008).

It is commonly assumed that overgeneral memory is not a general characteristic of psychopathology, but that it is specific to affective disorders like depression and PTSD (Williams et al., 2007). Patients who suffer from generalized anxiety disorder, OCD, or specific phobias for example do not exhibit difficulty retrieving specific memories (Burke and Mathews, 1992; Wilhelm et al., 1997; Wessel et al., 2001; Wenzel et al., 2002, 2003). The same applies to eating disorders (e.g., Dalgleish et al., 2003) and personality disorders like borderline personality disorder (e.g., Van den Broeck et al., 2015). When overgeneral memory is observed in other psychological disorders, it can usually be explained by comorbid depressive symptomatology (Sumner et al., 2010; but see Ridout et al., 2015).

Different mechanisms can explain the development of overgeneral autobiographical memory. Williams and colleagues (Williams, 2006; Williams et al., 2007) developed a theoretical model (CaR-Fa-X model) that focuses on three underlying mechanisms that are thought to explain the development of overgeneral memory and how it relates to psychopathology; rumination, functional avoidance, and impaired executive functioning. When trying to recall a specific event, an individual will start his search at the most general level of autobiographical memory and carry on to the level of event-specific knowledge. Different mechanisms can interrupt this search, whether or not in interaction with each other, and lead to overgeneral memory. Ruminating, or continuously dwelling over one's sad or depressive feelings (Nolen-Hoeksema, 1991), can disrupt the search for specific memories. When searching for a specific memory, an individual with a negative self-concept could activate a general memory about him- or herself that triggers ruminative thinking about the memory and the personal value of it. While ruminating about this general memory, the individual will not continue the search for a specific memory. Repeated ruminating can result over time in the development of overgeneral autobiographical memory. Besides rumination, functional avoidance of the potentially negative and overwhelming emotions memories can evoke, also plays a role in the development of overgeneral memory. By avoiding to recall specific personal experiences, intentional or otherwise, one protects oneself from the associated emotions. By not

being confronted with the potential negative and painful emotions related to the memory, the avoidant behavior will be negatively reinforced, increasing the likelihood of avoiding specific memories in the future. The avoidant behavior can generalize to other memories and eventually lead to overgeneral memory. So, the functional avoidance mechanism could be seen as a means of affect regulation that could be beneficial in the short term, but maladaptive over time. Finally, the search from general lifetime periods to event-specific knowledge requires sufficient executive capacities. When asked to recall a specific memory, the individual has to be able to inhibit non-related autobiographical knowledge and hold the final result of the search in his or her working memory. Affective disorders like depression are often characterized by reduced executive functioning, which hinders the search.

The role these mechanisms play in the development of overgeneral autobiographical memory has been repeatedly studied over the past two decades. Although several studies support the claims and predictions of the CaR-Fa-X model, there are studies that fail to replicate these findings (see Valentino, 2011; Sumner, 2012; or Williams et al., 2007 for reviews).

Summary and Discussion

More than three decennia of research on memory specificity has demonstrated the important role memory specificity plays in psychopathology and the mechanisms that underlie this relationship. To recapitulate, individuals suffering from depression and PTSD have been found to experience difficulty recalling specific personal memories compared to healthy controls. It has been theorized that three different mechanisms are responsible for the development of overgeneral autobiographical memory; rumination, functional avoidance and impaired executive capacities. However, the field of memory specificity is not without limitations. Since the original observation by Williams and Broadbent (1986), different research labs started focusing on this surprising cognitive phenomenon by implementing the same emotional cueing design, which is now commonly referred to as the Autobiographical Memory Test (AMT). The memory specificity literature is therefore originally based upon one particular paradigm instead of theoretical considerations. This paradigm-driven nature of the memory specificity literature created methodological benefits by facilitating comparisons between studies from different research groups, but it also raised some important theoretical questions. The most important question, in our opinion, being what the AMT actually measures. How Williams and Broadbent originally operationalized specific memories in the instructions of the AMT as being "memories about a particular event that happened on a particular day and did not last longer than 1 day" does not correspond to the way specific memories are defined in the Self-Memory System (Conway and Pleydell-Pearce, 2000). Conway and Pleydell-Pearce define specific memories or 'event-specific knowledge' as detailed information about individual events that are particularly rich in perceptual and sensory information. No limitations about the duration of the event are imposed. More research seems necessary to examine what the AMT exactly measures and how this can best be fitted within the Self-Memory System of Conway and Pleydell-Pearce.

MEMORY COHERENCE

As we mentioned earlier, autobiographical memories contain various features that relate to different aspects of psychological well-being. In addition to their specificity, autobiographical memories also differ in their overall internal structure, i.e., memory coherence. In this paper, we depart from the multidimensional model developed by Reese et al. (2011). This model states that personal memories can be considered coherent if three conditions are met; (1) the memory contains information about when and where the events took place, (2) the events are described in a logical and chronological order and (3) the memory consists of a highpoint and resolution, along with affective and evaluative information (Reese et al., 2011). These criteria show that memory coherence goes beyond the mere structural aspects of autobiographical memories to include a qualification of the emotional representation of the events. These three conditions of memory coherence represent three separate subcomponents or dimensions; respectively contextual, chronological and thematic coherence (Reese et al., 2011). Memory coherence is usually assessed by asking individuals to narrate about a personal experience (either orally or on paper), after which these narratives are coded for their coherence by an independent rater using one of the available coding schemes. Similar to memory specificity, memory coherence is related to well-being and effective functioning of the self in various ways. In what follows, we describe how memory coherence is associated with the self, but first we illustrate the concept a bit more with an example.

> *"The 50th wedding anniversary of my grandparents about 6 months ago was definitely one of the happiest moments of my life. They threw a big party at their house. When we arrived, we all got a copy of their original wedding picture with the schedule of the evening on the back. They renewed their vows during a ceremony in the garden, which is next to a beautiful lake. It looked so beautiful and romantic! My grandpa gave a beautiful speech, which made me very emotional. Afterward, we all had dinner and my grandparents reminisced about their lives together. I've always been a firm believer of true love, but a couple of months before my grandparents' anniversary, I went through a tough break-up. This made me kind of pessimistic and doubtful. Seeing my grandparents in love after all those years made me realize that true love is out there and that I should continue looking for it."*

This narrative can be considered coherent across all three dimensions. By describing exactly when and where the event took place, the individual creates a contextual coherent account of the experience. By using words like 'first,' 'then' and 'afterward,' the sequence of the events becomes clear. When referring to a previous break-up and stating when this took place relative to the anniversary, the individual places the experience within a broader timeframe, making the narrative chronologically coherent. Finally, the narrative contains a subjective evaluation

of the experience and ends with a resolution, which contributes to the thematic coherence of the narrative.

Self-Guidance

Memory coherence facilitates emotional problem solving through the process of meaning making. Narratives reflect the way in which we make sense of the world and our experiences (Bruner, 1990; McAdams, 2001). By creating coherent narratives about past experiences we can create meaning. This is particularly important when faced with negative or stressful experiences. Creating coherent narratives about negative or stressful events makes it possible to express and regulate the related thoughts and emotions and, eventually, come to some sort of resolution or closure (Pennebaker, 1997; Fivush and Baker-Ward, 2005). This facilitates recovery and is beneficial for the effective functioning and well-being of the self. One could then utilize this previous experience for future occurrences However, creating coherent narratives about negative events can be challenging, since the related emotions can be overwhelming. As research on this topic has shown, narratives about negative events are generally more coherent than narratives about positive or neutral events (Fivush et al., 2008). This could be explained by the fact that negative or stressful experiences imply a problem that must be solved, which in turn may lead to more efforts to construct coherent narratives about the events in order to understand and create meaning out of them (Fivush et al., 2008). So, memory coherence facilitates emotional problem solving and should be considered an important part of the meaning making process, because it represents the extent to which people can explain and understand the events they have experienced (Fivush et al., 2008).

Self-Identity

As we mentioned earlier, creating a stable and continuous sense of self is key to a healthy identity development, which is an important developmental task during adolescence (Erikson, 1968; McAdams, 1985). Akin to memory specificity, memory coherence is involved in forming a personal identity. Through the process of autobiographical reasoning (i.e., interpreting, evaluating, and integrating different specific personal experiences that are believed to be significant to understand who one is), single narratives will be connected and integrated into an overall life story (Habermas and Bluck, 2000; Habermas and de Silveira, 2008). An individual's life story is a subjective representation of his or her personal and unique development (Habermas and de Silveira, 2008). It's important that this life story is coherent and not merely a bundle of single narratives, since forming a coherent overall life story leads to feelings of purpose and meaning in life, and results in the formation of a continuous sense of self or personal identity (Kernberg, 1984; Antonovsky, 1985; McAdams, 1985; Habermas and de Silveira, 2008).

Self-in-Relation

Besides facilitating emotional problem solving and creating a continuous sense of self, memory coherence is also involved in the social function of autobiographical memory. Narrating and reminiscing about personal experiences is a highly social activity that facilitates the creation and maintenance of a social network. Through reminiscing with others our lives become intertwined and we create a shared past (Fivush et al., 2006). The manner in which this reminiscing occurs, especially in the context of mother-child reminiscing, relates to the child's memory coherence and well-being (see Fivush et al., 2006 for a review). Mothers who are more coherent will be more elaborative when reminiscing with their children (Reese, 2008). This elaborative style of reminiscing about personal experiences, especially about negative or stressful experiences, is related to numerous adaptive outcomes (Fivush et al., 2006). Besides being more coherent when reminiscing with others later in life (e.g., Fivush and Fromhoff, 1988), children from elaborative mothers also tend to have a more coherent and consistent self-concept (Welch-Ross et al., 1999; Bird and Reese, 2006) and a more advanced emotional understanding (Laible, 2004). Additionally, these children possess more effective coping styles and show less internalizing and externalizing symptoms (Sales and Fivush, 2005; Fivush and Sales, 2006).

Self-Regulation

As we mentioned earlier, creating coherent narratives about personal experiences facilitates emotion regulation (Pennebaker, 1997; Fivush and Baker-Ward, 2005). This is particularly important when faced with negative or stressful experiences, since such experiences can make the individual vulnerable for developing various psychological problems (e.g., Cole et al., 1990; Kessler, 1997; Kendler et al., 2003). Keeping this in mind, it is not surprising that memory incoherence is related to the presence of psychopathology. Individuals who experience difficulty with narrating about personal experiences in a coherent manner show more internalizing as well as externalizing symptoms. More specifically, memory incoherence has been associated with depressive symptoms, behavioral problems, and PTSD (e.g., Foa et al., 1995; von Klitzing et al., 2000; von Klitzing et al., 2007; Müller et al., 2014; Stadelmann et al., 2015). Additionally, a pattern of incoherence has been observed in patients suffering from a borderline personality disorder, eating disorder, and obsessive-compulsive disorder (Rasmussen et al., 2017). Research also seems to suggest that memory coherence can act as a buffer against the impact of negative life experiences. As we discussed earlier, memory coherence enables creating meaning out of a negative or stressful event and regulating the related cognitions and emotions. As a result, it can be argued that memory coherence protects the individual from the damaging effects negative life experiences can have on well-being, making incoherent persons more vulnerable (Müller et al., 2014; Stadelmann et al., 2015). However, there are still some outstanding questions and inconsistencies regarding the association between memory coherence and psychopathology, which we will discuss in more detail below.

Research on the association between memory coherence and internalizing symptoms yielded inconsistent findings. Stadelmann (2006, Unpublished), for example, found no relation between a lack of memory coherence and the presence of internalizing symptoms. Two possible explanations can be formulated for these discrepancies. First, internalizing symptoms form a very heterogeneous group of symptoms which contains,

for example, both depressive and anxiety-related symptoms. It is possible that memory coherence is only related to one of these clusters of symptoms, which could explain the inconsistent findings (Stadelmann et al., 2015). A related explanation is the fact that the majority of studies used broadband screening instruments (i.e., instruments that look at a variety of psychological symptoms instead of focusing on a specific disorder) that do not differentiate between different types of internalizing symptoms, which may contribute to the inconsistent findings.

The association between memory coherence and PTSD has also been topic of intense debate over the past few years (see Brewin, 2016; Rubin et al., 2016a,b). Different theories postulate that PTSD is characterized by memory incoherence. This means that when PTSD patients are asked to recall the trauma they experienced, their memories of this event will be more fragmented and disorganized, as compared to non-related memories and healthy control groups. In accordance with this hypothesis, numerous studies report more incoherence (in the form of fragmentation and disorganization) in trauma memories of individuals with PTSD compared to healthy controls (e.g., Foa et al., 1995; Harvey and Bryant, 1999; Halligan et al., 2003; Jones et al., 2007; Kenardy et al., 2007; Jelinek et al., 2009, 2010; Salmond et al., 2011; or see Brewin, 2014 for a review). This incoherence also seems to predict the course of PTSD over and above initial symptoms (Engelhard et al., 2003; Halligan et al., 2003; Buck et al., 2007; Jones et al., 2007; Ehring et al., 2008). There are, however, numerous other studies that do not seem to support this hypothesis (e.g., Berntsen et al., 2003; Waters et al., 2013a,b; or see Rubin et al., 2016b for a review). Crucial differences between studies could possibly contribute to these inconsistent findings. Some studies focus for example on aspects of global coherence (i.e., life story coherence) whereas other studies look at local coherence of the trauma memory in particular. Variability in coherence ratings (self-report, observer, etc.) and small sample sizes could also add to these inconsistencies (Brewin, 2016).

Summary and Discussion

Research on memory coherence has clearly demonstrated its importance for well-being and effective functioning of the self throughout the years. To recapitulate, memory coherence is associated with emotional problem solving, creating a personal identity, and establishing and maintaining a social network. Additionally, memory coherence has been found to be negatively associated with depressive symptoms, behavioral problems, and PTSD. Yet, there are some unresolved theoretical questions and inconsistencies, as well as methodological issues within this research field. First of all, there remains a lack of clarity about which subcomponent of memory coherence (i.e., context, chronology, or theme) is more or most important for the self. Since Reese et al. (2011) proposed their multidimensional model of coherence, there have been very few studies directly comparing these dimensions in terms of their association with well-being and psychopathology (Waters et al., 2013a; Rubin et al., 2016b). Furthermore, since the memory coherence literature has taken more of a developmental approach throughout the years, several remaining questions regarding the dynamics between coherence and psychopathology remain present. There is, for example, little information about the nature and the direction of the relationship between memory coherence and psychopathology, since most studies are cross-sectional in nature. It remains therefore unclear whether memory incoherence is truly a predictor of psychopathology or a mere by-product of the disorder. Additionally, knowledge about possible underlying mechanisms that could explain the relationship between memory coherence and psychopathology is rather scarce. More insight into the dynamics between memory coherence and psychopathology holds great potential for clinical practice (e.g., screening at-risk individuals, training memory coherence as treatment for certain disorders), but more research is needed. Besides unresolved theoretical questions, there are some methodological issues. Memory coherence has been operationalized in various ways throughout the years. Additionally, different research fields that study memory coherence, have used different coding schemes to assess coherence within personal narratives. This lack of clarity about the definition and assessment of memory coherence makes it challenging to directly compare studies across research fields. Unity and agreement in this regard could enhance our understanding of memory coherence by making it possible to directly compare studies and by enabling studies to build directly on each other.

TOWARD AN INTEGRATION

Memory specificity and memory coherence are both features of autobiographical memories that, as we portrayed earlier, relate to aspects of well-being and effective functioning of the self. Research on these two features developed throughout the past few decades as two largely independent research domains, with a more cognitive and psychopathological approach to the study of memory specificity and a more developmental approach to memory coherence. This separate development is unfortunate given the fact that memory specificity and memory coherence show a great number of similarities. These similarities made us wonder how these two features of autobiographical memory relate to each other. However, to the best of our knowledge, there have been no studies examining the relationship between these two features of autobiographical memory. Insights regarding this association are important from a theoretical and a clinical point of view. Evidence for an association between memory specificity and memory coherence would for example allow for a more extensive empirical and theoretical integration of these two domains in the future. Knowledge from 30 years of research on memory specificity could offer insights in the study of memory coherence (e.g., the work on the dynamics between autobiography and psychopathology, the work on training autobiographical memory specificity as a treatment protocol for depression). Conversely, the work on memory coherence, which has a strong developmental background, would provide a broader framework in which the work on memory specificity could potentially be fitted. Both domains have their own strengths and weaknesses, and both could potentially benefit from integration

by taking advantage of the other's strengths. In this section, we will link memory specificity and memory coherence by discussing some important similarities between the two and by formulating hypotheses about how they might relate to each other. We will make a first attempt at a theoretical integration of memory specificity and memory coherence by situating them in the Self-Memory System of Conway and Pleydell-Pearce. We will conclude this article by suggesting some new and exciting research possibilities and by explaining how both research fields could benefit from integration in future research.

Similarities between Memory Specificity and Memory Coherence

There seems to be quite some overlap between the way memory specificity and memory coherence are operationalized, especially between specificity and contextual coherence. One of the criteria to categorize a memory as specific according to the AMT, is that the memory has to consist of one particular event that happened at a particular time and place (Williams and Broadbent, 1986). This notion of time and place forms the basis of contextual coherence (see Reese et al., 2011). We would therefore expect that memory specificity and contextual coherence would be positively related.

Memory specificity and memory coherence also show a quite similar developmental pathway throughout childhood and adolescence. Young children are generally less specific and coherent than older children, although they are capable of creating specific and coherent stories when parents guide them by asking specific questions (O'Carroll et al., 2006; Reese et al., 2011). Specificity and coherence both increase with age due to the development of a similar skillset that supports specificity and coherence, such as overall verbal abilities, notion of time and place, perspective taking, memory storage capacity, and so on (Howe and Courage, 1997; O'Carroll et al., 2006; Reese et al., 2011). Memory specificity, as well as chronological and contextual coherence, are largely developed by middle childhood (Gathercole, 1998; O'Carroll et al., 2006; Reese et al., 2011). Thematic coherence requires more sophisticated abilities like self-knowledge and insight, and develops further throughout adolescence (Reese et al., 2011).

As we mentioned earlier, autobiographical memory serves the self in different ways; through self-guidance, self in relation, self-identity, and self-regulation. Both memory specificity and memory coherence are involved in these associations in similar manners. Both support effective problem solving, be it in a slightly different manner. Recalling specific past experiences that resemble the current situation enhances problem solving by transferring knowledge about the way the previous situation was solved to the current situation (Evans et al., 1992; Goddard et al., 1996, 1997; Scott et al., 2000; Raes et al., 2005). Additionally, the ability to create a coherent narrative about the current situation makes it easier to work through the emotions evoked by the situation (Pennebaker, 1997; Fivush and Baker-Ward, 2005; Fivush et al., 2008). One could then utilize this previous experience for future occurrences. So, memory specificity facilitates practical problem solving, whereas memory coherence promotes the process of emotional problem solving.

In addition to being involved in problem solving, memory specificity and memory coherence both play a role in the development of a personal identity. As we pointed out earlier, creating a sense of self is a crucial developmental task during adolescence (Erikson, 1968; McAdams, 1985). By autobiographical reasoning, the adolescent will link together different specific memories that are unique to the individual and differentiates him- or herself from others. By interpreting, evaluating, and connecting these single memories, the adolescent is able to form a coherent life story, which is a subjective representation of one's personal development (Bluck and Habermas, 2000; Habermas and Bluck, 2000; Habermas and de Silveira, 2008; Fivush et al., 2011). Creating a coherent life story is key to a healthy identity development and leads to feelings of continuity, purpose, and meaning (Kernberg, 1984; Antonovsky, 1985; Bluck and Habermas, 2000; Habermas and Bluck, 2000; Habermas and de Silveira, 2008).

Autobiographical memory also serves a social function. Through reminiscing with others about personal experiences, our lives become intertwined and we create a shared past (Fivush et al., 2006). The way in which this reminiscing occurs, especially in the context of mother-child reminiscing, relates to the development of both memory specificity and memory coherence. Mothers who are more elaborate when reminiscing with their children about their personal experiences (e.g., playdate or school trip) tend to have children who are more specific and coherent, concurrently and over time (Fivush and Fromhoff, 1988; Valentino, 2011; McDonnell et al., 2016). Elaborating on the circumstances surrounding the experience (e.g., cause, context, consequences) and the feelings it evoked (i.e., structural and emotional elaboration) facilitates children's memory specificity by helping them form a coherent narrative of their emotional experiences (Fivush, 2011; McDonnell et al., 2016). Whether elaboration positively predicts memory specificity and memory coherence depends on mother–child attachment status. Mothers are usually more elaborate when the child is securely attached (Fivush and Vasudeva, 2002). In contrast, elaborative reminiscing predicts less memory specificity in anxious or avoidant attached children (McDonnell et al., 2016). So, in addition to showing similar developmental pathways, the development of memory specificity and memory coherence are both influenced by the same contextual characteristics that can account for individual differences. Both features of autobiographical memory are scaffolded by elaborative mother-child reminiscing, and this association seems to be moderated by child attachment status.

In the previous two sections, we discussed how both memory specificity and memory coherence relate to the self in terms of self-regulation and psychopathology. This overview showed that difficulty recalling specific memories and difficulty creating coherent narratives about personal experiences show highly similar associations to psychological disorders. Both overgeneral autobiographical memory and memory incoherence are related to the presence of depressive symptoms and PTSD. As we pointed out earlier, besides inconsistencies in the literature, several questions concerning the relationship between memory coherence and internalizing symptoms and disorders remain unanswered. Later on, we will explain in more detail how an

integration could potentially contribute to resolving some of these inconsistencies and unresolved questions.

Besides these similarities, there are some conditions in which memory specificity and memory coherence seem to differ from one another. For example, episodic amnesia seems to impact memory specificity and memory coherence differently. Whereas patients suffering from episodic amnesia show deficits in recalling specific past events, they are still able to create coherent narratives if sufficient details are provided to them. So, it seems that episodic amnesia interferes with generating details about events instead of binding them into a coherent narrative, suggesting that damage to the hippocampus may influence the ability to recall specific events differently than the ability to create coherent narratives (Keven et al., 2017). To fully grasp the relationship between memory specificity and memory coherence, more research seems necessary to further explore the conditions in which they relate to each other and the conditions in which they seem to differ.

Integration within the Self-Memory System

Within the Self-Memory System, personal memories are stored across four different hierarchical layers going from abstract and general to concrete and specific (i.e., life story schema, lifetime periods, general events, and event-specific knowledge). As a first attempt to integrate memory specificity and memory coherence, we will situate them both within this theoretical model. This will provide more insight about how they might relate to each other and to the self, which can guide future research.

When trying to position complex cognitive phenomena like memory specificity and memory coherence in a theoretical model, we have to make certain assumptions. Both memory specificity and memory coherence are measured by scoring written or oral responses to cue words or instructions. These responses don't necessarily tell us something about how this autobiographical knowledge is organized on a higher cognitive level, since we cannot access this directly. Therefore we assume that someone's ability to retrieve specific events and create coherent accounts of the events is a reflection of the way this personal information is organized within the individual's memory. However, whether or not this assumption is a correct representation of the reality opens up a whole other debate, which falls beyond the scope of this manuscript.

Memory specificity represents a subclass of memories about single experiences that did not last longer than 1 day and therefore corresponds with the level of event-specific knowledge, which is the most specific and concrete level in the Self-Memory System. Overgeneral autobiographical memory arises when the search for specific memories truncates at a higher, more general and abstract level (Conway and Pleydell-Pearce, 2000; Williams et al., 2007). Different processes can influence this search and contribute to the development of overgeneral memory (Williams et al., 2007).

As we mentioned earlier, for a memory to be situated at the most specific level in the Self-Memory System, it must refer to a single event and it has to be rich in sensory and perceptual detail. These requirements for detail fit well with the criteria for memory coherence. A coherent memory contains specific information about where and when the event took place (i.e., context) and how the event unfolded (i.e., chronology). Additionally, the memory contains subjective information such as the emotions and cognitions that were evoked by the experience (i.e., theme). Although the focus typically rests on a single event, coherent memories are often extended in time. The individual will, for example, situate the event in his life story and describe the precursors and the consequences of the event, both short and long term. If this were to be the case when coding for memory specificity, such a memory would be categorized as a general memory because the experience described lasts longer than 1 day. However, Conway and Pleydell-Pearce do not impose a time restriction, therefore allowing memory coherence to be situated at the level of event-specific knowledge. So, we hypothesize that both memory specificity and memory coherence can be situated at the same hierarchical level in the Self-Memory System.

Positioning memory coherence at the most specific level of the Self-Memory System raises additional hypotheses about the relations between memory coherence, memory specificity, and the self. As we mentioned earlier, memory coherence is involved in emotional problem solving through the process of meaning making. Negative or stressful experiences are usually in conflict with the individual's current goals. The individual will strive to resolve this discrepancy between the current situation and current goals. By creating a coherent narrative about the negative experience, the individual will be able to create meaning and come to some sort of resolution (e.g., the realization that the current experience is not as negative as originally thought, changing goals to better fit the current circumstances, etc.), making the negative experience reconcilable with the working self. Additionally, placing memory coherence within the Self-Memory System makes it possible to theorize about how the coherence of single experiences relates to the overall coherence of the life story. The latter is represented by the life story schema, which is situated at the top layer of the Self-Memory System. As we mentioned earlier, being able to create a coherent overall life story is key to a healthy identity development. Through autobiographical reasoning, specific and coherent memories will be connected and integrated into a coherent life story schema. The working self (which contains a hierarchy of current goals) and the conceptual self (which contains personal attitudes, beliefs, etc.) will determine which of those event-specific memories will be integrated and stored within the life story schema. This shows how memory specificity, memory coherence, and global life story coherence interact to form a stable sense of self.

For this integration section, we based ourselves on Conway and Pleydell-Pearce's Self-Memory System, which offers a potential framework to look at the relationship between memory specificity and memory coherence and how they relate to the self. However, the Self-Memory System is just one way of trying to integrate memory specificity and memory coherence and does not provide absolute or definite answers. Nonetheless, this attempt at an integration suggests that there are a lot of open questions regarding the relationship between memory

specificity, memory coherence, and the self that can and should be investigated in future research.

Future Research Recommendations

As we pointed out throughout the previous sections, there is still room for improving our understanding of memory specificity and memory coherence. We argue that one possible way to achieve this is by examining how these features of autobiographical memory relate to each other and how they relate to the self. Given the similarities between memory specificity and memory coherence, we hypothesize that at least a moderate positive association could be expected between them. It seems indeed reasonable to assume that if a person has only limited access to specific personal memories, this would strongly impede the construction of coherent narratives about these experiences. Difficulty retrieving specific personal memories could also hinder the construction of a coherent life story, which requires the integration of multiple specific memories. Conversely, if an individual cannot make sense of an experience, and therefore cannot create a coherent narrative, this could disturb the emotional processing of the event, which could make retrieval of specific memories too threatening (Todd et al., 2013). This could in turn make the individual vulnerable for the development of emotional disorders. Additionally, given the similarities between memory specificity and contextual coherence, it is possible that memory specificity in fact is a subcomponent of memory coherence. Although we cannot make any definite claims about how memory specificity and memory coherence relate to each other, these different hypotheses demonstrate that further research is necessary.

More specifically, integrating memory specificity and memory coherence in future research could potentially provide answers to some remaining questions or resolve inconsistencies. For example, it is unclear whether memory incoherence is a vulnerability factor for the development of internalizing symptoms or a mere consequence or by-product of those symptoms. Likewise, little is known about possible underlying mechanisms that can explain this relationship. Research on memory specificity has focused greatly on its association with psychopathology, resulting in different theoretical models attempting to explain this association. Integrating memory specificity and memory coherence could therefore offer insights into the dynamics between memory coherence and psychopathology. For instance, the mechanisms described in the CaR-Fa-X model could be evaluated for memory coherence to get a better understanding of how and why incoherence relates to the presence of psychopathology. Additionally, research has shown that overgeneral autobiographical memory is not a general characteristic of psychopathology. It is, for example, related to the presence of depression, but not to anxiety-related disorders. It is possible that the same applies to memory coherence, which could potentially resolve the inconsistencies we pointed out earlier. Internalizing symptoms form a rather heterogeneous group of symptoms (i.e., depression and anxiety-related symptoms) and it is possible that memory incoherence only relates to the presence of one of these two, which could explain the inconsistent findings. Future research should therefore examine how memory coherence relates to the presence of depressive versus anxiety-related symptoms by using specific instruments instead of broadband screening questionnaires that do not differentiate between different types of internalizing symptoms. So, by transferring knowledge about the dynamics between memory specificity and psychopathology, we could potentially resolve certain inconsistencies regarding the relationship between memory coherence and psychopathology.

The domain of memory specificity could likewise benefit from an integration in future research. As we mentioned earlier, there seems to be some uncertainty regarding what is actually being measured with the AMT. A strong correlation between memory specificity and contextual coherence could indicate that memory specificity can be seen as a component of memory coherence, placing specificity within a broader framework. Insight into the relation between memory specificity and memory coherence could also have some clinical implications. For example, Memory Specificity Training (MEST) has been shown to be effective in decreasing depressive symptoms (Raes et al., 2009). If memory specificity would indeed be a part of the coherence construct, this could influence the content of the memory training. Instead of only focusing on specificity, the training could target overall memory coherence.

CONCLUSION

Research on memory specificity and memory coherence has developed as two largely independent research domains over the past three decades. This is, in our opinion, quite surprising since they both show highly similar associations to well-being and effective functioning of the self. These similarities make us therefore wonder how these two features of autobiographical memory relate to each other. Integration of these research domains offers new and exciting possibilities for future research and could result in new insights that enhance our understanding of the relationship between autobiographical memory and the self.

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The manuscript was written by EV after frequently brainstorming with DH, who also critically revised the article on multiple occasions. Likewise, PB contributed to this manuscript by revising the article and giving feedback.

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The Bodies "at the Forefront": Mentalization, Memory, and Construction of the Self during Adolescence

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Keywords: mentalization, memory, body, adolescence, self-identity, narrative

With this contribution, we offer a perspective focused on the mind-body relation in a specific phase of the life span: adolescence. In particular, we look at the complexity of some of the processes involved in the construction of an adult Self, which results from the interaction between experiences from infancy and a changing body during adolescence accompanied by implemented mental and social abilities/possibilities. Our interpretative hypothesis goes back to the construct of mentalization, focusing on the function of implicit bodily memories entwined with infantile experiences as precursors of relational dynamics that are mentalistically mediated. When troubled, these need to be dealt with, particularly during adolescence, when the demanding and inedited quests of the body may represent a hurdle that has to be overcome to achieve the formation of an integrated identity.

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The development of cognition, the complexity of behavioral and social processes and, not last, sexual maturation mark adolescence (e.g., Camaioni and Di Blasio, 2007; Faliva and Cozzani, 2011), defined as period "in transition" (Rutter, 1992; Palmonari, 1997). The individual develops a sense of self from infancy; however, during adolescence the very first conscious effort is made to answer to the question "Who am I?." This involves the organization of the individual's abilities, beliefs and history with the aim to form a coherent image of the Self through a sense of continuity over time (Pasupathi and Hoyt, 2009). In this stage, beliefs about the Self as well as beliefs of others are integrated within the process of identity development, which requires reaching a balance between commitment and confusion about one's beliefs, goals, values, and roles in society (Erikson, 1963). When commitment occurs, possibly after exploration of different alternatives, the adolescent can effectively resolve the identity issue dodging a chance to remain in a state of "identity diffusion" characterized by absence of integration and lack of commitment (Makros and McCabe, 2001). This scenario is further challenged by changes occurring in the adolescent's social cognitive and emotional brain, which significantly affect social behavior and choices during adolescence and, namely, the process of "social reorientation" (Nelson et al., 2005; see also Immordino-Yang, 2016).

Within this complex frame, adolescents are conventionally thought to build their identity hinging psychic with social (e.g., Erikson, 1950, 1953), very much in line with Mead's general conception of Self-construction (Mead, 1913). Less attention has been paid to maturation of the body, the first biological marker of our lifelong experiences. In fact, as thoroughly argued by several authors below discussed, in the transition from primary to tertiary intersubjectivity, the individual's transforming body and brain grow in active engagement with an environment of human factors—organic at first, then psychological or inter-mental (Trevarthen and Hubley, 1978; Trevarthen and Aitken, 2001; see also, Stern, 1985, 2004; Seganti, 1995).

Let's try then to reverse the classical view placing the body at the "forefront." The body is from birth (and even from the uterus) a constructive and expressive vehicle of the Self. Not by chance, it

has been suggested to add the body to the four levels of Doise's psychosocial analysis (Doise, 1982, Doise and Mapstone, 1986; Brunel and Cosnier, 2012). Then, how do we enquire the body to support the construction of an identity, the developmental transition from infancy to subsequent epochs, ferrying through adolescence? A plausible approach is to look at what happens when things "go wrong." It is emblematic that adolescents choose the body to express their discomfort: the developmental *impasse* in shaping the Self is explicit through injury of one's own body that—even if within dynamics involving different etiopathogenetic factors—represents a glaring example of how ruptures in developmental milestones carry effects through from infancy to childhood, ultimately reflecting on the adolescents' incapacity to manage all the dynamics underpinning their balanced maturation (Sempio Liverta et al., 2005; Midgley and Vrouva, 2012; Marchetti and Cavalli, 2013; Marchetti et al., 2013). In this respect, the capacity to *mentalize* represents a critical forerunner of the teen' perception of the physical Self, as well as of decisions taken with respect to their body. During the child's development, mentalization implies a gradual acquisition of the ability to correctly attribute mental states to oneself and others to understand behaviors, a maturation of reflective processes regarding people's internal states (Fonagy and Target, 2003; Allen and Fonagy, 2006). Mentalization is a construct that primarily origins from clinical studies and that—more than the construct of Theory of Mind, which mainly refers to an ability—implies one's *propensity* to look at social events in terms of mental states. It follows that, wherever mentalization fails, repercussions of different types and degrees can be observed affecting the child's behavior before, and the adolescent's psychological and physical integrity after, in a continuum between typical and atypical development.

Now, how can we approach mentalization failures that, as hypothesized initially, may be also tied to implicit, bodily rooted, memories shaped by infantile experiences? Moreover, assuming these dynamics entrenched in the adolescent's current perception of the Self, how can the teen's identification process be redirected and reinstated?

To leave something behind, it needs to be somehow remembered; to leave infancy, one needs to be able to disclose it. One of the most frequent and powerful human activities in which this process can take place is narrative: there seems to be no other way of "describing "lived time" save in the form of a narrative," a selective achievement of memory recall (Bruner, 2004, p. 692; see also Ricoeur, 1981; Nelson, 1989). For Bruner, narrative - as approached from a constructivist view intended as the mind "making the world"—encloses the sense of Self, one's autobiographical history (Bruner, 2004), which inevitably binds to who we are here and now and to what we carry around from our culture (see, e.g., Bruner, 1987, 1991, 2014). Relating mentalization and narrative, years of research on narrative (e.g., Feeney et al., 1994; Fonagy et al., 1998; see also, Van IJzendoorn and Bakermans-Kranenburg, 2008; George and West, 2012; Rossouw and Fonagy, 2012) emphasize on the idea that early experiences with primary caregivers are internalized and eventually reflected in the adults' self-narratives (Waters et al., 2017), which are to be viewed not as a record of what "actually happened" but rather as a continuing reinterpretation of one's experiences (Bruner, 2004). Seen from this perspective, one can then muster the use of memory through narration—regarded in this light as mentalization means—to build a sense of continuity against threats of identity fragmentation. Narrative-based practices would then emerge as an effective strategy helping teenagers found on infantile narratives an "upgraded" narrative accounting for the new personal resources and social quests. It is clear that this process does not imply denying or forgetting the past identity, but rather its integration—within one's own personality—with the new emerging identity.

But what narrative and which forms of memory are to be used that will not betray what said here at the beginning, and namely that the bridge that the mind needs to cross to reach the adult land is the body? From very early in life, the child is seen as an individual able to continuously self-regulate (e.g., Tronick, 1982, 1989; Stern, 1985). A cognitive-affective system of attachment emerges, able to continuously monitor the surrounding environment and endowing the child with procedural knowledge of his internal states with respect to relational events. These procedures incorporate, according to the "sensory memory of attachment relationships" (Seganti, 1995), information regarding the body recorded as sequences of activation states. Any attempt by the child to establish and maintain a balance between his/her internal system and the interaction with the caregiver would determine behavioral modifications persisting in memory (Tronick, 1989) that translate, in the adult life, in a bodily "unconscious/intuitive" response to the environmental stimuli (Seganti, 1995).

