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Autobiographical Thought as a Map: Using Introspection, Conversation, and Imagination to Navigate Identity Formation and Decision-Making

Enz, Karalyn Fay

Princeton, NJ : Princeton University

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AUTOBIOGRAPHICAL THOUGHT AS A MAP: USING INTROSPECTION, CONVERSATION, AND IMAGINATION TO NAVIGATE IDENTITY FORMATION AND DECISION-MAKING

KARALYN FAY ENZ

A DISSERTATION
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ADVISERS:
ALIN COMAN & DIANA TAMIR

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Abstract

Why do we think and talk about ourselves and our lives? Autobiographical thoughts about the past and future allow people to clarify their sense of self, strengthen their social bonds, and direct their behavior in the present. In this dissertation, we first introduce what autobiographical thought is as well as how and why people engage in it (Chapter 1). Then, we present three sets of empirical studies testing how the relations among autobiographical thoughts underly these self, social, and directive functions. In Chapter 2, we map individualized networks of people's memories and identities, showing that the pattern of connections people perceive among their autobiographical thoughts predicts self-concept clarity, rumination, and depression. It is not any one memory or identity but, rather, the relations among them that shape how people feel about themselves. In Chapter 3, we move to the social realm of autobiographical thought, where conversing about personal stories with others facilitates shared identity that strengthens people's sense of self and group identification. Autobiographical thought fosters identity through the relationships people form with others. In Chapter 4, we use autobiographical thought to mentally travel to the future by simulating an option for an upcoming decision, which shifts how people think about all of their options, not just the one they simulated. By enhancing the likelihood of choosing the simulated option relative to other options, autobiographical future thought ultimately affects the decisions people make. Finally, we consider a forgetting-based mechanism that could explain functionally relevant changes in the relations among autobiographical thoughts as well as implications of this research for clinical settings (Chapter 5). Researchers and clinicians alike need to consider the interconnectedness of autobiographical thought in order to fully understand how it functions. Only then can we follow the paths of autobiographical thought to help people navigate their inner selves, social relationships, and future decisions.

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For my mom, Elizabeth Enz Lewis,

the memory of my dad, Robert Enz,

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1

Introduction

"La vida no es la que uno vivió, sino la que recuerda y cómo la recuerda para contarla."

["Life is not what one lived, but what one remembers and how one remembers it in order to recount it."]

- Gabriel García Márquez

What use is it to think about life rather than just live it? Why do we rehash the past and imagine the future when we could just live the present? Through the self-reflective process of writing a memoir, Gabriel García Márquez concluded that life *is* memory, and the purpose of memory – and thus life – is to share it with others (García Márquez, 2003). Scholarship in the humanities has analyzed the question of how García Márquez connects his memories to his identity as a writer through integrating personal experiences into his fictional narratives and his autobiography (Jiménez, 2006; Sorensen, 2007). Modern psychologists – both experimental and clinical – have also taken an interest in the study of autobiographical memory, or memories for personal life experiences (Berntsen & Rubin, 2012; Watson & Berntsen, 2015). Many would agree with García Márquez's *functional* perspective that it is not just *what* we have experienced but *how* and *why* we think about those experiences that is most important (Bluck, 2003).

This dissertation considers the functions of not just memory, but autobiographical thought in general, including introspection, interaction, and imagination. Through three sets of empirical studies, we explore how autobiographical thought shapes how people think and feel about themselves (Chapter 2), form social bonds with others (Chapter 3), and make decisions for their future (Chapter 4). Throughout, we situate our research within a functional framework of autobiographical thought, culminating with a consideration of the clinical implications of autobiographical thought (Chapter 5). In this introductory chapter, we begin by overviewing the *what, how,* and *why* of autobiographical thought.

What is autobiographical thought?

Autobiographical thought covers a wide variety of content about oneself and one's life, spanning past, present, and future events and versions of ourselves. It includes autobiographical facts (e.g., your birthdate), life chapters (e.g., high school), specific memories (e.g., your 16th birthday party), life themes (e.g., relationships), personal traits (e.g., intelligent), personal values (e.g., lifelong learning), future goals (e.g., earn PhD), and social roles (e.g., parent), among others. Even though autobiographical thought is broad and varied in its content, it is theoretically comprised of two main forms of underlying information: episodic (specific details of personally experienced events) and semantic (general facts and knowledge about oneself and one's life). Episodic and semantic information remembered from the past can also be used to construct novel autobiographical thoughts about the future (episodic simulations and possible selves).

Episodic memories

Episodic memories are memories of specific past events that happened in a particular place and time (Tulving, 1983). Colloquially, these are the type of memories people mean when they use the word "memory" or "remember" (Coane, Cipollini, Barrett, Kavaler, & Umanath, 2023). When recalling an episodic memory, people are aware of the self being present in the

experience, as if they are "reliving" rather than just remembering it. This awareness – or autonoetic consciousness – is core to representing the self as a continuous entity across time (Tulving, 1985b; Wheeler, Stuss, & Tulving, 1997). Feeling present in the past also gives rise to the subjective experience of "mental time travel" that is characteristic of episodic remembering (Suddendorf & Corballis, 1997; Suddendorf, Addis, & Corballis, 2009). During episodic recall, people also perceive sensory details and feel emotions as if they were experiencing the event in the present (Morton & MacLeod, 2023).

Episodic memories play an important role in the other two forms of autobiographical thought (semantic self-knowledge and future simulation). As we will see later in this section, mental time travel is not restricted to the past – people can also project themselves into imagined future events by recombining details from episodic memories (Schacter & Addis, 2007). There is a link between episodic memory and the self as seen in memory disorders such as amnesia (Klein, Loftus, & Kihlstrom, 2007) and Alzheimer's (Irish et al., 2011), which often impair people's sense of self-continuity. Furthermore, in the self-memory system, a hierarchical model of autobiographical memory which we discuss further in Chapter 2, episodic memories form the substrate of conceptual self-knowledge (Conway & Pleydell-Pearce, 2000). Supporting this idea, people are faster to recall episodic memories when cued with trait-based self knowledge (Sakaki, 2007). People also use specific experiences when making trait judgments about themselves, pointing to the importance of episodic memory for semantic self-knowledge (Klein & Loftus, 1993; Klein, Loftus, & Sherman, 1993).

Semantic self-knowledge

Semantic memory, as contrasted with episodic memory, does not contain specific details related to time and place (Tulving, 1985a). Rather, it involves more general information about the world or – in the case of self-knowledge – about ourselves. Semantic memory is what people typically mean when they use the word "knowledge" rather than "memory" (Coane et al., 2023).

How do we "know" who we are in addition to "remembering" what we have experienced? There are several forms of semantic self-knowledge including facts, traits, and identities. Autobiographical facts, such as an individual's name, birth date, birthplace, and parental lineage, constitute essential components of one's self-knowledge repository, paralleling the information typically found in written biographies and autobiographies (Conway, 1987). This dissertation is more concerned with the subjective form of semantic self-knowledge – the conceptual self – than these more objective autobiographical facts.

Self-concept involves a person's views and beliefs about themselves, and its clarity is important for well-being (Campbell, 1990; Campbell et al., 1996). The overall self-concept is comprised of smaller sub-units, described by Burke (1980) as "an organized set of identities." In Chapter 2, we empirically map the organization of people's memories and identities to assess how the structure of autobiographical thought relates to self-concept clarity. A person's identities can further be categorized into multiple levels: personal identities are individual traits and characteristics, relational identities involve roles and relationships with specific others, and collective identities concern memberships to larger groups and social categories (Brewer & Gardner, 1996). In Chapter 3, we dive deeper into these levels of identity by studying conversational sharing of self- or group-identity relevant memories.

Future thinking

The reconstructive nature of memory enables the flexibility to imagine specific futures, essentially "pre-living" events that have not yet occurred (Schacter, Addis, & Buckner, 2007). Through the process of *episodic simulation*, people can create memory-like representations of events they have not (yet) personally experienced. Simulation not only allows us to imagine our own future experiences, but also the experiences of others (Gaesser, 2020). Through simulation, we can create fictional characters and imagine alternate worlds (Mar & Oatley, 2008; Oatley, 2016; Tamir, Bricker, Dodell-Feder, & Mitchell, 2016). Like memories, simulations serve

important functions as a part of autobiographical thought, allowing us to take on different perspectives and extend our life stories into the future (Hallford & D'Argembeau, 2022; Schacter, Benoit, & Szpunar, 2017; Thomsen, Steiner, & Pillemer, 2016).

Extending the self into the future also allows us to imagine *possible selves* (Markus & Nurius, 1986). In addition to trying to understand their past and present selves, people are motivated to understand who they will be in the future. Possible selves include representations of who we might become, who we want to become, and who we do not want to become (Markus & Nurius, 1986). Similar to semantic self-knowledge, possible selves form an integral part of the self-concept (Erikson, 2007) and help to guide future behavior toward the versions of ourselves we aspire to and away from those we fear becoming (Hoyle & Sherrill, 2006). Although this dissertation does not directly study possible selves, it is important to note that autobiographical future thought, like memory, exists in both episodic and semantic forms.

How do we engage in autobiographical thought?

Autobiographical thought lies at the intersection of many human cognitive and social processes. The basic systems model holds that autobiographical thought arises from the coordination among multiple such processes (Rubin, 2005, 2006, 2012). In this section, we describe and summarize three of the important processes that give rise to the types of autobiographical thought introduced in the previous section: (1) scene construction: the ability to recombine details from past experiences into novel mental scenes, (2) mentalizing: the ability to reason about our own and others' mental states, and (3) narrative: the ability to craft a coherent story.

Scene construction

The mental time travel of recalling episodic memories and imagining future events involves constructing detailed scenes in which to place ourselves. Through the process of scene

construction, we recombine details from past experiences into novel mental scenes. In order to project ourselves into another time and place, we need to be able to represent the spatial layout of the scene and traverse through that scene in a temporal manner. These aspects of scene construction are important for experiencing the sense of "reliving" that comes with episodic memory recall (Rubin, Deffler, & Umanath, 2019).

Even though all events are experienced from our own eyes, people can "see" the scenes they construct from either a field (first-person) or observer (third-person) perspective in their mind's eye (St. Jacques, 2019). The perspective from which people see these scenes has important implications for the memories and simulations they create from them. Shifting perspective from field to observer, for example, makes the corresponding memory more constructed and less accurate (St. Jacques, Szpunar, & Schacter, 2017). There are also reliable individual differences in visual perspective. People who worry and ruminate tend to use observer perspective whereas people who are more self-reflective see the scenes an own-eyes perspective (Finnbogadóttir & Berntsen, 2014). By placing themselves in a scene, people shape their autobiographical memories and simulations. In addition to representing their own visual perspective – what lies in front of the eyes – people also represent their mental states – what lies behind the eyes – in their autobiographical thoughts.

Mentalizing

In order to fully understand ourselves in autobiographical thought, we need to be able to mentalize. Mentalizing is the process that allows us to infer the mental states underlying people's intentions and behaviors (Fonagy & Allison, 2012; Frith & Frith, 2006). It is a core part of autobiographical thought as, in order to think about ourselves, we must represent our own mind. Our semantic self knowledge can be used to help us infer the goals, intentions, and mental states of our past and future selves in order to move from scenes to narratives (which will be discussed in the next subsection).

Mentalizing is not specific to autobiographical thought. It is also involved in social thought — helping us to understand other people's intentions and behaviors (Lombardo et al., 2010; Van Overwalle & Baetens, 2009), as well as creative thought – helping us to understand fictional characters and stories (De Mulder et al., 2022). The functions of autobiographical thought are closely tied to these other forms of mentalizing. The social function of memory – forming and maintaining relationships – could be enhanced by our ability to mentalize other people. Mentalizing helps us understand what information others might need in our stories to fully understand our experiences. It can also help us imagine another person's experience while listening to them share their autobiographical stories. This brings us to a third process involved in autobiographical thought: narrative.

Narrative

Narrative can be thought of as the process tying together mentalizing and scene construction. According to Brewer (1980), narrative is: "the mental representation of a series of temporally occurring events that are perceived as having a causal or thematic coherence". Often the perceived cause of events in narratives are mental states and intentions, even when the actors are not human (Heider & Simmel, 1944). In our own autobiographical narratives, we often perceive ourselves as the cause of events and strive to understand our own actions and behaviors. Why did we do what we did in the past? How can we get what we want in the future? Creating coherent narratives forms a key part of helping us answer these questions and form a continuous sense of self over time. The events of our lives are not just a series of random occurrences – or at least we do not perceive them that way. We play an active role in our life stories and the narratives we tell shape how we view ourselves.

The most important narrative we have is the life story (McAdams, 2001). Some, like Garcia Marquez, would say that narrative *is* identity – we *are* our life stories (Habermas & Bluck, 2000; McAdams & McLean, 2013). Creating a life story from our memories and self-knowledge

helps us find coherence, themes, and meaning in our lives (Baerger & McAdams, 1999; Grysman & Hudson, 2010). Organizing our life stories into chapters can improve our sense of self continuity beyond just specific memories (Thomsen & Pillemer, 2017; Thomsen, 2009). In the autobiographical memory literature, there is a distinction between narrative processing – creating stories with plots, characters, and goals – and autobiographical reasoning – interpreting and evaluating life experiences (Singer & Bluck, 2001). Both of these processes involve making a coherent, meaningful story out of our autobiographical thoughts. In this dissertation, we view autobiographical thoughts as a network of interconnected episodic memories and semantic self-knowledge and use the term narrative to mean any kind of story that connects at least two of these autobiographical thoughts (Chapter 2).

Default mode network

At the neurological systems level, autobiographical thought is supported by the default mode network (DMN) (Raichle et al., 2001; Raichle, 2015; Shulman et al., 1997). This network includes brain regions that are involved in all three of the processes described above. The DMN has been divided into two sub-networks: the episodic network and the mentalizing network. Tasks like remembering words from a previously studied list activate the episodic network – including the medial temporal lobe – whereas tasks like taking another person's point of view activate the mentalizing network – including the dorsomedial pre-frontal cortex (Andrews-Hanna, Saxe, & Yarkoni, 2014). Autobiographical thought involves both of these sub-networks, activating regions across the entire DMN. It is beyond the scope of this dissertation to make any strong claims about what exactly the DMN does (for current perspectives on the DMN, see: Menon, 2023; Smallwood et al., 2021; Yeshurun, Nguyen, & Hasson, 2021), but what we do know is that the DMN plays a core role in autobiographical thought.

The DMN is called the "default" mode because it is active when people engage in their natural, spontaneous thought processes, evidence that the mind rarely "rests" (Andrews-Hanna,

Reidler, Huang, & Buckner, 2010; Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015). Rather, we spend a lot of time and mental energy thinking about ourselves and others. Why do we spend so much time engaged in autobiographical thought when our brains could otherwise be truly at rest or processing whatever information is right in front of us in the present? Given the metabolic cost of having an almost-always-on DMN, autobiographical thought must benefit us in some way. In the next section, we consider these benefits in terms of the *functions* of autobiographical thinking.

Why do we engage in autobiographical thought?

In the introductory quote, García Márquez intuited two important functions of autobiographical thought: that thinking about our lives makes us who we are (the *self* function) and recounting our lives connects us to other people (the *social* function). He also wrote: *"La memoria tiene más interés en el futuro que en el pasado" ["Memory is more interested in the future than the past"]*, anticipating a third function of autobiographical thought: to inform future behavior (the *directive* function). These three functions – self, social and directive – have been the focus of much research in the area of autobiographical memory (Bluck, 2003; Bluck & Alea, 2011). They also serve as the organizing structure for the following three chapters that comprise the empirical portion of this dissertation. We now overview these core functions of autobiographical thought in an attempt to answer the question posed at the outset of this chapter – what use is it to think about life rather than just live it?

Self function

Arguably the most important function of autobiographical thought is helping people form a continuous and increasingly positive sense of self over time. Autobiographical reasoning in self-narratives allows people to maintain a sense of self-continuity despite disruptive life events (Habermas & Köber, 2015). On average, people view themselves as improving over time, more

so than they really are (Ross & Wilson, 2003). In line with this self-enhancing function, autobiographical future thoughts are both more positive and more central to identity than memories of the past (Özbek, Bohn, & Berntsen, 2017). Autobiographical narratives that go from negative to positive – redemption sequences – lead to better mental health outcomes than narratives that go the opposite direction, from positive to negative – contamination sequences (McAdams, Reynolds, Lewis, Patten, & Bowman, 2001).

Autobiographical thought does not always serve a self-enhancing function and can also be maladaptive – a prime example being self-focused rumination (Teasdale & Green, 2004). Rumination is a key contributor to mental health disorders like depression (Rimes & Watkins, 2005; Watkins & Teasdale, 2001; Zhou et al., 2020). In Chapter 2, we explore how the valence and connectedness of people's autobiographical thoughts indicate both adaptive (e.g., self-concept clarity) and maladaptive (e.g., rumination) forms of self-functioning.

Social function

Sharing memories with other people also helps us form social bonds and sense of belonging. Joint autobiographical thinking – particularly via conversation – helps us to form and maintain social relationships (Alea & Bluck, 2003). Couples often remember together as a single unit, forming shared memories of the past and filling in the gaps in one another's memories (Harris, Barnier, Sutton, & Keil, 2014). Conversational memory-sharing between parents and children also helps children learn to cope with social and emotional situations (McDermott & Fivush, 2005). Much of the research has focused on the social function of sharing autobiographical thoughts in existing relationships rather than in the formation of new ones. In this dissertation, we test the effect of conversational memory sharing on social connection and identification in newly formed groups of individuals (Chapter 3).

In addition to our own autobiographical memories, we also have memory-like representations that are fundamentally social in nature. Collective memories, for example, are group-level memories shared among individuals that bear upon their common group identity (Hirst & Manier, 2008; Hirst, Yamashiro, & Coman, 2018). Vicarious memories are episodic-like representations of other people's life experiences that we can see in our mind's eye as if they were our own (Pillemer, Steiner, Kuwabara, Thomsen, & Svob, 2015; Thomsen & Pillemer, 2017). These allo-biographical memories arguably form an integral part of our own autobiographical representations and serve to connect our identities to other people (Thomsen et al., in preparation). Although we do not directly study these more social forms of autobiographical thought in this dissertation, we consider them further in Chapter 5 as directions for future research on the functions of autobiographical thought.

