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Accuracy and reconstruction in autobiographical memory: (Re)consolidating neuroscience and sociocultural developmental approaches

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Abstract

Autobiographical memories are never isolated episodes; they are embedded in a network that is continually updated and prediction driven. We present autobiographical memory as a meaning-driven process that includes both veridical traces and reconstructive schemas. Our developmental approach delineates how autobiographical memory develops across childhood and throughout adulthood, and our sociocultural approach examines the ways in which autobiographical memories are shaped by everyday social interactions embedded within cultural worldviews. These approaches are enhanced by a focus on autobiographical memory functions, namely self-coherence, social embeddedness, and directing future behaviors. Neuroscience models of memory outlined in multiple trace and trace transformation theories and perceptual principles of predictive processing establish mechanisms and frameworks into which autobiographical memory processes are incorporated. Rather than conceptualizing autobiographical and episodic memories as accurate versus error-prone, we frame memory as a dynamic process that is continuously updated to create coherent meaning for individuals living in complex sociocultural worlds. Autobiographical memory is a process of both accuracy and error, an intricate weaving of specific episodic details, inferences and confusions among similar experiences; it incorporates post-event information through reminiscing and conversations, in the service of creating more meaningful coherent memories that define self, others, and the world.

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autobiographical memory, personal narratives, predictive processing, reconsolidation

1 | INTRODUCTION

Memory is a paradox. Early philosophers likened memory to a wax tablet, to traces etched in our brains remembered through specified retrieval paths that allowed us to recreate the original experience in the theater of our mind (Brockmeier, 2015; De Brigard, 2014; Sutton, 1998). Traces could decay, or interfere with each other, but, ultimately, memory was about the laying down of information and the subsequent retrieval of that information. The first

psychological experiments about memory conducted by Ebbinghaus in 1885 focused on the ability to recall accurately a series of nonsense syllables, strings of letters stripped of any semantic meaning so as to study recall and forgetting of the "pure" memory trace. But even early in the history of psychological science, this view was called into question. Bartlett, in his famous 1932 book on "Remembering," argued that it was impossible to strip meaning from any information presented to humans. Humans, by nature, made "efforts after meaning." Rather than memory as a storehouse of traces, Bartlett saw memory as a tool for organizing information through constructing and reconstructing information to "make sense," thus developing a dynamic, schematic view of human memory. The tension between veridical traces and reconstructive schemas have informed psychological theory and research on autobiographical memory for over 100 years. We now know that autobiographical memory is both specific and general, unique and universal, accurate and reconstructed (see De Brigard, 2014 for a review).

In this article, we address these paradoxical findings by outlining how contemporary research in autobiographical memory from both sociocultural and neuroscience perspectives demonstrate that accuracy and reconstruction are not binary but, rather, complementary. Sociocultural approaches address how autobiographical memories are shaped and modulated through everyday social interactions embedded in cultural contexts that provide evaluative frameworks for understanding the self and the world. Neuroscience approaches address how these sociocultural processes are mechanistically realized in the brain. Although these two literatures often do not speak to each other, both sociocultural and neuroscience approaches converge on autobiographical memory as a conglomeration of episodic details and personal and culturally mediated scripts and schemas. Moreover, both approaches provide a model of autobiographical memory as rooted in accurate episodic details that place boundary conditions on reconstructive elements over time; thus, both approaches do not posit accuracy and reconstruction as either-or but as both-and. Our major objective in this paper is to bring these two literatures into conversation in ways that will advance theory and research in autobiographical memory.