Also Stern (1985, 2000, 2004) supported the idea that the transmodal diffusion of the activation levels persist in the adult as a continuous source of extra-linguistic, non-verbal, evaluation of the interactive states with the others, which unfolds in parallel with language production. Language forces the individual's perceptual experience within categories, selecting only some parts of that conglomerate of sensations, perception, and cognition that, on the other hand, keeps substantiating the global non-verbal experience of our relations with the world, most of the times bodily-mediated (see, Werner and Kaplan, 1963). So-called "instinctive" behaviors may then stem from an evaluation of reality based on unconscious procedural memory liable to maintain an active and coherent Self in typical development. What Seganti (1995) refers to as the process of bootstrapping that can be then found in cognitive models of sensorial data, like the Parallel Distributed Processing (e.g., Bucci, 1984; Rumelhart and Mcclelland, 1986; Kihlstrom, 1987), relates to how information associated with the experience of one's body—alive and active—would be recorded in the adult's memory not only in a verbal format, but also in the form of anticipatory sequences of activation states (from the viscera). This idea recalls Damasio's debated proposal of somatic markers (Damasio et al., 1996), according to which signals would arise in bioregulatory processes as related to the body-state structure and to the brain representation of the body leading to, for example, undeliberated inhibition of responses learned previously (Damasio et al., 1996).

Within this scenario, the hard work that narration should undertake stems from the compromise between similarities and oppositions between the sensorial memory of relations—or bodily memory—and the present interactional context with the purpose to adequate one's own involvement to the new relational situation in a continuous, fast and effective manner (see, Seganti, 1995). This would allow individuals to re-establish healthy bridging with their past (see also, Bucci, 1998). Through narratives, it is therefore possible—both in daily life and in therapeutic settings (even though with different modalities and pervasiveness)—to access to unconscious defensive processes and distress-related memories encapsulated and intertwined in our mind and body. Once surfaced, they can be reflected upon and reconstructed by ascribing new meanings and understanding to past events (McAdams, 1993, 1998). Looking specifically at adolescence, the capacity to think about one's own mind, so painstakingly built during infancy, is now put to test and, wherever specific deficiencies are present, they now come to light, pushing the adolescent into a painful and harmful circuit that can result in real psychological problems. A good capacity to mentalize can help the adolescent handle difficult situations avoiding persistent discomfort and maladjustment. In this sense, intervening timely and precociously on risk factors can sensibly impinge upon the way in which young women and men will resolve past situations to face a more serene future. Bodily and representational have to be melded together, both conceptually and with respect to prevention and rehabilitation measures suited to aid adolescents in distress, fruitfully adjoining concepts like internal working models of attachment, the "procedural and sensorial memory of relationships," narrative as intended by Bruner, and the concept of Stern's "present moment, now" (Stern, 2004) as non-verbal means of psychic transformation.

Lastly, while we here made an attempt to outline the role of the body as a carrier of implicit memories strongly affecting behavior over development—from childhood to adulthood passing through the winding road of adolescence—we would like to ultimately bring forward not only the role of one's own body, but rather of the individual's body in relation to the others' minds and, mostly, to the *others' bodies*. For all the matters here addressed, this is particularly relevant when dealing with adolescence. The need emerges preponderant to reflect on theoretical models, educational and clinical at once, in which one's own body is regarded in relation to the others' bodies as a regulative system of the Self. The selection of our partners, friends, and the relational circle in general is no coincidence. Relationships do not develop only on the basis of a meeting of minds but also—and perhaps primarily and at a deeper implicit level—on recognition and synchronization dynamics, which are in our opinion bodily grounded.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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The Construction of Self in Relationships: Narratives and References to Mental States during Picture-Book Reading Interactions between Mothers and Children

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Previous studies showed that mothers vary in the way in which they discuss past experiences with their children, since they can exhibit *narrative* (*elaborative*) or *paradigmatic* (*repetitive*) styles to different extents. Given this background, the aim of the present study was to analyze differences in the mothers' use of narrative styles and mental state language (MSL), as a function of children's age and gender. Thirty dyads consisting of mothers and their 4- to 6-year-old children were observed during a picture-book reading interaction. Maternal utterances were coded according to the categories described by Tessler and Nelson (1994), classifying each mother as *Narrative* or *Paradigmatic*. Eight categories of MSL were analyzed: perceptual, emotional (positive and negative), volitional, cognitive, communicative, and moral. The results confirmed the existence of the two maternal styles observed in the earlier studies. Importantly, we found that the mothers of younger children were more narrative than paradigmatic, whereas the opposite pattern occurred for the mothers of older children (they were more paradigmatic than narrative). As concerns MSL, the results indicated that the use of communicative terms was significantly more frequent for narrative than for paradigmatic mothers, and decreased linearly with children's age. Lastly, the mothers of younger children referred their MSL more frequently to the book characters than to themselves or to the child. Taken together, these results support the idea that mothers adapt their narrative styles and MSL input to the growing abilities of their children, therefore contributing to the development of social understanding.

Keywords: narrative style, mental state language, children, picture-book reading

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INTRODUCTION

Although an implicit sense of self is already apparent before language acquisition (Rochat, 2010), it seems clear that, during infancy, the establishment of an explicit self-concept is primarily driven by the co-occurring growth in linguistic competence. This is because the comprehension and production of grammatical forms such as personal pronouns and verb conjugations require young children to draw an explicit distinction between the roles that can be assumed by themselves or by

other people (Bates, 1990). In facts, recent research suggests that the mastery of person reference is closely related to the use of language to express one's own and others' mental states (Markova and Smolík, 2014). The underlying assumption is that, to correctly produce personal pronouns and mental state terms, children need to acquire a full awareness of their own desires, feelings, and thoughts (Rochat, 2010); furthermore, they must also understand that other people can have different or even false beliefs about a given situation (Doherty and Perner, 1998; Spataro et al., 2017). Put in other words, they need to acquire an explicit Theory of Mind (ToM) (Flavell, 2004; Wellman and Liu, 2004; Low and Perner, 2012).

Theory of Mind can be defined as the "ability to appreciate the existence of one's own and others' mental states (e.g., intentions, emotions, desires), and use them to explain and predict behaviors" (Longobardi et al., 2016b, p. 424; see also Flavell, 2004; Lecce et al., 2015). In the laboratory, this complex set of skills is typically examined by testing children's understanding of first- and/or second-order false belief (Perner and Wimmer, 1985; Wellman and Liu, 2004). However, a crucial distinction has been drawn between passing false-belief tasks and spontaneously using one's own ToM abilities during conversations and interactions with peers and adults (Meins et al., 2006; Grazzani and Ornaghi, 2012). Although the existence of a relation between these two domains has been disputed (Tager-Flusberg and Sullivan, 1995; Charman and Shmueli-Goetz, 1998; Meins et al., 2006; Longobardi et al., 2016b), the spontaneous production of mental state language (MSL: a specific type of language including perceptual, physiological, emotional, cognitive and moral terms) has been shown to forerun and predict the acquisition of ToM and, more generally, the emergence of meta-representational awareness (Beeghly et al., 1986; Bartsch and Wellman, 1995). In agreement, significant positive associations between ToM and MSL have been reported by studies examining the behavior of preschool children in a variety of interactive contexts (e.g., book reading; Dunn et al., 1991; Hughes and Dunn, 1998; Rollo and Sulla, 2016).

Importantly for the present purposes, the acquisition of an explicit ToM and the associated production of MSL are strongly influenced by the quality and the frequency of the social interactions to which children are exposed during their first years of life. More specifically, social interactionist approaches to cognitive development posit that the use of language during mother–child conversations has a central importance in promoting the development of mind-reading skills (Ruffman et al., 2002; Symons, 2004; Taumoepeau and Ruffman, 2006, 2008), since children learn to interpret the meaning of their experiences by participating in culturally shared activities (Nelson, 1996; Fivush et al., 2006; Bamberg, 2011). Children's participation in communicative interactions is also critical to build their ability to construct and share stories with others – a conversational skill that emerges in the early childhood years and is strongly predictive of cognitive, literacy and socioemotional development, as well as school readiness and academic achievement (Deckner et al., 2006; Fivush et al., 2006; Cristofaro and Tamis-LeMonda, 2012). Parents can indeed scaffold the acquisition of children's narrative ability by sharing personal experiences during family reminiscing, by telling stories during pretend play, or by reading stories from picture books (Whitehurst and Lonigan, 1998; Escobar et al., 2017).

In this broad context, several researchers have begun to examine the social origins of memory, by asking whether differences in maternal narrative styles can affect children's memory for the narrated events (e.g., Engel, 1986, Unpublished; Fivush, 1994; Nelson, 1996; Nelson and Fivush, 2000; Lange and Carroll, 2003). Fivush et al. (2006), for instance, studied mother–child conversations about past events and found that the children of *elaborative* mothers, who engaged in richly detailed descriptions (e.g., "Memaw and Grandad came over, and Daddy cooked hamburgers out on the grill": Haden, 1998) and open-ended questions (e.g., "What did we do at the zoo?" and "Who was there with us?": Fivush et al., 2006), recalled significantly more information than the children of *repetitive* mothers (Fivush and Fromhoff, 1988; Reese et al., 1993; Haden et al., 2001). A similar distinction between narrative and paradigmatic interaction styles has been drawn by Tessler (1986, Unpublished) and Tessler and Nelson (1994), on the basis of previous work by Bruner (1986). According to these authors, *narrative* mothers tend to interpret events and actions in terms of intentions and mental states (e.g., "The frog is jumping on the stone because she's afraid to drown": Tessler and Nelson, 1994); in addition, they make frequent references to the autobiographical experiences of their children (e.g., "Do you remember when we went to the rugby match?": Farrant and Reese, 2000); *paradigmatic* mothers, on the other hand, focus on labeling objects and specifying their relations with superordinate categories (e.g., "What kind of animal is that? A bird, right!": Tessler and Nelson, 1994), or on repeating the exact content of a previous utterance (e.g., Mother asks, "We had fun, didn't we?" and in her next turn repeats, "Yes, we had fun": Haden, 1998). Although all parents produce both narrative and paradigmatic utterances when interacting with their children, most of them show a clear predominance of one style over the other (Lange and Carroll, 2003). Adopting this classification, Tessler and Nelson (1994) coded the spontaneous conversations occurring between mothers and their children during a museum visit: the results showed that the children of narrative mothers recalled the museum objects more accurately than the children of Paradigmatic mothers. Furthermore, in later studies, the use of a narrative style during parent–child interactions has been found to relate to other aspects of children's cognitive development, including conscience development (Laible and Thompson, 2000), emotion recognition (Ontai and Thompson, 2002), socio-communicative competence (Tadić et al., 2013), and ToM (Welch-Ross, 1997; Ontai and Thompson, 2008).

Besides narrative styles, a large body of research point to the conclusion that the frequency with which mothers refer to MSL during conversations is positively and significantly associated with children's performance in ToM tasks and the development of their psychological lexicon (Meins et al., 2002; Ruffman et al., 2002; de Rosnay et al., 2004; Slaughter et al., 2007; Ornaghi et al., 2011). Ruffman et al. (2002), for example, found that a composite measure of mothers' mental state utterances (including the use of desire and think/know terms) at 3 years predicted

unique variance in children's ToM performance at 4 years. Likewise, LaBounty et al. (2008) reported that the frequency of mothers' emotional explanations at 3.5 years predicted children's concurrent emotion understanding, whereas the frequency of fathers' explanations in terms of desires and emotions predicted children's concurrent and later ToM at 5 years. As concerns the relation between mothers and children's MSL, two classical studies by Taumoepeau and Ruffman (2006, 2008) showed that maternal references to desires at 15 months significantly predicted children's later MSL and emotion task performance at 24 months. In addition, mothers' talk about others' thought and knowledge to 24-month-old children significantly predicted their MSL at 33 months (see also Furrow et al., 1992; Jenkins et al., 2003; Rudek and Haden, 2005; Symons et al., 2006; Pearson and Pillow, 2016).

The Present Study

Considering the empirical background briefly summarized in the previous paragraphs, the present study sought to put together these two strands of research by examining the relation between narrative styles (as classified by Tessler and Nelson, 1994 and modified by Rollo, 2003, Unpublished) and the use of MSL in maternal conversations during a shared book reading activity. More specifically, we were interested in determining whether Narrative and Paradigmatic mothers differed in the use of specific categories of mental state terms and/or in the total amount of psychological lexicon directed to children. Although this question has yet to be assessed, the findings illustrated by Welch-Ross (1997) and Ontai and Thompson (2002), showing a direct association between the frequency of elaborative comments in maternal conversations and children's later ToM, lead to the prediction that elaborative/narrative mothers should produce more mental state terms, compared to repetitive/paradigmatic mothers. This result would be well consistent with previous evidence demonstrating that the mothers' use of MSL during parent–child interactions promotes ToM in preschool children (Meins et al., 2002; Ruffman et al., 2002; de Rosnay et al., 2004; Symons et al., 2006; Taumoepeau and Ruffman, 2006, 2008; Slaughter et al., 2007; Ornaghi et al., 2011). Hence, the positive effects of maternal elaborations on ToM performance might be potentially mediated by an increased frequency of internal state terms. In addition to this primary aim, we were also focused on determining whether maternal styles varied as a function of children's age and gender, and whether elaborative/narrative and repetitive/paradigmatic mothers referred their MSL to different agents – the self, the child, the dyad, the context or others (e.g., the characters described in the book). As concerns the first issue, available studies indicate that both mothers and fathers tend to be more elaborative with daughters than with sons (Reese and Fivush, 1993; Reese et al., 1993), and that the mothers of children between 40 and 70 months of age tend to become more elaborative over time. Regarding the second issue, there is at least some evidence showing that maternal references to others' internal states play a key role in the early development of psychological lexicon. Taumoepeau and Ruffman (2008), for example, found that maternal references to others' cognitive states at 24 months were the most consistent correlate of children's later MSL at 33 months. Similarly, a study by Longobardi et al. (2016a) showed that maternal references to others' mental states at 16 months were associated to the children's ability to use MSL to communicate their emotions at 20 months.

To summarize, the aims of the present study were: (a) to confirm the validity of the distinction between Narrative and Paradigmatic communicative styles; (b) to investigate whether the mothers' use of these two communicative styles varied as a function of children's age; (c) to identify internal state terms in mother–child speech and determine differences related to children's age and gender; (c) to verify whether mothers classified as Paradigmatic or Narrative differed in their use of MSL; and (d) to investigate whether Narrative and Paradigmatic mothers differed in the relative frequency with which they attributed mental state terms to different agents.

MATERIALS AND METHODS

Participants

Thirty mother–child dyads were observed individually. Only mothers and typically developing children whose first language was Italian were included. Children were 19 females and 11 males ranged in age from 4 years 1 month to 5 years 11 months ($M = 4.74$; $SD = 0.49$). The average age of the mothers was 35 years ($SD = 3.86$).

Children were recruited in a public school of northern Italy; they belonged to a medium socioeconomic group (according to parents' education and occupation); their receptive language was tested with the Italian adaptation of the Peabody Picture Vocabulary Test-R (PPVT-R; Dunn and Dunn, 1981; Italian version by Stella et al., 2001). The sample had no reported history of psychiatric treatment or neurological disorders.

In order to explore any differences based on children's age, we created three balanced groups in terms of numerosity and age, each composed of 10 children: (1) average age was 4.05 years ($SD = 0.04$); (2) average age was 5.05 years ($SD = 0.02$); (3) finally, the third group was composed of children who were 5 years and 11 months old.

Procedure and Measures

Mothers who agreed to participate in the study filled out an informed consent form. The form was composed of two parts: the research description and quotation of the relevant laws, which was retained by the mothers; the signature sheet expressing the consent for their participation in the study together with an agreement on data disclosure, which was retained by the first author.

The dyads were individually observed in their domestic settings during a book reading interaction. The instructions given to the mothers were as follows: "Look at this picture-book with your child and behave as you normally do when you read a picture-book at home." The observer familiarized himself with each dyad before each observation and did not interfere in any way during the narrative interaction, in order to maintain ecological validity.

The picture-book ("*Frog, where are you?*"; Mayer, 1969) was about the adventures of a frog in the pond, and has been largely employed in previous research (e.g., Reilly et al., 2004). The instrument was considered to be appropriate for the present study, because it did not induce any particular way of telling the story and therefore allowed the mothers to exhibit their usual narrative style. The duration of the sessions was variable, ranging from 15 to 25 min. To assess maternal style, the narratives were audio-recorded, transcribed and then scored by two independent judges.

The coding scheme included three successive steps:

(1) In the first instance, the transcripts were divided into utterances – the minimal unit of analysis, formally defined as "an uninterrupted stream of language, which is distinguished from other utterances on the basis of lengthy pauses, grammatical structure, and changes in vocal intonation" (Longobardi et al., 2016a, p. 758). Each utterance was then classified as Narrative or Paradigmatic by two independent coders – inter-rater reliability (Cohen's κ) was 0.83, and each disagreement was resolved through discussion with the first author. Maternal style was finally defined by the relative prevalence of narrative or paradigmatic utterances (more than 50%) on the total number of utterances produced during the narration, as in Tessler and Nelson (1994). **Table 1** reports examples of the eight narrative categories observed in the present study, out of the 18 originally proposed by Tessler and Nelson (1994). All other categories were excluded because they were not relevant for the present investigation.

(2) Then, the transcripts were coded according to the eight categories of mental lexicon used by Camaioni et al. (1998, modified; see **Table 2** for the coding scheme). Following these authors, two measures were computed: the overall proportion of internal state terms produced by each mother, out of the total number of words used during the interaction; and the relative frequency of each category, out of the total number of internal state terms produced during the interaction. Inter-rater reliability for coding each mental term in the eight categories was good (Cohen's $\kappa = 0.83$).

(3) Lastly, for each internal state term produced by mothers, the two judges coded whether it referred to the mother, to the child, to the dyad, to the story characters (coded as 'context'), or to others – identified as entities other than the mother–child couple and the characters described in the picture book.

RESULTS

Mothers' Communicative Styles

The first aim of this study was to identify two different maternal styles used during the picture-book reading interactions. Following the procedure outlined in the "Materials and Methods" section, 14 mothers out of 30 (46.7%) were classified as Narrative, while the remaining 16 mothers were classified as Paradigmatic (53.3%). When analyzed with respect to children's age groups, the two maternal styles showed a clear developmental trend that coincided with the increase in children's age. Mothers of 4.05-year-old children were more Narrative than Paradigmatic (90% vs. 10%); in contrast, the mothers of older children resulted to be more Paradigmatic than Narrative [70% vs. 30% and 80% vs. 20%, respectively; $\chi^2_{(2)} = 11.52$, $p < 0.001$]. Overall, these results confirm the existence of the two maternal styles observed in the earlier study (Tessler and Nelson, 1994), but additionally indicate that mothers adjust their narrative style depending on children's age.

Interestingly, there were no significant differences [$F_{(2,27)} = 0.050$; $p = 0.951$] in the total number of utterances produced by mothers: $M = 26.60$ (age 4.05), $M = 27.70$ (age 5.05), and $M = 24.60$ (age 5.11). The latter finding suggests that differences in the narrative styles were not due to differences in maternal verbosity.

Mothers' Mental State Language

Regarding the mothers' use of MSL during the picture-book reading, the overall percentages of internal state terms, out of the total of words produced by mothers, ranged from a minimum of 1.37 to a maximum of 11.39 ($M = 7.71$; $SD = 2.53$). Considering the different categories of internal state language, **Table 3** shows that emotional (positive), perceptual, and communicative terms were used more frequently than the other mental state terms.

In **Figure 1**, we can observe the types of internal state words used by mothers with their children. It can be noted that the mothers of younger children used a wider variety of inner state words referring to perception and emotion, while the mothers of older children used more inner state words referring to cognitive states or volition.

To formally verify differences in the mothers' use of MSL categories as a function of children's age, we performed a MANOVA (multivariate analysis of variance) that has showed a significant difference in the use of communicative terms [$F_{(2,27)} = 4.498$; $p = 0.021$; $\eta^2 = 0.44$] with a decreasing trend: mothers of younger children utilized more communicative terms ($M = 25.93$, $SD = 11.70$) than mother of the 5.05-year-old children ($M = 20.03$, $SD = 10.19$) and the 5.11-year-old children ($M = 12.17$, $SD = 8.15$). *Post hoc* comparisons using Bonferroni test indicated that the use of communicative terms was significantly lower in the mother of older children (5.11-year-old) than in the mother of younger children (4.05-year-old) ($p = 0.016$).

A marginally significant increase was instead noted in the use of volitional terms [$F_{(2,27)} = 2{,}788$; $p = 0.080$]. Mothers of 5.11-year-old children utilized more volitional terms ($M = 24.73$, $SD = 29.31$) than mothers of the 5.05-year-old children ($M = 13.26$, $SD = 10.60$) and the 4.05-year-old children ($M = 5.05$, $SD = 6.48$).

With regards to children's gender, no significant difference was found: mothers used internal state terms with girls and boys similarly. However, at a descriptive level (see **Figure 2**), it is interesting to note that mothers addressed emotional positive states more frequently to girls than to boys [$F_{(1,28)} = 1.313$; $p = 0.262$], whereas emotional negative states were directed more frequently to boys than to girls [$F_{(1,28)} = 3.065$; $p = 0.092$].

TABLE 1 | Coding scheme used to categorize maternal utterances (Tessler and Nelson, 1994; Rollo, 2003, Unpublished).

Style	Categories	Definition	Example
Narrative	(1) Describe activity	A depiction in basic, "surface" form of a behavior or occurrence taking place in view of mother and child.	*This frog is swimming in the pond.*
	(2) Autobiographical	A reference to something in the (usually shared) personal past; often a way of explaining by means of connecting the sight/activity/occurrence with something already experienced by the child.	*Where were we, not so long ago, when we saw something like this?*
	(3) Aesthetic/Affective	A depiction in aesthetic rather informative terms or expression of an emotion or attitude toward the thing observed.	*Those white flowers are beautiful, aren't they? I love those! They're my favorite!*
	(4) Interpretation	Utterance going beyond the basic information given about the feelings, intentions, possible future sequence of events or behavior relating to the person or object being observed.	*The frog is jumping on the stone because she's afraid to drown*
Paradigmatic	(5) Describe category	Utterance labeling an object (or person) defining class it belongs to.	*What kind of animal is that? A bird, right!*
	(6) Basic knowledge	Often used for purpose of explaining something in the present situation referring to something child already know ("semantic" knowledge rather than "episodic" experience).	*Sure, you know that. Where do frogs live?*
	(7) Specific physical properties/size	Reference, often for purpose of focusing attention, to perceptual properties of the object.	*Look at these flowers, as they are great!*
	(8) Similarities/generalizations	Also used as a form of classification.	*This is the same kind as that one.*

TABLE 2 | Coding scheme used to categorize the internal state words produced by mothers.

Type of internal states	Examples of internal state words used by mothers
Physiological	To be hungry, to be thirsty, to be sleepy.
Perceptual	To hear, to see, to look, to observe, to recognize, to be cold, to be hot, to feel ill.
Emotional positive	To enjoy, to be friends, to love, cheerful, happy, nice, satisfied.
Emotional negative	To be afraid, to become angry, to be sorry, to sorrow, unhappy, unpleasant, sad.
Volitional	To have intention of, to look for, to order, power (= to be able of), to want, good.
Cognitive	To know, to understand, to remember, to forget, to dream, to think.
Communicative	To say, to tell, to call, to ask.
Moral	Duty (to be obliged to do), power (= to have the permission), to forgive, good, bad.

TABLE 3 | Descriptive statistics for mothers' categories of MSL.

Terms of mothers' MSL	% *M*	*SD*
Physiological	0.46	1.75
Perceptual	19.13	11.87
Emotional positive	18.76	14.10
Emotional negative	5.25	9.51
Volitional	14.35	19.55
Cognitive	17.82	11.70
Communicative	19.37	11.33
Moral	3.94	8.32

Maternal Communicative Styles and Mental State Language

A primary aim of this research was to verify whether mothers classified as Narrative or Paradigmatic differed with respect to the use of psychological lexicon. A MANOVA carried out on the eight categories of mental state terms found only one significant difference between maternal style groups [$F_{(1,28)} = 5.872$; $p = 0.022$; $\eta^2 = 0.54$]: Narrative mothers used communicative terms more frequently than Paradigmatic mothers (see **Figure 3**). In addition, looking at **Figure 3** it can be noted that there was a marginally significant difference for the volitional category [$F_{(1,28)} = 3.455$, $p = 0.074$], with Paradigmatic mothers using these terms more frequently than Narrative mothers. In contrast, Narrative mothers tended to use physiological terms more frequently than Paradigmatic mothers [$F_{(1,28)} = 3.069$, $p = 0.091$].

Referents of Maternal Mental State Language

The last aim of the present study was to verify whether Narrative and Paradigmatic mothers differed in the way in which they referred mental state terms to themselves, to the child, to the dyad, to characters of the picture book (context) or to others (persons not described the book).

Overall, internal state words were referred preferably to the context ($M = 41.33$) or to the child ($M = 30.06$), while references to others ($M = 13.28$), to the mother ($M = 9.71$), or to the dyad ($M = 4.98$) were relatively rare. A MANOVA carried out on the referents of mental state terms revealed no significant differences between Narrative and Paradigmatic mothers [for example, References to the

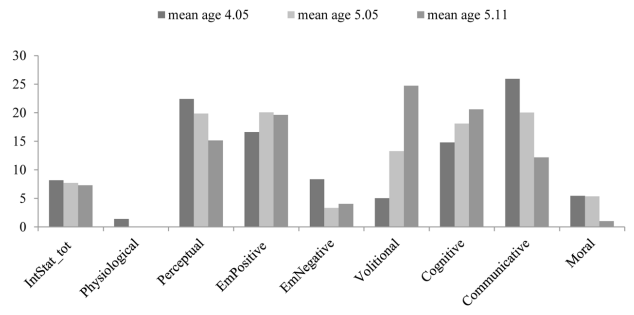


FIGURE 1 | Mean percentages of mental state terms used by mothers, as a function of category (physiological, perceptual, emotional positive, emotional negative, volitional, cognitive, communicative, and moral) and children's age. IntStat_tot = total percentages of mental state words.

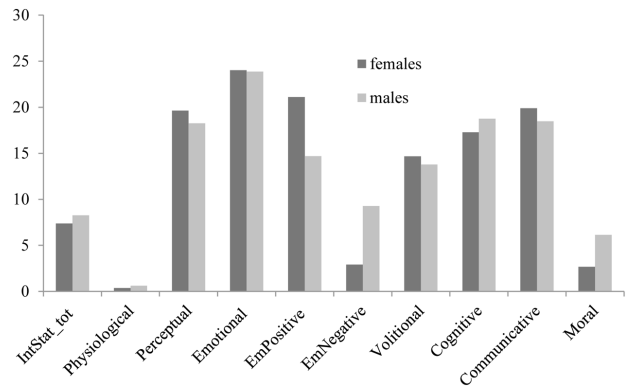
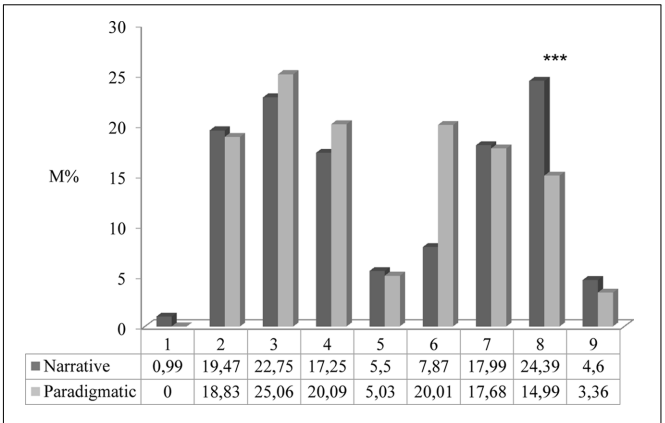


FIGURE 2 | Mean percentages of mental state terms used by mothers, as a function of category (physiological, perceptual, emotional positive, emotional negative, volitional, cognitive, communicative, and moral) and children's gender. IntStat_tot = total percentages of mental state words.

child: $F_{(1,28)} = 1.505$; $p = 0.23$; References to the context: $F_{(1,28)} = 1.459$; $p = 0.24$]. Interestingly, however, Pearson's correlations revealed that context references were negatively and significantly related to references to the mother ($r = -0.53$), to the child ($r = -0.67$) and to others ($r = -0.44$) (all ps < 0.01). These results suggest that the more the mothers referred mental state terms to the book characters, the less they referred them to themselves, to the children or to other persons out of the dyad (for example, their relatives).

As a last point, we analyzed possible differences in the references of maternal MSL as a function of children's age. The MANOVA results, reported in **Table 4**, show that the mothers of younger children referred their MSL to the context more frequently than the mothers of older children. *Post hoc* comparisons with the Bonferroni correction showed that the mothers of 4.05-year-old children referred mental state terms to the context more often the mothers of 5.05-year-old children ($p = 0.031$).



	1	2	3	4	5	6	7	8	9
Narrative	0,99	19,47	22,75	17,25	5,5	7,87	17,99	24,39	4,6
Paradigmatic	0	18,83	25,06	20,09	5,03	20,01	17,68	14,99	3,36

FIGURE 3 | Mean percentages of mental state terms used by mothers, as a function of category (physiological, perceptual, emotional positive, emotional negative, volitional, cognitive, communicative, and moral) and narrative style. 1 = Physiological words; 2 = Perceptual words; 3 = Emotional words (Emotional positive + Emotional negative); 4 = Emotional positive words; 5 = Emotional negative words; 6 = Volitional words; 7 = Cognitive words; 8 = Communicative words; 9 = Moral words.

DISCUSSION

Narratives provide a coherent structure for recounting the past to others, but also for representing the past to ourselves (Rollo and Benelli, 2003). Since language is the medium through which children learn the canonical narrative structures (Bruner, 1991, 1996), it is also the primary means through which adults "socialize" children (Fivush, 2014). In this context, mother–child conversations are essential instruments through which children learn the cultural norms that guide adult's behaviors. As Fivush et al. (2006) wrote: "Children's lives are organized such that the activities in which children are encouraged to engage are those that the culture deems important, and it is through participation in culturally mediated, socially structured activities that children learn the skills necessary to become competent members of their culture. With time, as children engage in adult-guided activities, they internalize the skills initially displayed by others and add them to their own intrapersonal repertoire" (Fivush et al., 2006, p. 1,568). It is then important to thoroughly investigate this continuous and circular process where adults narrate their own experiences and children learn to build their personal representations: how is the adults' narrative toward children organized?

Parents and their children spend many time in joint picture-book reading. This activity conforms to the turn-taking structure of conversation and occurs in a repetitive sequence formerly described by Ninio and Bruner (1978). Furthermore, it is from the frequent exposure to this format that children acquire the capacity to create stories. Since picture-book reading is characterized by a unique three-way intersection of narration, face-to-face interaction and self-reference, it provides an optimal setting for exploring the processes of self-construction (Lonigan and Whitehurst, 1998).

TABLE 4 | Mean percentages of mental state terms referred to mother, child, mother and child (dyad), context and others, as a function of children's age.

References of mothers' MSL	Children's age in years			$F_{(2,27)}$	*P*
	4.05 (*N* = 10)	**5.05 (*N* = 10)**	**5.11 (*N* = 10)**		
Mother	4.5 (6.37)	13.22 (14.88)	11.41 (13.73)	1.3	0.29
Child	24.45 (13.59)	30.35 (16.35)	35.39 (16.61)	1.19	0.32
Mother and child	2.00 (2.92)	9.68 (11.46)	3.22 (4.96)	3.11	0.061
Context	57.31 (17.38)	30.22 (21.35)	36.45 (26.24)	4.02	0.030
Other	11.72 (8.23)	14.62 (11.29)	13.51 (12.87)	0.235	0.79

Statistics and p-values (MANOVA) are reported in the last two columns.

Indeed, numerous studies have investigated the relationship between maternal mental lexicon during picture-book reading and their children's ToM (Ontai and Thompson, 2008). These studies examined both the variations in maternal styles and the consequences on children's understanding of mind. Although the results have highlighted a close association between maternal mental lexicon and the development of children's social comprehension, it is not yet clear which aspects of maternal language are essential to the establishment of this relation.

Within this broad context, the present study focused on maternal talk to 4- to 6-year-old children, to investigate: (a) whether narrative styles changed as a function of children's age; and (b) whether different narrative styles were associated to quantitative differences in the use of mental state terms, including their referents. First, we wondered whether it was possible to discriminate between mothers who utilized Narrative versus Paradigmatic styles. Within our relatively small sample, we found mothers who, during the task of picture-book reading, were highly consistent in referring to the autobiographical experiences of their children and the mental states of the book characters, and mothers who were primarily focused on specifying the properties of objects and their relations. In this respect, the results of our study confirm the distinctions illustrated in the literature between elaborative versus repetitive styles (Fivush and Fromhoff, 1988), narrative versus paradigmatic styles (Tessler, 1986, Unpublished; Tessler and Nelson, 1994), or expressive versus referential styles (Nelson, 1973). Clearly, these categories should be considered as the extremes of a continuum, since all the mothers produced utterances of both types. More interestingly, we found that the mothers' use of narrative styles varied as a function of children's age, although the direction of this difference did not replicate the results reported by Reese et al. (1993). In facts, our data indicate that the mothers of 4-year-old children used primarily an expressive/narrative speech, more centered on interactions and shared experiences, whereas the mothers of 5- and 6-year-old children were more likely to adopt a referential/paradigmatic speech, more focused on objects. This modification parallels what happens during early child development. As children develop and refine their interaction skills, they move from a narrative to a paradigmatic way of systematizing the reality around them (Rollo, 2003, Unpublished); likewise, mothers change their way of conversing with their children.

The second aim of the present study was to identify the internal state words used by mothers during the picture-book reading. To this purpose, the transcripts were coded using a scheme illustrated by Camaioni et al. (1998), which differentiates between eight different MSL categories (physiological, perceptual, emotional negative, emotional positive, cognitive, volitional, communicative, and moral). Confirming previous studies that examined the MSL addressed to 24-month-old children (Longobardi et al., 2016a), we found that perceptual terms were used with the highest frequency, followed by emotional positive, cognitive, and volitional terms. Importantly, communicative terms were produced with the same frequency of perceptual terms, suggesting that their use might be particularly relevant for the creation of a narrative frame in which children begin to build mature representations of themselves and other people (Nelson and Fivush, 2004). Indeed, the terms "to say," "to tell," and "to call" were frequently used by the mothers of 4.05-year-old children.

Statistical analyses revealed that the mothers' use of communicative terms varied as a function of children's age, being more frequent in the mothers of younger than older children. No other difference reached the significance level, although the general trend was well in line with the available literature. For example, the use of perceptual terms was quite frequent with 4-year-old children but decreased sharply in the mothers of older children; in contrast, the use of cognitive and volitional terms was relatively limited during the interactions with the youngest group of children, but exhibited a strong increase in the mothers of 5- and 6-year-old children. These results nicely mirror the results observed in previous studies which focused on children's production and comprehension of internal state terms (Bretherton and Beeghly, 1982; Shatz et al., 1983; Tardif and Wellman, 2000; Wellman and Liu, 2004; Kristen et al., 2012; Longobardi et al., 2014), and therefore confirm the causal role of maternal language (Meins et al., 2002; Ruffman et al., 2002; de Rosnay et al., 2004; Slaughter et al., 2007; Ornaghi et al., 2011). Furthermore, the mothers in our sample used emotional terms more frequently with girls than with boys – a finding which has been already observed in the literature (Lagattuta and Wellman, 2002).