Directive function

Autobiographical thinking also guides future behavior and decisions. This function – called the directive function – is likely the reason episodic memory is malleable rather than fixed (Pillemer, 2003; Pillemer & Kuwabara, 2012). It has been argued that the ability to create episodic simulations of the future is in and of itself evidence that our memory systems have been shaped by natural selection to serve a directive function, rather than to veridically recall every detail of the past (Klein, 2013). The existence of people with highly superior autobiographical memory supports this view (LePort, Stark, McGaugh, & Stark, 2015; Parker, Cahill, & McGaugh, 2006; Talbot, Convertino, De Marco, Venneri, & Mazzoni, 2024). Our brains actually do have the capacity to serve a record-keeping function – they are just optimized for the directive function.

By using our memories of the past to inform our understanding of the future, we can harness the power of autobiographical thought to shape more adaptive behavior. Recalling the specific details of past failures or threats can help us learn from them and avoid re-encountering these negative experiences in the future (Bulley, Henry, & Suddendorf, 2017). Memories can also

motivate us to engage in positive behaviors like exercising (Biondolillo & Pillemer, 2015) or donating (Kuwabara & Pillemer, 2010). People think about directive future experiences more often than directive memories, suggesting that episodic simulation might guide our present behavior more than thinking about the past (Sanson, Newman, & Garry, 2017). Four of the ten ways people use future thinking identified by Hallford and D'Argembeau (Hallford & D'Argembeau, 2022) fall under the broader category of a directive function: goal setting, planning, problem solving, and decision making. In Chapter 4, we looked at the decision making function of episodic simulation.

Limitations of existing research

In a recent review, Sow, Dijkstra, & Janssen (Sow, Dijkstra, & Janssen, 2023) identified some key limitations of the current literature on the three functions of memory. Specifically, most of the research on autobiographical memory functions relies on participants' self-awareness using survey-based measures, like the Thinking About Life Experiences (TALE) scale (Bluck & Alea, 2011). In the TALE, participants are asked to rate how they use their memories, with items corresponding to each of the three functions. Although such methods have generated important descriptive and correlational research, Sow and colleagues (2023) also call for more experimental research on the functions of memories. Lastly, they identify the importance of studying the role of different memory features (e.g., valence) in their functions as well as the role of individual differences (e.g., depression) in how people use their memories and in what contexts. The approach presented in this dissertation addresses many of Sow and colleagues' (2023) concerns.

Dissertation approach

The empirical chapters that follow explore the key functions of autobiographical thought: how different types of autobiographical thought structures support our sense of self (Chapter 2), how conversations about the self help us form shared identities with others (Chapter 3), and how

simulating possible futures affects our autobiographical decisions (Chapter 4). We conclude with a discussion of our empirical findings, with a particular focus on their clinical implications (Chapter 5). This dissertation takes a functional, dynamic, and relational approach to the study of autobiographical thought.

Our approach is *functional* in that, rather than asking people about how they use their autobiographical memories and simulations, we actually put people in situations where they engage in autobiographical thought. These situations allow us to test the effect of autobiographical thought on people's sense of self, social bonds with others, and decisions for the future, rather than just their perceptions of how they use their autobiographical thoughts. In Chapter 2, participants make connections among their memories and aspects of themselves, and we test the relationship between these connections and their sense of self (the self function). In Chapters 3 and 4, we directly observe people's affiliations with their group members and their actual choice behaviors. These behavioral measures truly get at the function of autobiographical thought, not just perceived or intended function.

The approach is *dynamic* in that it explores how the functions of autobiographical thought play out over time. In all three empirical chapters, we utilize pre-/post- designs to assess how autobiographical thought shifts people's self-perceptions, identities, and behaviors. All three chapters also include a study with at least a one-week follow-up to assess natural changes in autobiographical thought over time. In Chapter 2, we look at the stability and change in people's autobiographical memory structure over the course of a week. The one-week and one-month follow-ups in Chapter 3 allow us to observe people's behavior over time and test the longevity of any effects observed in the experimental contexts we set up in the lab. Lastly, in Chapter 4, we measure people's spontaneous use of autobiographical thought over the course of a week when considering upcoming decisions. By including a temporal component in the research, we can see

the natural dynamics of autobiographical thought as well as the longevity of any effects of autobiographical thought found in experimental contexts.

Finally, we view autobiographical thought as fundamentally *relational*. In our study of the self function (Chapter 2), we focus not just on a single memory or identity, but rather the relations among multiple memories and identities as they relate to one's overall sense of self. In our study of the social function (Chapter 3), we look at the relations among people across a series of conversations within a larger group. Both of these chapters employ network analysis, a method concerned primarily with the pattern of relations present among a set of units – in our case memories/selfs (in Chapter 2) and conversations/people (in Chapter 3). Even in our study of the directive function (Chapter 4), we view the relation among multiple options as a key component of the effect of autobiographical thought on decision-making. Not only does simulation enhance the option(s) we think about, but it also diminishes possibilities we do not think about.

2

Autobiographical Memory-Identity Networks

One of the primary functions of autobiographical thought is developing and maintaining a continuous, ideally positive, view of the self. In this chapter, we go deeper into the self function by discussing a core theoretical model of autobiographical memory – the self-memory system. We present three empirical studies designed to characterize this system using a network-based method we developed called Autobiographical Memory-Identity (AM-I) networks. AM-I networks map the structure of autobiographical thought using individual-specific dynamic representations of the connections people see among the aspects of who they are (selfs) and their life experiences (memories). In these studies, we test associations between features of individuals' AM-I networks and their self-reported sense of self and mental health, allowing us to draw conclusions about how the structure of a person's self-memory system underlies the self function of autobiographical thought.

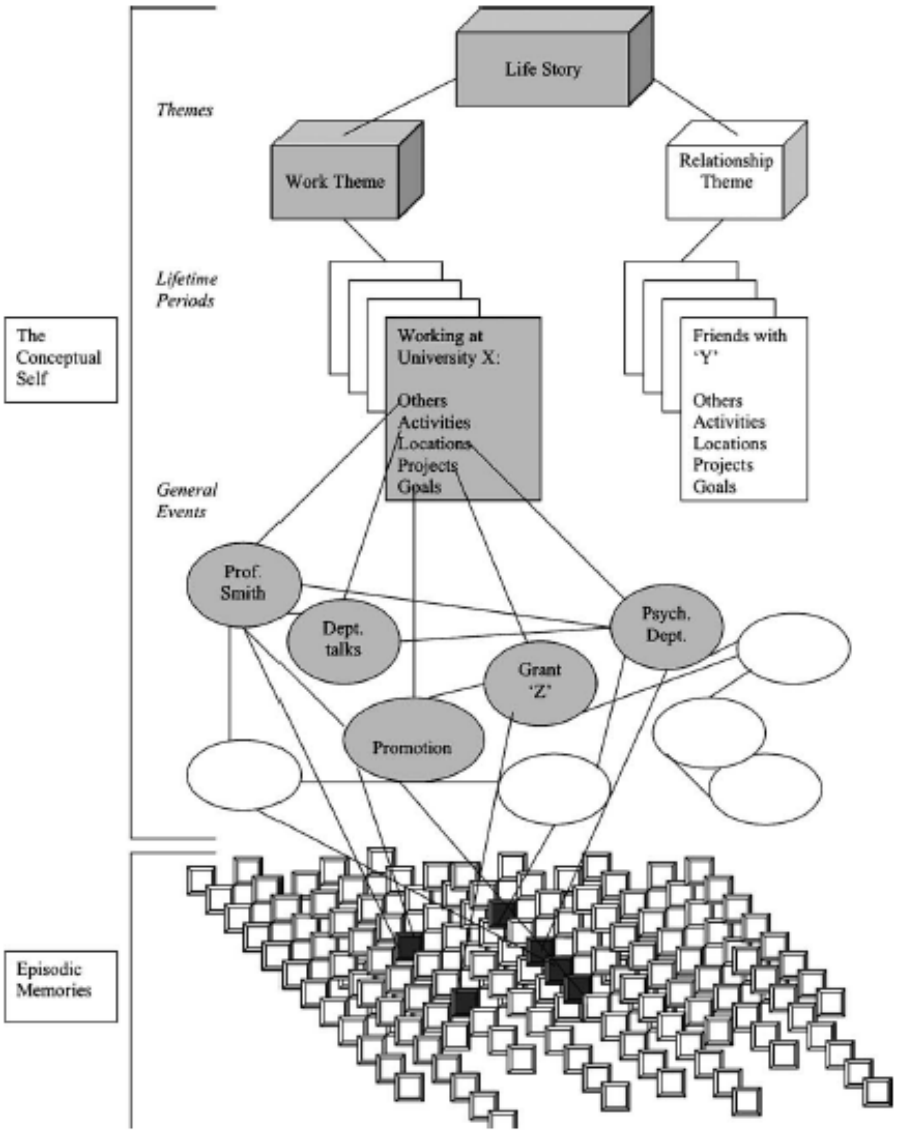
Self-memory system

An influential theoretical framework in autobiographical memory over the past 20 years has been Conway and Pleydell-Pearce's (2000) self-memory system (SMS). This framework has been used to explain how the multiple parts of autobiographical thought connect to form autobiographical memories and narratives, including the overarching life story. Figure 1

(reprinted from Conway and Pleydell-Pearce, 2005) shows their conception of the structure of the SMS.

Figure 1.

Theoretical Model of the Self-Memory System



Note. Diagram showing the hierarchical structure of the self-memory system, which is broadly divided into The Conceptual Self (upper) and Episodic Memories (lower). This figure is reproduced from Conway (2005).

In the SMS, autobiographical memory is hierarchical in structure (Conway & Pleydell-Pearce, 2000; Conway, 2005). At the top of the hierarchy are the more abstract semantic components including different self-concepts and at the bottom are lower-level episodic components including perceptual details. Higher order "themes" such as "work" and "relationships" organize the autobiographical memories into narrative threads at the highest level of the SMS. Within each theme or across themes, memories are temporally organized by lifetime periods consisting of events, which are further comprised of event details, the lowest level of the hierarchy. The self-memory system has been described theoretically in terms of networks of multiple interrelated components (Williams & Conway, 2009), but network models of the SMS have yet to be realized empirically.

Informed by the theoretical SMS, in the empirical portion of this chapter, we measure and manipulate the relations among episodic memories and the conceptual self to better understand how autobiographical thought supports or impedes overall sense of self and mental health. In Study 1, we characterize and visualize the interrelations Conway and Williams (2009) propose exist among the memories and the conceptual self in the SMS. In line with the functional perspective, this study also provides initial evidence for how different patterns of relations in AM-I networks (and theoretically the SMS) predict broader psychological constructs like self-concept clarity. In Study 2, we explore how telling narratives (the highest level of the SMS) affects one's overall sense of self and the underlying relations among memories and self-concepts, tying AM-I networks to both theory (the SMS) and practice (as an assessment of narrative interventions). Thus, across the two studies in this chapter, we empirically study all levels of the SMS using a single survey-based method: AM-I networks. This is an important extension of prior empirical research on the SMS, which has largely focused on specific types of autobiographical connections, rather than the system as a whole.

Types of autobiographical connections

To date, previous studies have focused on connections within portions of the SMS (either memory connections, self connections, or memory-self connections) rather than the SMS as a full network. This could be the result of methodological limitations (i.e., lacking a feasible way to measure multiple types of connections at once) of the nature of the questions being asked (i.e., being interested in the effects of just one type of connection). AM-I networks overcome these methodological limitations and allow researchers to study all three types of connections in the SMS using the same procedure. In this section, we overview the existing research on these different types of connections and argue for the benefit of studying multiple types of connections at once using the AM-I network procedure.

Memory connections. Most research in the area of autobiographical memory structure has focused on relationships among specific memories. Brown and Schopflocher (1998a, 1998b) studied "event clusters," using a method in which participants generated associate memories from a target memory and then rated the ways in which the associates were related to the target memory. For each associate, participants selected the type(s) of association from the following list: one event caused the other, the events are thematically related, they occurred around the same time, they occurred in the same location, the same people, places, or activities were part of both events, etc. Although they measured the associations between each associate and its target memory, they did not assess the relations among the associates, as is necessary to fully map out the topological structure of these associations even within the clusters they measured. Furthermore, the aim of Brown and Schopflocher's (1998a, 1998b) association task was to measure a characteristic of a single target memory, i.e., the number and type of associates it had, rather than to assess the pattern connectivity among all of the target and associate memories.

More recently, Demblon and D'Argembeau (2017) studied memory "networks". They asked participants to generate “initiating events". These initiating events were then used to cue a

network of events for each initiating event. Rather than measure the associations among all memories of a given network, they reported aggregate level rating data for each memory network and compared across networks. In this case, the assumption was that each network was cued from the same event so it must have internal associations. However, the pattern of relations within each network of memories was not actually measured. Furthermore, by conceiving of each network as a separate entity, this method failed to capture any possible links among memory networks for different initiating events. Our AM-I network method builds upon this work to assess full network structures across all events that might comprise these multiple smaller memory "networks".

Without characterizing full network structures among autobiographical memories, it is impossible to know whether the additional information about broader network structure would be informative. However, the existing research has yet to address this open question, and these larger interconnected memory networks are consistent with theorizing about the structure of the self-memory system (Williams & Conway, 2009). In the studies presented in this chapter, we aim to demonstrate the feasibility of characterizing full sets of connections among memories as well as the validity of these network-derived measures for predicting sense of self and mental health above and beyond ratings of individual memories.

Memory-self connections. Autobiographical memories, by definition, also have connections to the self, some more than others. How do people make connections among their personal life experiences and their overall sense of self? This is an important question for understanding the self function of autobiographical thought. Self-defining memories are episodic memories that, through autobiographical processing, become integral to one's sense of self and overarching life story (Blagov & Singer, 2004). In terms of the self-memory system, self-defining memories exist at the episodic memory level but are connected to the higher level of the conceptual self, more so than other memories.

In the SMS, semantic self-images can serve as cues for episodic memories. Rathbone and colleagues (Rathbone, Moulin, & Conway, 2008; Rathbone, Moulin, & Conway, 2011) used a task called the I AM task to assess the relations between self-image statements and the associated memories that support those statements. In their task, participants first generated 20 statements by filling in sentences that start with "I am…" (e.g., "I am an athlete"), a procedure adapted from the Twenty Statements Test (Kuhn & McPartland, 1954). Those "I am" statements were then re-presented to the participant as memory cues. So, in the "athlete" example, a person might remember their first soccer game or winning a competition. Each memory was dated for when it occurred and each "I am" statement was dated for when that self-image was formed. The researchers found that memories clustered around the time of the formation of each self-image. Continuing the example, if the person started playing sports in high school, many of the memories cued by their "athlete" self image would also be from that same time period, supporting the idea that memories are tightly connected to the self.

In the AM-I network method, we extend these I AM studies in two important ways. First, we characterize all perceived connections among a set of self-images and memories, rather than just the connections between one self-image and its associated memories. This allows us to examine entire networks of memories and self-images rather than just clusters. Second, we look at more conceptual, rather than temporal, relations in the SMS. Rather than dating their memories and self-images, we ask participants to rate how connected their memories and self-images are, which could give additional insights into the SMS.

Self connections. In addition to autobiographical memory connections, researchers interested in the self more broadly have studied the interconnections among various parts of the self-concept. Recall from Chapter 1 that the self-concept is a person's beliefs and views about themselves comprised of their multiple identities. An important measure of self concept is *self-concept clarity*, which is an overall survey-based measure having to do more with the self system

as a whole rather than any one aspect of the self (Campbell et al., 1996). Improving self-concept clarity could be an important indicator of the self-function of autobiographical thought. Self concept-clarity is one of our primary outcome measures in Chapter 2.

Recent work on the self-concept has mapped full networks of connections among sematic traits (Elder, Cheung, Davis, & Hughes, 2023). The researchers asked one sample of participants to rate a set of pre-determined traits such as "smart", "friendly", and "nice" by selecting which traits a given trait depended on. So, for example, in order to be "nice," one might need to be "friendly". The resulting network structure was based on the ratings of all participants, representing the norms for how people in general see the relationships among traits. Then, they asked a separate set of participants to rate themselves on each of the traits. In line with the self-enhancing function of autobiographical thought, people tended to rate themselves higher on the positive traits that a lot of other traits depended on – that is, traits that were highly *central* to the normative network. In our AM-I networks, rather than map our normative networks of researcher-provided traits, we map individual-level networks of self-generated identities, extending this method to include other identities beyond just traits. It also allows for more individual-specific data that could be more easily applied in clinical settings.

Autobiographical-Memory Identity networks

The AM-I network approach presented in this chapter integrates the earlier approaches outlined above by capturing all three types of connections – memory, memory-self, and self – at once using a method similar to Elder and colleagues (2023) for both memories and self-concepts. Autobiographical memory-identity networks are the first method we know of that allows researchers to empirically measure the structure of connections among a person's self-concepts and their memories in the full SMS, rather than just parts of it. This approach could show how individual differences in people's self-memory systems contribute to better or worse psychological functioning, allowing researchers to better understand which types of connections

are most important for people's sense of self and mental health. By providing a holistic view of how a person organizes their autobiographical experiences and self-understanding, assessing AM-I networks could also help researchers and clinicians identify avenues for future inquiry and intervention.

Unlike some of the previous methods used to study the SMS, AM-I networks do not privilege any one memory or self-image as the "target" or "initiating" event at the outset. Instead, every self-image and every memory serves as both a "target" and "associate". In the AM-I General Network Procedure (see below) we measure the overall pattern of perceived associations among all memories and identities by presenting each one as a cue and as an option to be checked as associated with other cues. In previous methods, the target event(s) were recalled first and the associates we recalled later using the target event as a cue. In AM-I networks, the items themselves are recalled on their own at first, and then the perceived associations among all memories and identities are assessed in response to each item. The AM-I Network method allows us to measure features of the network as a whole (e.g., density; Borgatti et al., 2018), as well as network-derived features of individual memories (e.g., centrality), whereas event-cuing methods can only derive local-level measures about clusters of memories and assess the connectivity of the initial event memory to its associates.