To foreshadow, we will first provide a broad overview of the autobiographical memory literature that demonstrates both accuracy and reconstructive processes over time, both short periods of time and across the life span. We then turn to an overview of the sociocultural approach to autobiographical memory. We take a decidedly developmental approach, delineating how autobiographical memory develops across childhood and throughout adulthood, examining the ways in which autobiographical memories are shaped by everyday social interactions embedded within cultural worldviews. We demonstrate how autobiographical memories maintain accurate detailed aspects of experience integrated with schematic generalized and reconstructed inferences, assumptions and interpretations. Importantly, we argue that the complex interweaving of what is remembered occurs over time, through multiple rememberings done in multiple contexts for multiple purposes, leading to a highly dynamic process of memory that brings the past to mind in complicated tapestries of accurate and reconstructed information. We then provide a description of neural-psychological representational correspondence (NPRC, Gilboa & Moscovitch, 2021) an approach that integrates recent findings on the neuroscience of memory, and show how NPRC provides a mechanistic account of the phenomenon of autobiographical memory that aligns with sociocultural theory. Rather than assumptions that accuracy and reconstruction are orthogonal, NPRC provides a mechanistic explanation of how and why autobiographical memory must be, at all points, a complex interplay resulting in both accuracy and inference, both personal and sociocultural. Our goal in bringing these two approaches into conversation is to underscore autobiographical memory as dynamic and flexible, maintaining both accurate and reconstructed elements, and to show how this system dynamically changes over time both within social interactions and within the brain. In the final section, we discuss how bringing these two approaches together might change the kinds of research questions we ask and the kinds of data we collect.

2 | AUTOBIOGRAPHICAL MEMORY FORMS AND FUNCTIONS

Autobiographical memory seems deceptively easy to define—memories of our personal experiences. Tulving's (1972) distinction between semantic and episodic memory, each as separate aspects of declarative memory (Squire, 2004), seems to equate autobiographical memory with episodic memory, and, indeed, much of the cognitive research on autobiographical memory has assessed recall, duration and accuracy of specific episodes. But as early as 1986, Brewer argued that autobiographical memory cannot be reduced to a collection of episodes. Autobiographical memory includes facts we know about ourselves (our date of birth, the names of our grandparents), extended and recurring events (summer vacations, varsity basketball), as well as more generalized schematic information about routine events (such as how to go to a restaurant, or to the supermarket). Further, episodes are not an unconnected series of happenings, but

are linked together temporally and thematically to form life periods (high school, college, first house) and life themes (schooling, romance), as laid out in the widely accepted model of autobiographical memory described by Conway and Pleydell-Pearce (2000). And, as has been made clear in the personality literature, these memories are not simply what happened, but include layers of interpreted and evaluative information, what this event means for who we are, how we became this way and who we may become (McAdams, 2008). In short, autobiographical memory is a biography of self, the story of "me" that is a dynamic evolving conglomeration of specific events, repeated and recurring experiences, extended events and life periods, organized temporally and thematically to create a coherent and consistent sense of self (Conway et al., 2004; Fivush, 2010; McAdams, 2008). The study of autobiographical memory is the study of developing individuals navigating and remembering complex sociocultural experiences in order to define who they are in relation to others and their place and purpose in the larger sociocultural world.

3 | SOCIOCULTURAL DEVELOPMENTAL APPROACHES TO AUTOBIOGRAPHICAL MEMORY AND NARRATIVES

Human beings are storytellers. Across evolutionary time and culture, humans tell stories about the world and about themselves (Boyd, 2018; McAdams, 2019). From the moment of birth, infants are surrounded by stories, fairy tales and myths as well as stories of the family into which they were born; as soon as children begin to talk, at about 16- to 18-months of age, they are drawn into sharing stories of their personal experiences in everyday reminiscing conversations with adults that highlight the forms and functions of personal storytelling (see Fivush, 2019, for a review). About 40% of all human conversation consists of storytelling (Boyd, 2018). The remarkable ubiquity and frequency of storytelling underscores its importance for the human experience; our sense of our past and of our selves is shaped through the stories we tell and share with others, and the stories others share with us (Pillemer et al., 2015).

Over the past three decades, research on personal narratives has exploded in two major directions: the early emergence of autobiographical narratives during the preschool years (Fivush, 2019) and the construction of a life narrative in adolescence and adulthood (Habermas & Bluck, 2000). Both of these approaches share a developmental sociocultural approach, viewing autobiographical memory and narratives as forming and re-forming in multiple everyday culturally mediated social interactions in which we tell, interpret, evaluate and re-evaluate our experiences and the experiences of others (McLean et al., 2007). These everyday narrative interactions are embedded in larger social and cultural environments that define what a self is—for example, construing selves along dimensions of autonomy and communalism—and what a life should look like. Both life scripts (Berntsen & Rubin, 2004) and cultural narratives (McLean & Syed, 2015) define the occurrence, timing and evaluation of specific events expected in a typical lifetime. Our autobiographical narratives are constructed and constrained by both our lived experience and by the sociocultural conventions of narrating a life (Eakin, 2011).