A central aim of our research was to verify whether mothers classified as Paradigmatic or Narrative differed with respect to the use of MSL. In contrast with our original hypotheses, the present findings suggest that conversational styles and MSL are rather independent: indeed, Narrative and

Paradigmatic mothers used the eight categories of MSL to the same degree, with one noteworthy exception: that Narrative mothers produced communicative terms more frequently than Paradigmatic mothers. This is interesting because the frequent use of verbs such as "tell" and "say" might facilitate children's understanding of tensed complements, which in turn "is a precursor and possible prerequisite of successful false-belief performance" (e.g., de Villiers and Pyers, 2002, p. 1,037). In agreement, studies have suggested that mothers' production of communicative (and more generally, cognitive) verbs might be closely related to children's understanding of false belief, representational change and the appearance-reality distinction (Le Sourn-Bissaoui and Deleau, 2001; Adrián et al., 2007).

Finally, we wanted to verify whether mothers referred internal state words to "others" (including their children and the book characters) more than to themselves. In this respect, correlational analyses showed that the more the mothers referred mental state lexicon to the book characters, the less they referred it to the children or to themselves, indicating a dialog between two different entities: the fictional characters of the story and real persons – the mothers and their children. Assuming that during the book-reading interaction there is a "match" among these three components (Reese et al., 2003; Fletcher and Reese, 2005), the social interaction established between these elements seems to move from the book and its "concrete characters" to the children and the mothers. This was confirmed by the results of the MANOVA, which showed that the attributions of MSL to the book characters were predominant in 4.05-year-old children; this suggests that mothers can tailor their mentalistic input to the abilities of younger children: in facts, the book characters provide a concrete anchoring to verbally expressed mentalistic content. In other words, the mothers of younger children use the book to objectify an internal reality, which later will be directly attributed to the child. Moreover, they adapt the language produced in shared narrative contexts to the age of their children, in order to guide them toward a gradual awareness of their inner world (Rollo, 2003, Unpublished).

CONCLUSION AND FUTURE DIRECTIONS

In summary, the present study examined the characteristics of maternal talk during narrative interactions with their children, with a particular focus on the different use of MSL by Narrative and Paradigmatic mothers. We learned that: (a) maternal narrative styles changed as a function of children's age, such that the mothers of 4-year-old children were more Narrative than Paradigmatic, whereas the mothers of 5- and 6-year-old children exhibited the opposite pattern (i.e., they were more Paradigmatic than Narrative); (b) the use of communicative terms decreased with children's age, and was more frequent in Narrative than in Paradigmatic mothers; and (c) mothers adapted the referents of their MSL to the children's age, such that internal state terms were first referred to the book characters, then to the child themselves, and lastly to the dyad.

These conclusions should be evaluated with caution, because the present study has several limitations. First, the sample size was relatively small, and this factor limited the possibility to observe significant differences between the three groups of children. A second limitation was that we focused on mothers' speech, and therefore no data about children's language was collected. This means that we could not assess whether changes in maternal MSL were partially due to simultaneous changes in the internal and non-internal language produced by children. Finally, no attempt was made to investigate children's performance in false belief tasks, although previous research indicates a close link between children's ToM and mothers' MSL (Furrow et al., 1992; Jenkins et al., 2003; Rudek and Haden, 2005; Symons et al., 2006; Pearson and Pillow, 2016). Even with these limitations in mind, we believe that our results may represent a starting point for future research.

Longitudinal studies should be conducted to delineate any parallel change in children's social and emotional development. Moreover, interventions can be planned in cases in which the narrative interactions between mothers and children are limited in frequency or dysfunctional (Tompkins and Farrar, 2011). In this respect, the use of language intervention practices is now well established in a variety of conditions, including children with language impairments (Cirrin and Gillam, 2008), children coming from economically disadvantaged families (Cain et al., 2005), and bilingual/immigrant children (Pirchio et al., 2015, 2017). This growing body of research has begun to document the fact that training mothers to talk elaboratively about past events can have positive effects on children's understanding of mind (Peterson et al., 1999; Reese and Newcombe, 2007; Reese et al., 2010a,b; Taumoepeau and Reese, 2013). More generally, interventions that induced caregivers, teachers, and educators to increase the frequency of book-reading interactions have reported significant benefits to children's oral language and their emergent psychological lexicon (Whitehurst et al., 1999; Aram and Biron, 2004; Aram et al., 2013; Grazzani et al., 2016). The present study adds to this literature by suggesting that, in addition to enhancing the overall quantity of elaborations produced by caregivers, training interventions should also focus on fostering the use of specific categories of mental state terms (communicative, volitional, and cognitive) and increasing the references to agents other than the book characters.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of AIP guidelines, with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the local ethical committee.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Life Themes and Interpersonal Motivational Systems in the Narrative Self-construction

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What makes unique and unrepeatable individuals is their ability to write their own story attributing meaning, sharing it through narration, giving coherence to the information related to the interpersonal motivational systems, and creating alternative hierarchies to those biologically provided by the genetic code. Through clinical narratives and narrative literature, we can observe the recurrence of specific topics, across time and different cultures. Hence, we wondered whether there are some evolutionary suggestions that guide us in the construction of the narrative-autobiographical contents. In this article we proposed a theoretical-clinical hypothesis about the existence of a biological disposition to identify as fundamental six Life Themes (LTs) that contribute to defining the image of the self and the world: Love, Personal Value, Power, Justice, Truth, and Freedom. Besides the innumerable narratives dependent upon context, there may be many ways of telling stories that, instead, would be reported to these few essential themes. A narrative review of the literature about these concepts follows the systematic explanation of the perspective about the LTs as attractors of meaning. The manuscript considers also the process of co-construction of meanings within the interpersonal relationships and the influences of these on the narratives. In particular, we focused on the importance of episodic and autobiographical memory related to the attachment and significant figures, in the construction of the personal story and the LTs. We also explained the possible clinical implications of the theoretical hypothesis of LTs. Within clinical conversations, the LTs could be expressed rigidly or, otherwise, in a confused way. The lack of narrative integration may lead to the dominance of chaos or rigidity that generates suffering. A better comprehension of the LTs in patients' narrations could be useful to identify a narrative profile about the areas of greatest suffering related to the idea of self and the world, as well as to construct an adequate care plan.

Keywords: narration, life stories, narrative themes, interpersonal motivational systems, meaning-making, theoretical model

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FUNCTIONS OF NARRATION AND THE SEARCH FOR MEANING

A complex innate perceptive and motor network drives human behavior from the earliest moments of life (Lambruschi et al., 2004) to generate a series of representations that regulate, select and process perceptual information and social actions (Liotti, 1996). These representations are adaptive suggestions called interpersonal motivational systems (IMSs) (Liotti and Gilbert, 2011).

Caregiving, attachment as wells as competitive/ranking, sexual-mating, and co-operative systems are specific for each critical situation that can be addressed through an appropriate interpersonal position and are activated and deactivated based on whether their goal is met (Liotti and Monticelli, 2008). In the history of human development, alongside the more archaic "reptilian" motivations (related to the regulation of basic homeostatic systems, survival and reproduction) and to the "limbic" social motivations (MacLean, 1984; Liotti, 1994), there are motivations associated with the neocortical brain (related to the intersubjective meaning system) which allow the organism to carry out an evolutionary passage (Veglia, 1999).

Liotti and Monticelli (2008) identified the most recent epistemic motivational systems (EMSs) supported by the activity of neocortical circuits and neural networks that mediate interhemispheric connectivity. These systems involve the ability to share and co-construct personal meanings and mental states.

The new evolutionary goal directs an individual to attribute meaning to his/her life by giving order, consistency and unity to the knowledge possessed and incarnated through the activation of the oldest limbic and non-social motivational systems to harmoniously organize his/her vision of self, others and the world. This evolutionary innovation, integrated with the purposes and advantages of previous goals, introduces the need to link elements of reality, perceived through logical and causal links, and to ask questions about the world (**Figure 1**). The individual makes meanings and creates new ways of conceiving and inventing reality (Bruner, 1997). In addition, in interpreting human action in terms of intentional states, he/she tends to tell a story that assigns a plausible meaning to the self and others (Feldman, 1997). Thus, the tools provided to carry out this new evolutionary mandate include the sense of time, integration of semantic and episodic memories, construction of mental images, languages, and metacognitive functions. The sense of time and the ability to link events distant from one another in space and time has been suggested to be closely related to the ability to tell stories and, in turn, to the development of communication based on the language (Ferretti, 2016).

The narration hypotheses, supported by Bruner (1990, 2003), have been demonstrated by neurobiological studies based on neuroimaging (Young and Saver, 2001; Mar, 2004, 2011; Spreng and Mar, 2012). Young and Saver (2001) identified four types of "dysnarrativia" (narrative impairments following focal lesions in different regions of the neural network that mediates the creation of narrative). These types of autobiographic experiences include "arrested narratives," "unbounded narratives," "under narration," "denarration," and involve the networks responsible for the encoding of autobiographical memories, language, and organization of information in narrative frames (the amygdalo-hippocampal system, the left peri-Sylvian region, and the frontal cortices and their subcortical connections). These defects in narrative construction destabilize the individual's personality. The story comprehension has been found connected to a network of frontal, temporal and cingulate areas that are related to working-memory and theory-of-mind processes (Mar, 2004).

Other authors suggested that the roots of narrative are closely related to human sensorimotor intelligence; thus, meaning-making would be embodied and linked to the organization of the purposeful movement (Delafield-Butt and Trevarthen, 2015).

THEMATIC CONTENT OF NARRATIVES

What makes individuals unique and unrepeatable is their ability to write their own story by attributing meaning to external and internal reality, giving order and cohesion to information and knowledge related to the work of interpersonal motivational systems, and building alternative hierarchies to biological goals provided by the genetic code (Veglia, 1999). The opportunity to make stories contributes to creating that space of self-determination for which biological constraints do not constitute inviolable limits, but resources to draw what is possible. The peculiarity of a personal story also involves the specificity of the development of some narrative themes that are shaped like the expression of neocortical motivational systems. Along the gradual and progressive definition of the image of the self and the world in historical and narrative form (Damasio, 1999, 2010), the individual confronts himself/herself with the particular thematic constraints, which act as organizers of meaning in the experience and manifest themselves across cultures and organizations of personality (Guidano, 1987). These themes are constraints, but also opportunities, for the development of the narrative plot as they guide the attribution of meaning to experience, leaving creative freedom to choose from countless variations (Veglia, 1999, 2013).

McAdams (1996, 2001) identified some "nuclear" and constant themes that permeate life stories. He distinguished two main critical themes around which individuals extend the accounts of their existence: agency and communion. The agency is based on self-identification and affirmation. Concepts such as strength, power, mastery, autonomy, separation and independence are included. Life stories are organized around a central nucleus that sees the individual protagonist and master of his/her life. Inside agency it is distinguished as: *self-mastery; status/victory,* namely the recognition of a prestigious position within interpersonal relationships; *achievement/responsibility*, related to the realization, achievement of goals and assumption of responsibility; *empowerment*, which is growth and self-strengthening.

Communion, on the other hand, is indicative of the processes of sharing within interpersonal relationships. It is linked to experiences of affiliation, union and intimacy. Communion includes *love/friendship,* or erotic love or friendship with another person; *dialog,* which concerns forms of mutual and non-instrumental communication; *caring/help,* which concerns care, assistance, physical, material, social or emotional support; *unity/togetherness*, which refers to the feeling of union, harmony, intimacy, synchrony, loyalty, closeness, and solidarity with a group of people, community, or any other type of aggregation of individuals.

Within constructionism, Ugazio (2013) identified some *semantic polarities* (i.e., meaning dimensions and the antagonists

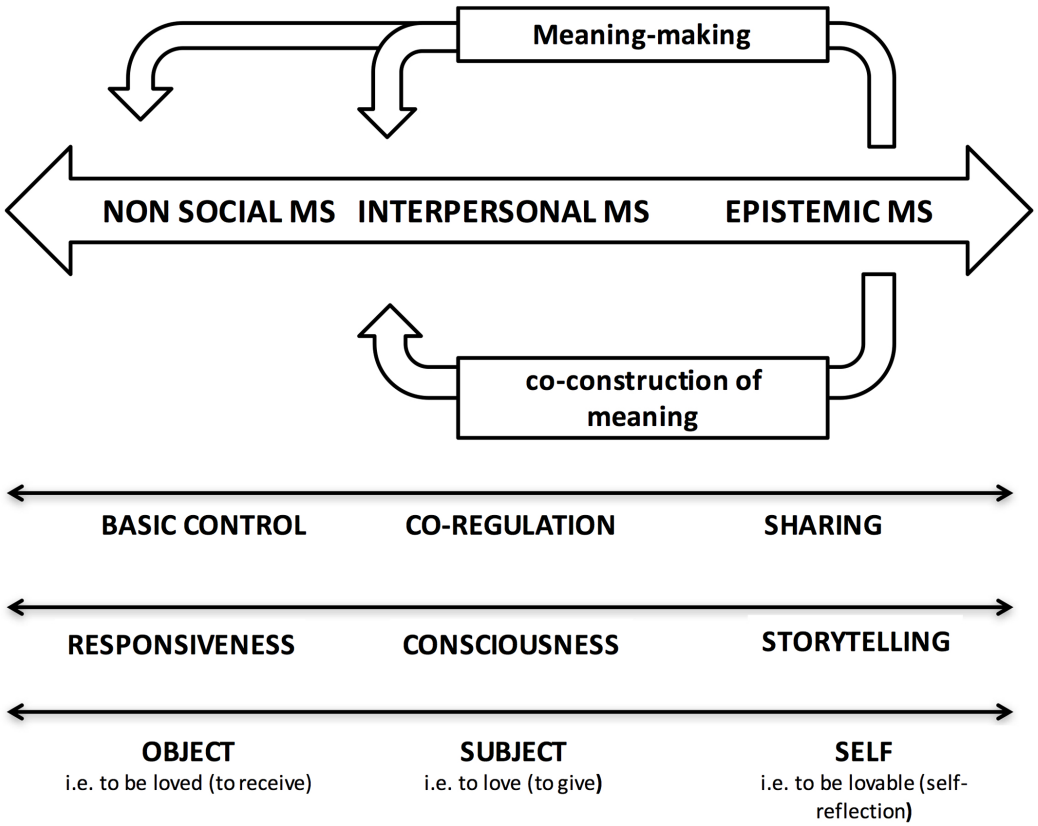

FIGURE 1 | The scheme summarizes the evolutionary steps according to the Triune Brain theory (MacLean, 1984). The development of epistemic motivational systems allows man to attribute and co-construct meanings to the world and the activity of the older motivational systems. On the bottom the figure illustrates the different trajectories that the thematic narrative can follow in the constant attempt to interpret the flow of incoming information. The bi-directionality of the arrows indicates the individual's ability to move in both directions along the continuum that connects the three evolutionary steps.

among them) around which each family organizes their conversations. Such "meaning organizers" identify what is relevant to a group, and articulates their experiences. Four sets of semantic polarities have been identified, nourished by specific emotions, called the *semantic of freedom, goodness, power, and belonging*. What is particularly salient is the reciprocal placements that the subject and meaningful people take in the family dialog with respect to the critical theme (Castiglioni et al., 2013).

THE THEORETICAL–CLINICAL HYPOTHESIS: CROSS-CULTURAL LIFE THEMES (LTs)

The existence of a biological disposition to identify as fundamental some LTs within which it is possible to carry out all our main biological goals in a structured and coherent manner has been hypothesized (Veglia, 1999). When IMS (Lichtenberg, 1989; Lichtenberg et al., 1992; Liotti, 2001) work, they follow in interdependence an evolutionary stage that involves the building of a coherent vision of the self and the world through which men/women can think and tell in a wide space of time (Guidano, 1987): LTs arise at this level. Reptilian and limbic motivations are lived by people as the primary needs to satisfy. Neocortical motivations are felt not only as a necessity but as something that allows us to approach what we consider the "true" purpose: the ultimate goal of life. In fact, neocortical motivations could be understood as a genetic invitation to carry out some LTs (Veglia, 1999). They are created on the basis of the significant life events, of individuals' interpretation, of the consequences they have derived. They contribute to defining the image of the self and the world.

Life themes can be considered as frameworks of common meaning to the human species and transversal to different cultures. Bruner (1990) described the "narrative genres" which impose thematic constraints on how to tell themselves and the world, but also allow for creative and personal variations. Narrative themes, therefore, should be considered not like scripts, but the primary, irreducible, and generative scenarios of countless, unique and unrepeatable texts narrated by individuals. While imposing thematic limits, the development of the neocortex offered the individual the freedom to create infinite variations on the subject that are as flexible as they allow the dialog between the different parts of the self.

Veglia (1999), in the first formulation of his theoretical hypothesis, tried to identify the primary thematic nuclei. Such systematization, in accordance with McAdams (1996, 2001) studies, included two thematic areas: *control/power* and *semantics/sharing*. The two thematic areas, through the formation of Me/You (sharing) and I/It (control) (Buber, 1923) relationships, contribute to the development of their own story and the achievement of increasingly complex goals. The area of *control/power* concerns issues that involve the possibility of having control over the survival, mating and maintenance of the wellbeing for self and offspring through automatic and partially intentional actions. The themes of the *semantic/sharing* thematic area underline the importance of interpersonal relationships and the influence they have on the attribution of meaning. These areas allow us to develop more themes and form the plot of our knowledge and our story. Each theme has intrinsic and optional development lines, each of which, through their continuous interconnections, influence in different ways the perception of self, behaviors, future design, cognitive styles, relational styles, articulation of knowledge, as well as the construction of organized social systems, cultures, and stories.

In a second formulation of the theoretical hypothesis, Veglia (2013) identified six recurring, transcultural, and trans-organizing LTs, within the previous two thematic areas, that would be expressed as the attractors of meaning and would be delineated through phylogenetic evolution and ontogenetic development of the various relational positions, and interpersonal motivational systems, such as attachment, caregiving, competitive/rank, sexual-mating, cooperation and belonging.

Narrative themes have been identified with reference to the analysis of mythology, narrative literature, anthropological, philosophical, psychological, and neuroscientific essays as well as the analysis of hundreds of clinical stories (see **Figure 2**).

The analysis, carried out over several years by a research group within the Department of Psychology of the University of Turin and a clinical group within the Crocetta Clinical Center in Turin, both led by Fabio Veglia, developed by applying focus-group and consensus-conference methods. After a broad brainstorming, constraints were created for generating conceptual maps using five main criteria.

The first criterion was the theme's irreducibility (i.e., the inability to consider the narrative content as part of another theme, regardless of the possibility to combine several themes to generate stories). The second criterion was the utmost independence from contextual characteristics (i.e., the inability to bring about the existence of the narrative content under consideration to a peculiar feature of a single, historical, geographical, or anthropological context by its nature not being necessarily recurring or non-generalizable). The third criterion was the presence of the theme in every culture and every historical period examined, regardless of the innumerable modes and possible recombination of its development. The fourth criterion was the intrinsic structural capacity of the theme (also called the "semantic attractor" or "narrative theme" or "life theme") to attract and generate meaning both in the form of expressions (even non-linguistic) and in the construction of the self and the dialog between parts of the self. The final criterion was not meeting the inclusion criterion of the simple high occurrence of arguments, contents, mechanisms, processes, mental states, attributes, meaning organizations, life events, mental representations that are often referred to as "themes."

The six Life Themes that emerged have been named: Love, Personal Value, Power, Freedom, Truth and Justice.

Subsequently, the six themes were subjected to qualitative analysis using the transcripts of the Adult Attachment Interview (AAI, George et al., 1985, unpublished). This strategy was in accordance with the hypothesis of continuity between the expression of the limbic/relational attachment/caregiving system and the neocortical system related to the attribution of meaning to the self and the world through the memory of significant interactions. This study highlighted the presence of the LTs in the AAI transcripts even though they were not the subject of the questions. Furthermore, these LTs were linked to the different states of mind with respect to the attachment. It allowed dissolving reservations on the theme of *Justice* which, according to the first hypothesis, seemed to be a derivative of the narrative of other themes, not respecting the criterion of irreducibility (Di Fini, unpublished doctoral dissertation).

An exploratory study of psychological literature was conducted on the six attractors of meaning identified by the theoretical–clinical hypothesis of Veglia (1999, 2013). With regard to the nationality of the authors of identified articles, most of the studies were conducted by Americans, followed by Canadians, Israelis, Dutch, English, Germans, and Australians. With respect to the historical trend of scientific articles from 1950 to the present day, frequency analysis showed a strong growth since the 1970s. This upward trend seems to be steady until today.

Referring to the content of the articles, there was great heterogeneity in the areas in which each theme was investigated: from the area of general psychology, to the discipline of psychotherapy, to social and developmental psychology.

The narrative review of the literature about each construct follows the systematic explanation of the perspective about the LTs as attractors of meaning. Instead, for the description of the axes, along which LTs may position themselves, see the section "The theoretical–clinical hypothesis: cross-cultural axes."

Love

In terms of evolution, the Love theme is in direct continuity of the experience of caring (caregiving), the search for proximity (attachment), sexual intimacy (sexual-mating system), friendship (co-operation) and is supported by neocortical motivations that allow men/women to be conscious and free.

The analysis of the substance of the love experience is beyond the boundaries of this work and of this discipline. This object of study has been always immense, mysterious, and irreducible for everyone who has approached it. However, the need to live and tell love by different expressions, interests, moves and guides all human beings.

Love, so different in its forms, but unique in something of its essence, is more than the proximity and protection by a safe base. Love is *philia*, *agape*, *caritas*, *eros*, friendship, shared

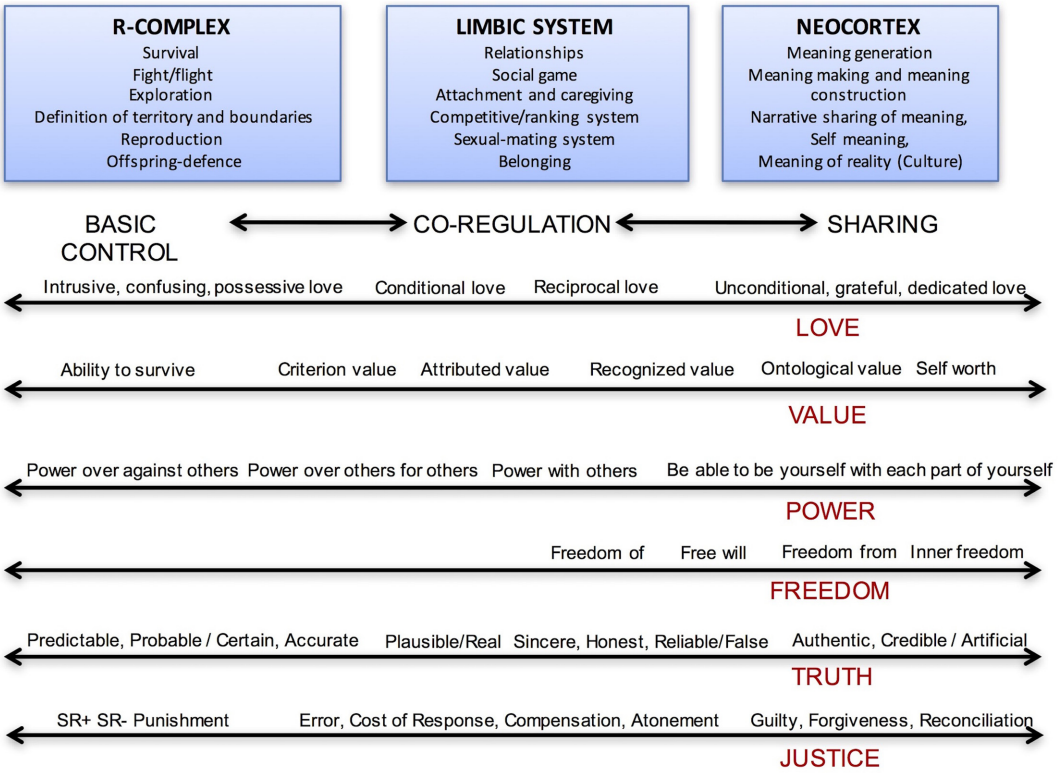

FIGURE 2 | Life themes and their different meanings along the continuum of evolution. The six themes meanings along the two-way arrows represent the tools that allow the narration to move through the three evolutionary steps.

and incarnated attribution of meanings through the body, its signs, emotions, and also (but not necessarily) through the word (Veglia, 1999). In this article, we refer to all these ways of love and its countless other possible manifestations.

We can hypothesize three narrative positions used to describe love: to be loved, or the object of someone's love, regardless of the quality of that love; to be loving, as a subject of love, though not necessarily in a relationship based on reciprocity; to be lovable, as perception, representation, and self-narrative.

Obviously in terms of presence/absence there may be those who have not been loved, disliked, and not recognized as a lovable person.

The positive/negative quality of the narration involves the position of having been badly loved, or having expressed his/her own love toward others in the form of control and possession, or having obsessively doubted even in the absence of well-founded motives of his/her own amiability.

The most complete expression of love narrative is based on the human capacity to generate and share the meaning of new tales and the high integrative abilities of the neocortex. It involves unconditional love, able to recognize others, be devoted to others, and be respectful of their boundaries, inexhaustible, manifest, and proactive. Hence, potentially, this is the love of parents, friends, and, in some cases, of partners.

The experiences of love based on emotional co-regulation are more conditioned, but still beneficial. These put an "I love you if you love me" constraint by reducing mutual freedom, but also the serious risks of suffering related to unconditional love.

Conversely, in its less integrated and more controllable expressions, love can be a semantically negative experience. A person who invades, uses, constrains, limits, confuses, scares, threatens, or humiliates the object of his/her love turns narrative into a toxic and traumatic experience for each person, but ultimately for himself/herself. Many wounds of the body and spirit are suffered in the name of love. The graphical representation of this Theme is reported in **Figure 3**.

In literature *Love* seems to be considered among the most intense feelings of human beings and among the most investigated ones. In fact, most of the articles considered for this topic tried to explain what love is by offering a wide variety of models and approaches.

Maslow (1962) made a distinction between Deficiency love (D-love), which emerges from the insecurity and lesser emotional need of an individual, and Being love (B-love), which emerges from a high emotional need of an individual. Livingston (1980) considered love to be a process of reducing uncertainty. The definition proposed by Pope (1980) seemed to proffer a great deal of agreement and seemed to capture the many affections and cognitions associated with love.

Rubin (1970, 1973) developed a "Love Scale" based on three theoretical components: the "Affiliative and dependent need," the "Predisposition to help," and the "Exclusiveness and absorption."

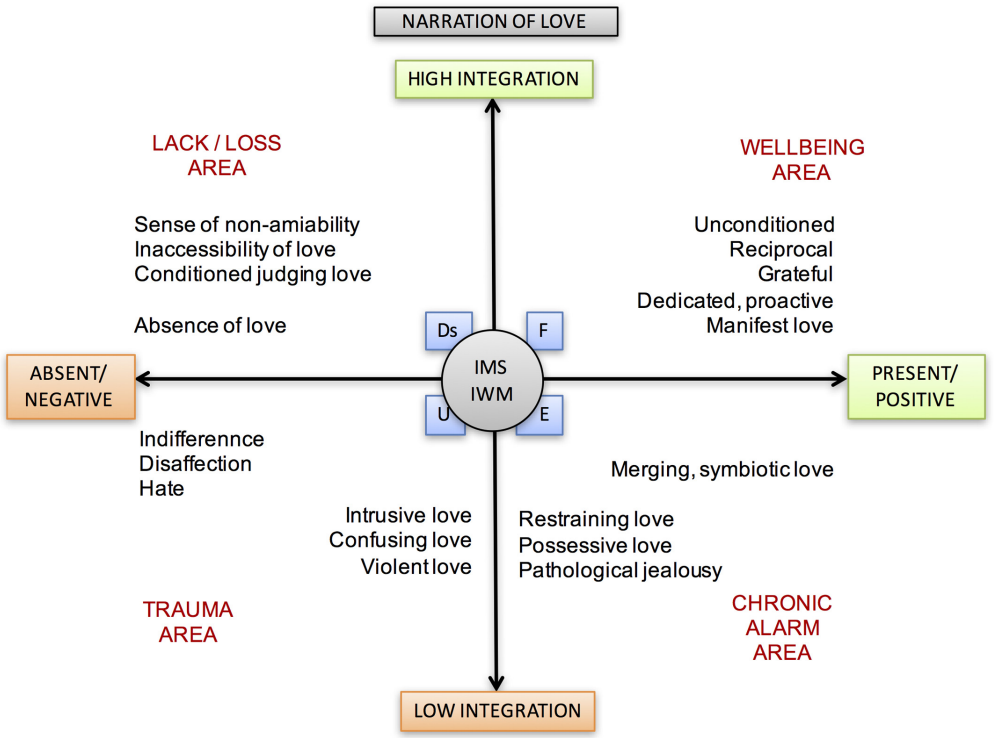

FIGURE 3 | Narration of Love theme and its different meanings according to its position in the areas between axes.

A scale of love measurement based on a different theory was proposed by Steffen et al. (1984). It is based on Tennov's (1979) theory of limerence, which defines it in terms of an intrusive cognitive activity, acute desire, addiction, and physical sensations in response to a loved one, painting it as an extreme romantic attachment to another person. Lee (1973) built a typology of styles of loving by analyzing the literature. This typology distinguishes six types of love (three primary and three secondary): *Eros* (romantic and passionate love); *Ludus* (love as interpersonal play between different partners); *Storge* (an inclination to fusion and friendship, without passion); *Mania* (a dependent and possessive love); *Pragma* (a rational calculation with focuses on the desirable attributes of the partner); *Agape* (a disinterested and unselfish love). Secondary styles are conceived as chemical compounds of the primary elements, and although all styles are interrelated, each one has qualitative independent properties.

Fehr (1988) identified a set of 68 characteristics of love, such as "love," "in love," and "liking," which seem to have a clear prototypic structure in the sense that some features are good examples of the concept. In psychotherapy, Natterson (2003) observed that love is a fundamentally dynamic element of the therapeutic process as any intimate relationship. Our article portrays therapy as a process of mutual love subject to the many vicissitudes to which love is concerned.

Value

The neocortex appears to push into estimating personal value and to consider it as a property of the self, hoping to see it recognized by others and thus shared. This theme is in continuity of the immediate evaluation of survival and reproduction capacity (R-complex) and the subsequent evaluation attributed by our conspecifics to our strengths, abilities, and competencies through the typical activation of interpersonal motivational systems (limbic system).

It involves types of value (considered to be a system of personal features that qualify an individual) that differ from each other according to the ways of assignment and attribution within interpersonal relationships. We distinguish, on the one hand, a *criterion* value if its attribution is based on external and quantifiable criteria and, on the other hand, an *ontological* value if its recognition describes the person's mode of being, according to internal parameters. The first one leads to a permanence problem because it will be attributed to the person until the criteria are respected. The second one will not be exhausted because it will not be contingent or tied to specific conditions, but will represent the essence of the individual, which persists even after a total disregard of all his/her properties.

As shown in **Figure 4**, in some cases, the concept of value assumes a relational connotation: we must seek dialog and relationship with others to continue to confirm and retain the feeling of having a value. Within interpersonal relationships, the value can be attributed, and generates for the individual a condition of expectation and dependence on the assignment and judgment imposed externally. On the contrary, it can be recognized in a climate of sharing and co-construction of the meaning. For a signal of personal value to be recognized

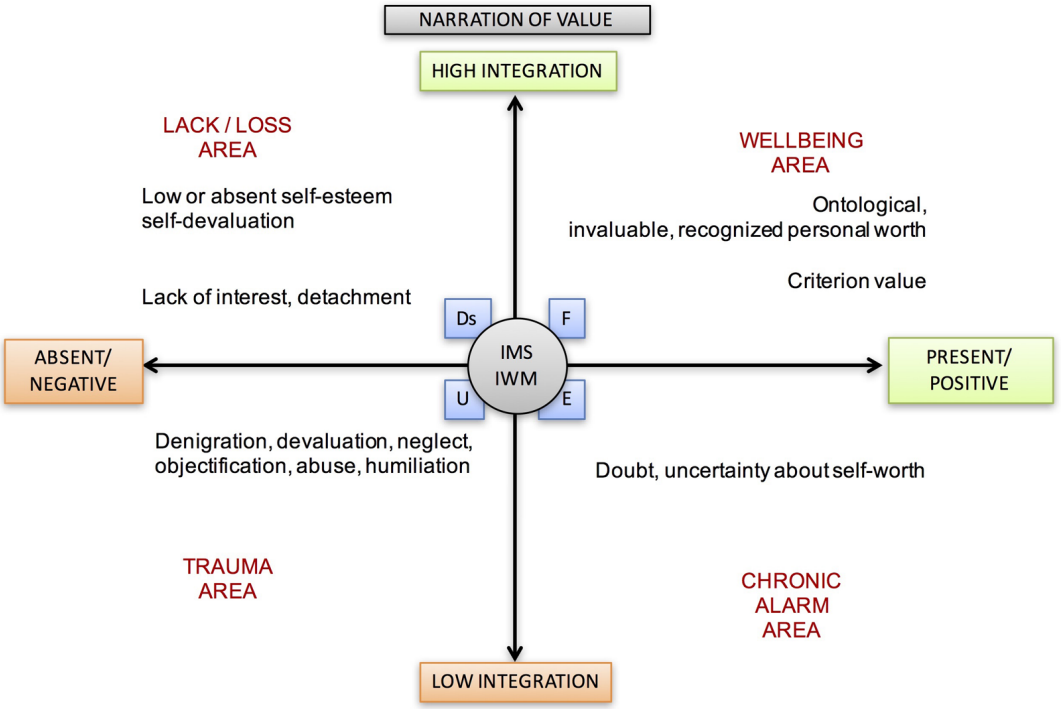

FIGURE 4 | Narration of Value theme and its different meanings according to its position in the areas between axes.

as effective requires a negotiation and sharing of meanings. The estimating indicators do not necessarily have to coincide with the rank indicators produced by the expression of the competitive/ranking system (Veglia, 1999).

With respect to *Value*, it seems that scientific research focuses on self-esteem as an operationalization of the Value theme. In particular, this construct is present in the literature in the dual meaning of self-esteem and self-worth. The concept of self-esteem means self-evaluation by the subject if the criteria for estimation are externally decided; self-worth means self-evaluation by the subject if the criteria are internal. Developmental psychologists (Erikson, 1963; Sroufe, 1978) gave great emphasis to the role of the early emotional experiences in determining the sense of emotional wellbeing, personal value and self-esteem. Children, presumably, learn whether their environment is loving and satisfying or hostile and frustrating, before the development of a complex cognitive system capable of evaluating specific beliefs about the self.

Drawing on the theory of self-determination, Pyszczynski et al. (2003) argued that people seem to feel better if their self-esteem is based on abstract and unique features rather than if it is based on more superficial aspects. However, according to Crocker et al. (2003), self-esteem is partly based on receiving the approval and liking of others (Mead, 1934; Coopersmith, 1967). In fact, self-esteem is generally correlated with the positivity of what people think others think of them (Coopersmith, 1967; Bowlby, 1982).

Furthermore, religious belief is also moderately associated with self-esteem and other aspects of psychological wellbeing (Baker and Gorusch, 1984; Bergin et al., 1987; Nelson, 1989). Religion can have positive effects on self-esteem through the belief that a person is loved, esteemed and unique in God's eyes. Another potential contingency for self-esteem is the morality or virtue of a person (Coopersmith, 1967; Benson and Lyons, 1991), because adherence to a moral code can lead to judgment that a person is good, moral and worthy.

Power

At the limbic motivational level, the competitive/ranking system (Liotti, 2001) regulates the ability to compete with others to defend privileges and gain new benefits by defining social ranks and resource-regulated access. At the neocortical level, the Power theme is a narrative framework within which there is thinking and telling of the stories of competitions. It also refers to the personal sense of control of oneself, others, and events, accompanied by the individual's awareness of being an active author of a project. Humans are obliged, for survival, to keep control of the physical and social environment to make more effective interactions with other conspecifics. Through metacognition, individuals make understandable to others the relationships and forms of control. The position of each of us with respect to control and being controlled contributes to the construction of the self and defines the perception of personal power (see **Figure 5**).