Compared to previous methods, the AM-I network method has less experimenter bias in deciding which memories or self-images are most important, instead identifying these most important components of the SMS in a data-driven way. It is also possible to compute holistic measures of the entire self-memory system using AM-I networks that are not possible with other methods. These measures at the structural level could prove to be more predictive of holistic psychological constructs such as one's broader sense of self and overall mental health than measures of smaller units (such as clusters or single events). Lastly, AM-I networks do not compromise the ability to examine more fine-grained relations at lower levels of analysis, *i.e.,*

within clusters or between individual memories or self-concepts. Within the broader network structure, researchers can identify clusters of events or self-images. They can also look at the characteristics of individual memories or self-images, and the ties between any pair in the network. Thus, researchers can study multiple levels of the self-memory system using one procedure in a data-driven, rather than researcher-driven, way.

The goal of the current studies is to explore whether the combination of AM-I network measures at different levels can be used to predict holistic psychological constructs like sense of self and mental health. If so, AM-I networks could be an efficient and effective means of gathering and summarizing complex idiographic data about an individual that can be used to identify specific targets for later interventions, without assuming we already know what those targets should for a given individual. At the aggregate level, network analysis enables succinct quantitative summarization of complex information about a whole system (in this case a person's autobiographical self-memory system) that can be used to identify and study different patterns of autobiographical thought.

Network analysis. In order to understand the details of the AM-I network procedure, we first overview the growing importance of network analysis in psychological research and the key terminology used in network analysis. In recent years, researchers in a wide range of scientific disciplines have begun to use network analysis to examine the structure of associations in their data (Borgatti, Mehra, Brass, & Labianca, 2009; Centola & Macy, 2007; Christakis & Fowler, 2013; Luke & Harris, 2007; Otte & Rousseau, 2002). In psychology and neuroscience, for example, network-based approaches have been used to study clusters of symptoms in clinical diagnoses (e.g., Borsboom & Cramer, 2013), patterns of interactions in social networks (e.g., Vlasceanu, Enz, & Coman, 2018), and connections among brain regions (e.g., Bassett & Sporns, 2017). Theoretical models of memory have also incorporated a connectionist perspective, from

hierarchical (e.g., Collins & Quillian, 1969), to spreading activation (Collins & Loftus, 1975), to network-based (Morais, Olsson, & Schooler, 2013) models.

In network analysis, a network is comprised of *nodes* – a set of units – and *edges* – the connections among those units (Borgatti, Everett, & Johnson, 2018). In the case of social networks, the nodes are individual people, and the edges are social interactions or social relationships (e.g., friendship) among those people. A common method for measuring social network structure is a survey-based method in which all individuals in the network rate their relationships with all other individuals in the network. Social networks can range in scale from large (e.g., the population of a country) to small (e.g., a nuclear family), so the survey-based approach is most often used for small- to medium-sized groups where surveying and rating all members is feasible.

In our AM-I networks, the nodes are a single individual's personal responses and the edges are the individual's perceived associations among those responses (Figures 2 thru 4 and Supplementary Figure A1). Inspired by the social network analysis survey technique, in the general AM-I network procedure, individuals generate a set of memories and self-concepts (nodes) in response to a survey question and then rate their perceived associations among all of the pairs of nodes they mentioned (see next section). Just as social network researchers cannot describe the associations among all people in the world, here the aim is not to fully map out an individual's entire set of autobiographical memories, but rather to map out the associations among a set of autobiographical units defined by certain criteria, in this case self-defining memories (Blagov & Singer, 2004; Singer & Salovey, 1996) and self-concept statements (Kuhn & McPartland, 1954; Rathbone et al., 2008). As shown in the studies in this chapter, using AM-I networks could be especially useful for characterizing the dynamic relations among people's memories and their sense of self.

General AM-I network method. Autobiographical memory-identity (AM-I) networks are mapped using a survey-based procedure consisting of three phases: generate, relate, and rate. These AM-I networks consist of two types of nodes: memories and identity-statements. In the generate phase, the participant provides the nodes of the network; in the relate phase, they provide the edges between the nodes and their weights; and in the rate phase, they provide the attributes of the nodes and other node-level measures (see Figures 2 thru 4, also summarized as Supplementary Figure A1 in Appendix A). All aspects of the networks are self-reported by the participants, although the networks themselves are constructed from this self-report data by the researchers.

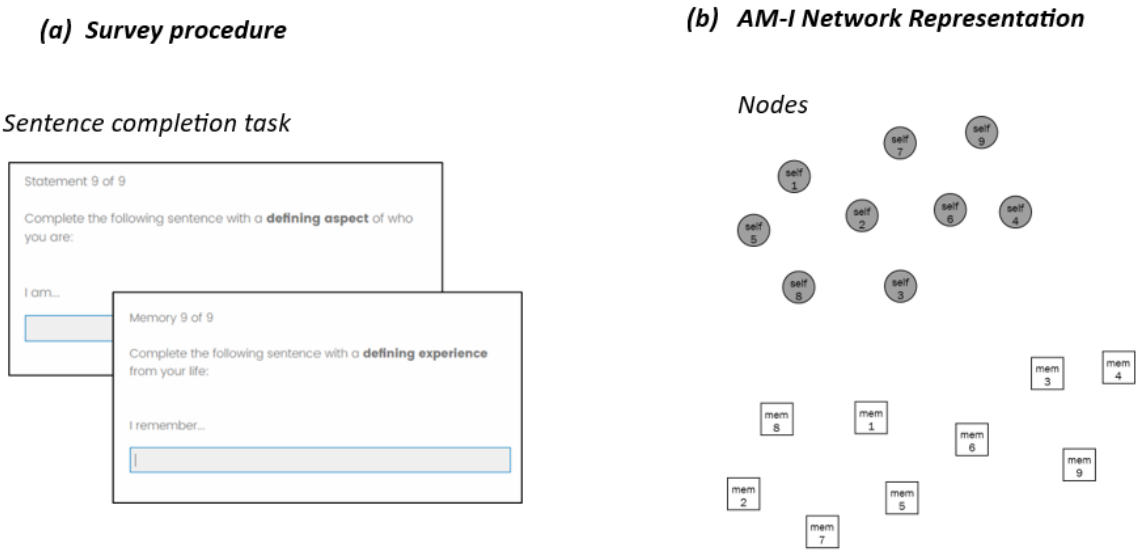
The general AM-I network procedure was first validated in a pilot study with networks of seven nodes of each type (i.e., memories and identity-statements, see Supplementary Figure A2), and the main studies involved networks of nine nodes of each type (Studies 1 and 2). The structure of this three-phase survey-based procedure could also be used to elicit different types of participant-generated networks by adapting the survey questions described here to different types of nodes and relations among them. For this reason, we first describe the general AM-I network procedure in detail before describing the rest of the study's procedures. The AM-I network procedure consisted of three phases: generate, relate, and rate. For each phase, we describe the survey procedure as well as its corresponding part of the network structure: nodes, edges, and attributes, respectively.

Phase 1: Generate (nodes). In the *generate phase*, participants provided nine memories and nine identity-statements by completing the sentences "I remember…" and "I am…" (adapted from the Twenty Statements Test, Kuhn & McPartland, 1954). For the "I remember…" sentences, participants were instructed to complete each sentence with "a defining experience from your life." Similarly, for the "I am…" sentences, they completed each sentence with "a defining aspect of who you are as a person" (see Figure 2a). The sentence completion task was

blocked and randomized such that participants completed either the identity-statements ("I am…") or the memories ("I remember…") first, in a counterbalanced fashion. Each sentence stem was presented separately on its own screen in order to limit the degree of auto-cuing from one item to the next within each block.

Figure 2.

Generate phase of the AM-I network procedure



Note. Sentence completion survey procedure (panel a) and corresponding AM-I network representation of nodes (panel b) from the generate phase of the AM-I network procedure. "I am" statements from the survey procedure correspond to the self nodes (circles) in the AM-I network, and "I remember" statements correspond to the mem nodes (squares) in the AM-I network.

The final set of memory and identity items generated during this phase was unique to each individual and their responses were re-presented throughout the subsequent phases to remind them of each item. Participants were told before generating their statements that the words they used to complete the sentences would be re-presented to remind them of their memories/self-statements later. They were told that their responses should be specific enough for them to

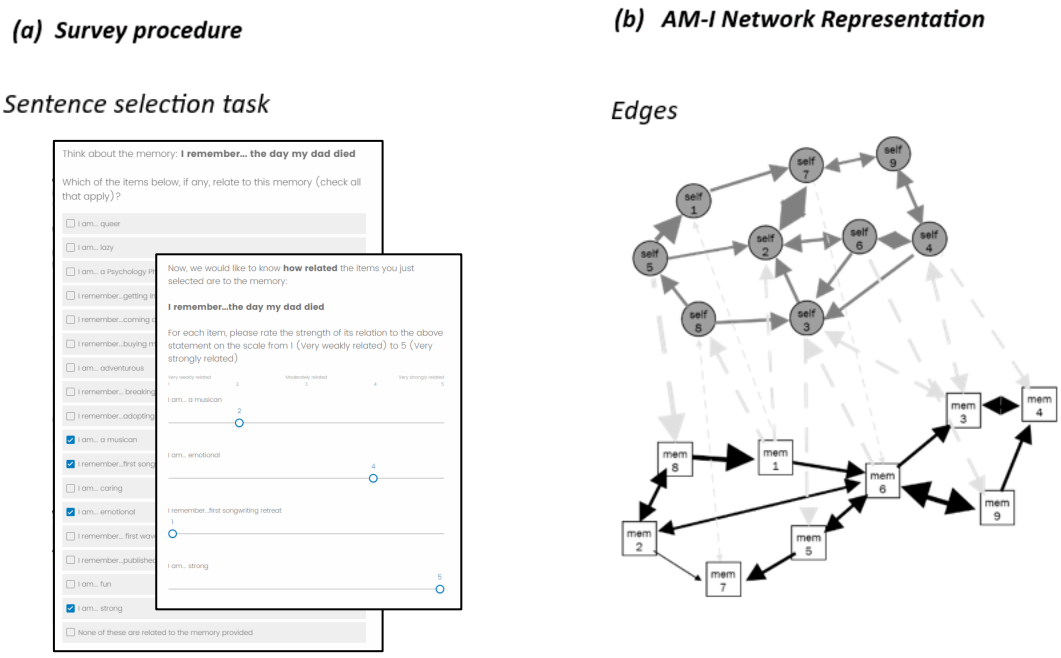
understand what they meant at the time but did not necessarily need to make sense to anyone else. These completed sentences comprised the nodes of each individual's AM-I network (Figure 2b).

Phase 2: Relate (edges). In the *relate phase*, participants were cued with each of their unique memory and identity items from the generate phase one at a time in a random order. For each item, they selected which of the other items, if any, related to the cue item (Figure 3a). The response options consisted of a randomized list of all their other items from the generate phase, excluding the cue. Unlike the generate phase, the relate phase was not blocked, so memory items and identity items were intermixed both at the cue level and the response option level. Participants could select all related items that applied to a given cue, and they also had the option to check "None of these are related to the item provided," which was always the final response option in the list.

These self-reported relations yielded the edges -- or connections between the nodes -- for each individual's AM-I network (Figure 3b). The edges were directional such that the cue was the originating node and each related item was the target node. Thus, it was possible for non-reciprocal relations to exist if an item was checked in response to a given cue, but the initial cue item was not checked when the related item was re-presented as the cue. Before moving on to identify relations for the next cue, participants rated how related each checked item was to its cue item on a scale from 1 ("very weakly related") to 5 ("Very strongly related") with a labeled midpoint ("moderately related"). The strength ratings served as the weights for the directional edges in the AM-I network.

Figure 3.

Relate phase of the AM-I network procedure



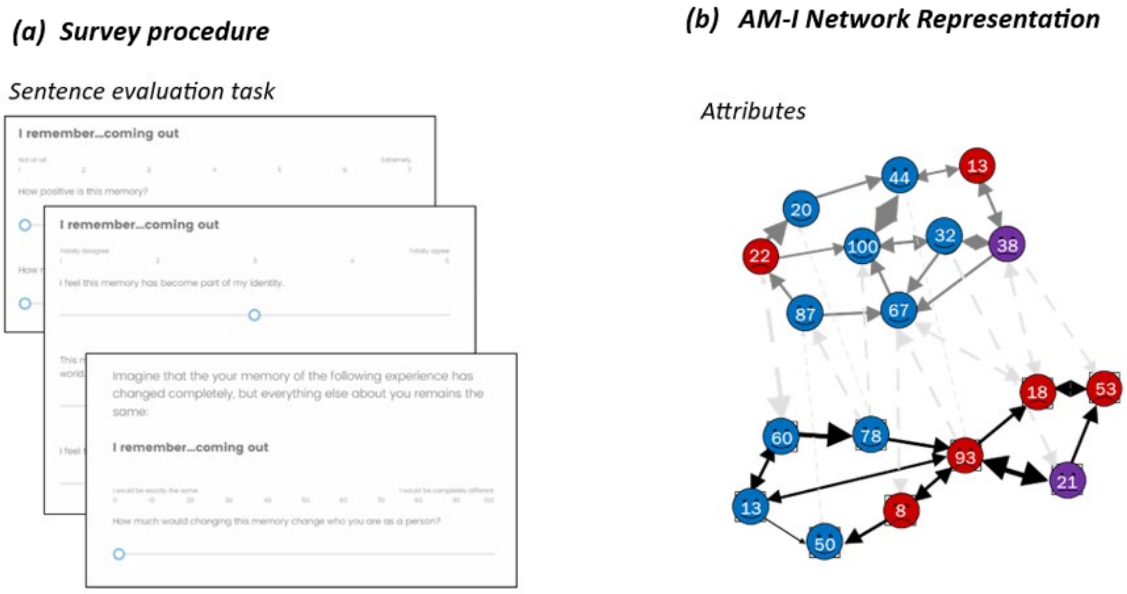
Note. Sentence selection survey procedure (panel a) and corresponding AM-I network representation of edges (panel b) from the relate phase of the AM-I network procedure. Arrows in the AM-I network go from the cue sentence to the sentences the participant selected as related to the cue sentence in the survey procedure. Dark gray arrows are ties between two self statements (self ties), black arrows are ties between two mem statements (mem ties), and light gray dotted arrows are ties across mem and self statements. Arrow thickness represents the participant's rating of the strength of the relation between the two statements.

Phase 3: Rate (attributes). In the *rate phase*, participants were again presented with each of their self-generated memory and identity items one at a time in a random order. For each item, they completed a series of rating scale items (Figure 4a). First, they rated how emotionally positive and negative the memory or self statement was to them on two separate unipolar scales ranging from 1 ("Not at all") to 7 ("Extremely"). These ratings were used to create a valence attribute for each node in the AM-I network by subtracting the negative rating from the positive rating. Nodes were coded as positive if they had a difference score of 1 or more, negative if they had a difference score of -1 or less, or mixed if they had a difference score of 0. Nodes were

color-coded by valence in the network visualizations: blue for positive, red for negative, and purple for mixed (Figure 4b).

Figure 4.

Rate phase of the AM-I network procedure



Note. Sentence evaluation survey procedure (panel a) and corresponding AM-I network representation of node attributes (panel b) from the rate phase of the AM-I network procedure. Colors correspond to codes (e.g., emotional valence) and numbers represent continuous ratings (e.g., centrality ratings).

For each item, participants also rated the centrality of each statement using three items from the Centrality of Events Scale (Berntsen & Rubin, 2006). Specifically, they rated how much they agreed with the statements "I feel this event has become part of my identity."; "This event has become a reference point for the way I understand myself and the world."; and "I feel that this event has become a central part of my life story." on a scale ranging from 1 ("Totally disagree") to 5 ("Totally agree"). For the self-statement items, the wording of the CES items was adapted by replacing the word "event" with "statement." Lastly, participants rated how much they would be changed as a person if each memory/aspect of themselves were changed completely but everything else about them remained the same, on a scale from 0 ("I would be completely the

same") to 100 ("I would be completely different"). This identity disruption measure was adapted from Strohminger and Nichols (2014).

All ratings were completed for a given item before moving on to rate the next item. Valence ratings were always presented first, then centrality, then identity disruption, but the individual valence and centrality items were presented in a random order within their block.

Overview of AM-I network measures. The general procedure described above can be used to derive both quantitative and qualitative measures that characterize an individual's autobiographical self-memory system. These measures can then be used to explore and test how AM-I networks relate to psychological constructs such as sense of self and mental health (see Study 1). In this section, we introduce some of the network-based measures that can be computed from AM-I network data (and network data in general) that will be referred to throughout the Results sections of the empirical studies presented later in the chapter. These measures can generally be broken down into two levels: individual node-level measures and aggregate or network-level measures. For each type of measure, we provide a description of the measure and some exploratory hypotheses about its relation to self and well-being.

Node-level.

Attributes. The most straightforward node-level measures are the node's attributes, in the case of AM-I networks, rating scale data for each node. Attributes could be any information associated with a given node though, including non-self-reported information, like dates of occurrence as a measure of memory recency or reaction time as a measure of memory accessibility. In the current studies, the attributes we collected for each node were ratings of emotional valence, psychological centrality, and identity disruption. We expected that the valence composition of AM-I networks specifically – having more positive than negative nodes – would be associated with better well-being. We also thought that more psychologically central nodes

would be more central in terms of network centrality as well, and the centrality of negative nodes would be associated with worse mental health.

Centrality. The main network-derived measure we computed at the node level was centrality. Centrality is broadly considered to measure a node's importance or influence in the network as indicated by its connections to other nodes, and there are different measures of centrality. Nodes that are structurally central to networks might have more connections to other nodes overall (degree centrality), serve as bridges between other nodes in the network (betweenness centrality), are connected to other highly connected nodes (eigenvector centrality), and can reach most other nodes via a short number of ties (closeness centrality). These multiple types of centrality, measuring different aspects of the node's importance to the network, could potentially capture different ways in which a memory or identity is important for the individual psychologically.

In our studies, we found that AM-I networks vary in their structure, and many are not fully connected (*i.e.,* there are isolated nodes or parts of the network that do not have connections to the rest of the network, for example networks see Figure 6 in the Results section). Unfortunately, three forms of centrality – betweenness, eigenvector, and closeness – are not well-defined for these disconnected networks, and we thought it was important not to exclude them from the analyses, so in the current studies we focus on just *degree* centrality.