3.1 | Development of personal memory

Autobiographical remembering is a deeply developmental process. Development occurs across both extremely short periods of time and across the life span (Fivush et al., 2017). Even in the course of a single reminiscing conversation, personal memories change, as tellers and listeners mutually shape the story as it is being told in ways that have consequences for what is subsequently remembered. For example, in terms of organization, attentive listeners solicit more coherent remembering than distracted listeners, and memories shared with attentive listeners are subsequently better recalled than memories shared with distracted listeners (Pasupathi, 2001). In terms of content, those aspects of the experience that are verbalized even in a single reminiscing conversation are subsequently better remembered, whereas non-verbalized aspects of the shared experience are prone to forgetting (Hirst & Echteroff, 2012). And interpretations and evaluations of the experience change as tellers express their experiences and listeners offer their own evaluations and re-interpretations of what it all means (McLean, 2015), and these changing interpretations are often linked to changes in the content of what is recalled as well (Schooler, 2001).

The process of constructing autobiographical remembering in social interactions begins in early childhood. Parents, and especially mothers, who provide coherently structured and elaboratively detailed questions to scaffold their preschool children's emerging autobiographical narratives, help children learn the forms and functions of reminiscing. Children of more elaborative mothers develop into more coherent narrators of their personal experience across childhood, and

develop a denser, more coherent accumulation of detailed autobiographical memories across childhood and adolescence (Reese et al., 2019; Reese, Jack, & White, 2010; Reese, Yan, et al., 2010). Pointedly, it is not simply a rehearsal effect; it is not that children learn to narrate specific events in more coherent and elaborated ways but that children are internalizing a style that allows them to process and reminisce about the experiences of their lives in more coherent and elaborated ways (Reese, Jack, & White, 2010; Reese, Yan, et al., 2010). The pattern of findings demonstrates unequivocally that personal memories are shaped across development in everyday reminiscing conversations in which lived experiences are remembered and re-remembered in dynamic evolving ways.

3.2 | Scripts and narratives

Individual personal memories develop alongside more schematized models of the self and the world. As individuals navigate their environments, they simultaneously process specific and generalized information about how the world typically works, often called scripts (Shank & Abelson, 1977). Scripts are generalized event schemas that specify the actors, actions, and objects most and least likely to occur in a given situation and the sequence of those actions. The prototypical example is the restaurant script—individuals living in particular cultures know what to expect when they walk into a restaurant: be seated, get a menu, order food, be served, eat, get the check, pay, and leave. This seems so simple and obvious that it need not even be mentioned. But for someone who has never been in a restaurant, or some other typical cultural experience, it is not obvious at all (as those of us fortunate enough to travel have learned, we often, and embarrassingly, do not know the "script"). Children learn the scripts of their culture at a very young age; by age 3, US children can report what generally happens at a supermarket, at a restaurant, when baking cookies, and such (Nelson, 1986). Early memory research debated which came first, scripts or specific memories, ultimately researchers realized that scripts and episodes develop in tandem, each informing the other in a highly interactive memory system (Hudson et al., 1992).

Whereas scripts organize coherent generalized knowledge about events, narratives add an additional layer of human understanding, moving beyond a simple account of sequenced actions and objects to include information about *why* characters do what they do—motivations, intentions, and goals—and also *why it matters*—interpretations and evaluations of characters and events (Labov, 2010). Essentially, as Bruner (1991) has argued, narratives integrate the landscape of action with the landscape of consciousness to create meaning from lived experience. As already alluded to, scripts and narratives are themselves hierarchically organized; scripts for everyday routine events are embedded in larger script structures that define longer periods of time, such as primary school, high school, first job, first child, and so forth. These more temporally extended scripted events are sequenced into an overarching life script (Berntsen & Rubin, 2004) that provides a culturally shared timeline of what a typical life looks like. In addition to temporally linked sequences, life scripts can also be organized into more thematically linked chunks, such as "school," "romance," and "parenthood" all of which are hierarchically organized through interacting temporal and thematic links into a life story (Conway & Pleydell-Pearce, 2000).