Power, because it not always involves shared possibilities, can include multiple effects within interpersonal relationships. *Power over others* is often synonymous with abuse and submission, and rarely is managed for the benefit of the group; it can become risky if its management represents a source of value. The *power for*

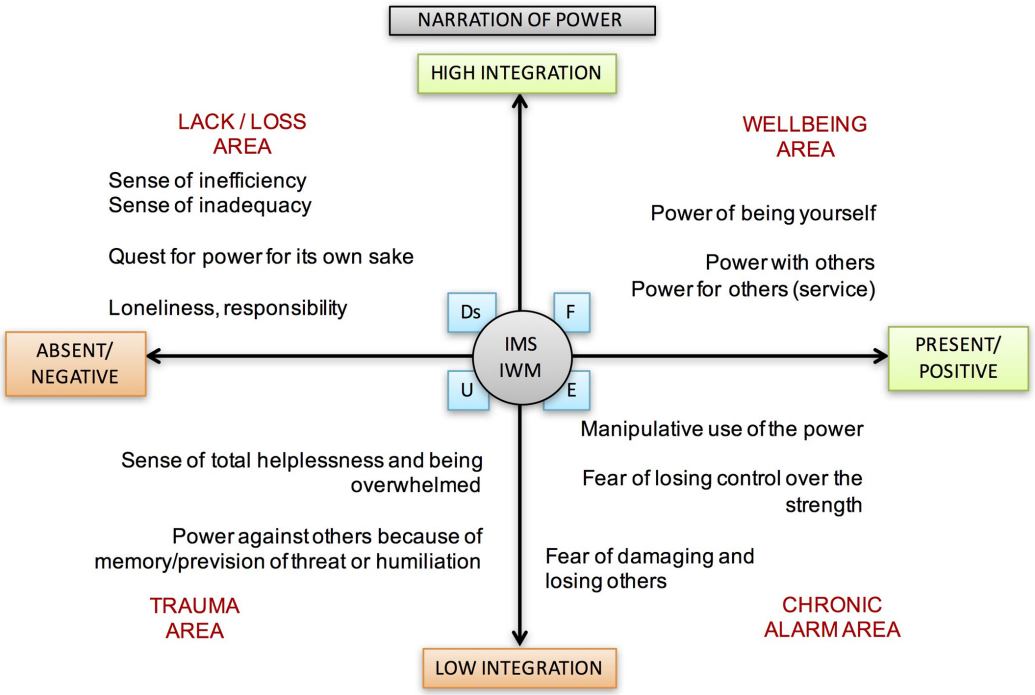

FIGURE 5 | Narration of Power theme and its different meanings according to its position in the areas between axes.

others is exercised in favor of a single person or a group (power is a service). *Power with others* involves solidarity and co-operation among people who share it in collaboration for a common goal.

The most meaningful power is, ultimately, the ability of being freely and authentically yourself with every part of the self. It involves the ability to become accomplished without having to adapt to the desires of others. However, "in order to be me" it is necessary for the existence of a grateful and respectful "you." This particular sense of power is similar to the concept of mastery (Semerari et al., 2003): management of individual mental states also in relation to the elaborated theory of the mental states of others.

In the literature, the *Power* theme seems to play a key part. The most frequently encountered perceptions for this Theme are "Power of" and "Power on," which is otherwise called control.

Decades of research in sociology and psychology have shown that the perception of control is a strong predictor of physical and mental wellbeing (Rodin, 1986; Bandura, 1989; Fiske and Taylor, 1991; Thompson and Spacapan, 1991; Lachman and Burack, 1993). According to Wong (1992), life is an unstoppable search for control: much of our time is spent in the effort to reach the sense of control. Conversely, aggression and conflict, submission and domination, negotiation, and cooperation are just some of the ways people try to solve control issues. Another interesting development in this area was the discovery that people have beliefs about how they can control their behaviors, emotions and attitudes in the sense of modifying or regulating them (Baltes and Baltes, 1990; Brandtstadter et al., 1993; Skinner and Wellborn, 1994). In this case, beliefs about control contain perceptions of the degree to which individuals can produce the desired results or prevent unwanted ones within themselves. The need for expertise is closely related to other control constructs; nevertheless, the notion of a psychological need of effectiveness as a source of motivation is distinct from subjective, objective, and experiential control. The need for competence is often confused with the need for autonomy or self-determination and, therefore, the constructions of perceived control are often confused with the belief system resulting from autonomy experiences, such as the locus of causal attribution (Rodin, 1990). Hegarty (2007) reported that psychologists seem to have largely ignored the way power works in real communities: who exercises it, where it derives, and how it is used to influence the attitudes and behaviors of community members. Considerable attention has been paid to these important issues by sociologists and political scientists.

In their revision of the literature on power, Keltner et al. (2003) suggested that power activates a general tendency to approach, whereas lack of power activates a general tendency to inhibition. If this were true, power-loving individuals should exhibit greater orientation to action than those without power, regardless of the social consequences of their actions. However, other researchers showed that power not always leads to antisocial consequences, but may be the catalyst for achieving prosocial results that might not be realized otherwise. In addition, those studies demonstrated that power can be conceived not only as an aspect of social structure, but also as a cognitive structure that can be triggered by appropriate environmental stimuli.

Galinsky et al. (2003, 2006) defined power as the ability to control one's own or others' resources without social interference (Thibaut and Kelley, 1959; Keltner et al., 2003). In many conceptualizations of power, the ability to influence and control the behavior of others is of primary importance (French et al., 1959; Manz and Gioia, 1983; Oshiaki Imai, 1993; Copeland, 1994). This type of power has been called "social power" because it derives from an individual's relationships with others (Fiske, 1993; Overbeck and Park, 2001). For Winter (1973), "power motive" designates the need to be authoritative, effective and have an impact on the surrounding world. Submitting to power is also a strong motivation to increase personal status or prestige. The Power theme in the sense of human possibility, and self-realization as the full affirmation of the most intimate essence of the person was taken up by McClelland (1975) in describing two tendencies of the individual: achievement and power motives. The first one is a type of personal achievement that uses feedback mechanisms to control one's own success; the second one includes a form of decline in personal power, or in the shade of power over others, or in institutional (or even social) power.

In a clinical setting, De Varis (1994) stated that power in the therapeutic relationship is like a double-edged sword which can either release the patient from the chains of psychopathology or, unknowingly, reduce the patient's empowerment.

The process of effective therapy provides considerable power and respect to the patient; it activates the patient's ability to cure himself/herself and his/her active participation in the change process. This strengthens the patient, reduces his/her arbitrary sense of authority, and strengthens mutuality; it also increases, clarifies and reveals the patient's personal power to himself/herself. In this process, the therapist, who was initially idealized, is finally recognized for his/her humanity, fallacy, and internal conflicts.

Freedom

This theme refers to the possibility of free choice, which probably belongs only to humans. Freedom emerges with partial evolutionary discontinuity and along with the new narrative possibilities that bring us into our cognitive horizons and greatly increases the risks associated with choices and decisions. Hence, it also takes shape in our stories in relation to the limits and boundaries necessary to stifle the experiences of anguish, confusion and disorientation that would result from its tendency to infinity (Castiglioni et al., 2014).

The share of freedom in an individual's life is indispensable for dealing with ethical issues and should be in balance with that portion of protective constraints that enables us to outline action plans in our life story. The limit of every personal freedom is the freedom of all other persons, so we must limit ourselves to receive mutual assurances. The notion of responsibility as the ability to guarantee safety within social relationships derives from this narrative theme. The Freedom theme is, simultaneously, the content and framework of the other themes, as well as the requirement for the existence of ontological value, of being yourself and of unconditional love. The freedom to act, express, and speak represents the different forms freedom can assume in the world of an individual's meanings and to make sense, especially within meaningful relationships.

Apart from the freedom to express, choose and decide, we can conquer, with the process of individual growth, the partial freedom from our inner constraints, which we normally perceive as irreplaceable and which dramatically limit needs. Adults who take care of us, accompany us during childhood and adolescence, must support us in the struggle for liberation from the irrepressible impulse to immediately satisfy our needs. The inner discipline resulting from it can give us new wide spaces of semantic and procedural freedom.

Finally, we distinguish the concept of free will, in which the general possibility of choosing anything, regardless of its ethical value, and the idea of freedom as an opportunity to choose from the infinite opportunities to preach the "good" (Saint Augustine, 5th century AD). The problem in this case is not to opt for socially negative behaviors, but to assess whether this option is self-narrative without triggering internal conflicts. In other words, the condition for freedom is represented by the possibility of telling one's actions, as well as guaranteeing access to the sharing and negotiation of their meaning. The increase in the degree of freedom and, simultaneously, of the flexibility with which it attributes meaning to experience, is the minimum requirement for any possibility of change. The graphical representation of this Theme is reported in **Figure 6**.

The basic problem pursued by psychologists who deal with *Freedom* comes from observing a broad belief in individual freedom and the indeterminacy of human action. It is important to recognize the distinction between freedom as a formal assumption of a psychological theory and personal conviction (Mandler and Kessen, 1974; Mandler, 1994).

Steiner (1970) introduced the concept of "perceived freedom." His conceptual analysis distinguished between two aspects of perceived freedom: "Outcome Freedom" and "Decision Freedom." The first is the estimated likelihood that the goal of each alternative course of action can be reached. The second is the degree to which the actor is seen as the critical determinant of the action, and not constrained by external conditions such as differences in the costs or benefits associated with the different rates of action. Once a value has been established for freedom of decision, Outcome Freedom influences the value of alternatives and changes the value of Decision Freedom.

In a 1997 publication, O'Connor et al. (1997) said that it is usually the negative aspect of freedom that leads people to approach psychotherapy: the desire to be rid of the weight of thoughts and emotions that reduce their freedom and act according to their wishes. In the course of psychotherapy, the positive aspect of freedom is cultivated in a context conducive to autonomy and self-regulation as desirable goals. However, the transition from the notion of "self-liberation" to that of "self-control" implies the exploration of the complex interaction between the subjective sensations of freedom and the objective limits placed upon it. People can become anxious and fearful in the face of what they perceive as too much freedom in the absence of significant boundaries for choices and behavior (Fromm, 1942).

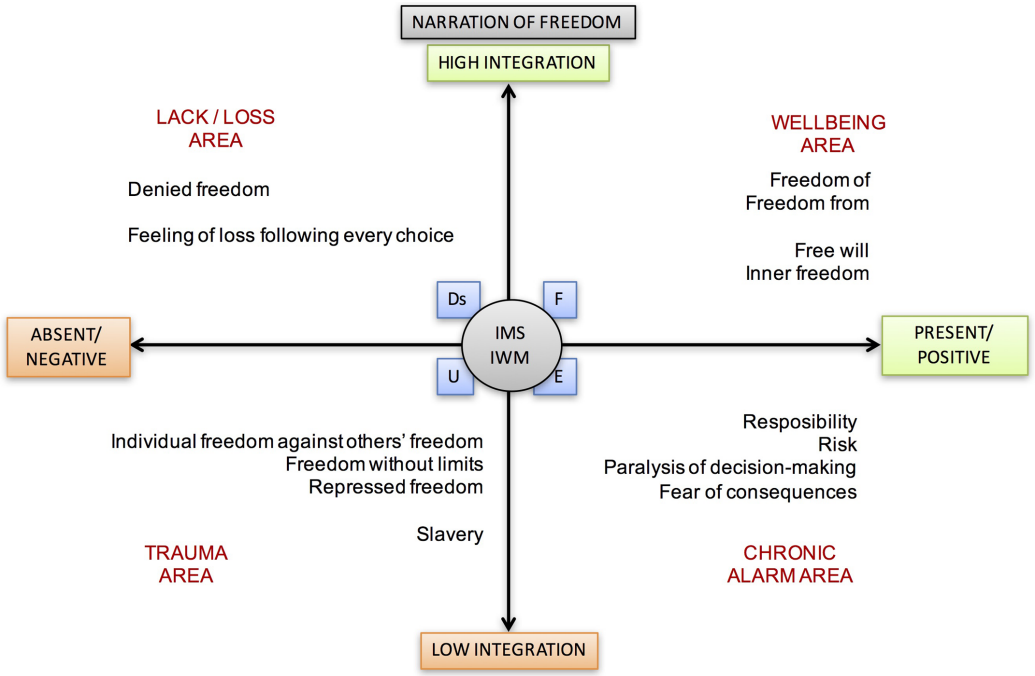

FIGURE 6 | Narration of Freedom theme and its different meanings according to its position in the areas between axes.

Truth

In terms of evolution, the topic of truth is linked to the need for living organisms to predict events as exact or probable in relation to the factual world. Unknowingly, the most archaic part of our central nervous system learns from experience, with reasonable chances of exercising sufficient control over the context despite the risk of developing superstitious behaviors.

Then, with the emergence of conscious awareness and intentionality, following the problem of prediction, there is the need to recognize and distinguish the true from false, or from deception and relational traps, or to pretend to gain relational benefits.

In its most recent semantic developments, however, this theme embraces and supports others as it directly represents the fulfillment of the third evolutionary mandate for the search for meaning. Here, truth is understood as the foundation for building meaning. The investigation of the truth within narrative plots means referring to its own way of telling the experience and explaining the continuous flow of time (Guidano, 1987).

However, if a person, in contact with his/her narrative truth, fails to accept it and coherently integrate it into his/her own story, he/she can create a sort of self-deception, "accommodation and adjustment of the truth," that makes it more compatible with the rest of the plot storytelling. It follows that there may be internal dissonances between the will to genuinely deepen meanings and the disturbance that derives from their examination. The Truth theme (see **Figure 7**) is carried out in full agreement with the constructivist view of knowledge as an incessant building-up based on experience, reflective reflection of one's own experience, on personal experimentation, and not on the search for an absolute truth that is alien to the subject's point of observation (Armezzani, 2004). It involves the search for the meaning created through the immediate comprehension of self-in-world, in which the other represents the necessary condition for validating and confirming our own perspective about the experience.

Justice

The Justice theme is extremely complex in its semantics, narrative forms, historical and cultural differences, and even more in precarious attempts for good administration. For a long time, we were hesitant about its inclusion among LTs.

In fact, it is closely related to Value, still in tune with merciful Love (severe punishment or forgiveness?), and employed constantly in trying to moderate the narration and arbitrary exercise of Power, Freedom, and Truth. It could, therefore, be traced back to the narratives of the other five themes and depend on them in their semantics without respecting the criterion of irreducibility. In fact, the research that we have conducted on AAI transcripts would show an autonomous structure of this narrative theme.

The most critical and perhaps more archaic positions in the narrative of Justice are related to the indifference to injustice, inability to assume responsibility for the damage or suffering caused to others, lack of guilt and to disposition toward repair and reconciliation. The poor integration of the semantics related to justice, the strong push to have control over others with every means at the expense of others and the experience of serious and protracted suffered injustices expose individuals and communities to serious psychopathological risks.

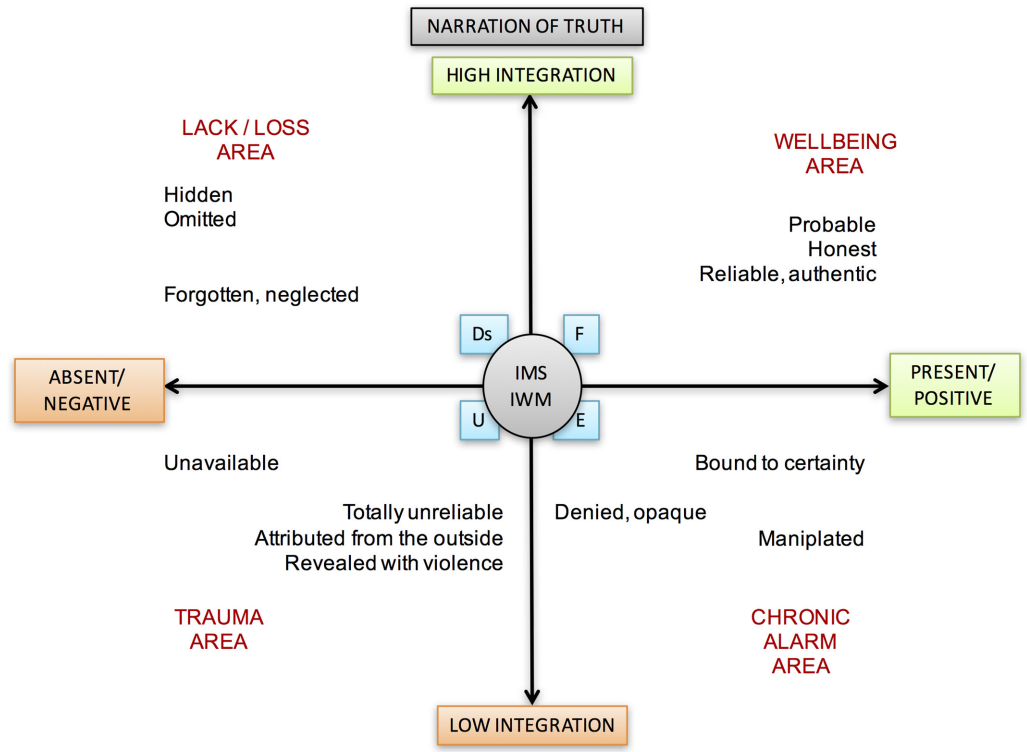

FIGURE 7 | Narration of Truth theme and its different meanings according to its position in the areas between axes.

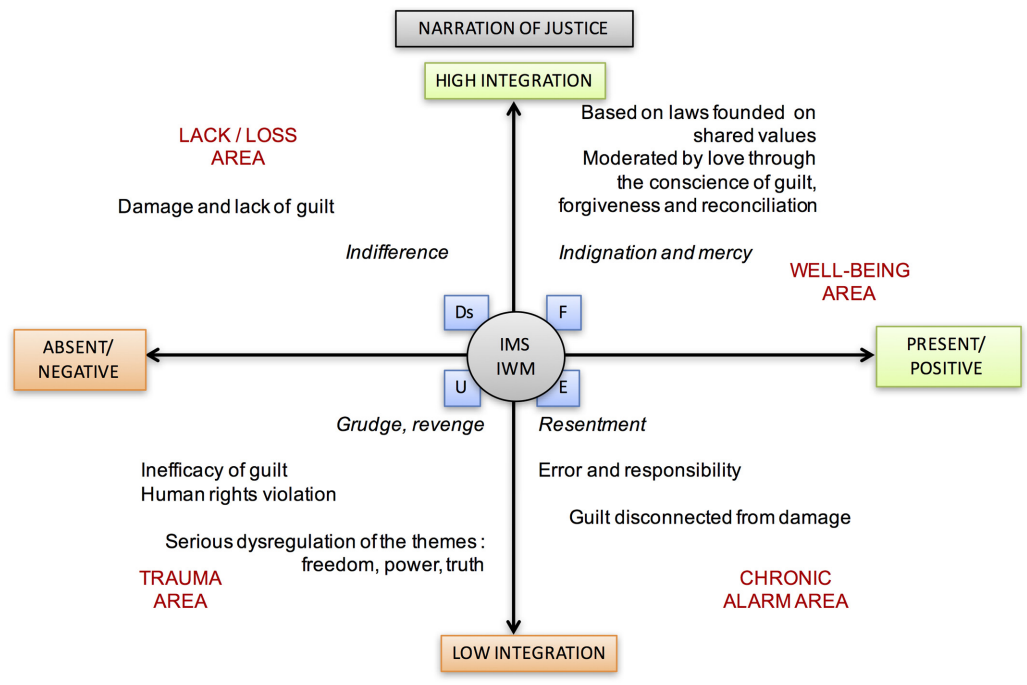

FIGURE 8 | Narration of Justice theme and its different meanings according to its position in the areas between axes.

Conversely, questioning the foundations of justice, the commitment to build it through a system of laws based on shared values, as well as combating injustice by mutual recognition of the same rights and duties protect us from semantic relational trauma and participate in the construction of a cohesive self-rooted in belonging to one's own community (see **Figure 8**).

At the evolutionary level, the narrative of the need for justice and the protest for injustice appears during childhood. However, its application is, for a long time, regulated by the outside and often, during adolescence, is perceived as a form of violence in a sometimes dramatic way of framing.

According to Colquitt (2001) *Justice* is involved in the field of organizational sciences. Justice is considered a social construction: consequently, an action is considered right if most individuals perceive it to be right. In particular, organizational justice can be described by focusing on the antecedents and consequences of two types of subjective perceptions: the correctness of the results of the distribution processes and the correctness of the procedures used to determine such distribution results. These forms of justice are typically referred to as "distributive justice" (Adams, 1965; Deutsch, 1975; Leventhal, 1976) and "procedural justice" (Thibaut and Walker, 1975; Leventhal et al., 1980). Efforts to understand the impact of justice on effective organizational functioning are included in the category of research on organizational justice (Greenberg, 1990).

Dzuka and Dalbert (2007) claimed that workplace justice matters to employees because these experiences meet the fundamental need to believe in a just world; on the contrary, experience of injustice can threaten this need by providing evidence of its infallibility (Cubela Adoric and Kvartuc, 2007). There are also empirical and theoretical reasons for considering belief in a fair world as a relatively stable conviction but, as Cubela Adoric and Kvartuc suggested, it is also conceivable that under certain conditions it may be weakened. A strong belief that the world is right will be linked to better mental health and wellbeing due to its association with the knowledge that helps us to function in everyday life, such as the confidence that we will be treated fairly by others and the perception of the significance of life events. According to many theorists of social justice, evaluations of fairness or iniquity are closely related to peoples' merits (Lerner and Whitehead, 1980; Lerner, 1987; Major, 1994; Feather, 1999). Moreover, these attributes strongly preach the impressions of justice and congruent emotions such as anger and rancor. There is, thus, the possibility of defining justice explicitly and largely in terms of what is deserved. According to Ellard and Skarlicki (2002), the factors affecting the merits of victims and observers and, therefore, judgments on equity, may differ.

In summary, the large number of articles confirmed the importance of LTs as powerful motifs of meaning from which individual and social narratives unfold. These Life Themes, in fact, are also present in a wide range of disciplines.

The first evidence emerging from qualitative analyses is that psychological research tends to fragment themes (as they are considered according to this hypothesis) in multiple dimensions and constructs. Moreover, because of this fragmentation, it is not always easy to attribute a construct to one topic or another.

Faced with the vastness of the results in many fields of interest in psychology, there are few studies on LTs in the purely narrative context. Thus, the "limbic" motivations are often confused with the higher "neocortical" motivations related to the attribution of meaning. Instead, the theoretical–clinical hypothesis of Veglia (1999, 2013) refers to conceiving these narrative themes as powerful organizational predispositions of narratives.

It might be interesting to repeat investigation of the literature at a deeper level of complexity and specificity to detail more clearly how these attractors of meaning are referred to.

THE THEORETICAL–CLINICAL HYPOTHESIS: CROSS-CULTURAL AXES

The narrative, conversational and relational nature of the LTs makes it necessary to locate the narrator's position and the direction of the "movement" associated with attributing meaning. Each person may alternatively be the object of attributing meaning to someone else, and the subject who attributes it to others and the world. Simultaneously, the individual can be the subject and the object of this action when he/she reflects on himself/herself. In **Figure 9**, we observe the six narrative themes studied in the three different positions and in the relational movements generated by them.

Study of the LTs has been formalized using three polarized axes. Each of these polarized axes describes a continuum of possible positions: starting from their common intersection at point 0, these axes identify areas of wellbeing and narrative suffering with all possible intermediate positions. Each of the areas is placed in connection with the four states of mind related to the AAI (*Free, Dismissing, Entangled,* and *Unresolved*).

At point 0, which generates the polarized directions of the three axes, early attachment/caregiving experiences and the related states of mind are represented. The three axes are described below.

Basic Control vs. Co-regulation vs. Sharing of the Theme

The prevalence and alternation of top–down and bottom–up activation related to the different life stories and to the flow of energy and information (Siegel, 2001, 2008, 2015) require a constant interpretation by the neocortex (especially in the left hemisphere) to maintain the consistency and continuity of consciousness and personal narrative (Gazzaniga, 2012). The brain continues to try to attribute meaning to automatic, unconscious and involuntary responses (*responsiveness*) and is modulated by older motivational systems and oriented toward the monitoring of context. Often, the subsequent narration is poor on relational and semantic levels, but effective in returning a sense of events and coherence with internal states. Conscious attempts (*consciousness*) to attribute sense and meaning to the thematic narrative are more evolved and effective if there are sufficiently good relational occasions. These attempts act through interpersonal co-regulation, based on the activation of polyvagal prosocial systems (Porges, 2001), interpersonal motivations (Liotti and Gilbert, 2011), and affective systems

THEME	OBJECT (TO RECEIVE)	SUBJECT (TO GIVE)	INDIVIDUAL (SELF-REFLECTION)
LOVE	To be loved	To love	To be lovable
VALUE	Attributed value Criterion value	Recognized value	Self worth Ontological value
POWER	Power by others Power received as a service	Power with others Power against/for others	Ability to be yourself with every part of self
FREEDOM	Restriction of personal freedom Granting freedom by others	Restriction of personal freedom Granting freedom toward others	Inner freedom Free will
TRUTH	Others as predictable / unpredictable Reliable/unreliable	To be predictable/Reliable for others	Authenticity Credibility
JUSTICE	Fair/unfair actions by others	Fair/unfair actions towards others	Guilt Forgiveness Reconciliation

FIGURE 9 | Meanings of the themes according to the interpersonal positions and movements.

sustained by the activity of the right hemisphere (Schore, 2009). However, the greatest narrative effectiveness is expressed through the semantic sharing in both its linguistic (*storytelling*) and expressive extralinguistic forms. The evolving advantages of the shared narrative of Life Themes also expose individuals to higher risks of interpersonal accidents and failures, and thus to top–down semantic traumas with consequent severe dysregulation of IMS activation and arousal.

Absent/Negative Narration vs. Present/Positive Narration of the Theme

The narrative of one or more LTs may have been excluded from experience due to the total lack of significant interpersonal occasions related to the semantic content expressed by the Life Theme. It may generate a serious narrative deficit and preclude the possibility of constructing an integrated and harmonic self (van der Hart et al., 2006; Lanius et al., 2010). In other cases, it may be inaccessible to memory because it is associated with severely and repeatedly traumatic relational experiences. It may have been removed to reduce access to excessively painful or disorganized mental or somatic states. It can be systematically avoided not to reactivate conscious traumatic memories. It can be easily accessible but negatively characterized so as to create dysregulated internal states or painful conflicts between parts of the self.

Conversely, it can be derived from rich interpersonal experiences, which are often positive and useful for building a wide and coherent self-concept and world-concept at the semantic level. The narrative of the Life Theme cannot be absent and positive (for a logical constraint) but can be present and negative. In this case it is placed in the axis portion with negative polarity.

Narration with Low Integration vs. Narrative with High Integration of the Theme

A narration with high integration is rich, coherent, extensive, extended in time, and continuous. It involves an articulated use of semantic, episodic and autobiographical memory. It highlights effective inter-hemispherical communication as well as good connections among cognitive, emotional, arousal, and action levels. It is normally associated with an excellent level of reflective function and Theory of Mind and, in a virtuous recursive process, generates and is supported by a good integration between the parts of the self.

The intersections between the three axes generate four different narrative areas within which the different themes can occupy all the positions arising from the different recombination. Therefore, each individual may have one or more themes located in each different area.

High presence and positivity of narration of the theme, high sharing, and high integration describe the area of wellbeing and resources.

Absence or negativity of narration of the theme, absence of integration, and lack of sharing describe the area of semantic trauma.

Absence or negation of the narration of the theme, but with sufficient integration and sharing describe the area of lack or loss of meaning.

Presence or positivity of the narration of the theme, but poor sharing and integration, describe the area of the chronic semantic alarm. For a graphical representation see **Figure 10**.

LIFE THEMES, INTERPERSONAL RELATIONSHIPS, AND ATTACHMENT SYSTEM

Narrative processes are not only responsible for the harmonization of different selves within the same person, but also of interpersonal integration (Siegel, 2001, 2008, 2015). As social processes, the narration, contents and tone of the story are affected by the influence of those who listen and thus contribute to the building of shared and collective meanings. In the construction of a personal story, attachment stories have a great importance (Bowlby, 1969, 1973, 1980, 1982). These stories are created within the relationship with the parents who, in turn, have a previous story and create a new one with us, laying the foundations for the realization of the goals in a unique way. The first are figures we relate to, the environment they offer us, as well as the cultural context we are part of, which are effective tools to differentiate and create our own personal story (Veglia, 1999).

Some studies (Oppenheim and Waters, 1995; Gini et al., 2007; Vetere and Dallos, 2008) have focused on the link between attachment and narrative based on the narrative assessment that evaluates both the content and structure of stories in childhood. Those studies were guided by the assertion that the particular way of interaction between mother and child is represented in the Internal Working Model of the relationship which will depend, on the one hand, on the flexibility in telling the experiences of attachment and, on the other hand, by the themes and consistency of these tales.

Thus, it was noted that as early as 6 years of age, children with a secure attachment elaborate narratives whose themes reflect the constant presence of parents, accompanied by rich and collaborative interactions and the representation of a good ability to face stressful situations (Oppenheim and Waters, 1995). Moreover, we can find a realistic description of oneself associated with the expression of both positive and negative emotions related to relationships, presented in terms of reflection and negotiation and without excessive anxiety with regard to communication processes (Farrar et al., 1997; Vetere and Dallos, 2008). Story processing by children classified as "insecure" is characterized by the disruption of relationship descriptions, inconsistent responses, or a reduced reflection on resolution strategies for the interpersonal problems. Other studies (Fivush et al., 2006; Fivush, 2008; Haden et al., 2009) identified different forms of mother–child conversation supported by many different elaborative styles with which mothers involve children of pre-school age in dialogs related to the past. The quality of attachment, therefore, can be a predisposing factor in the emergence of psychological disorders if we consider the various styles as meaning dimensions that can be elaborated on different levels of flexibility and generativity (Lambruschi et al., 2004). In disorganized attachment and consequent traumatic development (Liotti and Farina, 2011), self-depiction and autobiographical reconstruction of a person's experience of painful and fearful situations from which he/she felt overwhelmed may be fragmented and compromised (van der Hart et al., 2006; Dutra et al., 2009).

THE MEANING OF LTs IN CLINICAL PSYCHOLOGY

In recent decades, the literature agrees that a narrative approach is a useful clinical tool. In fact, a narrative approach based on the life stories of patients has become the focus of clinical practice (Veglia, 1999; Singer et al., 2008). This approach to psychotherapy focuses on the patient's life story as an opportunity to co-construct new meanings and readings of past experiences (White and Epston, 1990; Veglia, 1999, 2013; Goncalves et al., 2000; Angus and McLeod, 2004; Singer et al., 2008). This co-construction process, which also involves the sharing of emotionally relevant personal experiences, becomes the foundation for building a "therapeutic alliance" (Adler and McAdams, 2007). According to the authors who adhere to this approach, in the therapeutic work it is important to identify those repetitive patterns of emotions, representations of oneself and others, as well as positive and negative cognitions within autobiographical stories (Angus et al., 2004; Singer et al., 2008).

The development of LTs is the key to feeling like other individuals but, simultaneously, special beings with a specific identity. The individual has the ability and freedom to develop the themes in an original and particular way, but sometimes he/she is restrained by his/her own story, by life events, and the narrative structure of his/her tale. In therapy, in fact, stories that are carried out rigidly and stereotypically represent mostly an adaptation to dominant thinking. A static narrative, devoid of ideas and originality, imposes on the individual limits and constraints that cause a sense of confusion and suffering (Veglia, 1999, 2013). Thus, the therapist's work involves a re-reading of the patient's dominant story to offer him/her new narrative alternatives and the opportunity to continue his/her story around more centralized, self-centered themes.

Love, Value, Power, Freedom, Truth and Justice would, therefore, serve as attractors and semantic organizers by returning, on the basis of the occasions and limits that relationships and events offered to the patient, frames of meaning, identity, belongings and a unique and unrepeatable way of being himself/herself.

Unfortunately, autobiographical memory and personal narratives describe the main sources of mental suffering expressed in all its forms.

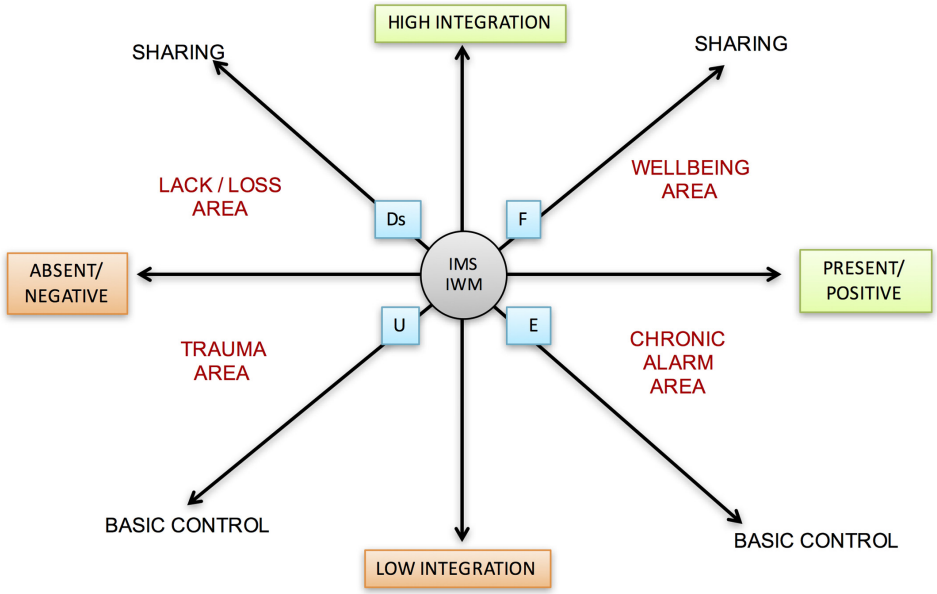

FIGURE 10 | Lines of development of thematic narration. This graphic illustrates the different axes, each of which describes a continuum of possible positions. Within the areas are also placed the connected four states of mind with respect to attachment (F, Ds, E, U). At point 0, attachment representations and the interpersonal motivational systems are represented.

Using the three axes proposed in this article, namely *presence/absence* of positive or negative narrative occasions, *high/low integration*, and *control/sharing*, it is possible to identify areas of greatest suffering, areas where it appeared (*lack/loss*, *trauma*, *chronic alarm*) and the predominant nature of the deficits and dysregulations of the narrative structure related to the idea of self and the world (see **Figure 11**).

By placing the weighed position of each narrative theme in relation to the three axes in a single map, a configuration of the areas of suffering, available resources and their connections, is useful for narrative understanding (diagnostics) and for the construction of the care plan.

For example, a graphic representation of the suffering and thematic resources of a patient with a psychiatric diagnosis of panic-attack disorders with agoraphobia, mild dissociative symptoms and severe deficiency of self-efficacy is shown in **Figure 12**.

It is clearly shown that self-representation with others with respect to the Love theme corresponds to a significant resource both in terms of love as well as the ability to give and receive love. Personal value is more uncertain; it suffers from more control, but still lies in an area of wellbeing. Instead, the meaning attributed alternately to Freedom is extremely distressing in terms of dysregulation of narrative control and integration. On the one hand, it is experienced as a strong push to the exploration and rejection of every constraint boundary; on the other hand, it is experienced as irreparable loss if he/she moves away from an attachment figure. This narrative mode is typical of patients with phobic disorders. The theme of personal Power is critical because of a narrative deficit in self-representation within a family narrative and poorly integrated with the strong sense of amiability described previously. From here, the lack of self-efficacy emerges. The traumatic nucleus, which is more difficult to access but is detected by mild dissociative symptoms, is related to the narration of the maternal and inaccessible truth theme, which hides the intriguing dramatic secrets of a patient with great confusion, loss and an overwhelming sense of helplessness.

The final thematic profile shown in **Figure 12** derives, in this case, from the analysis of the therapist's notes about a therapeutic session. The LT were identified through a coding process (which is already under construction by the Authors) that detects the occurrence of each LT within narrative units through general rules for the analysis. The different axes along which LTs are positioned are therefore considered as Likert scales.

In this case the narrative rereading of the six LTs placed on the three axes and on the consequent map according to the different positions allows to significantly increase the knowledge provided by anamnesis and psychiatric diagnosis, to more structurally and dynamically understand expressive suffering and build a more calibrated and targeted care plan.