The most straightforward form of centrality, degree centrality is the total number of edges connected to a given node. In directed networks where an edge between two nodes can go in either direction, overall degree centrality is comprised of both *in-degree* and *out-degree* centrality. In the case of AM-I networks as measured in the current studies, in-degree centrality represents the number of times a sentence was selected as related to other sentences, and out-degree centrality represents the number of other sentences that were selected when prompted with the given sentence. The full measure of degree centrality includes both in- and out-degree ties.

Note that degree centrality is a locally derived measure and is not dependent on the structure of the rest of the network. That is, the only thing that matters are the node's first-degree connections to other nodes. There is no consideration of the connected nodes' connections, as in the other forms of centrality. Although this could be considered a limitation of the degree centrality measure, it is also a strength because it means we can always compute degree centrality for all nodes and all participants, regardless of network structure. If degree centrality is meaningfully predictive of self-reported node attributes *and* also adds to their ability to predict sense of self and mental health, it could be a flexible and useful measure that can be calculated for any node in any AM-I network.

Network-level. There are also multiple measures that can capture the structure of the network as a whole. These measures are the most unique contribution of the AM-I network procedure and thus are of most interest in the current studies. If network-level measures help to predict sense of self and mental health above and beyond any individual node or pair-level ratings or measures, it would support the utility of using the AM-I method.

Network-level measures characterize *how* people tend to make connections. Is someone the type of person who finds connections among all of their life experiences and parts of themselves? They might have a very *dense* AM-I network. Are they the type of person who keeps coming back to the same autobiographical thought over and over again? They might have a highly *centralized* network. Do they tend to categorize their lives into smaller groups of related memories and self-images? They might have a very *clustered* network. We expected that these more global features of AM-I networks would predict overall ways of thinking about the self, such as self concept-clarity and rumination.

Density. Density is computed as the number of observed edges in a network out of the total possible edges in the network. It gives a rough estimate of how connected the network is overall. In terms of AM-I networks, density represents a person's tendency to find connections

among their memories and who they are in general. Density can be computed separately for different types of edges as well: memory connections, self connections, and memory-self connections. It could be a useful measure for testing the hierarchical structure of the self-memory system as well as the importance of different connection types for a person's overall sense of self.

Centralization. Centralization is based on the node-level measures of centrality and indicates how much a network's structure relies on one or a few highly central nodes. A highly centralized network has one or a few nodes that are connected to many other nodes that are not as connected to each other. Centralized AM-I networks might indicate that people's thoughts would keep coming back around to the same memories or self-statements.

Clusters. Clusters are groups of nodes in the network that have a dense set of edges among themselves but a sparsity of connections to other groups of nodes. To derive the clusters, we used the walktrap approach (Pons & Latapy, 2005), which performs short random walks on the network by following its edges. This bottom-up community detection is used to identify clusters where these walks tend to stay within the same group of nodes. Clusters could represent "areas" of autobiographical thought that the mind wanders for a while before moving onto another area. For each AM-I network, we counted the number of walktrap clusters, thinking that more clusters would be associated with less coherent sense of self.

Study 1. AM-I Network Structure Predicts Sense of Self and Mental Health

In the first study, we explore and validate the relationship between the AM-I network measures and two important families of psychological constructs: sense of self and mental health. We also look at self-referential processing – a form of autobiographical thought – as it relates to AM-I network structure and these outcome variables. The goal of this study was to explore ways in which the AM-I network method could be meaningful for understanding and fostering the self function of autobiographical thought, both in theory and in practice.

Sense of self

The self can be thought of as both subject – the "I" that acts – and object – the "me" that is perceived. These two aspects have been characterized in the literature as personal identity and self-concept, respectively (Schwartz, Meca, & Petrova, 2017). Through processes such as identity exploration and commitment, the "I" tries out different ways of being and thinking that affect the content of the "me". For example, "I" might start playing sports, making "me" athletic. Someone with a strong personal identity knows what they like, think, believe, feel, and do (Haslam, Jetten, Haslam, Pugliese, & Tonks, 2011). Someone with a clear self-concept feels that their various preferences, beliefs, traits, actions, and roles are not in conflict with one another (Jennifer D. Campbell et al., 1996). In daily life, these aspects of self have a reciprocal relationship; stronger personal identity leads to clearer self-concept and vice versa (Schwartz et al., 2011). In this study, we look at the predictive validity of AM-I network measures for both personal identity and self-concept clarity as well as mental health.

Mental health

Prior research has shown that the psychological centrality of negative memories is especially important for predicting a person's mental health (Gehrt, Berntsen, Hoyle, & Rubin, 2018). Individuals who experience a traumatic life event are more likely to meet criteria for post-traumatic stress disorder if they rate the trauma as highly central to their lives (Berntsen & Rubin, 2006). People who make positive meaning from their traumatic experiences are more likely to experience post-traumatic growth and not meet criteria for PTSD. Cognitive-behavioral therapy can reduce the centrality of negative events and improve symptoms of anxiety (O'Toole, Watson, Rosenberg, & Berntsen, 2018). The psychological centrality of negative memories also plays a role in depression, the most commonly diagnosed mental health condition (Vermeulen, Gandhi, Van Den Eede, Raes, & Krans, 2024). People with depression also display overgeneral memory – difficulty accessing specific memories even when prompted – a form of autobiographical thought

that often precedes and predicts depressive symptomology (Gibbs & Rude, 2004; Hermans et al., 2008; Sumner, Griffith, & Mineka, 2010). In this study, we explore the AM-I network correlates of depression and anxiety symptoms to better understand how the structure autobiographical thought might underly these disorders.

Rumination

The process of rumination, repeated general negative self-focusing thinking, has been studied as a key contributor to multiple psychological disorders (McEvoy, Watson, Watkins, & Nathan, 2013). In the CaRFAX model of overgeneral memory, rumination is one of the three main processes contributing to overgeneral memory and behavioral impairments, like difficulties solving problems (Williams, 2006). In the current study, we looked at the relationship between rumination and the structure of AM-I networks. Do people who ruminate more also make different connections among their experiences and sense of self? In terms of content, do they focus on more negative experiences and have a more negative sense of self? The patterns of perceived connections could give us an idea of how the process of rumination might shape one's view of their experiences and themselves (and also vice versa, how the structure of connections might reinforce or afford additional ruminative thought).

Method

Participants

One hundred fifty-two adult participants (aged 18-54, $M = 23.5$; 71% male, 28% female, 1% non-binary; 80% White, 14% Latinx, 5% Asian, 1% Other) were recruited from Prolific to participate in a two-part study about the self. Of the 152 participants who completed the initial questionnaire (Part 1), 139 also completed the follow-up one week later (Time 2), a 91% response rate. This exploratory sample had 23% power to detect a small correlation of $r = .10$, 97% power to detect a medium correlation of $r = .30$, and 100% power to detect a large correlation of $r = .50$

at an alpha level of .05. At a more conservative alpha level of .01, this sample had 9% power to detect a small correlation, 89% power to detect a medium correlation, and 100% power to detect a large correlation.

Participants were compensated a total of $10 for completing the study ($5 for the first part and $5 for the second part), which was awarded upon completion of the second part of the study. Participants were informed about this payment schedule in the consent form and were instructed to only participate in the first part of the study if they could also participate in the second part. Upon conclusion of the second part of the study, even participants who did not complete the second part were still compensated $5 for completing the first part of the study. The study protocols for these and all subsequent studies were approved by the Institutional Review Board of Princeton University.

Procedure

Time 1. Participants were invited to participate in a one-week long two-part study on the self. They were instructed that the study was about how they think about their life experiences and who they are as a person.

Current mood. First, participants were asked to rate how they were feeling in the moment using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The items on the PANAS are 20 words representing emotional states (10 positive, e.g., "interested", "enthusiastic", and 10 negative, e.g., "distressed," "nervous"), and participants were asked to rate the extent to which they were currently feeling that way on a scale of 1 "Not at all or very slightly" to 5 "Extremely" for each word. This measure was included for exploratory purposes.

AM-I Network Task. Then, participants completed all phases of the autobiographical memory-identity network task as described in the previous section. They completed the

statements "I am…" and "I remember…" nine times each, then rated the connections among their statements[1]. For each statement, they also rated how positive, negative, central, and identity disruptive the statement was (for more details, see section General AM-I network procedure).

Sense of self. After completing the AM-I network questionnaire, participants completed two sense of self measures which were presented in a random order. These measures were our primary outcome variables and are also the same two measures used to test the effect of social interaction on sense of self in the next chapter (Study 3). We adapted these measures to a state-based format by including "Right now" at the beginning of each statement.

Personal identity strength. Participants indicated the level of agreement with five statements (e.g., "Right now, I know what I like and don't like") using a 7-point Likert-type scale ranging from 1 "Strongly disagree" to 7 "Strongly agree" (Jetten, Haslam, Pugliese, Tonks, & Haslam, 2010). There were no reverse-scored items for this measure.

Self-concept clarity. Participants rated a set of eight items (e.g., "Right now, I have a clear sense of who I am and what I am") on a scale from 1 "Strongly disagree" to 7 "Strongly agree" (Campbell et al., 1996). This scale consisted of primarily reverse scored items (e.g., "My beliefs about myself are in conflict with one another").

Self-referential processing. Then, participants rated how they think about themselves in general using either the Rumination and Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999). The RRQ consists of 24 items rated on a scale from 1 "Strongly disagree" to 5 "Strongly agree". It consists of two subscales – Rumination and Reflection – which we considered separately in our analyses.

[1] In addition to the study reported here, we also piloted the AM-I network procedure using 7 nodes of each type and collected networks with 12 nodes of each type. We found that 9 nodes of each type allowed for both stability and change in the AM-I network over time, while also balancing the amount of time it took participants to complete the task.

Rumination. Twelve of the RRQ items correspond to the processing style of Rumination. Example items include: “My attention is often focused on the aspects of myself I wish I’d stop thinking about” and “I spend a great deal of time thinking back over my embarrassing or disappointing moments.”

Reflection. The other twelve items of the RRQ assessed the processing style of reflection. Example items include: “My attitudes and feelings about things fascinate me” and “I love analyzing the way I do things.”

Self-consciousness. Participants also completed the Private-Public self-consciousness scale (Fenigstein, Scheier, & Buss, 1975). This scale consists of 23 items rated on a scale from 1 “Extremely Uncharacteristic” to 5 “Extremely Characteristic”. It breaks down into three subscales: private, public, and social anxiety.

Mental health. Finally, as measures of mental health, half of the participants completed a depression assessment and half completed an anxiety assessment. Participants were randomly assigned to complete one of the two mental health measures. In the interest of time, we only had participants complete one of the two mental health measures.

Beck Depression Inventory II. To assess depressive symptomology, we used the Beck Depression Inventory-II (BDI-II), which asks participants to select statements that describe them best over the past two weeks (A. Beck, Steer, & Brown, 2011). The statements were grouped into twenty domains assessing different depression symptoms including: sadness, loss of pleasure, agitation, loss of energy, changes in sleep, changes in appetite, etc. For ethical reasons, we omitted the twenty-first domain of suicidal thoughts. Each domain contained four sentences related to that symptom, in increasing order of severity, and participants could select more than one sentence per domain if they felt multiple options applied to them over the past two weeks.

In scoring the BDI-II, each of the four sentences in a domain correspond to a value from 0 to 3 (from least to most severe). For each domain, participants were assigned the value corresponding to the most severe sentence they endorsed in that domain. The scores for all 20 domains were summed to get a total depression score ranging from 0 to over 40. Per standard classification criteria (Beck, Steer, & Garbin, 1988), scores of less than 10 are considered "minimal", 10-18 are considered "mild", 19-29 are considered "moderate" and over 29 are considered "severe".

State-Trait Anxiety Inventory. To assess anxiety, we used the State-Trait Anxiety Inventory (STAI), in which participants reported how they felt both "Right now" (state anxiety) and "In general" (trait anxiety) using the same set of twenty items, for a total of 40 responses (Spielberger, Gonzalez-Reigosa, Martinez-Urrutia, Natalicio, & Natalicio, 1971). Example forward-scored items include "I am tense" and "I feel frightened," and reverse-scored items include "I feel calm" and "I feel self-confident." The rating scale for the state-based measure ranged from 1 "Not at all" to 4 "Very much so" and the scale for the trait-based measure ranged from 1 "Almost never" to 4 "Almost always". For scoring, the state and trait versions of the STAI are summed separately, yielding two scores ranging from 20 to 80. Scores over 40 indicate possible clinical levels of anxiety.

Demographics. Lastly, participants provided demographic information and were debriefed.

Time 2. One week later, all participants who completed the first part of the study were invited to participate in a follow-up questionnaire.

Current mood. The same as at Time 1, participants began by rating their current mood at Time 2 using the *PANAS.*

AM-I Network Task. At Time 2, participants completed an adapted version of the AM-I Network Task designed to assess changes in both the content and structure of the AM-I network they produced at Time 1.

Generate phase. Participants first completed the *generate phase* of the general AM-I network procedure by completing the sentences "I am…" and "I remember…" nine times for each sentence type (similar to Time 1). They were explicitly told that we were not testing them on what they wrote at Time 1, and we were interested in how their responses may or may not have changed since the first time they took the study.

Coding phase. Next, participants coded the sentences they produced at Time 2 as either "old" or "new" relative to the ones they generated at Time 1. They were shown a list of their responses from Time 1 and instructed to sort the sentences they provided at Time 2 by dragging them into boxes labelled "old" and "new". "Old" was defined as conceptually the same as one of the memories/statements they provided previously, even if the wording was not exactly the same. That is, as long as the Time 2 sentence was referring to the same experience or aspect of themself as a Time 1 sentence, they should code it as "old".

This coding task was done separately for memories ("I remember…" sentences) and self statements ("I am…" sentences) in a blocked fashion. The order of the two blocks was randomized such that some participants coded memories first and some coded self statements first. Within each block, the sentences were displayed in a random order in the list shown.

Relate phase. Participants then moved on to complete the *relate phase* of the general AM-I network procedure for the sentences they provided at Time 1 only. Again, we instructed participants that they were not being tested on their responses from Time 1, so they should respond honestly as if they were doing the task for the first time.

This procedure allowed us to directly compare the pattern of edges in the network relations provided at Time 1 and Time 2 because they were rating the exact same nodes. Note that participants did not relate the sentences they provided at Time 2 because those networks contained different nodes than the networks produced at Time 1 and thus the edges would be incomparable to the Time 1 networks.

Rate phase. After reporting the relations among the sentences they provided at Time 1, participants then rated each of their Time 1 sentences on a set of rating scale items. For each sentence, they first rated how much they had thought and talked about that memory or part of themselves over the past week (since Time 1) on a scale from 1 "Not at all" to 7 "All the time". Then, they rated the same items as Time 1 in the same order: emotional valence (separate items for positive and negative on a 7-point scale), centrality (three items from the *CES* on a 5-point scale), and identity disruption (one item on a 100-point scale).

Sense of self. Lastly, participants rated their sense of self using the same two measures from Time 1: personal identity strength (5 items on a 7-point scale) and self-concept clarity (8 items on a 7-point scale). In the interest of time, we did not include the self-referential processing, self-consciousness, or mental health measures from Time 1.

Demographics. Lastly, participants provided demographic information and were debriefed.

Results

Quantitative analyses

To better understand the psychological meaning of AM-I network measures, we explored how well they predicted the rating scale measures of centrality, sense of self, mental health, and self-referential processing. First, we present a node-level analysis of the relationship between network centrality and psychological centrality. Then, we present an exploratory network-level

analysis of the sets of AM-I measures that were most predictive of each of the person-level outcome variables. All analyses were conducted in R version 4.2.3 using the igraph package for network analyses, the lme4 package for linear mixed effects models, and the leaps package for best-subsets regression.

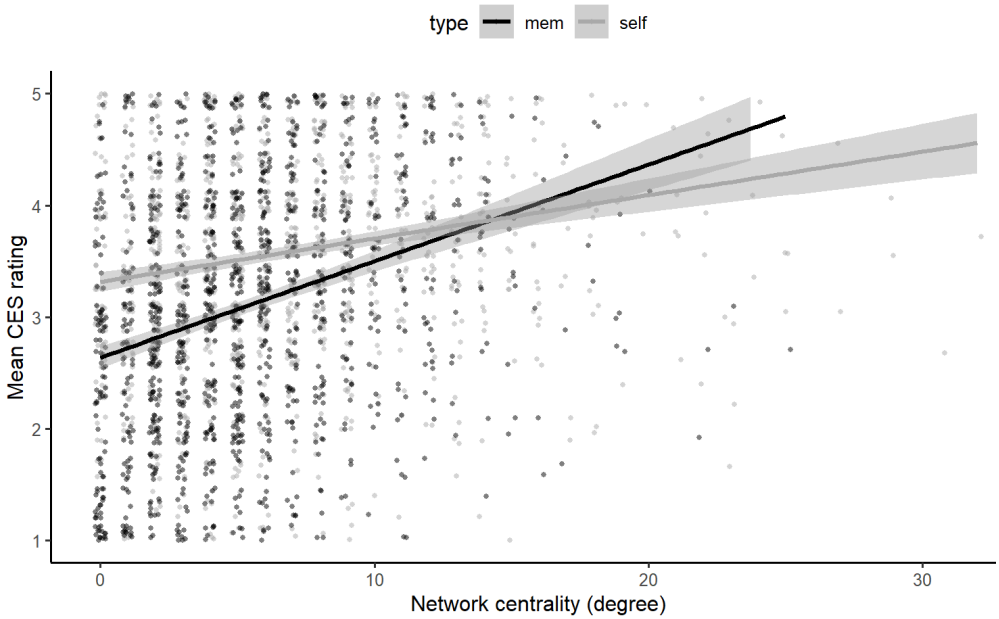
Node-level.

Structurally central memories and identities are also psychologically central. Were the memories and self-statements that participants rated as more central also more connected to other memories and self-statements in their AM-I network? That is, were psychologically central nodes also more structurally central? To answer this question, we used a linear mixed effects model predicting each node's mean *Centrality of Events Scale (CES)* rating from the node's type (memory or self) as well as its *degree* centrality in the AM-I network (see AM-I Network Measures section). To account for the repeated measures in our data – each participant reported on 18 nodes – the model also included a random intercept for participant.