These culturally shared scripts and narratives provide a background of how the world "usually" works, but also provide culturally mediated evaluative and thematic structures for interpreting experience in particular ways (McLean & Syed, 2015). A good example is the "redemption" narrative, one of the cultural narratives that defines the American experience (McAdams, 2004). Redemption narratives tell of hard work and perseverance leading to success—it is the story of the founding of America, the Pilgrims and the westward expansion, the immigrant experience, and continues to reverberate today in stories of cultural icons such as Oprah and Dolly. The redemptive narrative arc forms a template for how individuals interpret and narrate their personal experiences. Listeners pull for redemption when hearing the stories of others (McLean et al., 2020) and individuals who tell more redemptive personal stories show higher levels of life satisfaction and a higher sense of meaning and purpose (Cox & McAdams, 2014).

In a very real sense, the expression and recall of our autobiographical memories is mutually constrained by the experience itself and the cultural scripts and narratives we have internalized across development and share with others. As individuals internalize these various culturally defined scripts and narratives, they come to organize and understand their own personal lived experiences within these meaning-making structures (Bohn & Berntsen, 2008; Nadel & Moscovitch, 1997). When individuals recall specific personal experiences, they recall both the details of that experience and fill in the gaps with inferences and interpretations of "what must have happened" based on both personal and culturally shared scripts and narratives. Because culturally mediated scripts and narratives reflect what typically happens in the world, these inferences are quite often accurate to the specific experience being recalled (Reyna et al., 2016). Thus, autobiographical memory is reconstructive and yet can still be accurate. Human meaning-making is a process of forming a coherent narrative that integrates

the event as experienced with layers of personal history and cultural meaning systems in an ongoing evolving dynamic system in which accurate and reconstructed rememberings occur simultaneously.

3.3 | Developmental framings

Evaluative cultural narrative frames are also developmentally sequenced, following Erikson's (1968) psychosocial stages of developmental challenges that must be resolved: trust versus mistrust in infancy, autonomy versus shame in toddlerhood, and, perhaps most well-known, identity versus role-confusion in adolescence. As each of these developmental challenges is addressed and resolved, patterns of understanding personal experiences are shaped in new ways (Conway & Holmes, 2004; McAdams, 2008). The resolution of each developmental challenge sets the stage for future resolutions and interpretations of experience. For example, early in development, an internal working model, or schema, develops from the resolution of the trust versus mistrust challenge (Bretherton, 1995; Bowlby, 1969), setting the stage for filtering lived experiences through a lens of secure and safe attachment or through anxious and insecure attachment. Of course, developmental challenges are never fully resolved but re-visited again and again as new experiences are encountered. Thus the kinds of working models developed through lived experiences during resolutions of these developmentally paced challenges provide some constraints on future experience and interpretations, as lived experience also dynamically interacts with established schemas. For example, early internal working models of secure or insecure attachment are still playing a role across development, such that adolescents with a secure attachment style show more proactive exploration in their identity narratives (Graci & Fivush, 2017) and emerging adults with a secure attachment style are able to establish healthier intimate adult relationships (Mikulincer & Shaver, 2012). As individuals navigate midlife, and generativity versus stagnation become the developmental focus, individuals who successfully traverse this developmental task narrate their lives in terms of higher levels of resolution and redemption (McAdams, 2014). Thus the ways in which individuals narrate specific episodes is fashioned both through culturally shared scripts and schemas as well as individual trajectories of developmental challenges.