In the vast majority of cases, most meaningful content does not emerge from narrative personal stories. However, through conversation, as well as the alternation of active listening to empathic and floating attention, the therapist can approach the most incarnate aspects and even very painful and traumatic contents that cannot be narrated. What matters is attempting to capture the unique way of "making stories" of the patient according to his/her personal interpretation of the reality and in his/her way of telling the cause of his/her suffering. The therapist should, therefore, seek meaningful historical events (i.e., the subjective experience built by selecting meaningful data, arranged in sequence and placed in the flow of subjective

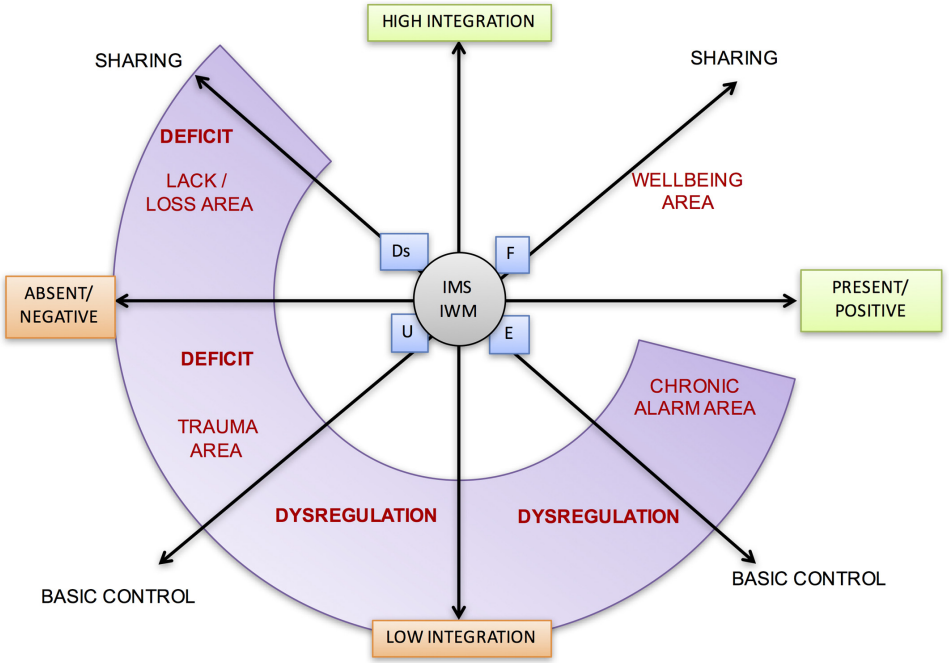

FIGURE 11 | Critical areas in the thematic narration. The schematic shows the deficit or dysregulation areas between the axes.

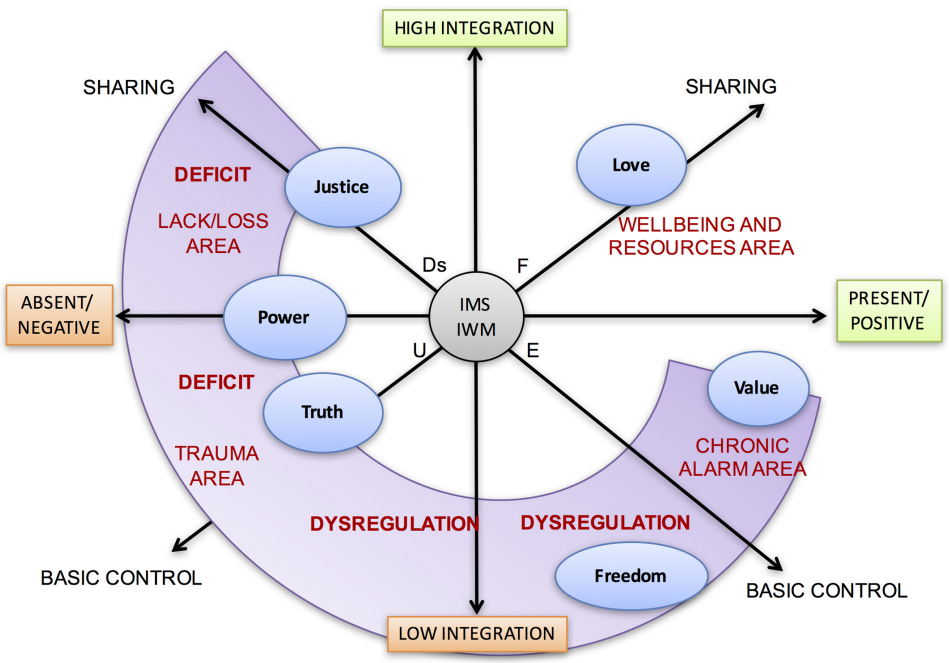

FIGURE 12 | Example of the critical areas in a patient's thematic narration. The patient suffers from panic attacks with agoraphobia, little sense of self-efficacy, and mild dissociative symptoms. The scheme reassumes the positions of the themes along the axes and within the areas between them.

time) that are somehow accessible and rebuildable through the memory. Historical consciousness can, therefore, be considered as a tool for re-reading events in another perspective and for building another possible future, because it offers the possibility to rearrange a plot that is very confused and a source of psychic suffering or to rewrite another. Often, whole stories are forgotten, deleted or "normalized" to maintain a coherent narrative plot. In therapy, traces of historical consciousness emerge in the form

of discomfort and symptoms; in these cases, the therapist must help the patient to falsify previous apparently probable theories, events, and the world. This strategy provides a second viewpoint to lay the groundwork for negotiating a third meaning and creating a new theory, more coherent with the self, that can orient and support change.

Therefore, the analysis of Life Themes was proposed as a method for entering into the specificity of the patient's history so that it can be re-read from a new viewpoint (Veglia, 1999, 2013). For example, identifying the various ways in which the patient interprets the theme of love allows the therapist to understand what specific aspect of love generates suffering. In fact, the patient may have problems with his/her lovable-self, loving-self, or loved-self. A person who has never been loved or loved by a "toxic" love may feel loved and contented by the therapist and at each session experience contentment and wonder in seeing him/her again because he/she will have an extra piece of the story to tell (Amanzio and Veglia, 2009). If, instead, the theme of Value becomes a critical topic, the therapist should favor the process of subtracting the critical attributes so that the ontological value of the patient can emerge in an act of self-recognition. Being lovable, with a value and through the power of being oneself, are dynamic and constantly moving conditions that need continuous confirmation from others. The criticality of the Power theme is expressed mainly in the sense of impotence and inability to act, up to the sense of alienation. The Freedom theme also has important clinical implications because each therapeutic act implies the possibility of change and is, therefore, geared to increasing the individual's degree of freedom.

In the light of these considerations, the work with LTs in psychotherapy allows treatment to go beyond symptomatic resolution to effectively prevent any subsequent side effects because of its ability to affect the patient's deep existential meaning. The perspective of Veglia (1999, 2013) focuses on this work, which considers clinically the thematic register as one that guides the therapist in collecting the patient's life story.

CONCLUSION AND FUTURE DIRECTIONS

In recent decades, most of the studies focusing on the role of narration in the clinical field decomposed this concept in more descriptive and phenomenological dimensions that can be operationalized. However, what seems to be missing today is a study on the narrative development of specific thematic contents in the clinical field. Little is known about how to empirically translate knowledge on the existence of LTs (Veglia, 1999, 2013), the essential and irreducible organizers of meaning around which the individual builds his/her interpersonal stories and shares them by telling them, for research purposes and the clinical process.

In the cognitive–evolutionary perspective (MacLean, 1984), it is believed that the presented LTs are in continuity with the work of IMS and their representations (Liotti, 2001). In the light of these considerations, a research group within the Department of Psychology at the University of Turin is focusing on systematization of a theoretical model that operationally defines thematic constructs within clinical narratives. The starting point of this empirical study in this sense was the attachment system, that is, the system that primarily contributes to determining self-referential meanings and generating a specific sense of self (Guidano, 1987; Siegel, 2001). The adult narratives of past attachment experiences are the main vehicle for investigating not only the narrative coherence processes, but also structured thematic contents in reference to internal working models. The nature of LTs is supposed to be relational for the basic function of the narration to share meaning; it is equally true that early attachment experiences represent the first interpersonal relationships within which to develop autobiographical narrative processes, autonoetic consciousness and integration mechanisms associated with the attainment of new levels of consistency of the mind (Siegel, 2001). A first step in the exploration of these thematic contents, organized in particular around specific LTs (Veglia, 1999, 2013), took place within the attachment stories (through the use of the adult attachment interview – George et al., 1985, unpublished) to cast a bridge of conjunction between the study of the narrative coherence and semantic investigation. The literature on which LTs hypothesis is based is very broad and heterogeneous with references to various areas of psychology. This can represent a limit but also a challenge for the future to study the model proposed through the analysis of the roots of narration and its contents.

In the literature, there are several tools for assessment of the thematic contents of memories and narratives. They focus mainly on the analysis of specific dimensions of narrative themes, omitting both the multiple facets of the same theme and the holistic view of the thematic content of a narration that takes place around more semantics. A further development of research, that is already a work in progress, is the construction of a reliable system for identifying and coding LTs in therapeutic-session transcripts or semi-structured clinical interviews. The Authors are working to systematize and standardize a reliable coding manual for LTs' identification, through the definition of general rules for the analysis of their occurrence in narrative units and their positioning along the axes proposed within the theoretical and clinical hypothesis. The identification of LTs *presence/absence*, the assignment of different degrees of intensity and their location on *high/low integration* and *control/sharing* axes could reveal thematic profiles from narrations, that are useful in understanding the patient's suffering.

AUTHOR CONTRIBUTIONS

FV developed the hypothesis of Life Themes and provided the theoretical insights and clinical foundations. GDF reviewed literature and contributed to the conception and develop of the manuscript. Both authors wrote the manuscript and have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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Exploring Memories of the Self: 2412 Self-image Norms for Adults Aged 17 to 88

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INTRODUCTION

Self-images are "I am" statements (such as "I am an optimist"). They are frequently used in psychological research as a measure of identity, as primes in experimental tasks, and as cues to elicit autobiographical memories. Typically, participants are simply asked to answer the question "Who am I?," such as in the 20 Statements Test (Kuhn and McPartland, 1954) which asks participants to generate up to 20 sentences starting with the words "I am." A more recent modification of this approach (the IAM Task; Rathbone et al., 2008) asks participants for between 4 and 10 "I am" statements and then uses these as autobiographical memory cues. Self-images can include traits (e.g., I am happy), roles (e.g., I am a nurse), hobbies (e.g., I am a tennis player), hopes (e.g., I am keen to work with animals), and fears (e.g., I am scared of being lonely). They comprise semantic facts about the self which help to scaffold narrative continuity and reflect the multi-faceted nature of the self (Kuhn and McPartland, 1954; Markus, 1977), allowing researchers to tap into the multiple identities people possess. One important benefit of self-image generation tasks is their open-ended nature. Tasks involving the completion of "I am" statements allow people to describe their identity using their own words. As a result, they are a powerful tool for examining differences in how identity is constructed across different groups.

Studies from a range of psychological disciplines have analyzed "I am" statements. From a social perspective, researchers have analyzed differences in self-images across age (McCrae and Costa, 1988), gender (Grace and Cramer, 2002), profession (Kuhn, 1960), and culture (Rhee et al., 1995; Wang, 2001). Within cognitive psychology, self-images have been used in experiments, both to prime a particular cultural identity (Wang, 2008) and to measure self-concept following an experimental memory manipulation (Charlesworth et al., 2015; Çili and Stopa, 2015). They have also been used as autobiographical memory cues (Rathbone et al., 2008, 2015). With clinical relevance, self-images have been explored in relation to psychopathological disorders including PTSD (Abdollahi et al., 2012) and schizophrenia (Bennouna-Greene et al., 2012). Self-images have also been studied in neuropsychological patients with amnesia (Rathbone et al., 2009; Grilli and Verfaellie, 2015) and Alzheimer's disease (Addis and Tippett, 2004), in an effort to understand the impact of memory loss on the self. As is evident from this brief review, self-images are relevant to a wide range of disciplines and have been utilized in a variety of paradigms.

The purpose of this paper is to present a database of self-image norms. At present, to the authors' knowledge, there is no publicly available resource for collating or depositing self-image data. That also means, that aside of attempts to classify the statements generated [e.g., into consensual and non-consensual (Kuhn and McPartland, 1954); concrete or abstract (Rathbone et al., 2008); psychological, social, and physical (Charlesworth et al., 2015)], there has been little consideration of the content of people's identity statements. Whilst coding schemes have been developed in the past to classify responses (Cousins, 1989; Rhee et al., 1995), these have been limited to a relatively

small number of categories (e.g., a maximum of 45 categories and subcategories; Rhee et al., 1995) and thus do not provide information on the frequency of specific self-images (e.g., being logical). Furthermore, previous studies have not reported the gender ratio or mean age of categories of self-images. Having a database of normative responses, coded by age and gender, will mean we will be better able to consider the content in people's identity statements.

The norms presented here represent the coding of 2,412 self-images. However, the main aim here is for this number to increase as other researchers add their data to the database. These norms can be used in a variety of ways. For example, if self-images have been collected from a case study (as is common in memory impairment) or a specific group of participants and the aim is to examine the way these participants have defined themselves, then the norms in the database can provide an age and gender indexed comparison. This will provide some information on whether a particular group of participants have described their identity in a way that is typical or atypical for their age and gender. This would be particularly relevant to studying possible changes to the self in clinical groups or patient case studies. At present, open-ended measures of self are limited to probing the number of self-images a person can generate, or the abstract/specific nature of these self-images (Addis and Tippett, 2004).

In addition to its utility in clinical groups, these norms will also be of use for researchers who want to use them as experimental primes or cues. Having identified which self-images are most commonly generated in young adults, for example, these could be used as standardized memory cues or primes in cognitive tasks, in the same way that it is common to control for word frequency or concreteness when using words as stimuli. As such, this database will provide a useful resource for cognitive and social psychologists, as well as sociologists and anthropologists. Finally, by tagging the year and country of data collection, as the database grows it will be possible to track changes in identity descriptions over time and across different nationalities.

METHODS AND MATERIALS

Participants

The data come from five studies, all of which required participants to generate self-images. Studies 1 and 2 are reported in Rathbone et al. (2008). Study 1 had an age range of 47–66 ($N = 16$ [11 Female], Mean age 54.56, SD = 4.95) and Study 2 had an age range of 39–88 ($N = 125$ [81 Female], Mean age 52.94, SD = 10.19). Note that for Study 2 the sample size in the database is higher than in Study 2 of Rathbone et al. (2008) as we only reported data from participants who completed the online questionnaire. In the database we include self-images for all participants who generated at least one self-image, leading to the discrepancy between sample sizes. Study 3 (reported in Rathbone and Moulin, 2014) had an age range of 17–50 ($N = 40$ [33 Female], Mean age 19.63, SD = 5.01). Studies 4 and 5 (Rathbone and Moulin, 2017) had respective age ranges of 19–61 ($N = 40$ [30 Female], Mean age 24.2, SD = 8.63) and 19–34 ($N = 17$ [12 Female], Mean age 20.56, SD = 3.65). These data were collected between 2004 and 2008, using an online questionnaire (Study 2) and paper questionnaires/tasks completed in participants' own homes (Study 1) or in the lab (Studies 3, 4, and 5). The data from studies employing paper questionnaires was collected in the UK whilst the online questionnaire data had potential for worldwide geographical coverage (details of participant nationality were not collected but the online questionnaire was advertised in both the UK and USA).

Task

All participants were asked to generate a set of between 4 and 20 "I am" statements to describe long-term and enduring aspects of their identity (for the full protocol see Rathbone et al., 2008). In Study 5 ($N = 17$), the instructions differed slightly as participants were asked to generate five self-images associated with being at home, and five associated with being at university. In all other cases, participants were free to generate whichever statements they felt best defined their identity.

Coding

All 2,412 self-images were coded by CJR and CJAM. This generated a set of 271 categories (including "Unclassified" which referred to any category indexing only one self-image). All 270 categories which indexed two or more self-images were then listed as norms (see Supplementary Material), accompanied by the number of self-images in the category, the full-text of each self-image generated, and the mean age and gender ratio of the participants that generated self-images in that category. For example, "Planner" had a count of three (two cases of "a planner" and one case of "able to plan ahead"), a mean age 28.67, and was only generated by female participants. Due to the way in which data was processed it is possible in a few cases that there is a discrepancy between the age given in the self-image and the participant's noted age. In one case this is due to a participant reporting an age which is actually different from their chronological age. For other cases it is due to how the data was processed by calculating the participant's age from a given year of birth. If a participant generated a self-image that covered more than one category then only the first category was coded (e.g., "Caring and sensitive" was coded as "Caring," "a daughter and sister" was coded as "Daughter," and "Independent, intelligent, adaptable, love travel" was coded as "Independent"). Our decision to code the first self-image in cases where two or more were generated was empirically grounded and based on previous work which shows that the self-images people generate first are generally rated as more personally significant (Rathbone and Moulin, 2014).

Database Websites

The fixed data set is publicly available in the UK Data Service ReShare Repository under Collection A of "Memory and the self in ageing" (Rathbone, 2017) at: https://dx.doi.org/10.5255/UKDA-SN-852127. The data set includes a data description document which explains the variables in the excel spreadsheet. There is also a publicly accessible database website hosted by Oxford Brookes University (http://psych.brookes.ac.uk/selfimage) which provides an introduction to the database,

a description of its potential uses, a search function, and the option to request a downloadable excel version of the database. One of the primary aims of the website is to form a long-term, growing resource for researchers who wish to deposit their self-image data. Thus, whilst the original data set, as reported in this paper, is fixed, there is also the option for this database to grow via the self-image website. Instructions are provided online for those who wish to upload data to the database. All uploaded data will be checked before being made publically available in the database.

Ethics Statement

All studies through which data was collected were approved by the University of Leeds School of Psychology Ethics Committee and were conducted according to the principles expressed in the Declaration of Helsinki. Any identifying information (such as participants' own names or the names of their friends, and of places) was removed during the preparation of the database. Written informed consent was obtained from participants in studies 3, 4, and 5. One participant in Study 3 was aged 17, but was deemed able to give informed consent without the need for additional consent from a next of kin, caretaker, or guardian. This was because the participant was enrolled as an undergraduate on a university degree course and because the British Psychological Society Code of Human Research Ethics classes participants aged 17 and over as a non-vulnerable group in terms of age. As studies 1 and 2 were solely questionnaire-based, participants were informed that submitting their data for analysis was taken as their consent to participate. Any new data submitted to the database will only be uploaded once ethical information has been provided.

ANALYSIS AND INTERPRETATION

Full details of self-image norms are provided in the Supplementary Material. By examining the frequency counts we can see which categories are most often used when people describe their identities. The most commonly generated category of self-image was Friend (count = 77), followed by Student (count = 70), Sports player (count = 70), and Occupation (count = 68). Thus, specific social roles are the most commonly generated single categories across the database. The highest frequency traits were Happy (count = 43), Optimistic (count = 41), and Friendly (count = 38). In line with previous research showing that people tend to define themselves in broadly positive terms (e.g., Baumeister, 1998), the highest frequency categories of self-image traits are generally positive in valence. However, several negative self-images were also generated multiple times (e.g., Lazy = 19; Worry = 15; Pessimistic = 10). In terms of mean age of participants, the youngest self-image category generated was Maths (e.g., ok at maths; Mean age = 18) and the oldest was Serious (e.g., serious minded; Mean age = 67.5).

By probing the database as a whole, it is possible to identify the most frequently cited self-images for people in given age ranges or for specific genders. For example, within females aged 60–70 the most commonly cited category of self-image was Mother (n = 9). As well as providing a useful resource for researchers interested in the lifespan development of identity (by showing which identities are most relevant at different ages), these age-specific norms may have particular utility for matching to specific clinical samples. Furthermore, this database may provide a useful resource for researchers who study cultural life scripts: representations of the timing of major transitional life events within a specific culture (Rubin and Berntsen, 2003; Berntsen and Rubin, 2004). Studies have shown that these normative life events are typically positive and reflect social landmarks such as graduation, marriage, and parenthood (Berntsen and Rubin, 2004). This database allows investigation of the age of participants who identify with particular life script categories, such as being a mother (mean age 51.79). Thus, whilst parenthood is a life script event that typically occurs in young adulthood, it nevertheless remains a salient self-image for adults across the lifespan.

One issue with the database, as it stands, is that some self-image categories feature relatively low counts. For example, Articulate is only generated twice, so the mean age for this category is not as meaningful as that for Caring (with a count of 21). Furthermore, at present, the participants in the database are mostly female younger adults. This must be borne in mind when making comparisons by age and gender. For example, the fact that Sister was generated 65 times and Brother only 12 does not necessarily indicate that males are less likely than females to frame their identity around their siblings—rather, this is probably a reflection of the gender ratio in the database. What is more informative is the within-category gender ratio data. For example, Travel had a relatively even split of 12 males and 13 females, whereas Worry was generated by 14 females and only 1 male.

These norms can be used as the basis for further studies on the salience of specific self-images. For example, one could investigate what proportion of people who are brothers actually generate brother as a self-image. This could be achieved by asking participants to complete an open-ended 20 statements task first, followed by responding yes/no to a standardized set of self-images based on the norms reported here. In this way it will be possible to explore which self-images are most salient for different groups, whilst also being able to account for which self-images are objectively present.

As with any self-reported data on personal identity, it is important to acknowledge the impact of environmental cues and social expectations on generation of self-images (see Markus and Kunda, 1986). Whilst this database cannot address the issue of how true (as opposed to confabulatory) or stable these self-images are, they nevertheless reflect an accurate snapshot of our participants' views of themselves at a given moment in time.

In conclusion, this database and table of norms represents the self-images that are most salient for a group of adults at the start of the twenty-first century. It provides an indication of which self-images are most relevant to participants of different ages and genders, and will provide a lasting resource for other researchers who wish to use these data or contribute their own.

AUTHOR CONTRIBUTIONS

CR and CM jointly designed the studies that comprise this data collection. Data analysis and preparation of this manuscript were carried out by both CR and CM.

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SUPPLEMENTARY MATERIAL

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Memory-Modulation: Self-Improvement or Self-Depletion?

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Autobiographical memory is fundamental to the process of self-construction. Therefore, the possibility of modifying autobiographical memories, in particular with memory-modulation and memory-erasing, is a very important topic both from the theoretical and from the practical point of view. The aim of this paper is to illustrate the state of the art of some of the most promising areas of memory-modulation and memory-erasing, considering how they can affect the self and the overall balance of the "self and autobiographical memory" system. Indeed, different conceptualizations of the self and of personal identity in relation to autobiographical memory are what makes memory-modulation and memory-erasing more or less desirable. Because of the current limitations (both practical and ethical) to interventions on memory, I can only sketch some hypotheses. However, it can be argued that the choice to mitigate painful memories (or edit memories for other reasons) is somehow problematic, from an ethical point of view, according to some of the theories of the self and personal identity in relation to autobiographical memory, in particular for the so-called narrative theories of personal identity, chosen here as the main case of study. Other conceptualizations of the "self and autobiographical memory" system, namely the constructivist theories, do not have this sort of critical concerns. However, many theories rely on normative (and not empirical) conceptions of the self: for them, the actions aimed at mitigating or removing specific (negative) memories can be seen either as an improvement or as a depletion or impairment of the self.

Keywords: memory-erasing, propanolol, autobiographical memory, regulative conceptions of self, rigid identity, extended identity

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FORGETTING ON DEMAND, THE SELF, AND THE AUTOBIOGRAPHICAL MEMORY

The human being has always tried to have control over his memory. In ancient times, when there were no external media to preserve data in an easily accessible manner, what today we call "declarative memory" was crucial for scholars or those exercising intellectual professions. The enhancement of that type of memory was sought with techniques like the *loci*, namely the association of information to well-known places and objects (Yates, 1966). But already then it was clear that memory was not a mere instrument, regardless of how it is used and accessed. Plato, for example, questioned writing as a way to preserve thought: in *Phaedrus*, Socrates says that writing is fixed and therefore "encloses" the contents of the message.

Autobiographical memory, on the other hand, has always been ambivalent: usually people want it to be precise and always available, but it can also be a curse. Remembering events and feelings of our lives, for many philosophers and most people, is conceived of as the essence or basis of personal identity. So, diseases such as Alzheimer's, which damage memory, are considered one of the worst possible tragedies. On the other hand, being able to forget unpleasant facts and negative emotions would in many cases appear to be a liberation, enabling one to live better without the weight of painful or disturbing memories.

Even the *Odyssey*, one of the founding works of Western culture, mentions the idea of oblivion through pharmacological interventions. Classical writers such as Cicero and Petrarch narrate that the Athenian leader Themistocles, having learnt the art of remembering taught by Simonides, said that he rather would have learnt the art of forgetting. *Ars oblivionalis* has always been an unreachable goal and yet it has been evoked and desired throughout the centuries.

On the one hand, we are aware—and contemporary psychological and neuroscientific research confirm this—that there is a constant process of acquisition of sensory data and information in general, most of which, despite passing through the filter of conscious attention, is soon forgotten (Baddeley et al., 2014). This is due to a principle of energetic economy embedded in the evolution of our body, but it is also an unconscious selection that relieves us of a mnemonic load that would be otherwise unbearable, both cognitively and emotionally. Consider the difficulties experienced by those who suffer—the term is appropriate both in the clinical and in the existential sense—from hypermnesia (Ally et al., 2013).

On the other hand, the drastic mnemonic selection of incoming data, the progressive loss of precision of memory over time and the fatigue entailed by storing a complete set of new data often make us wish for a larger and better accessible memory (supposing that the failed recollection of memories is due to an access problem rather than to the loss of the mnemonic trace). At the same time, the persistence of some memories clashes with our will to not have them in our consciousness. Hence the paradox by which the more you seek to ignore a given object or event, the more it comes to consciousness, alone or in association with other thoughts (Wegner et al., 1987).

The fact that an effective psychological forgetting technique is almost impossible, despite the attempts made, has discouraged neither the desire to forget nor the research on the cerebral bases of memory. The hypotheses of chemically-induced oblivion have long been a matter of science fiction—except for the massive memory damage caused by the unwanted side-effects of alcohol, psychoactive substances, and electroconvulsive therapy—so the reflection on the consequences of this "forgetfulness on demand" has not been very specific. However, recently, several neuroethicists have addressed the use of new possible tools to erase or mitigate negative personal memories (President's Council on Bioethics, 2003; Liao and Sandberg, 2008; Lavazza, 2015).

It is well-known that a huge amount of human and financial resources is being invested in trying to block memory loss caused by neurodegenerative diseases. And there is an ongoing ethical debate on the condition of those who have lost all or part of their autobiographical memories. In this condition, is one still a "person" and should one be treated as such? How much autonomy can one have? Does one still have authentic preferences and wishes? Now, consider new tools to modify or adjust memories, provided they are ever available: would they lead to a similar set of questions? Or would this be a different level of philosophical, neuroethical and psychological investigation compared to the one that focuses on the consequences of Alzheimer's? (Dworkin, 1986; Dresser, 1992; Jaworska, 1999; Strohminger and Nichols, 2015).

The common idea underlying these considerations is that autobiographical memory is strongly linked to the self and the identity of the individual, and this view is neither new nor original. However, in this paper I want to introduce an interpretative framework linked to the recent discovery of molecules that seem to be able, for the first time, to effectively modulate autobiographical memory by reducing the emotional reach of salient, negative and painful memories, according to the studies that have been carried out so far. The opportunity to intervene on memory "by subtraction" raises questions and perplexities. This seems to be due to the fact that we have certain ideas of the self and of personal identity, as well as of their relationship with memory.

The first point I would like to address is that attempts to give an axiological evaluation of memory modulation-removal interventions are based on conceptions and models of personal identity and the self that act as reference points also for a wider set of values. The ethical discussion on the chemical modulation of memories can thus be helpful to clarify and assess the relationship between self and autobiographical memory especially from a normative point of view (Selimbegović et al., 2016).

But there is a second point that seems to deserve greater attention, because perhaps it has not been sufficiently emphasized in the literature. Some conceptions and models of the self are based on empirical research, and others are essentially normative: that is, they are the direct result of scholarly reflection or the result of social and cultural processes due to the convergence of various elements. All of these conceptions and models of the self work as references for the evaluation of autobiographical memory interventions. So, potential judgments on memory modulation-removal can show that the relationship between self and autobiographical memory is extremely complex. In fact, there are competing empirical models and also normative concepts that have a significant persistence and play an important role in guiding both judgment and behavior. In this paper, I especially focus on narrative theories of personal identity and related normative issues about memory-modulation.

HOW TO MODULATE MEMORIES

As has been said, it is only recently that external tools have shown the potential to modulate memory in living things, specifically to modify memories. This is not the place to describe the specific action modes of the various techniques tested. In animal models, it was possible to achieve the deletion of specific mnestic traits

(at least in their behavioral manifestation) and to modify the salience of individual memories (evaluated by the search for or avoidance of behaviors that they arouse).

In human beings, because of the centrality and importance that memory has for the individual, it has of course been more complicated to make experiments. The most promising way, in the current state of research, seems to be related to molecules able, at least in many cases, to attenuate the emotional reach of autobiographical memories, making them less salient to the subject. I will not enter into the detail of the neuroscientific and clinical debate on the safety and efficacy of the treatment, since the focus of the paper is what the possible availability of such a treatment, presumably considered effective, can tell us about the relationship between autobiographical memory, self and personal identity. In this sense, it is useful to start with a definition.

> (Def1) "Memory-editing is a psychological (modification of the associative processes related to memories) or neurobiological (pharmacological and/or optogenetic) intervention in order to weaken or change the subjective negative valence of autobiographical memories or completely remove the memory trace of an autobiographical event" (Lavazza, 2017).

The memory-editing technique to which I will refer is that based on the administration of a particular molecule in certain temporal windows related to the memory on which it is intended to act: propranolol. As noted by James McGaugh, this molecule—normally used as a beta-blocker in hypertension treatments—can be helpful in diminishing the emotional effect of a given memory (Cahill et al., 1994). Situations of emotional turmoil are normally connected to the production of adrenaline and cortisol (the so-called "stress hormones"), which in turn lead to a significant increase in the neurotransmitter norepinephrine. The latter has a dual function: it connects the given memories to the fear circuit and causes anxiety, with symptoms such as tachycardia, tremor, or sweating. β-adrenergic receptors of the basolateral amygdala (β1 and β2), which norepinephrine binds to, produce a stream of molecules signaling the codification of the memory to the brain. This is a simplified description, shared by only some scientists. However, according to this view, propranolol blocks the activation of the receptors, thus preventing the (re)consolidation of a given memory.

According to early research, there is a connection between stress hormones and declarative memory: if an event causes emotional arousal, it is likely to produce a stronger and longer-lasting memory (Pitman et al., 2002). Propranolol only acts in such cases, if taken during or shortly after the stressful event, but is inefficacious on emotionally "bland" memories. This shows that if the adrenaline and noradrenaline produced by the adrenal glands are inhibited, as a consequence, the mnemonic process loses its emotional component: the subject thus preserves his or her declarative memory *without* the strong (negative) emotional component that would otherwise come with it, affecting given vital signs (respiration, heart rate, blood pressure) and arousing feelings of distress, fear or anxiety.

According to several findings related to experiments with propranolol, the molecule appears to work if taken shortly after the emotionally stressful event. For examples, victims of car accidents have shown to have less intense memories of the traumatic event if they take propranolol, which is the more efficacious the earlier it is taken (Brunet et al., 2011). Also, subjects suffering from post-traumatic stress disorder (PTSD) generally showed no benefit from the molecule (Muravieva and Alberini, 2010). Nevertheless, on healthy subject propranolol is known to be effective in weakening fear responses (Kindt et al., 2009), more than what usually happens according to Pavlov's paradigm.

To make one example, subjects suffering from arachnophobia have been able to overcome it by weakening the sensation of fear produced by seeing a spider, despite being still conscious of the potential danger it may cause. In addition to working on the immediate fear response, as previously mentioned, propranolol can affect the subsequent memories of a stressful event. This can happen both if taken shortly after the event, and by working on the reconsolidation of old memories. Reconsolidation is a mechanism by which recalling a memory activates a complex molecular process in the subject's nervous system, as a result of which the memory is biologically malleable (Nader et al., 2000; Nader and Hardt, 2009). This is the reason why often recalled episodes slowly change in time. Based on the fact that reconsolidation makes memories malleable, propranolol can be used to weaken traumatic memories even some time after the stressful event (Brunet et al., 2011; Soeter and Kindt, 2011; Elsey and Kindt, 2016).

Therefore, if taken during the recollection of a stressful event, propranolol will weaken the emotional component of the memory attached to it, while leaving the declarative memory of it untouched. For example, the subject may still remember being attacked one night when coming back home, but without the negative emotional burden and the related activation of the autonomic system, which can lead up to PTSD. Propranolol is effective for a short time period (a few hours) following the traumatic event and acts in a preventive way if taken during that period of time. When the traumatic event has already fixated in memory, one can try to intervene by explicitly recalling the memory in question while taking propranolol: in this case, the latter acts by exploiting the malleability of memory in the reconsolidation phase.

The effect of the intake of propranolol—immediately after the traumatic event or while explicitly recalling it to consciousness, when the biochemical processes lead to its cerebral reconsolidation—is that the memory will probably become less painful, if not emotionally neutral. As a consequence, it will be less able to motivate the subject by influencing her preferences, intentions and choices. This aspect is what I want to address now.

WHAT IS WRONG WITH "DELETING" A MEMORY?

Since it is possible to intervene on memories, the question has arisen whether to act on memory is ethically permissible or recommendable. An example that can help tackle this point was

offered by Erler (2011). There are two friends, Elisabeth and Sonya, who have both been bullied in high school. Despite this, they managed to finish school and lead a rather satisfactory life. However, later on Elisabeth starts experiencing the consequences of her past: when the former classmates invite the girls to parties and various activities, Sonya joins in with full ease and peace of mind, whereas Elisabeth cannot. She demands an apology first, as she thinks they have acted immorally, in a way that has scarred her deeply. On the other hand, Elisabeth wishes she were like Sonya, so that she could forget the past and not be stuck in painful memories. So she chooses to take propranolol: the negative memories of school fade, their emotional component almost disappears. Elisabeth remembers the facts, but with no pain or resentment. Now she can see her former classmates as if she had truly forgiven them, even though they never said sorry. Her life seems happier and more carefree: she no longer thinks of bullism, and her wellbeing has apparently increased.

However, the question arises whether Elisabeth's choice was authentic, in line with her "true" self. Of course, the very idea of a "true self" can be questioned, but it is undeniable that people have personality traits (partly genetic) and long-term personal preferences and aversions (such as sexual orientation, a given lifestyle, a religious belief etc.). These characteristics make up (at least partly) a person's identity or self, guiding him in his behavior and in his reactions. If a long-term choice (say, veganism) is perceived as defining, we often publicly declare it and stay loyal to it even when the given situation might induce us to make an exception (say, an important business meeting where they only serve meat).

In this sense, autobiographical memory has to be coherent, functioning as a tool to limit or guide the fundamental orientations underlying the self. According to Erler (2011), the chemical alteration of one's memory might lead to non-authentic choices. In Elisabeth's case, for example, she ends up "forgiving" her schoolmates without them apologizing, as would have been the demand of her "true" self. Indeed, Elisabeth's convictions—her *self*—would not have allowed her to make this choice, as it would have contradicted her general beliefs. The modification of part of her autobiographical memory, especially the emotional salience of some events, has made it so that the latter lost the motivating power they had before.

It could be objected that someone with good cognitive skills and a solid moral orientation would still judge an evil deed negatively. This would probably hold true for—say—rape, but bullism is a set of many little acts that, taken one by one, may be considered relatively harmless "pranks." Therefore, it is likely that bullism would arouse retrospective pain in the victim only if accompanied by the negative emotional component of its memories. A well-functioning autobiographical memory would be needed to this effect. So does it mean that Elisabeth "betrayed" her true self? And what about Sonya? Perhaps she doesn't share Elisabeth's moral inclination, or perhaps her memories are "naturally" less strong and distressing. Or else, she finds it easier to move on and leave the past behind.