As shown in Figure 5, overall, there was a strong positive relationship between network-based degree centrality and self-reported centrality ratings, $b = 0.11(0.01)$, $\beta = 0.52(0.03)$, $t(2716.00) = 14.92$, $p < .001$, indicating that network centrality is a meaningful indicator of psychological centrality. There was also a moderate effect of node type, with selfs being rated as more psychologically central than memories overall, $b = 0.71(0.06)$, $\beta = 0.36(0.04)$, $t(2605.15) = 9.46$, $p < .001$. Finally, degree centrality significantly interacted node type, $b = -0.06(0.01)$, $\beta = -0.27(0.03)$, $t(2645.64) = -6.68$, $p < .001$, such that network-based degree centrality was more predictive of centrality ratings for memories than it was for self-statements.

Figure 5.

Relationship between centrality ratings and network centrality in Study 1



Note. Relationship between network-based degree centrality and mean self-reported centrality ratings for mem statements (black) and self statements (gray). Confidence bands represent 95% confidence intervals.

Because self statements were rated as more psychologically central than memories, we also wanted to test whether self statements were more central to the AM-I network structure than memories. To test this, we ran a linear mixed effects model predicting degree centrality from node type with a random intercept for participant. In addition to being rated as more psychologically central, self statements also had a higher degree centrality, $\beta = 0.36(0.04)$, $t(2605.15) = 9.46$, $p < .001$, meaning they were more connected to other nodes in their AM-I network than memories were. This finding is consistent with the hierarchical structure of the self-memory system in which the conceptual self (the higher level) is supported by episodic memories (the lower level).

Degree centrality of most negative node predicts depression but not anxiety. Centrality ratings for negative memories have previously been associated with worse mental health. Could AM-I network degree centrality help to predict these important outcomes above and beyond participants' own ratings of psychological centrality? To answer this question, we ran separate linear regression models predicting each outcome variable from the degree centrality of the participant's most negative node, controlling for its mean *CES* rating and the participant's current negative mood as rated on the *PANAS* (see Supplementary Table A1)[2].

For depression, the degree centrality of the most negative node significantly predicted *BDI* scores, $b = 0.68(0.30)$, $t(63) = 2.27$, $p = .03$, above and beyond its *CES* rating and the participant's current negative mood. Note that degree centrality, but not psychological centrality, significantly predicted depression beyond just negative mood in this model. On the other hand, for anxiety, the *CES* score of the most negative node predicted *STAI* trait scores, $b = 0.07(0.03)$, $t(69) = 2.57$, $p = .01$, beyond both degree centrality and negative mood. In this case, the degree centrality of the negative node was not a significant predictor in the model. Thus, for mental health outcomes, there appears to be a dissociation between the *CES* – which is useful for predicting anxiety symptoms – and AM-I network degree centrality – which is useful for predicting depression symptoms.

Network-level. Next we were interested in whether the AM-I network-level measures meaningfully predicted ratings of sense of self, rumination, and mental health and, if so, which network measures were most informative for which outcomes. For this set of analyses, we included a summary of the node-level valence data (ratio of positive to negative nodes) in

[2] Supplementary Table A1 reports the results for all outcome measures, as well as analogous positive valence models predicting each outcome from the network centrality of the most positive node controlling for its CES rating and positive mood. Centrality of the most positive event was not a significant predictor of any of the outcome variables.

addition to the four main network measures described in the AM-I network measures section: density (overall, memory ties, self ties, and cross ties), centralization, and number of clusters.

Our analysis approach was to first look at the raw correlations between each network measure and each outcome (summarized in Supplementary Table A1), then identify best fitting models out of the significantly correlated network variables for each outcome (summarized in Table 1). For all primary outcome measures– personal identity strength, self-concept clarity, rumination, depression, and trait anxiety – the ratio of positive to negative nodes had the strongest individual correlation (all *r*'s > .29, all *p*'s < .001). Reflection was the only outcome that was not significantly correlated with the node valence ratio. Except for personal identity strength and anxiety, all outcomes were also significantly correlated with at least one other AM-I network measure.

To assess which of the correlated network measures were most predictive for each outcome, we next ran best-subsets selection (Beale, Kendall, & Mann, 1967; Furnival & Wilson, 2000; Hocking & Leslie, 1967). The goal of best-subsets selection is to identify the linear regression model that best fits the data with as few predictors as possible. It identifies all possible models that can be derived from the candidate predictors, then selects the one that maximizes adjusted R-squared. The standardized beta coefficients and adjusted R-squared for each of the best-subsets models are reported in Supplementary Table A2). Because best subsets regression is at risk of overfitting the data, we also report k-fold cross-validated R-square values for each model (Rodriguez, Perez, & Lozano, 2010; Wong & Yeh, 2020; Yadav & Shukla, 2016)[3].

[3] K-fold cross validation divides the full data set into k subsets, tests the model on each subset, then averages its performance across the subsets. The resulting cross-validated adjusted R-squared value can be taken as an indicator of how well the model might perform on new data. Here we used k = 5, with 5 replications.

Table 1.

Best subsets models for each of the outcome variables from Study 1

	Sense of self		**Self-referential thought**		**Mental health**	
Predictors	Self-concept clarity (SCC)	Personal identity strength (PID)	Rumination (RRQ)	Reflection (RRQ)	Depression (BDI-II)	Anxiety (STAI trait)
Density	-.10				.23	
Mem ties						
Self ties				.42		
Cross ties						
Centralization			.33			
Clusters	.15					
Pos-neg ratio	.28	.33	-.48		-.45	-.36
Multiple R2	**0.13**	**0.11**	**0.41**	**0.17**	**0.26**	**0.14**
Adjusted R2	**0.11**	**0.10**	**0.39**	**0.16**	**0.23**	**0.12**
k-cv R2	**0.13**	**0.11**	**0.44**	**0.18**	**0.31**	**0.14**

Note. Linear models predicting sense of self, self-referential thought, and mental health outcomes from the best subset of the initially correlated predictor variables (see Supplementary Table A2) for each outcome. In each column, standardized beta coefficients are reported only for the variables in the best-fitting model for that outcome.

Note that because the ratio of positive to negative nodes was significantly correlated with all outcome variables (except reflection), it was included as a candidate predictor for all of the best subsets analyses. Thus, the best subsets selection procedure also served as a test for whether the other aspects of the network structure predicted sense of self, rumination, or mental health beyond just node valence. For each best subset model that contained more than one predictor, we

visualize their relative contributions using added variable plots (Appendix A, Supplementary Figures A2-4).

More memory-identity connections indicate worse sense of self and mental health. First, we explored which features of AM-I networks predicted people's sense of self in terms self-concept clarity and personal identity strength. In addition to the ratio of positive to negative nodes, network density – particularly cross-tie density – and the number of walktrap clusters were significantly correlated with self-concept clarity, $r = -.18$ for density and $r = .16$ for clusters. None of the network measures other than the ratio of positive to negative nodes significantly correlated with personal identity strength (all r's < .08, all p's > .05). The best subsets selection for self-concept clarity identified the three-predictor model with overall edge density, number of walktrap clusters, and the ratio of positive to negative nodes as the best-fitting model. Together, these three network-based measures explained about 12% of the variance in self-concept clarity, a medium sized effect. Making many connections among self-statements to the point that they did not form distinct clusters was associated with *less* clear self-concept.

Next, we looked at whether measures of AM-I network structure predicted mental health. We again found a dissociation such that AM-I networks were predictive of depression but not anxiety. Whereas having more negative relative to positive nodes was the only AM-I network indicator of anxiety, AM-I networks with more dense connections – in addition to more negative nodes – were associated with higher levels of depression, $r = .23$, $p < .05$. The best subsets model for depression included both node valence ratio and network density, together accounting for about 25% of the variance, a medium to large effect. People who make a lot of connections among their autobiographical thoughts also experience more symptoms of depression.

People who ruminate have more centralized memory-identity networks. Next, we identified which network measures were most predictive of the positive – reflection – and negative – rumination – forms of self-referential processing. Reflection was the only outcome that

was *not* correlated with positive to negative node ratio. The only significantly AM-I network predictor of reflection was density, particularly of self ties. The model with just self tie density was the best fit for reflection. People who reflect see more connections among aspects of themselves (i.e, their "I am…" statements).

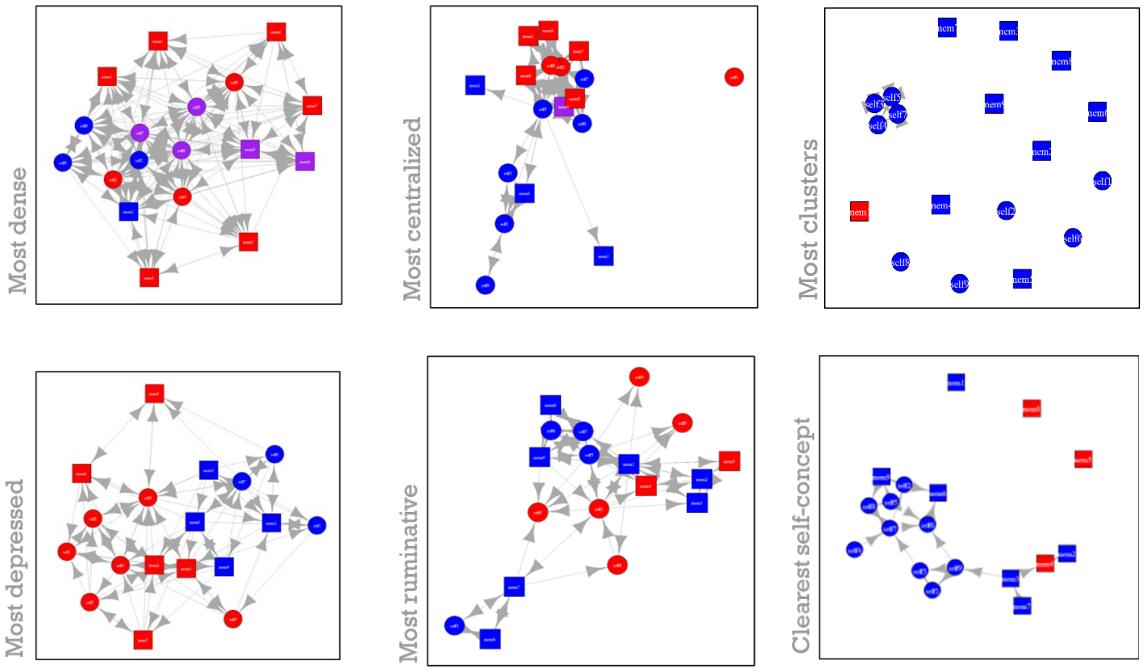
On the other hand, network density – particularly of cross-ties – and centralization were both significantly related to higher levels of rumination. Having a higher ratio of negative nodes was also associated with a tendency to ruminate. The best subsets selection for rumination identified a two-predictor model with just centralization and positive-to-negative ratio – but not density – as the best fit. Any additional information provided by network density did not add to the performance of the model. Together, valence and centralization accounted for about 40% of the variance in rumination, a large effect. People whose AM-I networks are more negative and more dependent on just a few central nodes tend to ruminate more.

Visual analysis

Example AM-I networks. As qualitative analyses supporting and exemplifying the above quantitative findings, we present visual examples of the AM-I networks for participants who scored highest on each of the measures, both for network-derived measures – to illustrate what we mean by a "centralized" network or a "dense" network, for example – as well as for the survey based measures, to see real examples of how people who "ruminate" or who have a "clear self-concept" organize their memories and sense of self (see Figure 6).

Figure 6.

Example AM-I networks from Study 1



Note. Examples of individual AM-I networks from Study 1 chosen based on their score on the labelled variable (e.g., highest density, highest centralization, etc.). Within each network, squares represent memory nodes ("I remember…" statements) and circles represent self nodes ("I am…" statements). Nodes are colored by their valence: blue nodes were rated as more positive than negative, red as more negative than positive, and purple as equally positive and negative. Arrows indicate that the node on the target end of the arrow was marked by the participant as related to the node at the originating of the arrow.

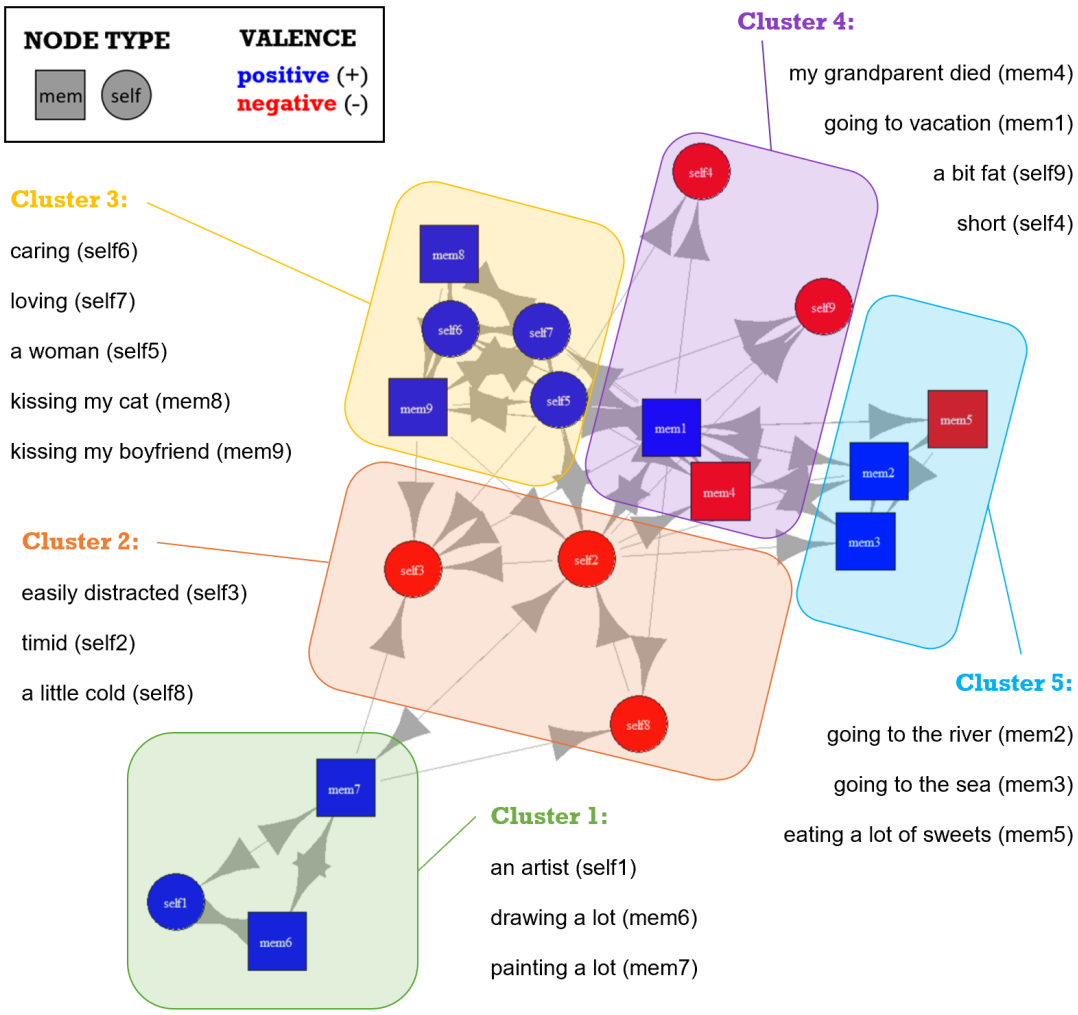
At the structural level, we can see that the most dense network and the most depressed network look similar, as do the most centralized and most ruminative networks, exemplifying the quantitative associations between these variables. Both the clearest self-concept and the network with the most clusters depict a set of interrelated positive self statements as well as a number of disconnected nodes – particularly memories. This sparsity of connections stands in contrast with the most dense and most depressed networks. Exemplifying the valence findings, we also see that the most depressed network has a majority negative nodes, whereas the clearest self concept network has a majority positive nodes. We were not able to quantify this, but it also seems like

the most depressed network is partitioned by valence, with the left side consisting of negative nodes and the right consisting of positive ones.

Rumination case study. In order to better understand how AM-I structure might promote rumination, we now present a more detailed case study of the "most ruminative" network (Figure 6, bottom center), including its walktrap clusters and their content (Figure 7).

Figure 7.

Most ruminative AM-I Network case example from Study 1



Note. Example AM-I network including node names (grouped by cluster) for the most ruminative participant. Node shape indicates type (mems or selfs), and color indicates valence (positive, negative). Nodes that occupy the same color tinted area were assigned to the same cluster by the walktrap algorithm.

At first look, we see that this network contains more positive (blue) than negative (red) nodes overall (12 positive, 6 negative), and it can be divided into 5 clusters. Negative self-views occupy key structural positions in the network. First, there is a walktrap cluster comprised entirely of negative self statements: “I am timid”, “I am easily distracted" and “I am a little bit cold” (Cluster 2, orange). This cluster of negative thoughts is centrally located between the other clusters containing more positive thoughts. In order to move from the positive Cluster 1 thoughts related to art, the person might end up thinking about how cold and timid they are before they can reach thoughts about how loving and caring they are (Cluster 3).

Note that the Cluster 2 negative self thoughts also have more in-degree than out-degree connections. If the person started thinking one of these negative thoughts, it might take awhile to move onto a different one. This observation is most apparent for the thought “I am easily distracted” (self3), where there are no outgoing ties at all. We see a similar pattern for the two negative self-statements in Cluster 4 (purple). Although they are more peripherally located, these negative self-views also have no outgoing ties. Such nodes could represent "stuck" points in the structure, pointing to how rumination might play out content-wise in this person’s autobiographical thought. In this case, the person might spend a lot of time thinking that they are easily distracted.

Unlike the negative nodes in this example network, the positive nodes all have both incoming and outgoing ties. It may be easy for the person to flow in and out of these positive thoughts. In fact, the most quantitatively central node in this AM-I network is “going to vacation” (mem1) from Cluster 4 (purple). This central positive vacation memory, however, is tied to all of the negative self-view “stuck” points which could ultimately lead the person to end up ruminating on a negative self-view again. Although this analysis is purely speculative and observational, it could provide insights into how AM-I networks could be used with individuals in clinical settings and can generate ideas for future research questions.

Discussion

In this study, we found that AM-I network-based measures of autobiographical thought structure predicted self-concept clarity, depression, and rumination beyond ratings of individual autobiographical memories and self-statements.