3.4 | Accuracy and reconstruction

Personal memories, culturally mediated scripts, and developmentally canonical cultural narratives infuse everyday reminiscing conversations in which we tell and share our experiences to and with others. The emerging autobiographical narratives are a dynamic process of ongoing reconstruction with each conversation and with each developmental challenge, yet personal memory can also remain consistent and accurate over time. Accuracy was, in fact, the foremost question guiding the resurgence of cognitive research on autobiographical memory in the 1980's, when Baddeley (1988) and Neisser (Neisser & Hyman, 2000) called for memory research that addressed more ecologically relevant questions of how memory is used in everyday life. Two research paradigms emerged: the diary study and so-called "flashbulb memory" studies. Diary studies compared current recall to diaries kept contemporaneously with the experience, whether by design (Linton, 1986; Wagenaar, 1986) or by happenstance (Neisser, 1981; Wagenaar & Groeneweg, 1990). Diary studies focused on the ability to recall accurate facts about the where, when, who and what of specific episodic memories. Overall, research participants are not wholly accurate to the episode, but are quite accurate in the gist; there are confusions and intrusions between similar episodes, and "time slice" confusions over specific event sequences (Hyman, 1999). Yet despite these errors, participants correctly recall many accurate details about what happened both within and across episodes, even after decades (Diamond et al., 2020; Wagenaar & Groeneweg, 1990). More emotional memories are recalled somewhat more accurately than emotionally neutral memories (Tyng et al., 2017), and personally significant memories are recalled more accurately than experiences that are not as relevant to self (Neisser, 1996). Often culturally shared memories, such as flashbulb memories of the JFK assassination or the 9/11 attacks, become more culturally "scripted" in that individuals begin to conform to the culturally shared narratives of what happened (Hirst et al., 2018). Thus these initial studies provided a glass half empty/glass half full view of accuracy in autobiographical memory—there is a good deal of accurate detail remembered embedded within inferences and confusions based on repeated occurrences and cultural scripts.

It also became clear that errors in remembering could be introduced through conversations after the experience through misinformation (Loftus, 2003). Simply suggesting to someone a particular aspect or interpretation of the experience (e.g., the car was "speeding" down the road rather than simply "driving" down the road) could lead to individuals

mis-remembering aspects of events, or remembering whole events that may not have occurred, such as a childhood memory of being lost in a shopping mall. While these kinds of results are robust, we would argue that the framing of these studies has yielded a perception of error as more pervasive than it actually is. First, the focus on error does not consider the accurate information that is almost always recalled alongside the erroneous information, leading to a distorted view of memory as completely unreliable. Second, in almost all of this research it is some percentage of participants that recall some details in error, but many participants recall quite accurately and are quite resistant to suggestion. Granted, convincing 25% of participants that an entire event happened when it did not (Loftus & Pickerel, 1995) is fundamental to understanding how people can be misinformed, but 75% of participants in that landmark study remained unconvinced. Moreover, it is also the case that some post-event conversations actually increase accurate recall. For example, when people engage in collaborative recall of a shared event, they are just as likely to subsequently increase the amount of accurate information recalled as erroneous information (Meade et al., 2017). Similarly, adults who recall elaborated accurate details with children during reminiscing conversations often bolster children's subsequent accurate recall (Conroy & Salmon, 2006; Goodman et al., 1994; Principe & London, in press).

Behavioral research clearly indicates that autobiographical memory is dynamic over time, with recall of accurate detail interwoven with scripted inferences and pieces of information gleaned from others. Further, memories can become more accurate over time as well as less accurate depending on the post-event context. The pattern of findings suggests that accuracy and error are not mutually exclusive but, rather, interactive. Critically, to be adaptive, memories must be at least minimally accurate to the world, if not in the specifics of single episodes, then certainly in gist and schemas. Indeed, often the schema or script is more adaptive for understanding the world than the specific episode. Intriguingly, contemporary neuroscience also converges on a model of autobiographical memory as dynamic, intermingling accurate and inferred information in a cascade of neural activity at encoding, consolidation and reconsolidation, providing a neural mechanistic account that complements a sociocultural approach to memory.

4 | MULTIPLE TRACE, TRACE TRANSFORMATION, AND NPRC

Accuracy and reconstruction in autobiographical memory narratives can best be understood in the context of current theory regarding memory reconsolidation. In outlining NPRC, Gilboa and Moscovitch (2021) expanded on extant models, namely Multiple Trace Theory (Nadel & Moscovitch, 1997) and its extension, Trace Transformation Theory (TTT, Moscovitch & Gilboa, 2021; Sekeres et al., 2018; Winocur et al., 2007). In NPRC, they argue that an original memory trace established at perception and encoding can be reconsolidated with every subsequent recall, regardless of how much time has passed. These reconsolidations open the door for changes in a memory's content, often based on gist or schematic content, such as filling in gaps in what "must have happened" when these details are absent from the memory trace itself. There are at least two aspects of NPRC that are specifically related to conceptualizing autobiographical memory as simultaneously accurate and reconstructed.