Either way, it seems that without propranolol Elisabeth would not have forgiven her classmates without them acknowledging their wrongdoing. Also, her morality drives her to fight bullism publicly precisely because she has undergone it herself. But if the motivational aspect of the memory fades, her commitment might also become weaker (victims of abuse or discrimination are often the best candidates to fight such things). However, one cannot overlook a possible objection to Erler's argument, namely that the equivalence between the act of forgiving, which is a process and an experience with a relevant social dimension, and the individual experience of forgetting is far from obvious. If there may be a cause-effect link between the assumption of propranolol and "forgiveness," it is still true that forgiveness, as it is generally understood, is a conscious process that takes into consideration the fact in question and elaborates it consciously, overcoming it in relation to its interpersonal effects without forgetting it on a personal level.

In this sense, it is important to recall the already mentioned concept of authenticity. It might be defined as follows:

> (Def2) "Authenticity is the consistency (and the second order identification of one's own desires, *a la* Frankfurt) of the choices made by the individual—obvious choices or ones with potentially observable effects—with the individual's identity (at any given time), or at least with some of the relevant identity components for the choice in question" (Lavazza, 2017).

This concept is based on what may be called *rigid identity*, that is, something given, tied to a self that tends to remain stable over time. This definition incorporates a normative component: not only is the self-stable, but it should be maintained such. Of course, the definition that I propose cannot be exhaustive of all theories of authenticity throughout history. In this sense, one should also consider the existential-phenomenological literature, which at least partially originated, especially with Heidegger (1927-1962), the very concept of authenticity. For Jaspers (1919), authenticity is what is most profound as opposed to what is more superficial; for example, what affects the core of every psychic existence as opposed to what only touches the surface, what lasts as opposed what is momentary, what has grown and developed with the person as opposed to what the person has accepted or imitated. In the same vein, Heidegger and Sartre have a "strong" conception of authenticity not as something true to a pre-given self but as fidelity to the true self. It should be understood as a construction that takes place in a relationship, and this relationship has the purpose of a whole life project which, from time to time, incorporates elements of the present situation. And this ideal of authenticity is connected to being a person of a particular sort with the virtues of integrity and perseverance. In a "weak" form this view can be connected to the contemporary theories of identity as a narrative rather than to the idea of rigid identity, which however recalls a widespread idea of authenticity as coherence with something given in the person.

> (Def3) The notion of *rigid identity* in the modern age originates from the idea of an "original entity" in the metaphysical sense (following Descartes) which was later considered to be of a psychological nature (following Locke), but dates back to ancient and widespread intuitions and concepts developed in many cultures; it is conceived of as the self-consciousness of a thinking self, rather than of an extended body—an identity core of the

> subject that has ideal more than real value. This identity may partly change over time, but always maintaining a stable core, namely something that characterizes the person and that can be discovered by different means, because it is sometimes concealed by external influences. It is what we think makes us unique and therefore must be preserved and not sacrificed.

The notion of rigid identity is an extremization and an idealization of the unsophisticated intuition of "core self," which is not a metaphysical substance, but a persistent set of consistent psychological traits and features (whose origin may be genetic or due to parental and environmental influences during childhood). There is evidence supporting this notion both from the empirical (Klein, 2013) and from the philosophical standpoint. Consider, for example, Rawls' theory of justice. Rawls presupposes an *original position* in which, thanks to a "veil of ignorance," the subjects are unaware of their personal characteristics and of the sociohistorical context. The implication is that, even without a rich biography, human beings preserve a (non-lockean) identity by which to make meaningful decisions in a consistent way.

Another example is that described by Damasio of a severely amnesic patient, David, who had an autobiographical memory span of less than a minute (Damasio, 1999. chs. 2, 4). In this case, we are faced with a person who, due to an encephalitis, can neither live in the past nor project himself consistently in the future, nor evaluate the consequences of his actions. This individual therefore does not have a personal identity in the sense of psychological continuity, according to the classic Lockean criterion[1]. Yet, based on the description of his behavior, we can infer that his present self and his short-term goals are vital and adequately related to reality. Moreover, thanks to mnestic traces present at an implicit level of which he is not conscious, David manages to be coherent with himself, with his tastes and behavioral choices. And for this reason, thanks to this minimal core of rigid identity, he can be fully considered a person, even if he has lost the explicit mnemonic continuity that for many constitutes the basic criterion of personal identity (cf. Meini, 2017).

Some claims that personal identity is not logically presupposed by memory (cf. Bernecker, 2010) and hence they can deny that there are circularity objections to accounts of personal identity based on memory. But it is likewise argued that memory presuppose personal identity (Schechtman, 2011). So I will not delve into this debate, even though it is doubtlessly relevant (cf. Bernecker and Michelian, 2017).

If there is something like the core self, then it is clear why authenticity should be considered a value or at least something to bear in mind. Choices that go against inclinations that logically and rationally follow from one's identity are a sort of "betrayal" of one's core self, to which one should rather be loyal—as this is, indeed, personal authenticity (e.g., President's Council on Bioethics, 2003). There are also social aspects that encourage a person to respect authenticity: the self we have manifested thus far generates expectations of consistency in those who interact with us. If we violate authenticity thus defined, we become unreliable (*qua* unpredictable) and risk getting away from reality, which has consequences over our lives.

In this respect, consider the example made by Glannon (2011) on memory editing. Imagine a scholar at the beginning of his career, who fails at his first major conference due to excessive nervousness: he might be so traumatized by this experience that he will be haunted by it at all future public speaking occasions. Therefore, he might resort to propranolol to weaken the emotional charge of the memory and start over without the weight of the past, so to speak. But if the next conference were also a failure, and the scholar resorted again to memory editing, this would lead to him not feeling anxious even though, in a way, he should, as his colleagues would still form a negative opinion of him. In other words, the scholar would risk being detached from reality, failing to understand his limits (which instead would be very clear to others). This could be seen as a case of non-authenticity, as the scholar would end up betraying the scientific standards he hoped to respect (as a full part of his core self), erasing his failures and not facing them (cf. Lavazza, 2016).

NARRATIVE IDENTITY AND MEMORY-MODULATION

Underlying the concepts of personal identity seen so far, there is the classic philosophical "question of characterization," that is, the issue of "what makes a person the person that she is" (e.g., Kind, 2015). The concept of rigid identity can be seen as the extreme point of an ideal continuum, the other end of which can be the notion of extended identity. The latter seems to have a weaker normative value than rigid identity, and is supported by the current scientific data on the matter.

> (Def4) *Extended identity* is based on the feeling of the bodily self, which is its core. The extended identity lies in interpersonal relationships, because it is not something original or innate, but something that emerges in the interactions of the individual (who has an innate instinctual endowment, which limits what can emerge from the interaction) and from social and cultural elements. The psychological dimension and the temporally distributed self, made of events and relationships, give rise to a more or less coherent narrative subject to rewriting (which, for some, does not reflect a self as a true entity).

This notion of identity is more consistent with the recent research in developmental psychology and psychology of personality, according to which consciousness is a purely relational concept (neither innate nor primordial) and emotions are first felt in the body and then internalized in the psychological world (cf. Neisser, 1995; Gergely and Watson, 1999; Habermas and de Silveira, 2008; Marraffa and Meini, 2016). In this vein, one may also consider Damasio's hypothesis (2010) that there is a hierarchy of selves, starting from the proto self (generated by

[1]Animalism is one of the theories that, like Lockeanism, seek to explain what human beings are. According to it, human beings are biological organisms, that is, human (i.e., thinking) animals. Animalism falls under the physical approach to personal identity (together with bodily theory and brain theory), and argues that our identity consists in being the same biological organism over time. This theory seems to give less importance to memory in relation to personal identity, and I will not deal with it here.

homeostatic alterations of the body in front of environmental stimuli) to the autobiographical self.

The concept of extended identity can include both a naturalistic vision of the self and of identity, like Carruthers's, and a more psychologistic one, like that proposed by Schechtman. Carruthers (2011, 2015) does not commit himself to an ontology of the self and of identity, but argues in favor of an epistemology of the mind that in any case subverts the notions underlying the Cartesian notion of rigid identity. Without going into the detail of his complex view, it can be said that for Carruthers we can only know our thoughts (which are mainly opaque to us, as we cannot access them directly and introspectively) in the third person, thanks to the mindreading we also use with others. Indeed, first we access the mental states of others and then, thanks to this, we are able to use mindreading on ourselves. Our access to our mental states is interpretative:

> "For present purposes, an *interpretative* process (...) is one that accesses information about the subject's current circumstances, or the subject's current or recent behavior, as well as any other information about the subject's current or recent mental life. For this is the sort of information that we must rely on when attributing mental states to other people" (Carruthers, 2009, p. 123).

Furthermore, Carruthers (2015) emphasizes the role of working memory and the neuronal activations that produce attention as opposed to the mentalistic conception based on beliefs, desires, objectives, and preferences. In other words, for him, when making our choices we do not have conscious access to a non-sensorial repertoire of contents (that is, the self), but we can only focus on what is present in our working memory.

In philosophical debates, the "question of characterization" about personal identity and the self has been mainly framed in the context of the so-called narrative identity. According to the latter, the characteristics and the events that make up an individual's identity are those that are connected in a more or less coherent way in a narrative structure. Here one can distinguish a line of philosophical reflection and a line of psychological investigation. I will first deal with the former and then with the latter.

In a useful example, Kind (2015, p. 127) notes that we can draw much information from the box score of a basketball game, including the final score and the players' performances. However, a reporter describing that same event may start her article from the last part of the match or even from many hours before the match (for example to say that one of the best players of a team was slightly injured in the warm-up). Therefore, the reporter will provide a narrative and not just information. For this reason, it may be particularly important to evaluate the use of memory-modulation interventions within the frame of narrative identity.

The idea of a narrative self and personal identity has been recently and persuasively defended by Schechtman (1996).

> "The difference between persons and other individuals (...) lies in how they organize their experience, and hence their lives. At the core of this view is the assertion that individuals constitute themselves as persons by coming to think of themselves as persisting subjects who have had experience in the past and will continue to have experience in the future, taking certain experiences as theirs. Some, but not all, individuals weave stories of their lives, and it is their doing so which makes them persons" (Schechtman, 1996, p. 94).

In other words, an individual constitutes herself as a person by forming and operating with autobiographical narratives, which are shaped as the story of a person's life. The unity of a person is therefore the unity of an autobiographical narrative. The narratives are mainly implicit, have to be rather precise, can be accessed locally and need to have a correct relation to external facts.

But, in general, "facts about the literal identity of beings like us are inherently connected to practical considerations" (Schechtman, 2014, p. 10). And this practical unity revolves around the concept of *personal life*, mainly characterized by "the attributes of the individual—the physical and psychological capacities and internal structures that she possesses"; "the kinds of activities and interactions that make up the individual's daily life"; and "the social and cultural infrastructure of personhood—the set of practices and institutions that provides the backdrop within which the kinds of activities that make up the form of life of personhood become possible" (Schechtman, 2014, p. 112–113).

Schechtman's notion of narrative identity can directly impact the evaluation of the processes of memory editing. In fact, Schechtman (2010) has made remarks on the Deep Brain Stimulation (DBS) used for Parkinson's that can be easily applied to interventions on memory. As known, neurosurgery can cause changes in the patient's character and inclinations. Schechtman believes that DBS can threaten personal identity because it can change—partly or fully—the subject's personality traits, aims and interests. According to her, if, after undergoing DBS, a patient shows a very different behavior, it can be said that she is, in a way, "a different person." What matters is *how* the patient has changed: not as a result of what she has seen, learned or thought about, but through the direct effect of a passively undergone deep brain stimulation.

Schechtman sets two constraints to her idea of narrative identity. The first is the "reality constraint," according to which the narrative of the self making up a person's identity should "fundamentally cohere with reality" (Schechtman, 1996, p. 119; a similar point to that made in Glannon's example). Obviously, a story may contain small factual errors or minor inconsistencies, but it cannot include clearly false claims or views of reality that are very different from those held by other people one interacts with. In this sense, it should not be possible to "remove" important memories, be it in a literal or metaphorical sense. De Grazia (2005) also supports a narrative theory of personal identity similar to Schechtman's, for which the narration must be made from the first-person standpoint but must also be realistic.

The second is the "articulation constraint," according to which the self-narrative should be constructed by the subject in a way that justifies her choices and behavior, a person "should be able to explain why he does what he does, believes what

he believes, and feels what he feels (Schechtman, 1996, p. 114); a similar point to that made in Erler's example). Schechtman claims that "the mechanism of personality change is important to its effect on forensic personhood and identity." In fact, if a patient treated with DBS were to show a personality change, one would "have to acknowledge that his current passions and interests—the things he takes as reasons—were caused by manipulation of his brain." As a consequence, this change would have to be considered "disruptive to his forensic personhood and identity in a way that natural personal development would not have been" (Schechtman, 2010).

It might be useful here to evaluate in terms of authenticity the alternative ways of modulating the mind/brain, that is, between classical psychotherapeutic techniques and chemical means. The memory-modulation techniques I am talking about seem to lack an active self-determination, as what matters is to achieve the goal (the removal of suffering) and reach success (see the examples made by Erler and Glannon). The subject's choice and personal path are less important, even if the subject consciously and voluntarily decides to take, for example, propranolol. In this case, we can say that the patient is passive, undergoing an external intervention, while in psychotherapy there is an active participation, an internal process that takes place over time. The two methods of intervention may have different degrees of effectiveness and sometimes drugs take less time. However, in psychotherapy there is a gradual change which one is aware of and agrees to one step at a time—one does not suddenly leap into another personal dimension.

Of course, this distinction may sometimes be less clear, because the therapist's guidance can lead the patient in directions toward which she would not otherwise go. In other words, the patient, who has to deal with traumatic memories, can find himself in a situation of emotional dependence (due to his situation), and cognitive dependence, on the therapist (due to the latter's expertise). In this sense, the patient's autonomy may be reduced, because he follows a path established by the therapist rather than his own. Unusual cases of unreal memories of abuse or multiple personality structures emerging during psychotherapy show the possibility of this risk (cf Hacking, 1995). However, pharmacological treatment and psychotherapy seem to still differ in terms of margins of autonomy of the self, because the conscious agency is less likely to evaluate and counter the "directive" effects of pharmacological treatment compared to psychotherapy, for the reasons set out above.

The individual should retain a certain ability to intervene to at least partially modify certain traits of his character that create discomfort or that he reflectively does not like, and this progressive construction should achieve a sense of unity: the various elements should be progressively integrated so that they can be subjectively recognized as one's own and the individual can actually identify himself in them. In other words, the pill treats the symptom, but does not build a character that will allow one to face other similar situations in the future. Furthermore, the ability to govern oneself is seen as a complex and stratified characteristic of personality (and as a value), which does not depend unequivocally on the biochemical balance of neurotransmitters.

However, it cannot be ignored in this regard that the most recent acquisitions of empirical psychology and cognitive science seem to point to a weak and fragmented ego, in which much of mental functioning and routine decisions take place within the cognitive unconscious. According to this perspective, there is no conscious active monitoring, if not when unexpected events happen, while environmental signals we are unaware of are continuously working to direct our behavior (e.g., Bargh, 2017). All this, as already seen, seems to contrast with the idea of authenticity as the reflection of a "rigid" ego, which remains largely stable over time.

In light of what has been said so far, the framework of narrative identity is particularly relevant because it is the main answer to the long-standing "question of characterization." Within it, memory is crucial, because it allows us to construct the narrative according to the constraints of reality and articulation. Having truthful, reliable, and coherent memories (within the limits of a cerebral and psychological faculty of which we know all the "sins"; Schacter, 2003) causes our narrative identity to be functional to our subjective continuity. This way we can construct a self we can be conscious of and identify with. But respecting the constraints also means building a narration that is coherent with the environment and the social context in which we live, allowing us to have adequate interpersonal relationships. In fact, if we edit our memory at will, erasing for example unpleasant episodes, we could disregard our moral responsibility for some events or, say, the duty to remember a crime in order to testify against the culprit. Furthermore, weakening the emotional impact of a memory, which is crucial in remembering salient facts, can make the whole of our existential narrative less coherent, making us less able to explain some crucial developments of our life.

It has been claimed (Müller et al., 2017) that Schechtman's objection to DBS (and implicitly, therefore, to memory-modulation) is a case of naturalistic fallacy, entailing confusion between the property of being natural and that of being good. However, the matter seems to be more complicated than that and this, indeed, is why it is interesting to analyse memory editing procedures. In fact, Schechtman certainly wishes to preserve the narrative self and personal identity, but she doesn't present a naturalistic picture as opposed to a value judgment. The idea of "forensic personhood" has a normative aspect due to which some change processes are preferred to others. On the one hand, narrative identity is certainly extended identity, on the other it is also a prescriptive identity. In this sense, autobiographical memory is not a "natural" neutral element, to which one may associate a potentially negative judgment: it is part of the construction of the self and personal identity in a normative sense, and therefore has the same constraints.

In general, theories of narrative identity (cf. Lindemann, 2001) can be descriptive or normative. In the first case, the theories limit themselves to explaining how conceiving of one's life in terms of a narrative plays an important role in building one's personal identity, explaining the most relevant aspects of this way of constructing identity. In the second case, theories claim that we *should* conceive our life in terms of a narrative structure and that this can be relevant to achieve an ethically good life (cf. Kind,

2015). The main exponent of this normative approach is Taylor (1989), according to whom thinking of one's life as a coherent narrative is part of our attempt to reach goodness.

The development of narrative theories of identity has generally comprised an interweaving of descriptive and normative elements. In this sense, chemical interventions on memory are to be considered problematic precisely because they affect the truthfulness and coherence of one's existential narrative in a way that is not fully achieved by the subject, but thanks to an external intervention. A narrative deprived of relevant events is in fact equivalent to a false narrative—something that Schechtman and DeGrazia, among others, consider dysfunctional.

An influential line of psychological investigation is that of Jerome Bruner, who explicitly speaks of a narrative model of self-construction (Bruner, 1991, 1997, 2002). For Bruner there is no evident and essential self. We are the ones who continually construct and reconstruct a self according to the situations we find ourselves in, guided by the memories of the past and by the emotions and goals aimed at the future. The narrative mechanism, similar to that of literature, accumulates and stratifies stories, so that it does not start from scratch every time. But their link with the objective memory of events, according to Bruner, is quite weak. Rather, the narrative acts that construct the self are guided by the expectations of others and by implicit cultural models that suggest, if not impose, what the self should or should not be.

The creation-narration of the self, for Bruner, uses selective memory to adapt the past to the needs of the present and to the expectations of the future. Furthermore, it expands to adopt new beliefs and values, even though it maintains a degree of continuity over time despite the considerable changes it goes through. Identity can therefore be conceived as a verbalized meta-event which gives coherence and continuity to one's confused and chaotic experience. There is no "real" autobiography: ours is just one of the possible versions, a way of achieving coherence—a characteristic that both we and society tend to appreciate.

Bruner's essentially constructivist approach—that is, the idea that we create and recreate our identity through narrative—is not just a theoretical-normative view, but is based, in his opinion, on precise psychological mechanisms. Without the ability to tell stories we would not have an identity: this is shown by *dysnarrativia*, a neurological pathology, associated with syndromes such as Korsakoff or Alzheimer's, which involves serious damage to this capacity, canceling not only the memory of the past but the very sense of the self and of the other (Castelli et al., 2011; Baglio et al., 2012). The construction of the self therefore implies the precondition of good psychological and cerebral functioning. However, Bruner also insists on the cultural dimension of the construction of the self, which is not something innate, if not in its basic characteristics.

The narrative process of construction and reconstruction also involves a component of invention with respect to the past. As Bruner notes, this is due to both the normative component of the creation of identity, which often follows the indications of one's culture, and a naturalistic fact, that is, the fact that the human mind can never completely and faithfully recover what happened and was experienced in the past. In this vein, the unreliable and necessarily subjective character of memory can be combined with Bruner's constructivism to provide a narrative model in which the constraints posed by Schechtman have a lesser—or no—role, allowing one to say that pharmacological interventions on memory would not be a source of particular concern, especially if inserted into an appropriate narrative.

Contrary to narrative theories, the naturalistic idea of the self *a' la* Carruthers doesn't seem to incorporate explicitly normative elements, but rests on interpretation in the form of inference to the best explanation of the available empirical data (Chudnoff, 2016). A selective intervention on autobiographical memory only affects the integrity of the self insofar as a single memory is particularly relevant to the (largely subconscious and automatic) functioning of the mind. However, this is only the case with extreme PTSD patients, where a clinical intervention aimed at weakening the emotional salience of the given memory is the very condition for the person's recovery of autonomy. But this does not mean that there may not be a regulative component also in the naturalistic conception of the self.

MEMORY-MODULATION AND THE BATTLE OF THE SELF

The definition of rigid identity as such should imply an acceptance of memory modulation, as the very idea of a fixed and stable core entails that single memories cannot modify the self. However, the idea of rigid identity also entails the notion of authenticity, with its normativity. It implies the respect and acceptance of what nature and life have given every person (Sandel, 2009). The purpose is not to change an anthropological perspective that refers to an (implied) idea of the self as a real, self-conscious, free entity capable of managing its autobiographical memory as a storage of memories. The latter—positive and negative—are considered something given and valuable *qua* experience, which cannot be changed at will.

A very different view is offered by the psychoanalytic perspective, which is not part of the main focus of this article, but which deserves at least a mention at this point because it attributes a special role to memory with regard to self-development and self-transformation. Simply put, according to Freud, the patient's problems arise from secrets and memory lapses which concern the unconscious, by definition inaccessible directly. Free associations provide the analyst with the tools to unveil those secrets, to reconstruct those memories, and to reveal and modify the patient's internal resistance to knowledge and remembering. Treatment implies a definitive renunciation of the conflicting childish desires thus revealed (Mitchell and Black, 1995).

It can be affirmed that the purpose of this treatment is not to erase memories but to bring them to consciousness, in order to integrate them in the fabric of the other conscious psychic contents. In general, the memory of the traumatic experience is removed and delivered to oblivion, from where, however, it continues to act on the subject causing an uneasiness that she cannot deal with. The psychoanalytic perspective

therefore does not seek the "dampening" memories—something that it considers impossible—but rather the reestablishment of associative links and the reintegration in the self of something that has been removed. The therapeutic act lies in the ability to narrate the self in a coherent and understandable way. It is a matter of reconstructing the continuity of one's representations of the self and of the world, which were interrupted by an event to which one has not been able to give meaning within one's life story.

Winnicott's idea of True and False Self goes in the same direction of memory recovery as an act of disclosure of the False Self, while erasing dysfunctional memories or a mitigation of their emotional capacity would probably end up preventing a recovery of the True Self. Indeed, when the infant lacks a good enough parenting, she takes shelter in fiction and, through the False Self, she "builds up a false set of relationships, and [...] even attains a show of being real" (Winnicott, 1960). But the False Self is a defensive structure that is cloaked with objectivity and elements of the external world to protect the more fragile True Self, in order to protect the individual from being crushed by emptiness and inauthenticity.

However, in Western culture there has been a passage from a psychological view of the human being to a view that progressively relates to the body, and to the brain in particular (Rose, 2007 ch. 7). Ultimately, the idea is that we are biochemical selves, in which the functional (mental) elements converge into the cerebral aspects. The truth about our Self, provided it exists, comes from scientific research with its experimental models and diagnoses that attempt to categorize it objectively. And science only works with the brain and its potential modifications, the implementation of which requires drugs that are molecules as much as those contained in the brain itself. According to Rose, if the mind is just brain activity and psychic disorders are biochemical imbalances, then we are faced with a new ontology that inevitably bears more general consequences.

This point is very important. That psychiatric diagnosis is now done at a molecular level, by recognizing an ever closer link between neurochemistry and behavior can only be considered a form of progress, as better knowledge allows for the cure of disorders that were previously untreatable. Too low or too high levels of a given neurotransmitter as well as inadequate neuronal transmission mechanisms cause variations from a "normal" or "functional" to a "dysfunctional" state for the subject. The scientific idea that now subjects can be treated chemically also contributes to the creation of a cultural metaphor.

For example, Rose writes, Prozac is a drug that only affects serotonin reuptake, selectively acting on the subject's mood. On the one hand, it does not have any significant side effects, but on the other hand, it promotes the view that there are single isolated systems producing identifiable diseases that are not associated with other causes. The disorder is only organic, society does not matter, nor do personal relationships and social interactions. There is only one clear target, which is within us. We are made of many small pieces that can mostly be cured.

In general, says Rose (2007), it appears that new psychiatric drugs cure somewhat vaguely defined diseases, whose very existence is sometimes questioned. They do not cure a specific pathology—in the classic sense—but modify the ways in which salient events (emotionally or objectively significant) of life are experienced and understood by people. These drugs appear to be targeted at the so-called "biovalue," that is, the conception of what human beings are or should be, which is internalized in the idea underlying these drugs as norms, values, and opinions. There is an ethics inscribed in the molecular composition of these drugs: they carry and stimulate particular forms of life in which the "true self" is both "natural" and to be constructed. These drugs have important effects not only in terms of how they treat patients but also because they affect the way in which we see, interpret and describe ourselves and the world.

If autobiographical memory can be modulated at will, without getting to "cosmetic neurology" (Chatterjee, 2004), then what follows is the idea that the individual can be adjusted to be more "functional" (to society, to consumerism, to production etc.). This is not, of course, a direct and enforced form of control. However, the choice to take psychotropic drugs (including propranolol, in the future) may be due to a strong social pressure or a cultural climate, also because the mindset promoted is that the cure will restore the person's true self. The neurochemical coordinates of a "normal" or "efficient" self are in fact established by science considering the average brain physiology, regardless of all other variables. Once the neurochemical self is identified, it needs to be restored whenever it loses its balance. But whether this self is desirable is open to discussion.

Nevertheless, the consideration above should not lead to an anti-psychiatric stance that completely discards science and its findings. Consider the mentioned topic of dysfunctional memories: on the one hand, they can lead to the stigma of mental illness in relation to PTSD; on the other hand, they can create pressure for treatment by means of memory-modulation, with a change of autobiographical memory. Modulating a painful autobiographical memory (or canceling it altogether, which may be possible in the future) has undeniable personal and social consequences that go beyond the objective clinical (and mostly beneficial) intervention on the disorder identified as the hyperactivation of the circuits described in paragraph 2. The decision to intervene on one's autobiographical memory—and potentially on one's self—also implies value decisions involving the subject's autonomy and identity, as well as implicit social values (materialism, efficiency, and scientific humanitarianism being in favor of the cure; classical humanistic and religious values being against it).

One should also consider Michel Foucault's remark that medicalization—linked to the naturalization of the biochemical self—implies a passage from the legal regulation of society to its normalization, with the application on the social body of a set of knowledge, institutions, and controls that structure the life of the population according to binary criteria (normal-pathological, legal-devious, healthy-sick). Medicalization can take on a disciplinary function: it can structure, and control individual and collective physiology in order to qualify it normatively in educational, productive, and consumerist institutions (cf. Pandolfi, 2006).

In general, it is interesting to note that, according to Foucault, self-care and ethics as practices concerning the most important

aspects of freedom have become the most advanced fronts of political struggle in our societies, where those in power try to limit and influence the choices of everyone else. Self-care and ethics bring into play the idea of human nature as the target of all manifestations of social power. Human practice is losing its traditional center identified with the self, consciousness, or other aspects of personal identity. The Multiple Personality Disorder/Dissociative Identity Disorder (MPD/DID) debate is linked to this scenario and involves what Hacking (1995) refers to as politics of memory. In his view, the new memory sciences, developed since the late nineteenth century, have taken the soul away from religion and handed it over to science. In this way, "moral struggles" have become objective and impersonal. For example, as suggested (albeit in a different sense) by Herman (1992), the new knowledge and theories about memory functioning have contributed to the development of feminism, a political movement that also exploits traumas connected to MPD as a tool to show the subordinate condition of women and pursue their emancipation.

According to Braude (1991) multiple personalities give rise to distinct autobiographical memories which, however, are not indexical, being described in the third person. They would, therefore, be based on a unifying self or mind: "It seems compelling to appeal to an underlying synthesizing subject who simply evolves into a multiple as a complex and creative response to various life situations" (Braude, 1991, p. 173). In fact, the primary awareness seems to be continuous and unified also in subjects diagnosed with MPD, which therefore could be an extreme dissociative disorder. But what's at stake here, regardless of the several different diagnoses and scholarly opinions on the phenomenon, is above all the subjectivity of the descriptions, both on the part of the patient and on the part of the therapist. Therefore, the "battle of self" linked to autobiographical memory can be traced back to purely normative models, because there is no scientific consensus either on the disorder or on the way in which the traumatic memory should be treated.

In accord to Foucault, even the organic unity of the body tends to fragment itself, so as to be reduced to its genetic bases. And if genetic foundations can be changed, natural inequalities—once considered irremediable—can be easily modified. In a sense, there is nothing natural left and this may mean that there is no longer a structured and precise self that stays stable over time, since everything becomes fluid and malleable at will. Genetic susceptibility to PTSD could thus be treated in ways similar to memory modulation, with a preemptive intervention that would prevent negative and painful memories from causing discomfort to the individual. The underlying idea is that of self-construction, by which the self is an open field for experimentation. Think of the attempt to contain the response of the immune system after a transplant, a response that is completely natural and adaptive, but has to be countered to allow the organism to welcome a new part. Something similar can happen with memory: the chemical modulation of memory goes against its biological functioning, which tends to emphasize memories that may be important to our survival in a certain environment, although they may be painful for the individual experiencing them.

Autonomy, a fundamental value of modernity that implies freedom of choice and ability to act independently of others, may thus give way to a new normativity: that of "appropriated affirmation" (Ehrenberg, 2010). Now that social bonds are weaker, people must be able to rely on their interiority and subjectivity, which must be functional. However, the traditional ban against being oneself now turns into the "obligation" to become oneself—and it remains to be seen what "self" one should become. So, biopolitical battles are now fought on an unsteady ground, with no invariants or hard cores, but only varying and modifiable physical and social conditions, up to the post-anthropological and post-humanist hypothesis of machine-body hybrids, with embedded or uploaded external memories constructing a blurred self.

CONCLUSION

It is unquestionable that, over time, people change the way they react to stimuli and events (and these reactions can be objectively assessed, contrary to the more "fleeting" notion of the self). It is equally unquestionable that autobiographical memory is an important component in relation to the subject's response, as it contributes to building the subject's repertoire of reactions and affects the probability of such responses. Change as such does not imply a change of identity or self. Unless one adopts a deconstructionist view of the self (Metzinger, 2009; Strawson, 2009), personal identity and the self are usually taken to be precisely what persists in a person through change.

However, the possibility of memory editing (which, for now, is still fairly limited) entails consequences on the self, broadly understood as the subject responsible for choices and behaviors (while taking into account the differences related to the various notions of self on the market). Objections to the modulation of autobiographical memory are mainly linked to regulative conceptions of the self, related to descriptive conceptions of the self (like the "narrative" one).

One of the ideas underlying such objections is that "natural" change in one's self is gradual, allowing one to foresee how one may be *after* as opposed to *before*. Instead, the choice of drug-induced oblivion implies an immediate transition with no intermediate stages, making such a comparison impossible. Another view against memory-editing interventions is that change should be *purposeful*, that is, it should aim at liberating the "true" self, developing elements that were already present in the self since childhood. In this sense, experimental philosophy has recently shown that people tend to describe positive changes (for example, acquiring qualities generally seen as desirable, such as self-control vs. impulsivity) as consistent with their identity, while judging negative ones (for example, being violent) as a deviation from their true self (Tobia, 2015).

This intuition, despite being often fallacious *qua* based on a prejudice, can lead to an important consideration. Indeed, it seems that personality changes differ based on the subject's ability to account for them. If one can explain how and why one has changed (albeit with the limitations of a subjective explanation), it means that probably this change is at least partly consistent with the self as it was *before* the change. And yet this criterion seems

hardly objective. In fact, as we have seen, the ideas of naturalness and authenticity stem from specific conceptions of the self and its relation to autobiographical memory—in particular from an idea of "rigid identity," as I have called it. This conception of the self goes against many elements of recent empirical research, whose results are more aligned with what is termed "extended identity."

Constructivist conceptions do not regard the self as original and complete entity but as emergent, fragmented and only *narratively reconstructed* as a whole. For these conceptions, the single (non-systematic) modulation of autobiographical memory is not a relevant problem, so long as it does not imply detachment from reality, understood as the set of material and social conditions in which the person can flourish and from which she gets feedback on her actions.

There also are conceptions that are predominantly normative, based on an extremization of the available scientific data. In this perspective, a so-called "neurochemical self" is the battlefield of external influences, and memory modulation can be considered an invasive tool, extrinsic to the process of personal identity construction. In this sense, one can speak of self-depletion, as the self is manipulated and impoverished—for example—due to an efficientist social pressure relying on a purely brain-based conception of identity.

On the other hand, a conscious choice to modify one's memory to modulate painful and paralyzing memories, within constructivist self-conceptions, appears as an effective tool that, however, is not qualitatively different from other narrative strategies to harmonize one's identity and make it functional in specific environmental conditions. In this sense, one can talk about self-improvement, in a perspective from which memory-editing is not akin to cosmetic neurology but rather to self-care and self-enhancement.

But, as we have seen, in the general perspective of narrative identity, both on a descriptive level and above all on a normative level, memory-modulation interventions are problematic because they violate the constraints of a functional and coherent narrative. Instead, models that adopt a more openly naturalistic perspective seem to pose fewer normative restrictions to the partial modification of one's autobiographical memory, as these modulations do not seem to concern the functioning and balance of the autobiographical self-memory system.

It must be repeated here that forgetting traumatic experiences or generically unpleasant ones represent different sides of the wider problem of forgetting. Although it is difficult to draw a clear distinction, as such situations should always be assessed individually, there are two extreme situations that are more easily classified along the continuum of possible interventions on the "self and autobiographical memory" system. On the one hand, clinical situations related to serious trauma; on the other hand, pure cosmetic neurology. The first ones are those that arouse the least concern with respect to their manipulation, while the latter are those that arouse the highest. However, the former also present relevant issues, as in the hypothetical case of witnesses of the Shoah (cf. Lavazza and Inglese, 2013).

The present discussion, which is undoubtedly partial, has shown that it is difficult to break the strong bond between descriptive and normative conceptions on the self when it comes to the potential modulation of autobiographical memory. But this twine will be more easily "undone" at an analytical level when neuroscience and psychological research achieve a clearer understanding of the mechanisms that make up what we call self and personal identity.

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The author confirms being the sole contributor of this work and approved it for publication.

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Neuropsychological Predictors of Trauma Centrality in OIF/OEF Veterans

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This study examined whether reduced performance on two neuropsychological tasks, cognitive flexibility and working memory, were associated with higher levels of trauma centrality. A growing body of research has shown that trauma centrality, the extent to which a person believes a potentially traumatic event has become central to their self-identity and life story, is associated with post-traumatic stress disorder (PTSD). Furthermore, PTSD is often associated with alterations in neuropsychological functioning. The relationship between neuropsychological processes and trauma centrality, however, has yet to be explored. OEF/OIF combat veterans (N = 41) completed the Post-traumatic Diagnostic Scale (PDS), the Beck Depression Inventory-II (BDI-II), the Centrality of Event Scale (CES), and on-line measures of cognitive flexibility and working memory assessed via WebNeuro. Bivariate Pearson correlations showed that CES scores were positively correlated with PDS and BDI scores, and negatively correlated with cognitive flexibility and working memory. Linear regressions revealed that working memory significantly predicted CES when controlling for depression and PTSD severity while cognitive flexibility approached significance when controlling for these same variables. This study employed a cross-sectional design, precluding causality. The small sample size, entirely male sample, and use of an online neuropsychological assessment warrant follow-up research. Although numerous studies have found an association between CES and PTSD, this is the first to suggest that neuropsychological processes underlie the construct of trauma centrality. Given the importance of maladaptive cognitive processes underlying the pathogenesis of PTSD, these data suggest that future studies aimed at examining the link between neuropsychological processes and maladaptive cognitive processes, such as trauma centrality, may help to characterize and treat PTSD.