Memories and self-statements that people said were central to their identities were also more connected in their AM-I network. This is promising in that it validates both measures, confirming that AM-I network centrality is psychologically meaningful, and also that people's responses to the *Centrality of Events Scale* (Berntsen & Rubin, 2006) are consistent with the conception of the scale. One of the other items on the *CES* that we did not use in this study, for example, is: "If I were to weave a carpet of my life, this event would be in the middle with threads going out to many other experiences." This item is reminiscent of what central nodes look like in AM-I networks: in the middle with ties going out to the other autobiographical thoughts.

Our study extends beyond the centrality of singles events, however, to other aspects of this metaphorical carpet. For example, we found that particularly dense autobiographical "carpets" are associated with less clear self-concept and worse mental health, but only depression not anxiety. At first, we thought that overgeneral memory, which is common in depression, might look like a sparsity of connections between memories and self-statements, but instead we found that more connections across all nodes in the network correlated with depression symptoms. This finding counterintuitively suggests that pruning connections might actually be more important for treating depression than creating new ones.

We also found that ruminators tend to have highly centralized autobiographical thought structures, or to extend the carpet metaphor, lots of threads connected to just a few central designs on the rug. This finding is correlational, and the causality could go either or both ways. The process of ruminating might focus a person's thought on a highly negative experience or view of

themselves, thus strengthening its accessibility and increasing its centrality to one's autobiographical knowledge structure. On the other side, having a highly central negative experience or self-view could encourage rumination because it would be very likely that one's autobiographical thought would continue to return to that central part of the structure, as we speculated in our qualitative analysis of the most ruminative network example.

In the next study, we explore the effect of writing about selected pairs of AM-I network nodes on the overall structure of the network. Theoretically, in the self-memory system, narratives are built from these underlying building blocks, but does telling narratives also shift the structure of these underlying units? If so, can AM-I networks help us better understand the effects of narrative interventions such as psychotherapy, diary writing, or just telling our stories to friends on our overall sense of self?

Study 2. Narratives in AM-I Networks

This section serves as a proof of concept for the study of autobiographical narratives using AM-I networks. A strength of the network method over autobiographical narratives alone is that researchers can test the effect of narrative interventions on the perceived associations among non-narrated memories and identities as well as narrated ones. Given our earlier finding that networks with *more* connections centered on negative memories and views of the self are associated with worse outcomes, such an approach may even be necessary to identify mechanisms of improvement in sense of self and well-being following narrative interventions.

Narratives in networks

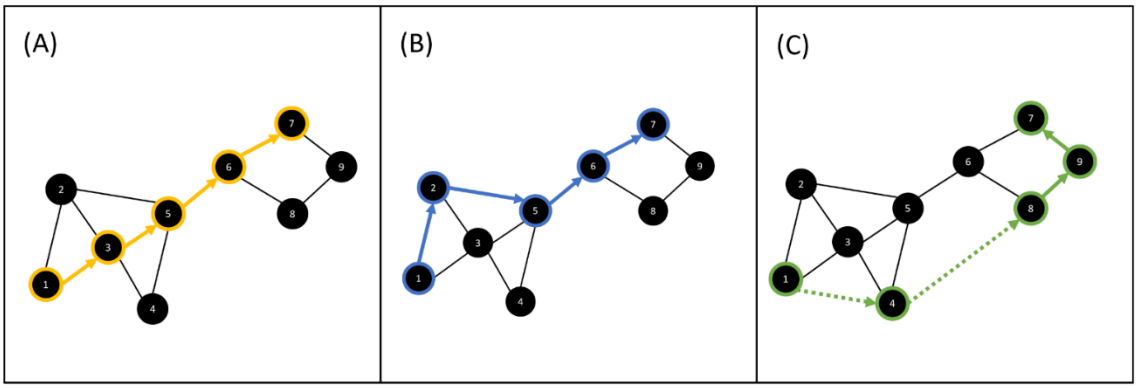
Directed graphs have been used in network analysis to examine the flow of information among connected individuals, where directed ties are represented by arrows indicating the direction of influence (Borgatti et al., 2018). Directed graphs may be particularly useful in the autobiographical memory context for examining possible narrative trajectories or "life stories"

that could be told given an existing structure of memory units and their perceived associations (Figure 8). In some cases, it might not be necessary to change an individual's network structure in order to change their story. Given the same network and the same starting and ending event, one could come up with different narrative trajectories. For example, in the network structure shown in Figure 8, a narrative path from node 1 to node 7 could go through node 3 (panel A, in yellow) or through node 2 (panel B, in blue).

Rehearsing one narrative path through an autobiographical memory network could strengthen the perceived associations among the memory units along the path, but it could also theoretically weaken the perceived associations for related memory units that are not on the narrative path (Anderson, Bjork, & Bjork, 1994). If a particular memory unit is especially central to one's existing network, it may not be possible to create a narrative path around it given the existing pattern of perceived associations in the network (e.g., nodes 5 and 6 in Figure 8). In this case, it may be necessary to use a narrative intervention that creates new perceived associations across clusters of memory units (panel C, in green).

Figure 8.

Narrative paths in network data



Note. Hypothetical network graphs, each showing a narrative path (colored lines) from node 1 to node 7. Panels A and B show two different narrative trajectories (yellow and blue) using the same network structure. Panel C shows a new narrative trajectory (green) involving the addition of new perceived associations (dotted arrows) to the network structure.

The current study

In this initial pilot study, we assigned people to narrate a connection between two sentences drawn from their AM-I network structure or between two non-autobiographical words. We were interested in whether narrating autobiographical connections would shift AM-I network structure relative to the control condition (either by densifying, sparsifying, centralizing, or clustering the network), and whether any changes in network structure would predict differences in self-concept clarity across different narrative types.

Specifically, we manipulated the type of AM-I network nodes that participants were assigned to connect (either two memories, two self-statements, or a memory and a self-statement). Given the findings of Study 1 that selfs are more central to the AM-I structure overall, we thought that self narratives might have a larger effect on both sense of self and AM-I network structure compared to memory narratives alone. We also thought that cross-tie narratives might lead to more dense network structures and lower sense of self given that more cross-ties were associated with lower self concept clarity in Study 1.

Method

Participants

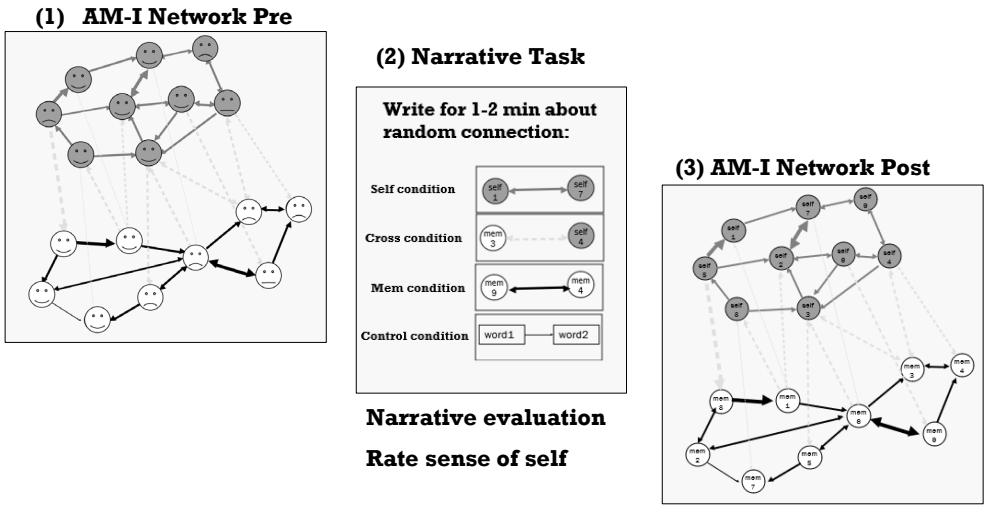
One hundred thirty-five adult participants (aged 18-65, M_{age} = 27.7; 41% female, 57% male, 1% non-binary; 81% White, 12% Latinx, 2% Asian, 1% Black or African American, 3% Other) were recruited from Prolific (an online recruitment platform) to participate in a study about the self. For our primary analysis – a one-way ANOVA with four levels – this sample had 14% power to detect a small effect (Cohen's f = .10), 67% power to detect a medium effect (Cohen's f = 0.25), and 98% power to detect a large effect (Cohen's f = .40) at an alpha level of .05.

Procedure

In this study, participants reported their AM-I network before and after completing a narrative writing task (see Figure 9). Given the findings from the previous study that cross-ties were more predictive of sense of self, we were interested in whether making a narrative connection between two memories, two selfs, or across a memory and a self would shift AM-I network density relative to a word association control condition. After the narrative task, we assessed participants' sense of self and they re-rated the connections among the nodes in their AM-I networks. Honing in on the self function of autobiographical thought, we focused on two dependent measures: personal identity strength and self-concept clarity.

Figure 9.

Overview of Procedure for Study 2



Note. The stages of the procedure for Study 2 in the order participants completed them: (1) pre-narrative AM-I network task, (2) narrative writing task (participants were assigned to one of four conditions), and (3) post-narrative AM-I network task. Narrative evaluation and sense of self ratings took place after the narrative task (stage 2) and before the post-narrative AM-I network task (stage 3).

AM-I Network (pre-narrative). Participants first completed the AM-I Network task as described in the General AM-I Network Method Section by completing the "I am…" and "I remember…" sentences nine times each (as in Study 1), then selecting all of their perceived connections among the sentences. They also rated how positive, negative, and important each sentence was using 7-point rating scales ranging from 1 "Not at all" to 7 "Extremely". We truncated the rating portion of the procedure relative to the previous study in the interest of time given that participants would be doing the AM-I Network procedure again later in the same session.

Narrative task. Then, participants were asked to write a narrative connecting two of their sentences (or two words in the control condition). They were instructed to try to think of the connections between the two items, even if they didn't think the two items were very related. We provided an example narrative connecting two sentences (or two words in the control condition), as well as suggestions for how they might connect their responses, including writing about their common meaning or writing a story connecting the two items. They were reminded that there are no right or wrong answers.

After reading the narrative task instructions, participants were presented with two items and asked to reflect on the connection between those items for one to two minutes by typing into a text box. The button to advance onto the next page appeared after one minute but they could use up to two minutes to type their narrative before being advanced to the next screen. For the narrative task itself, participants were randomly assigned to one of four conditions in which we manipulated the type of sentences they were asked to connect:

Memory tie condition. In the memory tie condition, participants were randomly presented with two of their "I remember…" sentences and instructed to reflect on those two experiences from their life. They were then prompted with the question: "How might these two experiences be connected to one another?" at the top of the text box.

Self tie condition. In the self tie condition, participants were randomly presented with two of their "I am…" sentences, instructed to reflect on those two aspects of themselves, and prompted with the question "How might these two aspects be connected to one another?" above the text box.

Cross tie condition. In the cross tie condition, participants were randomly presented with one of their "I remember…" sentences and one of their "I am…" sentences and reflect on the relation between that life experience and aspect of themselves. At the top of the text box, they were asked "How might this aspect and this experience be connected to one another?"

Word tie control condition. In the word tie control condition, participants were presented with two random words from a list of 18 words (see Appendix). Example words are: river, clothes, message, art. They were told to reflect on the relation between the two words and prompted with the question "How might these two words be connected to one another?" above the narrative text box.

Narrative task evaluation. They were then asked to rate their experience of the narrative task. Specifically, they rated how difficult it was to write about the relation between the two items, how positive/negative they felt while writing, and how engaged they were while writing, on a scale from 1 "Not at all" to 7 "Very much". Participants were specifically told their answers to these questions would not affect their compensation.

Sense of self. As our primary outcome measure, participants then responded to the Personal Identity Strength and Self Concept-Clarity measures that were used in Study 1.

AM-I Network (post-narrative). Our second outcome measure was the AM-I network structure and node attributes themselves. To assess the post-narrative AM-I network structure, participants completed the *relate phase* of the General AM-I Network Method for the sentences they generated during the AM-I Network (pre-) stage of the experiment. They also rated the edge

strength for all self-reported connections between autobiographical thoughts during the relate phase on a N-point rating scale. To assess node attributes, participants then re-rated the positivity, negativity, and importance of each sentence using the same 7-point rating scale (the *rate phase* of the General AM-I Network procedure).

Demographics. Finally, participants provided demographic information and were debriefed.

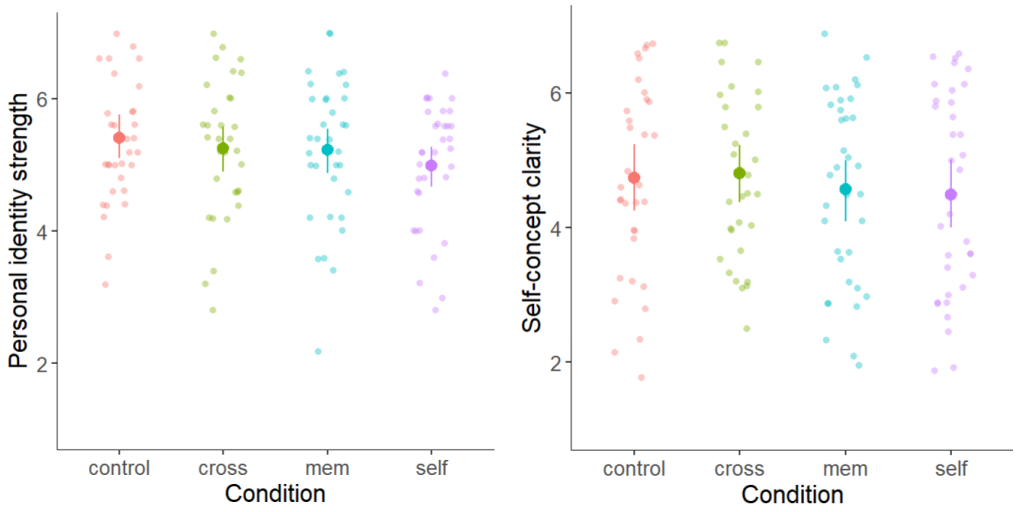
Results

Sense of self did not differ by narrative condition

First, were interested in whether the type of narrated tie affected people's sense of self. To test this, we conducted one-way ANOVAs comparing mean personal identity strength and mean self-concept clarity across conditions.

Figure 10.

Mean post-narrative personal identity strength and self-concept clarity ratings in Study 2



Note. Mean personal identity strength and self-concept clarity ratings after writing a narrative connecting two words (control condition, red), a memory and a self-statement (cross condition, green), two memories (mem condition, blue), or two self-statements (self condition, purple). Error bards represent 95% confidence intervals.

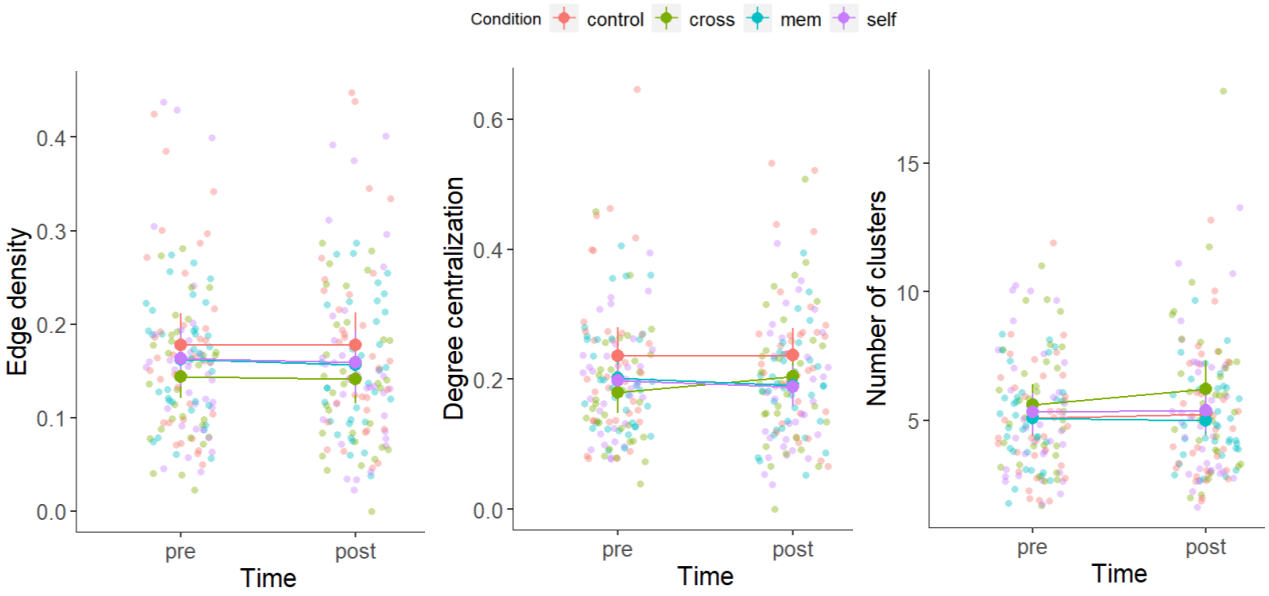
As shown in Figure 10, there were no significant differences among the narrative conditions in personal identity strength, $F(3, 131) = 1.02$, $p = .39$. The four narrative conditions also did not differ in self-concept clarity after people had written the assigned narrative tie, $F(3, 131) = 0.37$, $p = 0.78$.

AM-I network structure did not shift from pre- to post-narrative

We also compared changes in AM-I network structure by narrative condition. Specifically, we conducted two-way mixed-model ANOVAs comparing each network measure across narrative conditions by time (pre- or post-narrative). To account for the repeated measures in our data, we also included an error term for participant.

Figure 11.

Change in AM-I network structure from pre- to post-narrative by condition in Study 2



Note. Mean edge density (left), degree centralization (center), and number of walktrap clusters (right) for pre- and post-narrative AM-I networks in the control (red), cross-tie (green), mem-tie (blue), and self-tie (purple) conditions. Small dots are individual data points, large dots are group means and error bars represent 95% confidence intervals around the mean.

If network structure shifted in general from before to after the narrative task, we would see a main effect of time in the mixed ANOVAs. There was no main effect of time for any of the AM-I network structure variables: edge density, degree centralization, or number of clusters (all *p*'s > .05). If only some of the narrative types affected network structure, we would expect to see an interaction between time and condition in the mixed ANOVAs. Again, there were no significant effects for any of the network structure measures (all *p*'s > .05). As shown in Figure 11, all post-narrative network measures were similar to their baseline levels in all conditions.