The first is that autobiographical memory is not localized in any single brain area. As emphasized by NPRC, although the hippocampus is essential for some aspects of autobiographical memories, such as perceptual qualities and specific episodic details, autobiographical or episodic memories do not reside in a particular location; to understand the neural signature of an event is to consider both the location of some information and its functional connectivity to other brain areas (Gilboa & Moscovitch, 2021). Furthermore, although semantic or schematic memories (linked to the anterior temporal lobes and mPFC, respectively, see Ghosh & Gilboa, 2014; Irish & Piguet, 2013) can be considered declarative but not episodic, the converse cannot be said for episodes themselves. Recalling an episode will activate semantic and schematic memory, and so the sharp distinctions implied by referring to different types of memory does not hold when considering widespread activation that occurs when recalling an episode. A model of memories whose various aspects are multiply intertwined and constantly open to change via reconsolidation lays the foundation for understanding memory errors, but also for understanding the typical life course of a memory. As Moscovitch and Gilboa write:

> We have now gone beyond the idea that a memory is mediated by one structure or another (HPC vs neocortex) depending on memory age ... or even that dividing memories into semantic and episodic is sufficient, as the early versions of MTT suggested. Instead ... what is crucial in identifying the structures that mediate memory in systems consolidation is understanding how memories are represented, leaving open the possibility that the expression of some (all?) memories consist of different, integrated, but separable components, each of which are mediated by different structures. (2021, p. 77)

The second aspect, and related to the first, is that, based on this model of how episodic memories are neurally processed over time, episodic memories are a constant interplay between unique episodic details and the semantics, biases, schemas, and expectations brought to their recollection, much as autobiographical memories have long been described as an agglomeration of multiple systems and capacities (Nelson & Fivush, 2004). Importantly, some aspects of a memory are verbatim, that is, retrieved as experienced and encoded, while others are filled in from knowledge, as has long been established in various research paradigms (e.g., Johnson et al., 1993; Reyna & Brainerd, 1998). But when memories reconsolidate, individuals are not necessarily aware of which elements are uniquely episodic and which are inferred (Edelson et al., 2011; Johnson et al., 1993). In the words of Gilboa and Moscovitch (2021, p. 12):

> ... our view posits that (1) the neocortical representation that ensues is different from the hippocampal one, (2) neocortical representations are often laid down concurrently with hippocampal ones, (3) hippocampal memory trace formation is influenced by cortical representations of prior knowledge just as cortical traces are influenced by the hippocampus, and (4) neocortical and hippocampal representations continue interacting with one another and in the process can modify each other or their expression throughout the life of a memory.

In addition, the semantic elements of the memory that are "filling in" gaps in the episodes themselves can be based on schematic knowledge, that is, knowledge of how things *usually are*, and are thus often correct. As such, errors in memory are not the norm, but crop up in certain circumstances. A focus on errors distracts from a model of memory that is constantly in flux, widespread throughout the brain, and a patchwork combination of episodic information with correctly inferred semantic and schematic details leading to mostly accurate recollections of past experiences. As described in the above quote, memories are represented by multiple simultaneous pathways, both hippocampal and neocortical, but most importantly, these two areas continually interact, meaning that a memory never ossifies, but instead retains a constant dynamism. Understanding autobiographical memory through the lens of NPRC underscores the false dichotomy of accuracy versus error in remembering a specific single episode. It replaces this question with asking how the process of remembering any specific episode is at all points embedded in larger systems of autobiographical and semantic knowledge. Both this approach and the sociocultural approach to autobiographical memory converge on placing episodic memories in larger contexts: sociocultural contexts in which individuals recall memories in conversations framed by cultural understandings of how the world works, cognitive contexts in which episodic memories are framed by generalized scripts and schemes, and neural contexts in which cascades of activation across multiple brain regions inform all aspects of episodic recall, including the initial perception of the event. Thus, to fully understand memory, we must also understand perception.