Keywords: PTSD, military, centrality of events, working memory, cognitive flexibility, autobiographical memory

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INTRODUCTION

The way in which a person remembers and interprets the impact of a traumatic event appears to play an important role in the pathogenesis of post-traumatic stress disorder (PTSD) (Horowitz, 1997; Foa et al., 1999; Conway and Pleydell-Pearce, 2000; Ehlers and Clark, 2000; Dalgleish et al., 2003; Bryant and Guthrie, 2007). In particular, a growing body of research has shown that

PTSD symptoms are positively associated with *trauma centrality*, the extent to which a traumatic event is viewed as central to one's identity and as a turning point in one's life story (Berntsen and Rubin, 2006, 2007). Trauma centrality has been measured with the 20-item (or abridged seven-item) self-report measure, the Centrality of Event Scale (CES) (Berntsen and Rubin, 2006, 2007). Numerous studies have shown that higher scores on the CES are positively correlated with greater PTSD symptom severity in both clinical and non-clinical populations including college students (Berntsen and Rubin, 2006, 2007; Robinaugh and McNally, 2010), combat veterans (Brown et al., 2010), and adults with a history of childhood sexual abuse (Robinaugh and McNally, 2011). The relationship between trauma centrality and PTSD symptom severity has been shown to be significant even after controlling for stress, anxiety, depression, dissociation, negative perspective, and emotional intensity (Berntsen and Rubin, 2007; Schuettler and Boals, 2011). Most research examining trauma centrality has been cross-sectional, however, a recent prospective study found that trauma centrality longitudinally predicted PTSD symptoms (Boals and Ruggero, 2015). Although the relationship between trauma centrality and PTSD symptomatology is well-established, the extent to which neuropsychological processes underlie trauma centrality has yet to be examined.

Although studies have yet to test the association between neuropsychological performance and trauma centrality, prior theories and research suggest that alterations in cognitive and neuropsychological processes are intertwined with changes in self-related processes, such as recall for autobiographical memories. Neuropsychological impairments are related to the construction of maladaptive self-representations that have been proposed to underlie the onset and maintenance of PTSD. For example, there is now a robust body of research showing a link between PTSD and impairments in recalling specific autobiographical memories (e.g., Aupperle et al., 2012; Polak et al., 2012; Scott et al., 2015). Additionally, individuals with PTSD are more likely to recall trauma-related memories than trauma-exposed individuals without PTSD (for reviews see, Moore and Zoellner, 2007; Williams et al., 2007; Lapidow and Brown, 2015). These impairments in autobiographical memory may be linked with deficits in neuropsychological functioning, as overgeneralized memory in depression has been associated with impairments in working memory, verbal fluency, and executive functioning (for a review see, Sumner, 2012).

Neuropsychological research aimed at characterizing and studying healthy and clinical populations suggest that two executive functioning processes, working memory and cognitive flexibility, are associated with processes involved with the capacity to generate autobiographical memories and self-representations (e.g., Piolino et al., 2009; Prebble et al., 2013). Working memory, or the ability to process and manipulate information that is no longer perceptually present (Baddeley and Hitch, 1994; Smith, 1999), has been proposed to contribute to the "working self" in cognitive models of autobiographical memory (Conway and Pleydell-Pearce, 2000). The working self, or one's hierarchy of active personal goals and self-image, has been suggested to serve as a schema, guiding the accessibility and content of autobiographical memories. Given that the working-self has been proposed to be a part of working memory (Conway, 2005), deficits in working memory may alter this top–down process and impair one's ability to recall non-trauma related memories. Similarly, cognitive flexibility refers to the readiness to switch attentional focus between multiple concept systems depending on environmental stimuli; one's ability to think about multiple concepts simultaneously or to change how one thinks about concepts (Scott, 1962; Diamond, 2013). As proposed by Ehlers and Clark (2000), people with persistent PTSD often have autobiographical disturbances that inhibit their ability to reorganize previous and future experiences, thus impeding an established stable view of themselves. Having a deficit in cognitive flexibility, then, may be related to one's inability to think of themselves outside of the context of their trauma.

Theoretical frameworks have posited that maladaptive personal schemas for traumatic events are in part linked with neuropsychological impairments, such as deficits in working memory (Ehlers and Clark, 2000; Dalgleish, 2004). Specifically, working memory has been proposed to contribute to the ability to hold multiple self-representations and appraisals (Dalgleish, 2004). The Schematic, Propositional, Analog, and Associative Representational Systems (SPAARS) model (Power and Dalgleish, 1997, 1999; Dalgleish, 1999) proposes that working memory manipulates schematic (abstracted, generic knowledge), propositional (referential meaning in verbal form), and analogical (non-verbal referential information) formats of mental representation. SPAARS accounts for cognitive processing and representation, and explains that while the propositional and analogical levels of processing involve more basic manipulations of thoughts and mental images, schematic level representations are constructed and integrated *using* the propositional and analogical levels. In other words, analogical representations, such as sight and smell, and propositional representations, or thought content, of a particular autobiographical event combine to create a schematic sense of the entire experience greater than its component parts (Dalgleish, 2004). Discrepancies between schematic representations and active information, processed through working memory, are detectable in the SPAARS model, but a disruption of working memory could potentially leave schematic representations of oneself or an autobiographical event unchallenged. Thus, higher scores on the CES, which may reflect difficulty in generating non-trauma related self-representations, may be associated with a reduction in working memory.

The goal of the present study was to assess the relationship between trauma centrality, neuropsychological functioning, and PTSD symptomatology in a sample of US military Iraq and Afghanistan veterans. We hypothesized that neuropsychological performance, specifically working memory and cognitive flexibility, would be negatively associated with CES total scores. Similar to previous findings (Berntsen and Rubin, 2006, 2007), we hypothesized that CES total scores will be positively correlated to clinical measures of PTSD and depression. Moreover, we expected to find that the aforementioned neurocognitive measures would maintain their negative association with trauma

centrality when controlling for PTSD symptom severity, thus linking deficits in working memory and cognitive flexibility directly to trauma centrality. Because of the known relationship between executive functioning and depression (see Veiel, 1997; Harvey et al., 2004), depression will be controlled for in analyses.

MATERIALS AND METHODS

Participants

Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) combat veterans ($N = 41$, $M_{Age} = 33.02$, $SD = 6.31$) with current PTSD ($n = 11$) and without current PTSD ($n = 30$) were recruited from the Mental Health Services of the Manhattan, Bronx and Brooklyn Veterans Affairs Medical Centers, other regional VA medical centers, Veterans Service Organizations, National Guard, reservist agencies and organizations, and from the general community. Recruitment methods included flyers, in-person presentations, media advertisements, internet postings (e.g., Craigslist), and referrals from clinicians. All study procedures were approved by NYU's IRB and all participants provided written, informed consent. Participants were excluded if they had a lifetime history of psychosis, bipolar disorder, major depression with psychotic features, pre-deployment obsessive compulsive disorder, or were less than 2 months stable on psychiatric medications. Participants with exposure to trauma within the past month or with active suicidal ideation were also excluded.

Procedures

All participants involved in this study were enrolled in the Cohen Veteran Center Study and a Department of Defense funded project at New York University's Langone Medical Center. As part of these studies, participants completed a battery of self-report assessments and the comprehensive neuropsychological battery WebNeuro. The self-report assessment included measures of depression, symptoms of PTSD, and trauma centrality as well as instruments not used in this particular work. Similarly, given our specific predictions of executive functioning, only the variables of cognitive flexibility and working memory were used from WebNeuro. In full, WebNeuro took participants roughly 40 min to complete and was administered with the participant alone in a windowless testing room.

Measures

Post-traumatic Diagnostic Scale – Part III (PDS; Foa et al., 1997)

Part 3 of the Post-traumatic Diagnostic Scale (PDS) is a 17-item self-report questionnaire used to assess the severity of PTSD symptoms as related to a single event. Additionally, the PDS offers a diagnostic status for PTSD, which was used in this study to determine groups ($\alpha = 0.91$).

Beck Depression Inventory-II (BDI-II; Beck et al., 1996)

The Beck Depression Inventory-II (BDI-II) is a 21-item self-report measure of depression that assesses the severity of various cognitive, behavioral, and physiological symptoms associated with depression ($\alpha = 0.93$).

The Centrality of Event Scale (CES; Berntsen and Rubin, 2006)

The Centrality of Event Scale is a 20-item self-report measure that assesses how central an event is to a person's self-identity and life story (e.g., this event was a turning point in my life) ($\alpha = 0.96$).

Neuropsychological Assessment (WebNeuro, Brain Resource Company)

Subjects completed two test batteries via WebNeuro, an abbreviated form of IntegNeuro (Silverstein et al., 2007). Data from WebNeuro is linked to the standardized and integrative Brain Resource International database and cognitive functioning domain outputs were computed via WebNeuro software algorithms. For this study, norm-referenced sten scores were used for both variables in analyses.

Working Memory

Working memory was measured by the Digit Span task (forward and reverse), where the participant observed an increasingly growing sequence of numerical digits and was asked to recall the sequence correctly. The length of the longest correctly ordered sequence entered was recorded as the participant's digit span.

Cognitive Flexibility

Cognitive flexibility was measured by Switching Attention task, a computerized adaption of the Trail Making test (Reitan, 1958). The participant was first presented with 25 numbers in circles and asked to click them with a mouse in an ascending numerical sequence with lines automatically drawn between clicked circles. The second part of the task consisted of the same basic task, but with a mixture of 13 numbers and 12 letters. The participant was instructed to switch back and forth between numbers in an ascending pattern (i.e., 1 A 2 B 3 C . . .). Performance for the Switching Attention Task was measure time taken to complete the task and accuracy.

RESULTS

SPSS version 21.0 (Statistics Package for Social Sciences, Inc. Chicago, IL, United States 2012) was used for all analyses. Group means and standard deviations for demographic characteristics and scores for the PDS, BDI, CES, and WebNeuro measures are presented in **Table 1**. Among the veterans exposed to traumatic events, there were significant differences between veterans with PTSD and veterans without PTSD in BDI, PDS, and CES scores. They did not significantly differ by age or in neurocognitive measures.

Bivariate correlations (**Table 2**) revealed significant ($p < 0.05$) relationships between the CES total and BDI total ($r = 0.39$), PDS current total ($r = 0.53$), cognitive flexibility scores ($r = -0.33$), and working memory scores ($r = -0.36$). The PDS total and BDI total were significantly correlated with each other ($r = 0.85$). Cognitive flexibility scores were significantly correlated with working memory scores ($r = 0.54$) as well as age ($r = -0.38$).

TABLE 1 | Demographic and self-report data for OEF/OIF veterans.

	Veterans with PTSD		Veterans without PTSD		
Variable	***M***	***SD***	***M***	***SD***	***t***
Demographic variable					
Age	33.94	6.51	32.38	6.22	0.78
Clinical and self-report measures					
PDS	23.94	7.90	6.67	4.90	−7.99**
BDI	16.12	9.82	4.08	4.51	−5.28*
CES	68.00	18.95	54.08	22.15	−2.10*
Cognitive measures					
Cognitive flexibility	5.59	1.88	5.38	1.94	−0.35
Working memory	5.18	2.42	4.48	2.45	−0.89

OIF/OEF, Operation Enduring Freedom/Operation Iraqi Freedom; PDS, Post-traumatic Diagnostic Scale; BDI, Beck Depression Inventory; CES, Centrality of Events Scale; Cognitive measures assessed via WebNeuro, presented as sten scores.
*$p < 0.05$; **$p < 0.001$.*

TABLE 2 | Correlations among clinical, self-report, and cognitive measures.

Variable	PDS	BDI	CES	Cognitive flexibility	Working memory
PDS		0.85**	0.53**	−0.16	−0.09
BDI			0.41**	−0.00	−0.13
CES				−0.33*	−0.36*
Cognitive flexibility					0.54**

OIF/OEF, Operation Enduring Freedom/Operation Iraqi Freedom; PDS, Post-traumatic Diagnostic Scale; BDI, Beck Depression Inventory; CES, Centrality of Events Scale; Cognitive Flexibility and Working Memory assessed via WebNeuro.
*$p < 0.05$; **$p < 0.01$.*

Age was not found to significantly correlate with any additional measures.

Two linear regressions assessing the effects of cognitive and clinical measures on centrality were then implemented. The dependent variable, CES total scores, was found to be normally distributed (K-S = 0.130, $p = 0.079$) without significant issues of kurtosis (−1.01, $SE = 0.724$) or skewness (−0.413, $SE = 0.369$). BDI and PDS scores were centered to account for multicollinearity (all transformed VIF values were below 4.09). The first regression ($F_{3,37} = 6.36$, $p < 0.05$; $R^2 = 0.34$) found that CES total scores was *not* significantly predicted by cognitive flexibility but was approaching significance ($t = -1.72$, $p = 0.09$) when controlling for PDS total scores ($t = 1.93$, $p = 0.06$) and BDI-II total scores ($t = -0.14$, $p = 0.89$). In this model, there were no significant coefficients ($p > 0.05$). A subsequent model dropping BDI total scores ($F_{2,38} = 9.79$, $p < 0.001$; $R^2 = 0.34$) found that PDS was a significant predictor of CES scores ($t = 3.67$, $p < 0.05$) but cognitive flexibility was still only approaching significance ($t = -1.83$, $p = 0.07$).

The second linear regression assessing the effects of working memory on centrality ($F_{3,36} = 7.09$, $p < 0.05$; $R^2 = 0.37$) found that working memory significantly predicted CES total score ($t = -2.45$, $p < 0.05$) when controlling for the PDS total scores ($t = 2.63$, $p < 0.05$) and BDI-II total scores ($t = 0.84$, $p > 0.05$). A subsequent linear regression using only the significant predictors of working memory and PDS total scores revealed similar results ($F_{2,37} = 10.36$, $p < 0.01$; $R^2 = 0.36$), with both working memory ($t = -2.39$, $p < 0.05$) and PDS ($t = 3.65$, $p < 0.05$) as significant coefficients.

DISCUSSION

This study establishes a link between neuropsychological functioning and trauma centrality. In addition to replicating a growing body of studies showing a positive correlation between trauma centrality and PTSD symptom severity, these findings show that lower levels of working memory and, albeit only approaching significance, cognitive flexibility are associated with trauma centrality when controlling for measures of depression and PTSD severity. This work highlights the need to consider how changes in neuropsychological processes may be linked to self-appraisals in the wake of traumatic events.

This work is novel in that it is the first to directly assess the relationship between trauma centrality and neuropsychological processes. Our findings are in line with the well-established phenomenon of overgeneralized autobiographical memory in PTSD. That is, the inability to successfully retrieve specific autobiographical memories has been linked to related deficits in working memory and executive control (e.g., Moore, 2009; Sumner, 2012). Furthermore, cognitive models of PTSD have proposed that executive functions, such as working memory, may underlie one's ability to process and maintain adaptive self-representations after a traumatic event (e.g., Dalgleish, 2004). Deficits to working memory may then be the cause, or a reflection

of, the inability to maintain and adapt self-representations, thus being tied to a person's inability to see themselves and their autobiography outside of the context of their traumatic event. Future work would benefit from examining the extent to which neuropsychological deficits are associated with autobiographical memory and self-appraisals associated with trauma centrality.

The present study cannot determine whether it is neuropsychological deficits affecting trauma centrality, or vice versa, though previous research supports multiple explanations. Cognitive, clinical, and brain imaging studies have shown that self-related processes are supported by working memory and executive functioning, and damage to brain regions that support these processes often lead to profound alterations in self-identity (Kelley et al., 2002; Spreng et al., 2009). These studies suggest that deficits to working memory and executive functioning caused by trauma could therefore affect identity and trauma centrality. Alternatively, it is possible that impairments to self-related processes affect cognitive performance, where the working-self is biasedly selecting autobiographical recollections (present in the autobiographical knowledge base) that protect the self, even when those self-views may be maladaptive (Conway, 2005; Conway et al., 2005). While the direction of this relationship remains unknown, our findings are an important step to understanding how working memory and cognitive flexibility contribute to, or are affected by, autobiographical memory and identity following traumatic events.

Although our findings are promising, this work is limited in a number of ways. Principally, the direction of this relationship must be examined to determine whether it is centrality affecting neuropsychological functioning or vice versa, which these data cannot support due to the cross-sectional study design. In addition, although this study points to a link between neuropsychological functioning and trauma centrality, future work should aim to assess if lower neuropsychological functioning is a predisposition to both PTSD and centrality, or if PTSD is the source of neuropsychological decline. Additional measures and methods of testing working memory, cognitive flexibility, and executive functioning should also be employed to further determine the extent of the relationship between neuropsychological functioning and trauma centrality. For this study, a brief online assessment was used; however, in-person and more thorough assessment could provide additional insight into the complexity of working memory, cognitive flexibility, and neuropsychological functioning in general. An assessment of self-awareness would also be useful to determine any effects on self-administered measures (CES, PDS, BDI). In addition, those with PTSD may have had trouble attending to the on-line tasks. Thus future work would benefit from exploring these links with neuropsychological assessments that can better control for this potential artifact. Finally, this study's generalizability is limited in that it only included male combat veterans. Future work should explore the relationship between centrality and neuropsychological functioning among diverse populations with varying traumatic events.

Despite these limitations, these findings begin to shed light on the potential mechanisms underlying trauma centrality, a construct strongly associated with PTSD. Such findings provide initial support for the possibility to the extent to which targeting working memory and cognitive flexibility in treatment may also help to promote self-representations that are less dominated by a traumatic event(s).

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the Institutional Review Board (IRB) at the New York University (NYU) Langone School of Medicine with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the NYU Langone IRB.

AUTHOR CONTRIBUTIONS

RH, RB, NR, RAB, CM, and AB all contributed to study design, data collection, data analysis, and manuscript preparation. RT-P contributed to data analysis and manuscript preparation.

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OPINION
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The Role of Slow Wave Sleep in Memory Pathophysiology: Focus on Post-traumatic Stress Disorder and Eye Movement Desensitization and Reprocessing

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Post-traumatic stress disorder (PTSD) is a clinical condition that may develop after a person experienced a traumatic event. PTSD can be considered as a disorder in which a fear conditioned response fails to extinguish, leading to several symptoms such as re-experiencing of the traumatic moment with intrusive thoughts, flashbacks, and nightmares, avoidance of situations related to the trauma, negative alterations in cognitions and mood, and hyper-arousal.

One important feature of PTSD is the re-experiencing of specific aspects of the traumatic memory. This aspect is related to the fact that, as originally suggested by Van Der Kolk et al. (1997); Van Der Kolk (1998), traumatic memories are encoded differently than memories of ordinary events, including several multisensory fragments that cannot be integrated in a structured meaningful narrative.

At a neurobiological level, memories recorded during extreme stressful situations cause a maximal potentiation of amygdalar synapses, assumed to temporarily store the events. This causes the saturation of all amygdalar alpha-amino-3-hydroxy-5-methyl-4-isoxazole (AMPA) receptors-bindings sites, preventing the recorded emotional memory trace to be merged with the cognitive memory trace from the hippocampus (Corrigan, 2002; Harper et al., 2009). Therefore, the fragments of emotionally charged memories remain trapped in the limbic system and cannot be transfered to the cortical areas, where a further processing and integration into already existing networks should take place.

Eye Movement Desensitization and Reprocessing (EMDR) was initially proposed in the late 80's by Francine Shapiro (Shapiro, 1989) and it's now a well-established psychological treatment for PTSD (Bradley et al., 2005; Chen et al., 2014). EMDR is a complex therapeutic approach that integrates elements of many traditional psychological orientations, but one of the key aspects is the use of Alternate Bilateral Stimulations (ABS) such as eye movements (EMs). Over recent years a large debate has developed whether EMs are an active treatment component and if the mechanisms responsible for EMDR efficacy differ substantially from those operating in trauma-focused cognitive behavioral therapy and standard exposure therapy. The original theory of Adaptive Information Processing (AIP), which is the basis of EMDR (Shapiro, 2001), posits that humans have an innate information processing system that assimilates new experiences into already existing memory networks. Pathology arises when new information is inadequately processed and then stored in a maladaptive mode in the memory networks, along with associated distorted thoughts, sensations and emotions. When memories are adequately processed, symptoms can be alleviated and memories integrated. EMDR seems to facilitate the access to and processing of the components of traumatic memories bringing them to an adaptive resolution (Shapiro, 2001).

EMDR therefore aims at re-elaborating non-integrated memories and consolidating new memories into already existing semantic links, promoting the insertion of traumatic but no longer disturbing memory in a coherent and adaptive autobiography.

In recent years, the crucial role of sleep in memory consolidation has been highlighted (Stickgold and Walker, 2007; Rasch and Born, 2013). Physiological normal sleep presents a cyclic alternated pattern of Rapid Eye Movement (REM) and non-REM Slow Wave Sleep (SWS). EEG recordings show synchronous delta wave activity (0.5–4 cycles/sec, i.e., 0.5–4 Hz) during SWS, and synchronous theta waves (4–8 Hz) during REM sleep. The non-REM SWS appears to play a key role in memory consolidation, as edited memories are transferred from the hippocampus to the neocortex, and then integrated into neocortical neuronal networks upon this phase.

During the waking state, new memories are encoded in a temporarily form in the hippocampal network. Over SWS, such hippocampal memories are reactivated by slow oscillations (<1 Hz) originating from the cortical networks in which the encoding originally took place (Born et al., 2006).

The combined activation of hippocampal memories and cortical synapses favors the transfer back to the neo-cortex, and during REM sleep the memories might be further consolidated and integrated in already existing associative links, therefore promoting a meaningful narrative of the event.

As mentioned above, traumatic memories may cause over-potentiation of amygdalar synapses, while the recording of the episodic aspect of the memory in the hippocampus results in a normal potentiation of hippocampal synapses. This difference in potentiation between amygdalar and hippocampal synapses makes impossible to merge the emotional and cognitive aspects of the traumatic memory, which normally takes place *via* the anterior cingulated cortex, then preventing the subsequent transfer to neocortex (Harper et al., 2009). Therefore, non-processed emotional memories remain trapped and unchanged at subcortical level without contextual integration, causing in some cases PTSD symptoms.

The first who proposed a similarity between EMDR physiological effects and sleep processes was Stickgold (2002), focusing mainly on REM sleep. Moving a step forward, one of the hypothesized mechanism of action of EMDR posits a parallel between synaptic depotentiation occurring during SWS and EMDR bilateral stimulation (Harper et al., 2009; Pagani et al., 2017). During EMDR the client is asked to hold into attention the fragmented traumatic materials while the therapist performs the ABS, favoring the reactivation of the traumatic memory in amygdalar and hippocampal networks. Recent findings have shown that ABS elicits delta waves in a range (1.5 Hz) very similar to the one registered during SWS (Rétey et al., 2005; Harper et al., 2009; Pagani et al., 2011, 2012). It is then conceivable that EMDR bilateral stimulation mimics the low-frequency stimulations naturally occurring during SWS, causing a depotentation of AMPA receptors of amygdalar synapses, which in turn facilitates the merging of the amygdalar emotional and the hippocampal episodic memories thus creating an associative memory that can be further transferred and processed by neocortical areas, leading to the cessation of symptoms.

This hypothesis on EMDR mechanism of action is also supported by previous neuroimaging findings. Pagani et al. (2012) showed a shift of cortical activation elicited by traumatic memories after successful EMDR treatment from an implicit subcortical to an explicit cortical state suggesting their integration into existing semantic memory. Herkt et al. (2014) observed an increased activation in the right amygdala during auditory ABS upon processing of negative emotional stimuli, suggesting that an initial enhancement of emotional processing is a prerequisite for the effective reintegration of traumatic material.

Other neurobiological findings frequently reported by neuroimaging studies in PTSD are supporting this hypothesis. Three main brain areas have been identify to be altered in PTSD: amygdala, involved in emotional interpretation of incoming information (Etkin and Wager, 2007; Francati et al., 2007; Patel et al., 2012), medial prefrontal cortex (mPFC), implicated in the processing of emotional materials and in emotion regulation (Shin et al., 2006; Patel et al., 2012; Nicholson et al., 2017) and hippocampus, involved in contextual learning and spatial and episodic memory (Burgess et al., 2002; Liberzon and Sripada, 2008; Liberzon and Abelson, 2016). The most recurrent finding is a relative decreased mPFC activity and a parallel increased amygdalar activation. In light of the SWS hypothesis such hyperactivation could be considered as the macroscopic expression of the molecular-level alteration, i.e., the above described over-potentiation of amygdalar synapses. At the same time mPFC, despite its tight connection with the limbic system, doesn't exert its role of normalizing amygdalar hyperactivity, probably as a consequence of the remarkable hyper-activation of the latter. The insufficiency of top-down prefrontal cortex functioning, coupled with dysregulated bottom-up activity of limbic structures accounts as well for the impaired autonomic response and concomitant inadequate emotional regulation peculiar of PTSD.

Recently, a pathologic bottom up mechanism involving cerebellum in PTSD has also been proposed (Carletto and Borsato, 2017). This structure has a key role in associative learning, fear regulation, attention, and in motor control (Wolf et al., 2009; Schmahmann, 2010) and it is strongly interconnected to cerebral cortex (Bergmann, 2008). Growing evidence shows altered functions of cerebellum in PTSD patients (Osuch et al., 2001; Anderson et al., 2002; Pissiota et al., 2002), with traumatic reminders ehnancing its activation (Fernandez et al., 2001; Driessen et al., 2004). Furthermore, cerebellar volume is smaller in adults with PTSD than in healthy controls (De Bellis and Kuchibhatla, 2006; Carrion et al., 2009; Baldaçara et al., 2011), and this reduction is associated with the magnitude of PTSD symptoms.

Cerebellum has also an indirect link to PTSD since it is a key structure in associative learning. In fact, PTSD can be described as the result of a fear conditioned response where extinction fails (Milad et al., 2009; VanElzakker et al., 2014). More specifically it is a conditioning to the context rather than to a specific stimulus (Davis et al., 2010) and it is well-documented how cerebellum appears to be involved in both conditioning and extinction process (Sacchetti et al., 2005; Kim and Jung, 2006).

In a rodent study, Sacchetti et al. (2007) showed how cerebellum could be as crucial as amygdala in long term fear memories: when amygdala is inactivated the fear-conditioning response is carried out by cerebellum.

Zhu et al. (2006) analyzed the extensive connectivity between cerebellum and whole brain suggesting that this area is an essential modulator and coordinator of visceral and behavioral response through cerebellar-hypothalamic circuit.

Cerebellum has also a central role in the sleep-wake cycle (Cunchillos and De Andrés, 1982; de Andrés et al., 2011; DelRosso and Hoque, 2014). There seem to be a bidirectional interaction between cerebellum and sleep: malfunction of cerebellum affects quality of sleep but also quality of sleep affects cerebellum dependent memory formation and memory consolidation (Canto et al., 2017). Patients with spinocerebellar ataxia, a degenerating pathology of cerebellum and its connections, show alterations in sleep stages as well in non-wakefullness. In this way cerebellum tunes neocortical forms of sleep related activity (Pedroso et al., 2011; Canto et al., 2017). On the other hand, sleep improves cerebellar learning as learning-dependent timing, procedural memory formation, and spatiotemporal predictions of motor actions (Verweij et al., 2016).

Fogel et al. (2015) reported that sleep after a procedural task showed an increment in SWS density, highlighting a putative cerebellar involvement.

Typically, cerebellar activity decreases during the transition from pre-sleep wakefulness to SWS (Braun et al., 1997; Hofle et al., 1997; Kajimura et al., 1999; Hiroki, 2005). During SWS cerebellar fMRI signals co-occurred with slow waves in neo cortex, and the level of density of those waves in cerebellum was correlated with gray matter volume (Dang-Vu et al., 2008; Saletin et al., 2013).

According to Born et al. (2006) since the synchronization caused by slow oscillations during SWS is not restricted to neocortex but spreads to hippocampus, thalamus, and brainstem, it can be speculated that also cerebellum is involved in such synchronous activation which in turn might favor its involvement in processing the procedural aspect of the psychological trauma, an essential component of therapy successful outcome.

The role of cerebellum in such process needs further investigations: cerebellar transcranial Direct Current Stimulation (tDCS), a form of brain polarization that influences motor functions and learning processes (Gandiga et al., 2006) could be a promising tool in understanding this complex relation. Previous findings have shown that tDCS applied to frontocortical regions induced an increase in SWS and enhanced consolidation of hippocampal-dependent declarative memories (Marshall et al., 2004, 2006). Moreover, a recent study (Ferrucci et al., 2013) indicated that cerebellar tDCS improves implicit procedural learning. This technique could be potentially coupled with Electroencephalography, assessing brain frequencies evoked by this manipulation, in particular testing if cerebellar electrical field modulation could lead to a "SWS-like" brain activity.

In conclusion, this opinion article aims at underlining the role of SWS in the physiological storage of memories and its participation in putative mechanisms of recover from conditions in which memory remains pathologically unprocessed, as in PTSD. This will also stimulate further research, both at theoretical and experimental levels, on the role of various structures in formation, consolidation, and reprocessing of traumatic memories.

In our opinion, there is a need of deepening the current model of PTSD going beyond the role of top-down processes. Investigating other brain regions such as cerebellum in bottom-up processes involved in PTSD will allow to better understand the underlying mechanisms of this disorder and to promote effective and neurobiologically-grounded therapies for trauma treatment.

AUTHOR CONTRIBUTIONS

MP and TB were responsible for the conception of the hypothesis outlined. SC wrote the article, that was integrated and critically revised by MP and TB. All authors have approved the final manuscript.

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Rescripting Memory, Redefining the Self: A Meta-Emotional Perspective on the Hypothesized Mechanism(s) of Imagery Rescripting

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Imagery Rescripting (ImRs) is a therapeutic technique that aims to reduce the distress associated with negative memories of early aversive experiences. It consists of prompting patients to *rescript* the autobiographical memory in line with their unmet needs. In recent years, ImRs was found effective in reducing symptoms of disorders such as depression, social phobia, obsessive-compulsive disorder, post-traumatic stress disorder, and personality disorders. However, the cognitive mechanisms underlying such broad effectiveness are currently an object of debate. Empirical evidence has shown that ImRs reduces the negative self-belief derived from aversive memories in different types of mental disorders. However, existing accounts are not very accurate in explaining how this change in self-belief occurs and therefore why ImRs is effective across psychopathologies. We propose that ImRs changes the semantic self-representation encapsulated in the aversive memory by reducing the meta-emotional problem (i.e., perceiving a negative emotion as problematic and unacceptable). Empirical evidence implicates the meta-emotional problem or "secondary problem" in the maintenance of different disorders and has shown that treating it leads to symptoms reduction. Here we hypothesize that: (i) ImRs as a stand-alone treatment may lead to a reduction of symptoms; negative self-belief and the meta-emotional problem; and (ii) the reduction of the meta-emotional problem might mediate the relation between symptoms and negative self-belief reduction. To test our hypothesis, we present an experimental procedure that could be used in future studies. We conclude discussing the existing theoretical frameworks that attempt to unravel the mechanisms that play a role in ImRs.

Keywords: imagery rescripting, autobiographical memory, self-representation, psychopathology, emotional invalidation, secondary problem, meta-emotional problem

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INTRODUCTION

Early traumatic experiences are considered to increase vulnerability to psychopathology by classical cognitive models of emotional disorders underlying cognitive behavioral therapy (CBT) (Beck, 1976; Beck et al., 1985; Foa and Kozak, 1986; Wells, 1997; Harvey et al., 2004). Childhood aversive events can be considered traumatic in two ways. In the stronger sense, the trauma corresponds

to single or repeated episodes of abuse or violence. In the weaker sense, trauma corresponds to experiences of lower emotional intensity over a longer time, such as a disorganized/unsure type of attachment between parents and children. According to both perspectives, traumatic experiences interfere with the self. For some authors, traumatic experiences interfere with the self as a process by disorganizing its structure and eliciting dissociation (van der Kolk et al., 1996; Liotti, 2004). In contrast, we agree with those positions that see trauma as interfering with self-representation (i.e., a form of semantic memory that describes the quality associated with the self, Brewin, 2006). Specifically, the type of attachment to primary relational figures plays a pivotal role in forming "Internal Working Models," "Internal Schemas," or "Early Maladaptive Schemas" which trigger and maintain psychopathology (Beck, 1964; Lorenzini et al., 1985; Lorenzini and Sassaroli, 1995; Young et al., 2003). Accordingly, a vast body of literature indicates that issues in self-concept and emotional regulation are associated to "emotional invalidation" during childhood (Drea, 2016; Witkowski, 2017), which consists of the invalidation, negation, or trivialization of a child's emotions and thoughts by caregivers (Linehan, 1993). These early aversive experiences are often associated with intrusive imagery and linked to distressing autobiographical memories. Imagery rescripting (ImRs) is a therapeutic technique, used in the context of Schema Therapy and CBT, that aims to reduce distress associated with these memories (Arntz and Weertman, 1999) and change their meaning (Arntz, 2011).

The classic procedure (Arntz and Weertman, 1999) consists of three phases. First, the patient is asked to enter a distressing memory with a similar emotional content of that characterizing current symptomatology. Ideally, the memory should belong to an event that occurred during childhood (see Ehlers et al., 2005 for examples of the procedure used in case of traumatic events occurred during adulthood). In this phase, the therapist encourages the patient to talk in the present tense from the child's perspective. After the factual details are clear, the therapist asks the child about his/her emotions and needs. Then, the rescripting begins and the patient is asked to step into the image as an adult and to take care of the child-self. This may involve the prevention of abuse, the creation of a safe environment for the child, and doing whatever the adult feels is right in that situation considering the child's needs. In the third phase, the child can ask the adult for further intervention until her/his needs are fully met.

A prominent feature of ImRs is its efficacy across psychopathologies such as: personality disorders (PD), post-traumatic stress disorder (PTSD), social anxiety disorder (SAD), body dysmorphic disorder, bulimia nervosa, depression, and obsessive-compulsive disorder, both as part of a treatment package (Arntz, 2012) and, more recently, as a stand-alone treatment (Morina et al., 2017). However, despite these promising results, the cognitive mechanisms underlying such broad effectiveness are currently an object of debate.

Several studies support the view that ImRs impacts self-representation. Specifically, ImRs reduced the strength of negative self-beliefs encapsulated in aversive memories of socially anxious participants (Wild et al., 2007, 2008; Lee and Kwon, 2013). Unfortunately, in these studies, ImRs was always preceded by cognitive restructuring, making it difficult to derive conclusions about ImRs' direct impact. ImRs' efficacy as a stand-alone treatment was investigated for SAD, revealing a significant reduction in participants' ratings of the validity and accuracy of their memory-derived core beliefs, as well as in the content of these beliefs, which was revised following ImRs (Reimer and Moscovitch, 2015). Similarly, a single session of ImRs diminished negative self-belief in bulimia patients when compared to a control condition that consisted of verbally examining the effects of beliefs on current functioning, including dieting. Emotional (and rational) negative self-belief reduction was associated with mood and behavior change, including a decreased urge to binge (Cooper, 2011). Finally, a recent study assessed the impact of ImRs on self-structures as measured by state self-esteem; self-concept clarity; self-description consistency, on memory characteristics (i.e., vividness and distress) and on affective measures. At follow-up, participants rated the memory as less important for their sense of self than at the first ImRs session. They also reported higher state self-esteem and positive affect, as well as reduced negative affect and anxiety after recalling the memory (Çili et al., 2017). Taken together, these results seem to indicate that ImRs strongly affects what a person thinks or has learned about him/herself (i.e., self-representation). A change in self-representation could explain ImRs' trans-diagnostic effectiveness, however, *how* does this change occur? Here, we propose that ImRs facilitates a change in self-belief *by* modifying the appraisal that the patient has learned to make about his/her own aversive emotions. Indeed, negative beliefs about aversive emotions may determine a secondary emotional response that might exacerbate and maintain the primary reaction and the consequent regulation attempts (Greenberg and Safran, 1990; Ellis, 1999; Greenberg, 2002; Hayes et al., 2006; Mennin and Farach, 2007; Clark and Beck, 2010). Indeed, perceiving an emotion as problematic, aversive, or unacceptable instead of normal, comprehensible, and acceptable can influence the way a person regulates the emotional state itself (Gardner et al., 1988; Hofmann, 2013). This phenomenon, which has been defined as "*secondary problem* or *meta-emotional problem*" (Ellis, 1980, 2003), has been considered by Clark and Beck (2010) as one of the most relevant factors in psychopathology. Indeed, the authors claimed that: "*the greatest differences between clinical and non-clinical anxiety are evident in the secondary, strategic controlled processes responsible for the persistence of anxiety.*" (p. 53).