Unexpectedly, there was a significant main effect of narrative condition, such that the control condition had more centralized, $F(3, 261) = 3.34$, $p = .02$, networks than the other conditions. Because this difference was present both before and after the narrative manipulation, we attributed it to unintended natural variation among the groups despite random assignment to condition.

Discussion

Writing a narrative connection between two randomly selected autobiographical thoughts (either memories, selfs, or one of each) did not affect the overarching structure of connections among people's autobiographical memories and identities as a whole. Furthermore, participants who wrote about one of the three types of autobiographical connections did not differ from those who wrote a non-autobiographical narrative in terms of their sense of self.

The narrative intervention in this study was designed to test the effect of narrative at different structural levels of the self-memory system but did not take into account the valence or centrality of the nodes selected for narration. Past work has shown that positive self-event connections in autobiographical narratives are associated with clearer self concept and fewer psychopathological symptoms (Holm & Thomsen, 2018) and that the order of valence – going from negative to positive, rather than positive to negative – in narratives is important (McAdams

et al., 2001). Future experiments could use the valence and centrality of nodes to design more targeted narrative manipulations tailored to an individual's AM-I network.

The manipulation in this experiment was just a first step in studying the relationship between autobiographical narratives and memory-identity networks. More targeted experimental narrative research could also look at the effect of narrating multiple AM-I connections, as opposed to just one. Narrating the same connection multiple times could be a way of mimicking the repetitive nature of rumination in a laboratory setting. This could help us to understand the causal direction of the relationship between autobiographical thought structure and rumination observed in Study 1.

Finally, in order to improve the ecological validity of this research, future work could allow participants to freely tell narratives based on their AM-I networks starting at a randomly selected node. This would be a human equivalent of the "random walk" and could help us better understand the interaction between the dynamics and the structure of autobiographical thought.

Chapter Conclusion

In the studies presented in this chapter, we validated Autobiographical Memory-Identity Networks as a meaningful procedure to be used for psychological research on sense of self and mental health. In this procedure, participants provide statements about who they are as a person and experiences they remember from their lives, then report on the connections among their self and memory statements. We used this procedure to map individualized networks of autobiographical for each participant, finding that network-based measures such as density, centralization, and clusters predict depression, rumination, and self-concept clarity, respectively (Study 1) and that participants can generate written narratives connecting these sentences (Study 2).

Importantly, in Study 1, we found that AM-I network based measures added explanatory power above and beyond survey-based measures of individual memories, such as the Centrality of Events Scale (Berntsen & Rubin, 2006), and mood, such as the Positive and Negative Affect Scale (Watson et al., 1988). Although we did not find any effect of connecting two randomly selected nodes on sense of self in Study 2, the link between narratives and networks of autobiographical thought is an important one to continue to study as two different but likely interacting ways that people make connections among their autobiographical thoughts.

Using AM-I networks to study the relations among autobiographical thoughts could be an efficient and informative procedure for both researchers and clinicians alike. Existing interventions could act at different levels of autobiographical thought that AM-I networks can capture. For example, cognitive reappraisal strategies (Brockman, Ciarrochi, Parker, & Kashdan, 2017; Troy, Shallcross, & Mauss, 2013) could operate by changing the emotional valence of individual autobiographical thoughts (node-level), whereas narrative-based interventions (McAdams et al., 2001) could operate by changing ties between specific autobiographical thoughts (edge-level), and mindfulness approaches (Kabat-Zinn, 2003) could operate by changing the state of relations among all autobiographical thoughts (network-level).

3

Identity Formation via Autobiographical Conversations

In Chapter 2, we saw how episodic memory supports one's sense of self and identity, in line with the self function of autobiographical memory. Do autobiographical memories also underly our sense of connection with others and the social groups we belong to? Recall from Chapter 1 that memory-sharing also serves a social function (Bluck, 2003; Bluck & Alea, 2011). Prior research has mainly focused on the social function of autobiographical memories in naturally occurring relationships (e.g., parent-child, romantic partners; Harris, Barnier, et al., 2014; Sales & Fivush, 2005). There is far less research, however, on how – or even whether – sharing autobiographical thoughts with unknown others can support identity formation. Here, in Chapter 3, we introduce different levels of identity within an individual and how those identities connect us to others: both in dyadic and group contexts. Then we present two empirical studies testing how anonymously conversing about personal stories strengthens these identities.

Individuals: Levels of identity

Within the individual, identities exist at different levels (Brewer & Gardner, 1996). Personal identities (also known as self identities) highlight what make an individual unique from others, *e.g,* individual traits like "I am… intelligent". The other two levels of identity are inherently connected to other people. Relational identities (also known as interpersonal identities) have to do with ties to specific others, *e.g.,* relationship categories like "I am… a friend" or “I

am… a mother." Collective identities (also known as social identities) have to do with one's membership to larger social groups or categories, e.g., "I am… a woman" or "I am… a Princetonian". In the empirical studies in this chapter, we explore the content of people's autobiographical conversations for the types of identities they discussed (Study 3). Then, in Study 4, we manipulated the type of identity salient during autobiographical memory-sharing– either self- or social- identity – to test its effect on the social function of autobiographical thought. In both studies, we also looked at the role of how people identified with their conversation partners in the strengthening of identity.

Dyads: Shared identity

Through social interaction we can form a sense of "we"-ness with others (Koudenburg, Jetten, Enz, & Haslam, 2024; Koudenburg, Postmes, & Gordijn, 2013). Our connections to other people are based on a sense of shared identity – that we have similar identities, *i.e.,* traits, interpersonal roles/relationships, and social group memberships – as well as a sense of shared reality – that we experience common inner states, *i.e.,* thoughts, feelings, and attitudes about the world (Echterhoff, Higgins, & Levine, 2009). These types of "we"-ness are closely interrelated (Hogg & Rinella, 2018). An pre-existing shared social identity can lead to a stronger a sense of shared reality during conversation (Greenaway, Wright, Willingham, Reynolds, & Haslam, 2015). Even in the absence of a prior shared social identity, shared identity can emerge specific to dyadic relationships (Cruwys, South, Halford, Murray, & Fladerer, 2023; Rossignac-Milon, Bolger, Zee, Boothby, & Higgins, 2021; Rossignac-Milon & Higgins, 2018). In the empirical portion of the chapter, we show the formation of a sense of "we"-ness – operationalized as "identification" with one's conversation partner – plays a role in how autobiographical conversation strengthens one's sense of self (Study 3) and group identification (Study 4).

Groups: Group identification

All of us are members of groups in some form or another, be they broad social groups like people of the same gender, or more specific groups like teams of people who work together. Our individual-level identities and relationships with specific group members contribute to the degree to which we identify with our groups (Jans, Postmes, & Van der Zee, 2011, 2012; Miller & Prentice, 1994). Group identification is a feeling of "identification with" or "closeness to" the social group as an entity in and of itself (Lau, 1989). People also perceive that their groups vary in how unified – or entitative – they are as well as how different they are from other groups (Hamilton, Sherman, & Castelli, 2002; Lickel et al., 2000; Spears et al., 2004). Our understanding of our group's members, structure, and relationship to other groups all shape how we identify with the group as a whole. In Study 4, we examine the role of autobiographical conversations with group members embedded in a larger social structure on group identification.

Overview of studies

The first study in this chapter shows that conversing with another person in a dyad (i.e., a pair of conversation partners) about personal topics strengthens sense of self via connection to others. As such, it bridges both the self and social functions of autobiographical thinking. The next study, involving conversational networks of multiple dyadic interactions, shows that conversing about autobiographical memories with other members of newly formed groups strengthens people's identification with their group as a whole. This study extends the social function from one-on-one relationships to more complex social structures.

In both studies, the identity-strengthening effect is largely contingent on the degree to which people feel a sense of shared identity within the conversations they had with their partner(s). Bonding one-on-one with people forms the grounds for a stronger sense of self and identification with others more broadly. In the discussion section of this chapter, we consider

what it is about conversation, versus thinking about memories on our own, that leads people to feel connected to both themselves and others.

Study 3. Conversation Grounds the Self in Shared Identity

Social theories of self

The notion that the self is socially constructed is not new. Philosophers and sociologists have positioned the self as inextricably linked to society for over a century. One of the earliest theories of a social self was Mead's (1934) theory that people develop their own individual identities through interaction with others. The process of social interaction allows us to mentalize and take on another person's perspective to imagine how they might be viewing us, a concept known as the looking-glass self (Cooley, 1902). This social reflection of self helps us develop self-awareness and an ability to think of ourselves from an outside observer's perspective.

Classic social psychological theories also position the self as socially contingent. Self-perception theory, for example, posits that we come to "know" ourselves not only through our first-person internal experiences of our thoughts and emotions, but by inferring these internal states from our outward behaviors and environments as third-person observers (Bem, 1972). Driven by our desire not just to "know" ourselves but to be "known" by others, we prefer to interact with people who validate or verify our own self views (Swann, Stein-Seroussi, & Giesler, 1992; Swann & William, 2012). Thus, people are motivated to integrate and align others' perspectives with their own sense of self.

The current study

Does sharing autobiographical thoughts with one another strengthen people's sense of self? In this study, we asked people to engage in general autobiographical thought by reflecting on what is important to them in life, what they are (dis)satisfied with about their lives, and what they wish for their future. We compared the content of these reflections when participants

reflected in isolation (i.e., the introspection condition) and when they reflected via chatting with another person (i.e., the conversation condition). In addition to overall differences in sense of self after discussing autobiographical thoughts in a social context vs. reflecting on them alone, we were interested in the *process* by which conversations lead to higher levels of personal identity strength and self-concept clarity.

Specifically, we hypothesized that there would be a social process involved in the strengthening of sense of self when people conversed with one another. In line with the social function, conversational sharing of autobiographical thoughts should increase a sense of shared identity with others and help to validate people's views of themselves. We hypothesized that the degree to which a conversation fostered shared identity and social validation should subsequently predict post-conversational personal identity and self-concept clarity. The results reported in this chapter involve a text analysis of the conversation data for linguistic markers of this social process.

Method

Participants

The total recruited sample comprised 467 Prolific workers from the United States, who were assigned to one of two conditions: introspection or conversation. A power analysis based on a previous sample yielded a target sample size of 398 (199 introspection, 199 conversation) to detect an effect of .25 at .80 power at an alpha level of .05 for the mean difference in self-concept clarity between the two conditions.

According to our preregistered criteria, participants were excluded for failing the attention check (n = 9), having a non-responsive partner in the conversation condition (n = 42), or not being matched with a partner in the conversation condition (n = 10). Given the disproportionate number of exclusions in the conversation condition due to partner-

responsiveness and -matching issues, once the target sample size was reached for the introspection condition, we continued to sample participants for the conversation condition until its target sample size was reached as well.

The final sample consisted of 406 participants (M = 35.52, SD = 12.05; 202 female, 197 male, 5 non-binary, 2 prefer not to reveal gender; 72% White, 14% Asian, 10% Hispanic/Latino, 6% mixed race, and 2% other). This sample was balanced between the introspection (N = 203) and conversation (N = 203) conditions.

Procedure

The experimental procedure consisted of four main phases: a reflection task (either introspection or conversation), evaluation of the reflection task, rating of social processes, and rating of sense of self. At the end of the study, participants also completed an assessment of their (and –in the conversation condition – their partner's) participation in the study.

Reflection task. Participants were asked to reflect on how they would answer three personal questions about themselves ("What is important in your life?", "If you think about your life, what are you satisfied with and what are you dissatisfied with?", and "What are your wishes for the future?"). They either reflected on these questions alone (introspection condition) or with another participant (conversation condition) for five minutes[4]. In both conditions, the three questions were available at the top of the screen while completing the task.

Introspection condition. In the introspection condition, participants were instructed to make sure they were in a quiet space without any interruptions so they could focus on their introspection. They were presented with an open-ended text box and instructed to write down any thoughts they had during the five-minute introspection period in the text box. To avoid any

[4] The idea was for participants to engage in an equal amount of either individual or social autobiographical thinking, rather than to discuss/think about their own personal answers for the same amount of time (in which case the conversation condition would need to be twice the length of the introspection condition).

communication goals, participants were told that their writing did not need to be understandable to anyone but themselves.

Conversation condition. In the conversation condition, participants were entered into a chat box with another participant (embedded into Qualtrics using Chatplat.com). Given individual variability in study timing, the first participant might have been waiting in the chat box alone (for no more than five minutes) until another participant reached the chat box page. Once they were matched with the next available participant, they had five minutes to reflect on themselves in the chat box by interacting in real time with the other participant. Both participants received the same instructions. To keep the conversations as natural as possible, they were not told how to structure their conversation.

Task evaluation. After reflecting for five minutes either alone or with a partner, participants rated their experience of the reflection – either introspection or conversation – task. These task evaluation measures were included for descriptive/exploratory purposes as a way to identify any potential differences in how participants felt during the conversation vs. the introspection task. The task evaluation items were presented on the same page in a random order with instructions to respond about the task they just completed.

Flow. First, participants rated the flow of the reflection task using three items ("How [smooth/effortful/engaging] was the [conversation/introspection] task?") on a 7-point Likert-type scale ranging from 1 "Not at all" to 7 "Very much". This measure was adapted from Koudenburg and colleagues (2017).

Emotional valence. Then, participants rated how positive and how negative they felt during the reflection task (again from 1 "Not at all" to 7 "Very much"). Note that emotional valence was rated on two separate unipolar scales allowing for the task to be rated as both positive and negative if the participant experienced it that way.

Social processes. Next, participants rated their current sense of shared identity and social validation, the two social processes we hypothesized would mediate the effect of conversation on sense of self. The two scales were presented on two separate pages, with shared identity first. Both sets of items were adapted to a state-based format ("Right now,") and the items for each scale were randomized. The instructions were to indicate the extent to which they felt the way described by the statements provided.

Shared identity. To assess the feeling of shared identity, participants rated three items ("Right now, I feel a sense of [belonging/unity/togetherness] with others") on a scale from 1 "Not at all" to 7 "Very much". This measure was adapted from a similar measure used to assess crowd identification (Drury et al., 2009). By changing the wording to "with others" in general rather than referring to any specific group, we were able to assess participants' general sense of "we"-ness in both the conversation and introspection condition. The three items were presented in a random order.

Social validation. The degree to which participants felt their self-views were shared by others was measured using three items ("Right now, I have the feeling that my [ideas about myself are well-founded/views about who I am are shared/opinions about myself are validated].") on the same scale ranging from 1 "Not at all" to 7 "Very much". This measure was adapted from Koudenburg, Postmes, and Gordijn (Koudenburg, Postmes, & Gordijn, 2011). The three items were presented in a random order.

Sense of self. After rating the social processes, participants rated their sense of self in terms of personal identity strength and self-concept clarity, which were our two primary outcome variables. These scales were the same ones used in Studies 1 and 2, but they were adapted to a state-based format ("Right now…"). Each scale was presented on a separate page, with items randomized on each page. The instructions were to indicate how much they agreed with each of the statements.

Personal identity strength. The personal identity strength measure consisted of five items (e.g., "Right now, I know what I like and don't like") rated on a 7-point Likert-type scale ranging from 1 "Strongly disagree" to 7 "Strongly agree" (adapted from (Jetten et al., 2010)

Self-concept clarity. Self-concept clarity was assessed using 8 items from the Self-Concept Clarity Scale (e.g., "Right now, I have a clear sense of who I am and what I am") using a scale from 1 "Strongly disagree" to 7 "Strongly agree" (Campbell et al., 1996).

Participation assessment. Lastly, participants responded to a series of questions about their participation in the study. They were instructed to be as honest as possible in their responses and assured that their responses would not affect their compensation.

Attention checks. After completing the sense of self measures, participants were asked to report what they were asked to reflect on during the introspection/conversation period using an open-ended text box. We also included another attention check earlier in the study, which was presented as a sixth item interspersed in the personal identity strength scale: "Right now, I will select six to indicate that I am paying attention." If a participant did not pass both of these attention checks, they were excluded per our preregistered criteria.

Self-disclosure. In both conditions, we also asked participants how much they revealed about themselves in the conversation/introspection task on a 7-point Likert-type scale ranging from 1 "Nothing at all" to 7 "Very much." This item was included as an exploratory measure to see whether the two conditions differed in how much participants were willing to share about themselves. It also served to ensure that participants were doing the task as intended by reflecting on the personal questions, which were intended to elicit self-disclosure.

Social context. Because our primary independent variable was the social context of the reflection task, we asked participants about the number of people in the room with them while they completed the study and whether or not they talked or texted with anyone outside of the

study while completing it. This check was most relevant for the introspection condition where asked people to be in a quiet place with no interruptions during the introspection task, although external people and social interactions could have distracted participants in either condition while completing the study.

Conversation assessment. For participants in the conversation condition, we also asked whether they were matched with another participant during the conversation task and whether they had a conversation with them (or if the partner was non-responsive). This question was used to exclude participants from the conversation condition who did not actually have conversations. For those who reported that they did have a conversation, we also asked how connected they felt to their partner during the conversation task on a scale from 1 "Not at all" to 7 "Very much".

Demographics. Finally, participants reported their age, gender, ethnicity, native language, and comfort with English. They also had the opportunity to provide their feedback on any problems they encountered during the study before being debriefed.

Results

Primary analysis

The primary preregistered analysis for this study tested the effect of conversation (vs. introspection) on sense of self via the social processes of shared identity and social validation. Using a serial mediation analysis, we found a significant indirect effect such that conversations that fostered a sense of shared identity validated one's self views and predicted better sense of self in terms of self concept-clarity, β =.063, bootstrapped 95% CI [.008;.128], and personal identity strength, β =.060, bootstrapped 95% CI [.009;.117][5]. Interestingly, there was no overall difference between the two conditions in sense of self ratings post-reflection, suggesting that both

[5] I do not report these analyses in detail in this dissertation because they do not constitute my own original work. Interested readers should refer to the published version of the article containing this study for more information about these analyses, which were conducted by the first author (Koudenburg, Jetten, Enz, & Haslam, 2024).

introspection and conversation serve to support sense of self, but via different processes. The serial mediation finding suggests that, for conversation, the process is a social one involving shared identity and social validation (the social process pathway), but it is not clear what the underlying process might be for introspection. The remainder of the results section for this dissertation focuses on text analysis of the qualitative conversation and introspection content to better understand the mechanisms underlying the social process pathway found in the quantitative analyses.