5 | PREDICTIVE PROCESSING

Clark (2013, 2015) outlines that the central challenge of perception is getting from sensory stimulation to the internal experience created, namely a cognitive decision about the specific cause of the stimulation. In order to "know" what we are seeing; we must integrate what is in the environment with our sensory experience of that environment. To *inductively* reason about the external realities that cause some perceptions is simply too cognitively overwhelming, as many potential causes could generate similar sensory experiences. Instead of generating a theory based on the data we experience, we approach experience in a *deductive* manner, testing the input from our experiences against our expectations of the world and assessing any mismatch. Called *Predictive Processing* (PP), this approach posits that perception is a process of matching input to expectations, rather than inferring causes from input. For example, we instinctively see a trapezoidal door simply as open rather than misshapen because that matches expectations and explains its odd shape on the retinae. Examples of this process include both sensory and more complex cognitive perceptions, such as the *hollow mask illusion*, where a convex face is seen instead of the actual concave one when a light is shined on the inside of a mask, or Heider and Simmel's (1944) famous moving shapes to which viewers attribute motives, intentions, and feelings. In these examples, the mind's generative predictions readily classify thousands of actual faces but no concave faces, and the types of movements in Heider and Simmel's videos are only really seen in sentient beings, and so the examples best fit into these predictive frameworks, and hence are interpreted as such.

Hirsh et al. (2013) apply Clark's PP model to narratives. They argue that narratives organize expectations, serving as a high-level organization of perception. This aligns with our earlier discussion of scripts and narratives organizing episodic recall, as well as with an emphasis on narrative coherence in autobiographical memory as a form of meaning-making

(McAdams, 2004; Reese et al., 2011, 2011). Coherent narratives provide for meaningful interpretations and evaluations of experience at various levels of memory processing, from encoding to organizing to retrieval. Even in the moment of experiencing an event, related episodes, scripts, narratives, and semantic knowledge are activated, as demonstrated by MTT and TTT, that provide a dynamic organizational structure for taking in this new information in ways that "fit" existing information, and with each retrieval, memories are consolidated and reconsolidated in ways that continuously update and integrate incoming information with existing information. This process begins very early in development; infants are already generating scripts for image processing in the first 6 months of life (Mandler & Canovas, 2014). As already mentioned, through the preschool years, children are using script-like knowledge to predict and direct behavior (Nelson, 2006), and working models of attachment relationships serve to define self and relationships (Mikulincer & Shaver, 2012). These scripts and narratives become more complex as children traverse developmental challenges (Fivush et al., 2017) and, with adolescence, scripts and narratives become integrated into larger temporal sequences and themes, creating an organizational template, the life narrative, for understanding self as continuous and coherent through time (Habermas & Bluck, 2000).

At all points, these developments are embedded in sociocultural interactions in which children are learning the forms and functions of autobiographical narratives through reminiscing with others. Just as post-event conversations can lead to the misinformation effect, these conversations can also help individuals to create more coherent socially and culturally shared narratives that provide a basis for understanding and evaluating self, others and the world in culturally appropriate ways. Individually, children whose mothers are more narratively elaborative and coherent in joint reminiscing during the preschool years continue to tell more coherent narratives through adolescence and report higher levels of self-esteem and meaning and purpose in life (Reese et al., 2010, 2010), suggesting that socially constructed autobiographical coherence helps build self-concept and meaning in life. Personal narratives are further embedded within cultural narratives (Hammack, 2011) that unite individuals' meaning frameworks with each other, such as the "redemption" narrative arc discussed earlier. At each level of organization, episodes are compared to adjacent information: how does the event fit with norms and expectations dictated by scripts? How does it connect to other events and fit into a unified framework of the self? How does it implicate the cultural narrative within which a person identifies? The answers to these questions will in part determine how and how much is remembered (e.g., Berntsen & Rubin, 2004; Bower et al., 1979; Singer et al., 2013). As such, an episode is never an isolated event, either in perception or recall—it is always being processed and reconsolidated with reference to these various levels of knowledge and understanding.