AUTHORS' HYPOTHESIS

Traditional ImRs procedure implies: (i) a change in perspective from that of the child to that of the adult and (ii) the attempt to meet the child's unmet needs (Arntz and Weertman, 1999). Depending on the situation this could result in different types of actions (e.g., nurturing; protecting, soothing, empowering, etc.), however, in order to meet the needs of the child-self, the adult-self must first adopt an empathic disposition and acknowledge the child's-self affective state. Indeed, clinical observation suggests that if the patient does not legitimate his/her own feelings it

is very unlikely he/she will complete the exercise at all. In our perspective, this attitude of the adult-self could validate the child-self's suffering. Therefore, the new meaning that could emerge from ImRs is that child's suffering was legitimate, adequate, and deserving of care. In our view, this would be in contrast with the meaning inferred during childhood in attachment relations (i.e., the invalidation of the child negative emotions, Gardner et al., 1988). Indeed, in a meta-emotional perspective, if an individual believes that experiencing negative emotions is problematic, those could become aversive events, which amplify emotional reactivity (Greenberg and Safran, 1990; Ellis, 1999; Greenberg, 2002; Hayes et al., 2006; Mennin and Farach, 2007; Clark and Beck, 2010). Therefore it could be hypothesized that the secondary problem might negatively affect self-representation, ultimately maintaining psychopathology (Gardner et al., 1988; Hofmann, 2013).

Consistently, panic disorder is characterized by the catastrophic assessment of anxiety and its physiological correlates (i.e., anxiety sensitivity) (Clark, 1986). Similarly, social phobics often worry about the negative consequences of their anxiety in social contexts (e.g., being judged as weak or stupid; (American Psychiatric Association [APA], 2013). Despite these observations, currently there is no direct empirical evidence that the meta-emotional problem is a trans-diagnostic phenomenon, or that it plays a role in ImRs effectiveness. Indirect support of the role played by the meta-emotional problem in amplifying emotional reactivity across different pathologies comes from research on self-criticism. There is evidence that trait self-criticism is a *trans*-diagnostic phenomenon implicated in the development and maintenance of a range of psychopathologies (Schanche, 2013) as it triggers, perpetuates, and intensifies emotional reactivity (Shahar, 2013). However, the key difference between self-criticism and the meta-emotional problem is that in the latter patients only criticize themselves for having a specific emotion, whereas self-criticism refers to all aspects of a patient's life (Couyoumdjian et al., 2016). A more direct relation between the meta-emotional problem and anxiety symptomatology has been empirically tested by (Wells, 2000) who applied his Metacognitive Therapy in the context of both generalized and social anxiety. The author found reductions in fear of negative evaluation after treatment to such anxiety disorders (Wells, 2007). Moreover, a recent study directly tested whether reducing the negative assessment of specific negative emotions related to phobic stimuli (i.e., secondary problem) also reduced the experience of the aversive emotion itself (i.e., primary problem). Results revealed that participants whose meta-emotional problem was addressed during therapy also presented a decrease in autonomic arousal (as observed by decreased heart rate and increased heart rate variability) during a second exposure to phobic stimuli (Couyoumdjian et al., 2016). Furthermore, the meta-emotional problem is considered to play a role in affective disorders. Indeed, depressive rumination, a key risk factor for clinical depression, is related to negative thinking about depressive symptoms (Nolen-Hoeksema, 1991, 2000) and fear of depressed mood and anxiety was associated with rumination and emotional avoidance (Trincas et al., 2016). Strikingly, this study revealed that the tendency to have a negative secondary reaction to distress, as measured by the *Non-Acceptance* subscale of the Difficulty in Emotion Regulation Scale (Gratz and Roemer, 2008), was strongly correlated with higher negative beliefs about emotions (i.e., that emotions are irrational). Moreover, this idea was associated with feelings of guilt, shame, embarrassment, and weakness in reaction to emotional experience (Trincas et al., 2016). In line with this finding, it has been observed that feeling ashamed and humiliated for having PTSD or guilty about intrusive thoughts in OCD are predictors of poor therapy outcomes (Gilbert and Andrews, 1998; Clohessy and Ehlers, 1999) because patients avoid seeking treatment or engaging in exposure (Leahy, 2007). Finally, it has been found that negative appraisals of the sensations, emotions, or intrusive thoughts and images that are experienced are related to depression, anxiety, PTSD, metacognitive aspects of worry, alcohol abuse, marital discord, and PD (Leahy, 2001a,b, 2002, 2003; Leahy and Kaplan, 2004). Taken together, this literature seems to support the notion that the meta-emotional problem could be a trans-diagnostic phenomenon, whereas, to the best of our knowledge, there is still a lack of direct evidence that ImRs reduces the meta-emotional problem. Intriguingly, a pilot exploration of the use of Compassion-Focused imagery (CFI) in a group of self-critical people showed a significant improvement in the reported self-soothing abilities (Gilbert and Irons, 2004). However, self-criticism has been described as a personality trait that enhances people's frustrations and anger toward themselves in reaction to failures and setbacks (Blatt, 2004; Gilbert et al., 2004; Gilbert and Irons, 2004) while in the meta-emotional problem patients only criticize themselves for having negative emotions. Moreover, CFI is different from ImRs. Thus, our hypothesis needs further testing.

FUTURE DIRECTIONS

Future studies could test whether: (i) ImRs as a stand-alone treatment leads to a reduction of symptoms; negative self-belief and meta-emotional problem; and (ii) the reduction of the meta-emotional problem mediates the relation between symptoms reduction and negative self-belief. Social anxiety patients would be a good target for several reasons. Firstly, the role of the meta-emotional experience is commonly acknowledged and included as part of cognitive treatments for social anxiety (DSM-5 APA; Wells, 2000, 2007). Therefore, the experimental sample receiving a session of ImRs could be compared with a control sample receiving Metacognitive Therapy (Wells, 2000). Secondly, the strength of negative self-beliefs encapsulated in aversive memories of socially anxious participants has previously been tested. A similar procedure could thus be used to extract the negative self-belief from the memory and assess its strength (Wild et al., 2007, 2008; Lee and Kwon, 2013). Several measures could be administered before and after treatments to assess the hypothesis that ImRs reduces the meta-emotional problem. Specifically, the Beliefs about Emotions Questionnaire (BAEQ; Manser et al., 2012) entails six dimensions consisting of beliefs about emotions such as: overwhelming and uncontrollable, shameful and irrational, invalid and meaningless, useless, damaging and

contagious. Furthermore, the Affective Control Scale (ACS; Williams et al., 1997) was designed to assess fear of losing control over emotions or fear of behavioral reactions to emotion. The scale contains four dimensions: fear of anger, depression, anxiety, and positive emotion. However, since the meta-emotional problem refers specifically to aversive and problematic emotions, its nature and intensity can be investigated more directly by means of a semi-structured interview asking participants to define what they think about their negative emotional reaction and how much they believe such an evaluation to be true on a Likert scale (Couyoumdjian et al., 2016). Moreover, since previous results have shown that the *Non-Acceptance* subscale of the DERS was strongly correlated with higher negative beliefs about emotions, this scale could be included as a measure of emotional regulation. Finally, changes in symptoms could be assessed using measures used in previous studies such as the Social Phobia Inventory (SPIN; Connor et al., 2000), the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), and the Fear of Negative Evaluation Scale (FNE; Watson and Friend, 1969). If the reduction of the meta-emotional problem plays an active role in ImRs effectiveness, a reduction of SAD symptoms; negative self-belief and meta-emotional problem should be expected in the ImRs group. This reduction should be comparable or greater than that observed in the Metacognitive Therapy group. In addition, if as we here hypothesize, negative self-belief is reduced by a reduction of the meta-emotional problem, the relation between symptoms reduction and the reduction in the strength of negative self-belief should be mediated by a reduction in the meta-emotional problem.

DISCUSSION OF EXISTING ACCOUNTS

Here we proposed a meta-emotional perspective on the mechanism underlying ImRs effectiveness. Specifically, a body of literature shows ImRs to strongly impact self-representation, but how? In our view, this question should be considered when assessing the predictive power of the theories that attempted to unravel the mechanisms underlying change in ImRs.

According to Arntz and colleagues (Arntz, 2012), ImRs works by directly changing the valence associated with an unconditioned stimulus (US) corresponding to the representation of the aversive event. This theory has been termed "US-revaluation" (Davey, 1989; Arntz and Weertman, 1999), a process where fear memories are weakened by changing the meaning of such stimuli. Preliminary evidence in support of the involvement of "US-revaluation" in ImRs comes from a study showing that ImRs, added to extinction, reduced the estimated probability of the occurrence of the "US" and a reduction of the "US" negative valence (Dibbets et al., 2012). One critical point of this perspective is that saying that ImRs works by changing the valence of the memory does not necessarily imply that the meaning of the self is changed. For instance, Hagenaars and Arntz (2012) found that ImRs brought about a reduction in the development of self-blame cognitions along with a reduction in intrusion development. In our view, the latter result suggests that what is changed in the patient's knowledge system is not just the valence of the memory but a more general system of learned goals, cognitions, and beliefs of oneself. However, it appears unclear if, according to the US-revaluation hypothesis, the reduction of negative self-blame cognition is epiphenomenal or causal with respect to the change in memory valence. It has been proposed that the expression of negative emotions could restore a more general sense of control over life, increasing self-efficacy (Arntz, 2012). However, concepts like self-esteem or self-efficacy are rather aspecific and seem neither sufficient nor necessary to explain the emergency and maintenance of psychopathology or its remission. Additionally, it has been suggested that the expression of inhibited emotions facilitates the integration of the adverse memory within the autobiographical knowledge base (Dibbets and Arntz, 2016). Again, even acknowledging the cathartic power of the expression of emotion, it seems unclear how a better integration of the adverse memory in the autobiographical knowledge base would result in the reduction of negative self-belief. Moreover, even assuming that intrusions of aversive memory, as in PTSD, are prevented by a higher integration of those memories into the autobiographical knowledge base, integration seems unnecessary in PD, where aversive memories seem perfectly integrated with strong negative beliefs towards the self (i.e., schema).

Alternatively, Brewin proposed that rather than schema change at the core of CBT there is competition for retrieval between alternative representations (Brewin, 2006). He suggested that beliefs about the self do not only take the form of abstract semantic knowledge (e.g., "*I am a failure*") but are also underpinned by episodic memories of specific autobiographical events. Therefore, an improvement in symptoms could be expected not only by verbally reappraising negative self-belief but also preventing the retrieval of episodic memories in support of the negative semantic knowledge. Consequently, ImRs may "*draw on associative* and automatic *processes to create an alternative image in memory that shares similar sensory features but is accompanied by positive rather than negative emotions*" (Wheatley et al., 2007). Furthermore, ImRs may add new contextual information to the inflexible but more salient sensory-bound representation of the aversive event, making it more likely for the new representation to win the retrieval competition (Brewin et al., 2010). However, it is worth noting that the acquisition of new contextual information relative to external events does not appear to be strictly necessary in the traditional procedure (Arntz and Weertman, 1999).

In sum, previous accounts suggested that ImRs promotes the reduction of symptoms and of negative self-belief either by changing the valence of the aversive autobiographical memory or by reducing their accessibility. In our view, both approaches offer a plausible explanation of the observed reduction in negative self-belief, however, they are not very accurate in clarifying how the change in self-belief occurs. Additionally, none of the examined theories considered the role played by emotional appraisal in connecting the aversive memory to the negative self-belief encapsulated within. Notably, appraisals concerning emotional experiences involve individuals' beliefs about emotions.

Because working with beliefs about emotions is a fundamental part of cognitive and behavioral psychotherapies (Linehan, 1993; Wells, 2008; Clark and Beck, 2009, 2010; Leahy, 2015) we here propose a link between the change occurring in the beliefs about one's own emotion and the change occurring in self-belief.

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AM and FM substantially contributed to the conception of the work and drafting the manuscript.

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MINI REVIEW
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Neural Correlates of Outcome of the Psychotherapy Compared to Antidepressant Therapy in Anxiety and Depression Disorders: A Meta-Analysis

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The most prevalent mental disorders, anxiety and depression, are commonly associated with structural and functional changes in the fronto-limbic brain areas. The clinical trials investigating patients with affective disorders showed different outcome to different treatments such as psychotherapy or pharmacotherapy. It is, however, still unexplored how these interventions approach affect the functional brain. This meta-analysis aims to compare the effects of psychotherapy compared to antidepressant therapy on functional brain activity in anxiety and depression disorders. Twenty-one samples with psychotherapy and seventeen samples with antidepressant therapy were included. The main finding showed an inverse effect of the two treatments on the right paracingulate activity. The patients undergoing psychotherapy showed an increase in the right paracingulate activity while pharmacological treatment led to a decrease of activation of this area. This finding seems to support the recent studies that hypothesize how psychotherapy, through the self-knowledge and the meaning processing, involves a top-down emotional regulation.

Keywords: psychotherapy, pharmacotherapy, neural correlates, anxiety, depression

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INTRODUCTION

A human being is the outcome of a developing process, which depend on a complex interaction between the genetic information and the environment. A remarkable characteristic of the brain is that it allows the nervous system to process information from the interacting environment, modifying itself by experience in measurable ways (Markham and Greenough, 2004). With the recent advances in neuroimaging techniques, scientists are able to identify neural correlates not only of mental disorders but also of the changes associated with therapeutic interventions (Fuchs, 2004). These interventions are broadly categorized into psychotherapy or pharmaceutical treatments. However, it is very interesting to understand how the outcome of different treatments affect the functional brain activity and neural circuits (Salone et al., 2016).

The main impairment in affective disorders is related to emotional dysregulation and is characterized by abnormal brain activity in the cortico-limbic brain networks (Ochsner and Gross, 2008; Wager et al., 2008; Messina et al., 2013). Patients with depression showed hyperactivation

of "default mode network" (DMN), consisting of the posterior cingulated, precuneus, inferior parietal lobule, medial prefrontal cortex, and of the amygdala during resting-state and in response to emotional stimuli (Greicius et al., 2007; Siegle et al., 2007; Grimm et al., 2009; Carlson et al., 2017). The patients with anxiety disorders showed multiple underlying structural abnormalities within the fear circuit, in particular of the ventromedial prefrontal cortex (Cha et al., 2014; Carlson et al., 2017) and an increased response in the amygdala, anterior cingulated cortex, and insula in anticipation of aversive and neutral stimuli (Stein et al., 2007; Nitschke et al., 2009; Carlson et al., 2011, 2017).

Accordingly, studies on the neurobiological outcomes of the therapeutic interventions in anxiety and depression disorders report the changes in neural activity in the cortico-limbic brain regions implicated in the emotion regulation (Ressler and Mayberg, 2007; Messina et al., 2013). With respect to prognosis and improvement of psychopathological symptoms, both psychotherapy and pharmacotherapy are clinically effective for treating psychopathological disorders (Cuijpers et al., 2013). Despite psychotherapy and pharmacotherapy seem to lead to a final common neurobiological pathway, it is reasonable to hypothesize that these widely differing treatments might engage diverse neural mechanisms (DeRubeis et al., 2008; Marano et al., 2012; Quidé et al., 2012). In according with this hypothesis, a recent meta-analysis showed that in patients with major depression the psychotherapy induced modifications in the left frontal, temporal, lingual gyri and in the cingulate cortex, as well as in the right frontal and precentral gyri. Otherwise, pharmacotherapy affected brain activation in the right insula (Boccia et al., 2016).

The pharmacotherapy is directly oriented to the emotional reactivity through the balance of neurotransmitter activity that seems to modify the neural activity in the limbic structures normalizing the cortical activity through bottom-up approach (Stahl, 2013). On the other side, the psychotherapy works on to build and to elaborate meanings that can regulate the attention and memory systems inducing changes in cortical brain activity that through top-down approach restores the limbic system functions reducing the emotional dysregulations (Linden, 2006).

Despite the impressive growth of neuroimaging techniques, how different treatments affect the functional brain is yet to be established.

In order to investigate the neural correlate of the outcome of different treatments used in the anxiety and depression clinical trials, in the present meta-analysis the therapeutic interventions were divided into two different categories: psychotherapy and antidepressant therapy.

The aim of the current meta-analysis was to compare the neural correlates of pre and post-treatment effects of psychotherapy and antidepressant therapy in affective disorders.

METHODS

In order to reach the aim of the meta-analysis, the following comparisons were performed: (1) pre- vs. post-treatment changes in the activations of brain regions due to psychotherapy (2) pre- vs. post-treatment changes in the activations of brain regions due to antidepressant therapy, and (3) post-treatment changes in the activations of brain regions due to psychotherapy vs. antidepressant therapy. Successively, the same contrasts only on resting state studies were re-performed. The significant effects for all contrasts were considered in both directions (increased and decreased effects post-treatment).

Search Criterion

A systematic search strategy was used to identify relevant neuroimaging studies reporting the changes in functional neural activity as a treatment outcome of cognitive/psychodynamic therapies and antidepressant therapy on the anxiety and depression disorders. For this purpose, PubMed and Scopus database search was performed by two independent researchers to find putative studies reporting the treatment for the anxiety and depression disorders following DSM-IV-TR criteria. The search was conducted for studies published between 2000 and 2016. The following search terms were used: "imaging," "fMRI" (functional MRI), "PET" (positron emission tomography), and "SPECT" (single photon emission computed tomography) in combination with the name of the disorder (anxiety, PTSD, panic disorder, phobias, and depression). Furthermore, the reference lists of the articles were manually checked for the studies not identified in earlier literature search. To achieve a high standard of reporting we have adopted "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) guidelines.

Selection Criteria

Studies were included if they met the following criteria: (a) being original papers in a peer-reviewed journal, (b) involving subjects with a pre and post-treatment effects, (c) having employed functional imaging, (d) having reported the brain coordinates in standard brain atlases, (e) having adult samples (age 18–65).

The studies in which the entire group of patients had received prior interventions at the time of the start of the treatment study and the studies which reported a single case study were not included in the meta-analysis to reduce the possible biases.

Recorded Variables

The variables recorded for articles in the meta-analysis were: sample size, gender, mean age of participants and peak coordinates reported along with the software and stereotactic space of these coordinates. Additionally, we recorded the statistical significance of the treatment outcomes and the method employed to correct the results for multiple comparisons. The studies which compared between two types of treatments (psychotherapy vs. antidepressant therapy), only the pre to post brain changes for each treatment separately were considered.

Study Classification

The studies were then classified into two categories based on the treatment type. The studies that included the cognitive (CT) and dynamic (DPT) based treatments were categorized in psychotherapy group, and those including the intake of antidepressant drugs in antidepressant therapy group (see **Table 1**).

TABLE 1 | Studies included in meta-analysis.

Study	Disease	Therapy	Patients	Technique	Task	Mean age
Farrow et al., 2005	PTSD	Psychotherapy	13	fMRI	Emotional task	42
Felmingham et al., 2007	PTSD	Psychotherapy	8	fMRI	Emotional task	36.8
Fu et al., 2008	Depression	Psychotherapy	16	fMRI	Emotional task	40
Huang et al., 2014	Depression	Psychotherapy	23	fMRI	Resting state	27.7
Kircher et al., 2013	Panic	Psychotherapy	42	fMRI	Emotional task	35.42
Paquette et al., 2003	Phobia	Psychotherapy	12	fMRI	Emotional task	24.8
Ritchey et al., 2011	Depression	Psychotherapy	11	fMRI	Emotional task	36.1
Sakai et al., 2006	Panic	Psychotherapy	11	PET	Resting state	29.8
Schienle et al., 2007	Phobia	Psychotherapy	14	fMRI	Emotional task	27.2
Yoshimura et al., 2014	Depression	Psychotherapy	21	fMRI	Emotional task	37.3
Aupperle et al., 2013	PTSD	Psychotherapy	14	fMRI	Emotional task	40.1
Buchheim et al., 2012	Depression	Psychotherapy	16	fMRI	Emotional task	38.9
Wiswede et al., 2014	Depression	Psychotherapy	13	fMRI	Emotional task	39.8
Beutel et al., 2010	Panic	Psychotherapy	15	fMRI	Emotional task	32
Furmark et al., 2002	Social Phobia	Psychotherapy; Antidepressant therapy	6; 6	PET	Emotional task	35.2
Goldapple et al., 2004	Depression	Psychotherapy; Antidepressant therapy	14; 13	PET	Resting state	41; 36
Kennedy et al., 2007	Depression	Psychotherapy; Antidepressant therapy	7; 9	PET	Resting state	32.7; 40.1
Konarski et al., 2009	Depression	Psychotherapy; Antidepressant therapy	7; 9	PET	Resting state	32.7; 40.1
Prasko et al., 2004	Panic	Psychotherapy; Antidepressant therapy	6; 6	PET	Resting state	31.8; 32
Brody et al., 2001	Depression	Psychotherapy; Antidepressant therapy	14; 10	PET	Resting state	40.7; 36.4
Martin et al., 2001	Depression	Psychotherapy; Antidepressant therapy	13; 15	SPECT	Resting state	38.4; 39.4
Brockmann et al., 2009	Depression	Antidepressant therapy	44	SPECT	Resting state	47.2
Carey et al., 2004	Anxiety	Antidepressant therapy	37	SPECT	Resting state	33.5
Kennedy et al., 2001	Depression	Antidepressant therapy	13	PET	Resting state	36.7
Mayberg et al., 2000	Depression	Antidepressant therapy	4	PET	Resting state	49
Samson et al., 2011	Depression	Antidepressant therapy	10	fMRI	Emotional task	41.5
Seedat et al., 2004	PTSD	Antidepressant therapy	11	SPECT	Resting state	33.6
Vlassenko et al., 2004	Depression	Antidepressant therapy	14	SPECT	Resting state	42.8
Warwick et al., 2006	Anxiety	Antidepressant therapy	31	SPECT	Resting state	33
Kilts et al., 2006	Anxiety	Antidepressant therapy	12	PET	Emotional task	38
Hoehn-Saric et al., 2004	Anxiety	Antidepressant therapy	6	fMRI	Emotional task	36

In these studies, the brain activity was scanned during the resting-state, focuses on spontaneous, low frequency fluctuations in the BOLD signal (Lee et al., 2013), or during an emotional task, i.e., during emotionally arousing stimuli (Messina et al., 2013)."

Standard Meta-Analyses of Functional Changes Post-treatment

Voxel-based meta-analyses of functional brain changes to the treatment were conducted with the effect-size version of signed differential mapping (ES-SDM; Radua and Mataix-Cols, 2009, 2012). This technique has been used in meta-analysis studies on obsessive compulsive disorder, schizophrenia and bipolar disorder, etc. (Bora et al., 2010, 2011; Palaniyappan et al., 2012). This method is based on using the peak coordinates to recreate, for each study, a map of the effect sizes of the differences between pre and post-treatment changes in patients, and then on conducting a standard random-effects variance-weighted meta-analysis in each voxel.

Between group comparison among the two treatments (psychotherapy vs. antidepressant therapy) was conducted and significant results were reported after threshold at $p < 0.001$ uncorrected (equivalent to $p < 0.05$ corrected for multiple comparisons (Radua et al., 2010) with an extent threshold of Ke > 10 voxels. Default ES-SDM kernel size and thresholds were used (FWHM = 20 mm, peak height Z = 1, cluster extent = 10 voxels; Radua and Mataix-Cols, 2009).

Robustness of the significant results was assessed by means of exploration of the jack-knife analyses by systematically repeating the meta-analyses by excluding one study at a time. If a significant brain region remains significant in all or most of the combinations of studies it can be concluded that this finding is highly replicable.

RESULTS

Thirty-one studies met the inclusion criteria. Four-teen studies tested neural correlate of psychotherapy (eleven using CT,

three DPT) and ten studies investigated neural correlate of antidepressant therapy. The remaining seven studies were performed on two randomized trial (five with CT vs. antidepressant therapy and two with DPT vs. antidepressant therapy). Thus, the meta-analysis included 16 samples reporting treatment outcomes with CT, 5 samples with DPT and 17 samples with antidepressant therapy. The overall sample was equivalent to a cohort of 546 individuals undergoing treatment for anxiety and depression (Mean age, $SD = 36.3, 5.46$) contributing data to the meta-analysis.

Comparison of Regional Brain Response: Psychotherapy and Antidepressant Therapy

Data for this analysis was obtained from 21 samples of 296 patients undergoing treatment with psychotherapy and 17 samples representing 250 patients undergoing antidepressant therapy.

As shown in **Table 2**, both psychotherapy and antidepressant therapy showed a decreased activation (post vs. pre) of the right inferior frontal gyrus, bilateral superior frontal gyrus, bilateral anterior cingulate, and right insula. However, other patterns of activations varied between these groups. In particular, patients undergoing psychotherapy showed an increased activation of right paracingulate gyrus and precuneus, and a decreased activation of right hippocampus, right parahippocampal gyrus, right amygdala, right rolandic operculum, right putamen, right temporal pole, right superior temporal gyrus, and bilateral anterior cingulate gyrus. Conversely, antidepressant therapy showed an increased activation (post vs. pre) in the right middle frontal gyrus, and a decreased activation of the bilateral supplementary motor area, bilateral paracingulate gyrus and bilateral caudate nucleus.

Interestingly, an inverse pattern of activation was observed in right paracingulate gyrus.

In order to control the effect of the task on the difference between outcome treatment of psychotherapy and antidepressant therapy, a comparison between the two treatments on only the resting state studies was conducted. Data for this analysis was obtained from 15 resting state studies representing 8 samples with 95 patients undergoing treatment with psychotherapy (25% anxiety and 75% depression disorders) and 11 samples with 192 patients undergoing antidepressant therapy (36% anxiety and 64% depression disorders). The findings confirm the inverse pattern of activation observed in right paracingulate gyrus in the previous analyses (**Table 2**).

Robustness Analysis

The analysis of robustness (jack-knife sensitivity analyses) showed that the results were highly replicable with possible exception of right parahippocampal gyrus, right superior frontal gyrus and bilateral caudate nucleus in antidepressant therapy group, and with possible exception of the left middle frontal activation in psychotherapy trials where this activation did not remain significant in 10/21 re-sampling combination trials.

DISCUSSION

This is to our knowledge is the first neuroimaging meta-analysis which focuses on a comparison between psychotherapy and antidepressant therapy in patients with anxiety and depression.

The patients undergoing psychotherapeutic and pharmacological treatments for anxiety and depression showed an overall decreased activations in right inferior frontal gyrus, bilateral superior frontal gyrus, bilateral anterior cingulate and right insula suggesting the relevant role of these areas in the symptoms reduction. Superior frontal gyrus and anterior cingulate represent the components of central executive networks of information processing which is activated when performing a task requiring focused attention. Furthermore, anterior cingulate and insula are involved in the Salience Network (Ham et al., 2013) which is responsible for switching between the default mode network (the network which is active during the rest when the brain is not engaged in a specific task) and the central executive network (Goulden et al., 2014). The intensity of interactions of default mode and central executive network in insular salience network activity have been previously associated with the severity of symptoms in major depressive disorder (Manoliu et al., 2013). The reduced post-treatment activations of these areas in anxiety and depression could indicate the restored activity of the brain.

The main finding of the present study was the inverse effects of psychotherapy and antidepressant therapy on the right paracingulate activity. The patients undergoing psychotherapeutic treatment led to an increased activation of the right paracingulate activity while those with antidepressant therapy showed a decrease of this area. The paracingulate cortex (approximately corresponding to BA32) is often considered to be part of the anterior cingulate cortex, however the BA32 has been described cytoarchitectonically as a cingulo-frontal transition area (Devinsky et al., 1995) and therefore anatomically (and maybe functionally) distinct from the anterior cingulated cortex (Gallagher and Frith, 2003). Specially, the paracingulate cortex activity seems to be associated with the mentalizing ability (Gallagher and Frith, 2003) and with self-monitoring such as: visual self-recognition (Kircher et al., 2000, 2001), autobiographical memory (Maguire and Mummery, 1999; Maguire, 2001), conflict monitoring (Botvinick et al., 2001; Beckmann et al., 2009), verbal self-monitoring (McGuire et al., 1996b), self-generated thoughts (McGuire et al., 1996a). The components of these abilities are implicated in initiation and maintenance of the symptoms of anxiety and depression (Roiser et al., 2012; Weightman et al., 2014; Anastasides et al., 2015; Bartczak and Bokus, 2015). Moreover, a study showed that the paracingulate cortex is active during the "rest" condition (Gusnard et al., 2001). The authors suggested that this might indicate a "default" mode of functioning in which "we think about ourselves" (Gusnard et al., 2001). In light of these findings, it seems that cingulo-frontal section could be specialized on internal mental states processing (Gallagher and Frith, 2003).

In a very interesting way, different authors reported that the anterior cingulated cortex is evolutionally very recent, in fact, it is present only in humans and in higher primates (Nimchinsky

TABLE 2 | Comparative results of treatment outcome of Psychotherapy and Antidepressant therapy.

	Psychotherapy (Post vs. Pre)					Antidepressant therapy (Post vs. Pre)					Psychotherapy(Post-Pre) vs. Antidepressant therapy (Post-Pre)							
											Psychotherapy				Antidepressant therapy			
		Coordinates	SDM-Z	*P*-value	Voxels		Coordinates	SDM-Z	*P*-value	Voxels	Coordinates	SDM-Z	*P*-value	Voxels		Coordinates	SDM-Z	*P*-value	Voxels
L lingual gyrus						↑	−12,−44,−2	1.19	0.00119	117									
L supramarginal gyrus						↑	−58,−28,28	1.04	0.00432	101									
L supplementary motor area						↓	−4,16,44	2.59	0.00002	367					↓	0,8,44	2.41	0.00001	307
							−4,12,48	2.41	0.00016	319						−4,2,44	1.78	0.00009	164
R supplementary motor area						↓	6,16,46	2.30	0.00011	224					↓	0,8,44	2.41	0.00001	169
							4,14,48	2.42	0.00012	186						4,2,46	1.78	0.0001	88
L inferior parietal						↑	−58,−28,28	1.04	0.00432	120									
L cerebellum						↑	12,−42,−16	1.17	0.00133	303									
R inferior frontal gyrus	↓	52,32,16	1.45	0.00121	300	↓	44,16,8	1.71	0.00169	155									
L middle frontal gyrus	↓	−34,54,−2	1.95	0.00015	280						↓	−34,54,−2	1.61	0.00040	187				
R middle frontal gyrus						↑	26,12,50	1.55	0.00017	124					↑	26,14,48	1.16	0.00140	48
							26,12,50	1.66	0.00012	123									
L superior frontal gyrus	↓	−8,42,−8	2.27	0.00001	699	↓	−4,18,40	2.47	0.00004	91	↓	−6,60,−4	1.61	0.00040	48				
		−6,60,−4	1.46	0.00165	254		4,14,48	2.42	0.00015	39									
R superior frontal gyrus	↓	8,42,−8	2.27	0.00001	582	↓	4,18,40	2.47	0.00004	75									
L paracingulate						↓	−6,10,42	2.51	0.00004	399					↓	−2,6,36	2.25	0.00002	452
R paracingulate	↑	14,−52,40	1.02	0.00054	119	↓	4,10,32	2.56	0.00003	337	↑	2,6,36	2.25	0.00002	306	↓	2,6,36	2.25	0.00002	306
L median paracingulate						↓	−8,14,38	2.07	0.00054	158					↓	−4,2,44	1.78	0.00010	319
R median paracingulate	↑	12,−12,38	1.16	0.00248	36	↓	8,10,38	2.04	0.00056	122	↑	4,2,34	1.48	0.00063	238	↓	4,2,34	1.48	0.00063	238
R hippocampus	↓	26,−4,−16	2.06	0.00002	84														
R parahippocampal gyrus	↓	26,−4,−16	2.06	0.00002	78														
R amygdala	↓	26,−4,−16	2.06	0.00002	193														
L anterior cingulate	↓	0,48,4	3.00	∼0	674	↓	−2,8,36	2.41	0.00001	159									
		−2,38,2	1.33	0.00349	226														
R anterior cingulate	↓	0,48,4	3.00	∼0	399	↓	2,8,36	2.41	0.00001	61									
R insula	↓	48,4,2	2.43	0.00001	702	↓	32,18,8	1.89	0.00074	265					↓	34,18,8	1.30	0.00230	51
							34,16,10	1.61	0.00305	25									
R rolandic operculum	↓	48,4,2	2.43	0.00001	305														
R Putamen	↓	48,4,2	2.43	0.00001	302														
R temporal pole	↓	48,4,2	2.43	0.00001	201														
R superior temporal gyrus	↓	48,4,2	2.43	0.00001	136														
R heschl gyrus	↓	48,4,2	2.43	0.00001	41														
L rectus gyrus	↓	−12,36,−10	2.23	0.00004	34														
L caudate nucleus						↓	−8,4,10	1.86	0.00082	17					↓	−10,8,16	1.36	0.00130	39
							−8,4,8	1.61	0.00308	15									
R precuneus	↑	14,−52,40	1.03	0.00054	86														

SDM-Z: Voxel probability; threshold P-value: p = 0.005; Peak height threshold: z = 1. In red, results on only the resting-state studies.

et al., 1999). Specifically paracingulate cortex seems to be present only in 50% of humans (Paus, 2001) and it might be indicative of a progressive evolution of this region in humans (Zilles et al., 1988; Gallagher and Frith, 2003), suggesting as its development could be affected by the environment and by the relative meaning attribution.

In line with the theoretical aspects of psychotherapies that emphasize the importance of the internal reality, as the representations, and the processes of the meaning attribution and elaboration (Timary et al., 2011), the increase of the right paracingulate activity might be interpreted as psychotherapy conditioned increase of the attention to personal inner states and of the emotions regulation ability (Keune et al., 2012; Messina et al., 2016).

Moreover, through the introspection and the self-knowledge, "a subject can construct itself as psychologically self-conscious (and not only as physically self-conscious) in an interplay of meta-representational abilities, autobiographical memory, and socio-communicative capacities" (Guerini et al., 2015). Conversely, the neurobiological outcome of the antidepressant therapy showed a decrease of the right paracingulate activity, which can be explained by the fact that this kind of treatment is not focused on the elaboration of internal mental states.

An alternative interpretation is that the inverse effect of the two types of treatment could be due to the different experimental tasks used during the neurobiological data acquisition (Messina et al., 2013). The results of the meta-analyses including only resting state studies, where the inverse effect of psychotherapy vs. antidepressant therapy on paracingulate activity was maintained, it falsifies this interpretation.

Limitations

The present meta-analysis entails certain limitations. First, methodological limitation concerns the data available for analysis. Several studies had small sample sizes, variable duration, heterogeneity of techniques and study designs which might affect the outcome of the therapeutic outcome and thus the quality of the meta-analysis.

A second limitation is the considerable heterogeneity in the samples due to the combination of anxiety and depression together. However, in order to reduce the pathology biases, we considered homogeneous number of studies for anxiety and depression in psychotherapy and antidepressant therapy studies. Another limitation is that this meta-analysis also includes the studies reporting only the region of interest involving fronto-limbic brain. Finally, the present meta-analysis did not compare different types of psychotherapies (cognitive vs. dynamic). This lack was due to the exiguous number of clinical samples treated with dynamic psychotherapy. In order to perform this comparison more studies on the neurobiological outcome of dynamic treatment are needed.

CONCLUSIONS

The finding of the present meta-analysis showed a different neurobiological outcome of the psychotherapy compared to antidepressant therapy in anxiety and depression. The psychotherapeutic and pharmacological treatments showed inverse effects on the right paracingulate activity. This finding seems to support the recent studies (Linden, 2006) that hypothesize how psychotherapy, through the self-knowledge and the meaning processing, involves a top-down emotional regulation.

AUTHOR CONTRIBUTIONS

Participated in meta-analysis design: CL and NK. Performed data analysis: NK. Wrote or contributed to the writing of the manuscript: NK, DA, RT, PA, CT, CD, and CL.

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