6 | CONCLUSION

Autobiographical memories are never isolated episodes. Memory is embedded in networks of social and cultural meaning-making frameworks that are mechanistically realized in cascading neural networks. Whereas sociocultural approaches demonstrate the ways in which personal memory is continuously shaped by the external environment, reconsolidation provides the neural mechanism by which updating occurs, and PP establishes that a cognitive process driven by meaning creation is the norm in the cognitive system. Rather than conceptualizing episodic memories as accurate versus error-prone, this conceptualization frames memory as a dynamic process that is continuously being updated to create coherent meaning for individuals living in complex sociocultural worlds (see Brockmeier, 2015, for similar arguments). By conceptualizing memory in this way, memory becomes a process of both accuracy and inference, an intricate weaving of specific episodic details, scripts and schemas, interpretations based on previous experiences, incorporation of post-event information through reminiscing and conversations, all in the service of creating more meaningful coherent memories that define self, others and the world.

Bringing sociocultural and neuroscience approaches into conversation opens new research questions that necessitate more collaborative theorizing and data collection. Sociocultural approaches place autobiographical memory in larger social and cultural contexts in which personal memory develops and is modulated at all points by the social interactions in which individuals engage and by the cultural frames of interpreting and evaluating information within which individuals are embedded (Fivush, 2010). Neuroscience approaches place autobiographical memory in the brain, delineating the neural processes that underlie the subjective phenomenon of remembering lived experience (Cabeza & St Jacques, 2007). Yet ground-breaking neuroscience methods now allow investigation of neural processing in real time, as individuals are remembering, and as individuals are interacting (Czeszumski et al., 2020; Nam et al., 2020). Brain-to-brain neural synchrony methods have shown that individual brains synch during social interactions, especially interactions among individuals who care about each other (Goldstein et al., 2018).

Intriguingly, there is emerging evidence that sharing stories, or narratives, are an especially effective way of synchronizing brain activity (Xie et al., 2021). These findings underscore that neural development and neural processing occurs within socially embedded interactions; the ways in which neural processes unfold is modulated by the environments in which we interact. Future research integrating sociocultural and neuroscience theories and methods can address important questions about how personal memories develop and evolve over time in social interactions by simultaneously examining brain synchronization alongside behavioral narrative measures used in sociocultural research. Integrating these approaches moves beyond conceptualizing memory as personal or social, accurate or error-prone, to examine the complexity of how individual memory is neurally constructed in social interactions, providing a more transactional understanding of individual and culture. Rather than individual and culture being conceptualized as independent factors, integrating sociocultural and neuroscience perspectives provides a framework for understanding and studying individuals and cultures as parts of a single system. Indeed, neural synchronization studies suggest that individual consciousness itself must be re-conceptualized as socially constructed (Valencia & Froese, 2020).

Similarly, both sociocultural and neuroscience approaches underscore that autobiographical memory is a conglomeration of episodic details, and semantic, scripted and schematic information. Merging these approaches in research studies can provide critical information about the ways in which neural underpinnings are realized in actual social interactions that shape evolving memories. Any given specific event is being experienced, remembered and interpreted in the context of existing information. This further highlights the need for a developmental approach, an approach that takes seriously how individual history relates to current experience and subsequent remembering. Moreover, memories are modulated in developmentally predictable ways, both in terms of the kinds of social interactions in which children and adults engage and in terms of the individual developmental challenges faced. Predictive processing provides tools to understand how what each individual brings to each new interaction shapes what that individual subsequently takes away.

In sum, integrating sociocultural and neuroscience approaches calls for mixed-method, longitudinal investigations that integrate neural and narrative measures of individual memories evolving in sociocultural contexts. Autobiographical memories, often perceived by the self to be unique and distinctive, are actually part of a complex, dynamic, constantly reconsolidating cognitive system that allows individuals to create a coherent sense of self within social groups and shared cultural understandings of what a person is, how a life is lived, what the world is like, and how this changes across the life span.

AUTHOR CONTRIBUTIONS

Robyn Fivush: Conceptualization (equal); writing – original draft (equal); writing – review and editing (equal). **Azriel Grysman:** Conceptualization (equal); writing – original draft (equal); writing – review and editing (equal).

CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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