Linguistic analysis

There were two main aims of the linguistic analysis. First, wanted to check whether there were differences in the types of autobiographical content that people wrote about in the two conditions. It is possible that in the conversation condition, participants' answers to the prompt questions contained more social and/or positive content, whereas in the introspection condition, their autobiographical thoughts contained more personal and/or negative content. Such a difference would suggest that the conversational context prompted a fundamentally different kind of autobiographical thought. Is socially validating content just more likely to come up when sharing autobiographical thoughts with others (compared to when thinking about oneself alone)? If the answer is yes, direct social interaction might not be necessary to strengthen sense of self via the social process pathway, as long as the thoughts themselves are social and positive.

On the other hand, if the social aspect of conversation is what triggers the social process pathway, we would expect to see linguistic markers of shared identity and social validation occurring in the interaction itself. For example, we would expect words of agreement (e.g., yes, agree) and/or similarity (e.g., me too, same) to be present in the conversation texts but not in the introspection texts. Note that these words of agreement and/or similarity do not represent the *content* of the autobiographical thoughts themselves, but rather the social *context* surrounding those thoughts. If we see that agreement and/or similarity words play a key role in the

conversation texts (but not the introspection texts), it would imply that social interaction itself underlies the observed pathway connecting the shared identity and social validation to sense of self.

Note that these two possible outcomes of the text analysis suggest subtle differences in *how* autobiographical conversations affect sense of self via shared identity and social validation, but neither linguistic finding would negate *that* there is a social process pathway linking conversation to a stronger sense of self. It is also important to note that the two explanations for the social process pathway proposed above are not mutually exclusive. We could potentially see evidence for both mechanisms in the same text analysis if the conversation condition both contained more social/positive words *and* words of agreement/similarity. Lastly, although we did not have any specific predictions about the process underlying the strengthening of self via introspection, the exploratory nature of the text analysis could help identify linguistic indicators unique to the introspection context that could allow us to speculate about such a process.

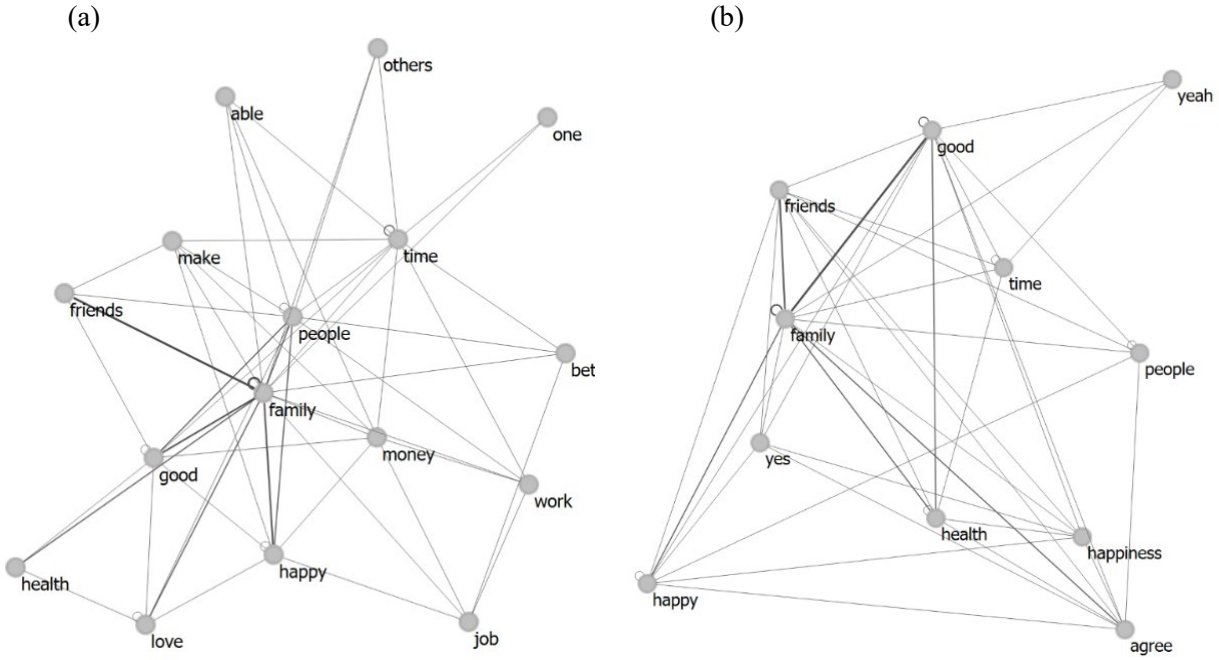
Text corpus. The corpus comprised a total of 327 documents: 203 individual-level introspections and 124 dyadic-level conversations. All conversation documents in which both participants addressed the prompt and engaged in dialogue were included in the text corpus, regardless of the completeness of the rest of their data (accounting for the discrepancy between the number of conversations in the text corpus and the number of participants in the conversation condition for the primary quantitative analysis). Note that the conversation documents contained the text written by two participants, so there are fewer conversation documents compared to introspection documents. To analyze the texts, we used methods that went beyond just frequency counts, although word clouds and tables showing the raw frequencies of the top words in each condition are presented for reference in Appendix B. The following analyses emphasize the relations among words using word co-occurrence networks and among themes using concept maps.

Word co-occurrence networks. We first analyzed the documents at the word-level by creating word co-occurrence networks for each condition. This analysis was run in Orange version 3.36.1, which is an open-source toolbox in Python (Demsar et al., 2013). This toolbox allows researchers to design data analysis pipelines incorporating machine learning, text processing, network analysis, and other data mining algorithms in a visual programming environment. The Orange file used for this analysis is available on the Open Science Framework: https://osf.io/mg2yp/. First, we pre-processed the text by removing punctuation, capitalization, and common English stop words. During pre-processing, we also removed words from a custom list that included prompt-related words (e.g., important, satisfied, wish) and conversation words (e.g., hi, hey, bye) (see Appendix B). We then used the corpus-to-network and network explorer features in Orange to analyze and visualize the most frequently co-occurring words in each of the two conditions.

At the corpus-to-network stage: (1) the *frequency threshold* for a word to appear in the co-occurrence network was set to a number corresponding to 25% of the documents in that condition (51 for the introspection condition, 31 for the conversation condition), (2) two words were considered to co-occur if they appeared within a *window size* of 20 words of one another in the same document, and (3) a pair of words was connected in the network if their number of co-occurrences exceeded a *threshold* corresponding to 10% of the documents in a given condition (20 for introspection, 12 for conversation). The more co-occurrences between a pair of words (beyond the threshold), the thicker the connection between them in the co-occurrence network (Figure 12). The more *central* the word, the more other words it is connected to in the network (similar to the concept of centrality in the AM-I networks presented in the previous chapter). Again, we were interested in social content words (e.g., people, family), valence words (e.g., good, bad), and agreement/similarity words (e.g., agree, same).

Figure 12.

Word co-occurrence networks for introspection and conversation text in Study 3



Note. Panel a shows the word co-occurrence network for the introspection condition and panel b shows the word co-occurrence network for the conversation condition. Circles (nodes) indicate the most frequent words in each condition, with lines (edges) indicating the frequency of co-occurrence between two words. Small loops next to a node indicate that the word co-occurred with itself. Thicker lines indicate more frequent co-occurrences.

As shown in Figure 12, for both conditions, the most frequent and central word in the co-occurrence network was "family," indicating that participants focused on social content in both conditions, not just in the social interaction condition. Visually, we see that "family" occupies a central position in the diagram, has connections to 9 out of the 10 other words in the conversation network (panel b) and 12 of the 15 other words in the introspection network (panel a). "Family" also has the thickest ties and people seem to continue to reflect on family given its strong tie to itself. Other social words (e.g., "friends" and "people"), positively valenced words (e.g., "good" and "happy"), and intangible resources (e.g., "time" and "health") were also common to both conditions' co-occurrence networks.

There were also some notable differences in the content of the word co-occurrence networks. The introspection condition contained words of agency (e.g., "make" and "able") and financial words (e.g., "money" and "job") that were not as frequent in the conversations (Figure 12a). In the social interaction condition, words of assent – "agree", "yeah", and "yes" – featured in the network of most frequent and most connected words (Figure 12b). We can see that the word "agree" has ties to 8 out of the 10 other words in the conversation network, indicating that it frequently appeared in close proximity to multiple types of autobiographical thought content. These words of assent could be a linguistic indicator of the social process pathway that validates people's self-views.

Concept maps. To examine the text data beyond just the word-level, we also created concept maps to visualize the relations among the higher-level themes that emerged when people reflected on themselves alone or with another person. This analysis was run in Leximancer version 5.0, a patented software that identifies and visualizes themes in text data (Smith & Humphreys, 2006). Unless otherwise noted, all settings used were the Leximancer defaults.

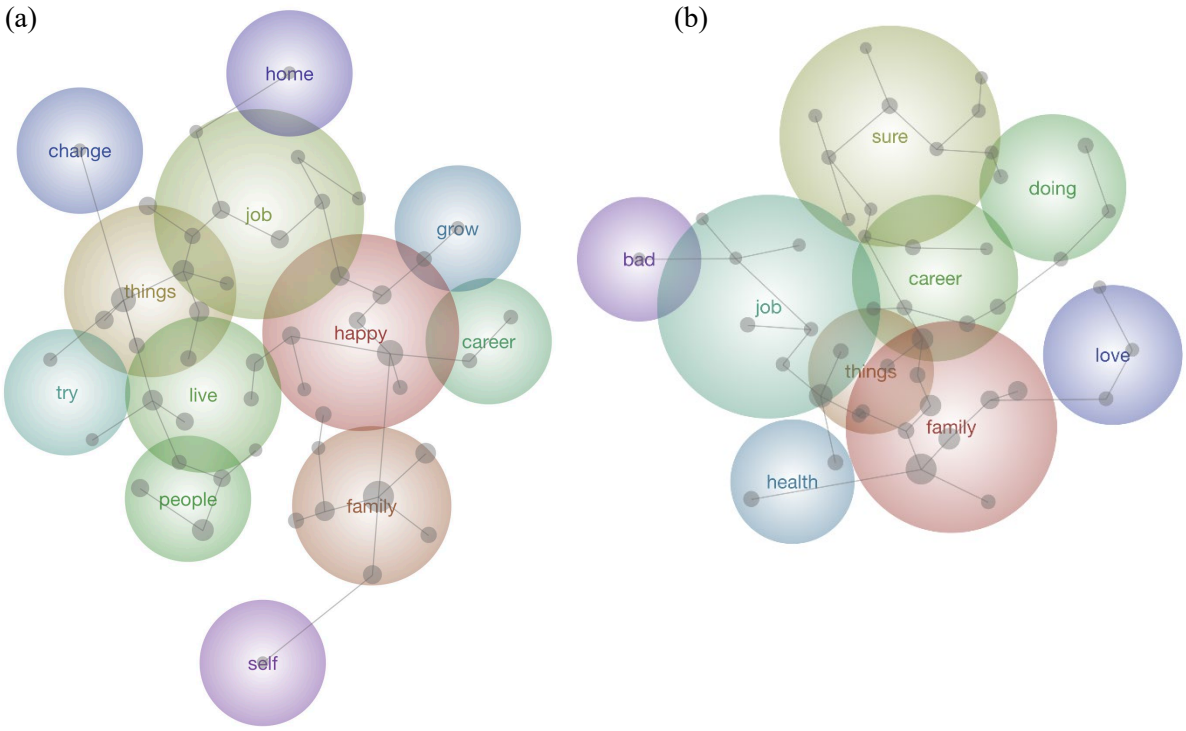
Leximancer first generated a set of concept seeds from the frequent words across the documents in each condition, then defined concepts by creating a thesaurus of words semantically related to each seed. We removed all concept seeds related to the prompt questions (e.g., "life", "satisfied", "future") before generating the thesaurus. These condition-specific thesauruses were then used to code the documents at the level of two-sentence blocks for the presence of multiple concepts (note that using the thesaurus method, a block could be coded with a concept even if it did not contain the seed word for that concept). Leximancer then used the concept codes to construct a matrix of how all concepts co-occurred with one another across the documents in each condition[6]. The high-dimensional co-occurrence matrices were then used to identify themes of

[6] Note that these concept co-occurrences provide more nuanced information than the word co-occurrence data used in the previous analysis. Although both analyses essentially rely on co-occurrence information, the first word co-

interconnected concepts, which were visualized in two-dimensional space using concept maps. The level of granularity for these themes is user-defined in Leximancer as the *theme size*, here set to 40% for both conditions[7].

Figure 13.

Concept maps for introspection and conversation text in Study 3



Note. Panel a shows the concept map for the introspection condition and panel b shows the concept map for the conversation condition. Bubbles indicate topics with their corresponding labels, as generated by Leximancer. Color is not informative and is only used to distinguish visually among the topics.

Similar to the word co-occurrence networks, the concept maps contained the theme of "family" in both the introspection and social interaction conditions (Figure 13). The themes of

occurrence network analysis parsed text based on an arbitrary number of words rather than semantically informative units like the two-sentence blocks used in the concept map analysis. Likewise, the word co-occurrence network analysis counted only exact word matches rather than considering semantically similar words as the same concept. If participants were using different words to refer to the same concept, the word co-occurrence network analysis would not have been sensitive to these differences.

[7] The two other user-defined parameters – *concepts* and *rotation* – were both set to 0%. This means that the names of the seed words for the underlying concepts were not displayed on the map, and we kept the map in its original orientation.

"job" and "career" appeared in both conditions as well, whereas they only appeared in the introspection condition for the word-level analysis. This could indicate that people were using a variety of words in the conversation condition to discuss the topic of jobs and career, hence why they appeared in the topic-level analysis but not the word-level one. This observation supports our overall conclusion that the content of the autobiographical thoughts themselves were similar across the two conditions.

Notable differences between the two concept maps include the themes of "growth," "change," and "self" in the introspection condition (Figure 13a), which were not apparent in the word-level introspection analysis or in the concept map for the social interaction condition. These personal growth themes could suggest a different process by which introspection strengthens sense of self that was not measured in the current study. In the concept map for the social interaction condition, the theme "sure" emerged (Figure 13b), again suggesting that agreement might be a potential linguistic marker of the social process pathway observed in the quantitative analyses.

Discussion

In this study, we found that one's sense of self can be strengthened via conversations that foster a sense of shared identity and social validation. This social process pathway is a direct link between the social and self functions of autobiographical thought, as it is through the process of connecting to others (the social function) that people can clarify their personal sense of self (the self function). When conversing with one another about their autobiographical thoughts, people did not just share the content of their memories or views of themselves. They also used words of affirmation and agreement that likely helped validate each other's self-views.

The core content of people's autobiographical thoughts was remarkably social during both introspection and conversation, focusing on topics like family, friends, and people in

general. Previous research has found that people's spontaneous thoughts often turn to others (Mar, Mason, & Litvack, 2012; Mildner & Tamir, 2021; Song & Wang, 2012). The fact that we think about others when trying to "find ourselves" further suggests a reciprocity between the self and the social in autobiographical thought. Although we did not test the reverse direction in the current study, introspecting about social relationships and tying them to our sense of personal identity (the self function) when not directly interacting with others could theoretically help to solidify social bonds with specific people we have interacted with before (the social function).

Study 4. Group identity formation in conversational networks

In the previous study, we showed how conversation affords an opportunity to connect with another person and strengthen our own sense of self. Further, via conversation with just one person, we can come to feel a sense of shared identity with others more broadly. Between these two levels of social connection lies another layer: connection to specific groups of people. In this study, we track the formation of group identity in newly formed groups using the minimal groups paradigm, that is, defining groups of otherwise unrelated individuals by arbitrarily distinguishing them from other groups (Tajfel, Billig, Bundy, & Flament, 1971; Turner, Brown, & Tajfel, 1979). How do the interactions among these group members relate to their ultimate identification as a group?

Sociologist Charles Tilly (2005) wrote that "interpersonal transactions compound into identities, create and transform social boundaries, and accumulate into durable social ties". The formation of groups involves multiple interpersonal transactions with our group members. It also involves generalizing from these specific social interactions to form an identity with the group as a whole. What effect do repeated social transactions have on group identification? And does it matter what people talk about in those transactions?

Conversational memory-sharing

One form of social transaction people regularly engage in is the exchange of autobiographical memories via conversation. Conversational memory-sharing is an under-explored way that people might naturalistically form social bonds and identities. In natural conversation, people often discuss themselves including their personal and shared experiences (Demiray, Mehl, & Martin, 2018; Demiray, Mischler, & Martin, 2019; Wank et al., 2020). At the dyadic level, discussing autobiographical topics leads to more closeness than discussing non-self-related topics (Beike, Brandon, & Cole, 2016). Does sharing autobiographical memories across multiple dyadic interactions with new group members help people feel more connected to the group as a whole?

Different types of autobiographical memories are likely associated with different levels of a person's identity. Self-defining memories might be more likely to be associated with personal identities or at least tied to more central self-identities, whereas memories cued by a specific aspect of group membership (e.g., Princeton for a Princeton student) might be more likely to activate collective/social identities. Does it matter whether people discuss more personal or social-identity salient memories in their conversations? In this study, we manipulated the type of memories people exchanged with one another — either self-defining or Princeton-related – thinking that both forms of memory-sharing could lead to group identification, but via different routes.

Routes to group identity formation

Group identity can form inductively via the bottom-up contributions of individual group members, as well as deductively from awareness of existing top-down social categories (Jans et al., 2011, 2012). In their studies, Jans and colleagues (2011, 2012) found that groups who created a group t-shirt design from a combination of their own unique contributions identified with one

another just as strongly as those who made t-shirts based on a top-down logo design that was common to all group members. Prentice and colleagues (1994) similarly found that some groups form in a bottom-up way via common bonds to other group members, whereas other groups form via a common identity as members of the same social groups. How might talking about autobiographical memories lead to the formation of group identity via these two routes?

Bottom-up. Bottom-up identity formation via conversational memory-sharing is likely based on the process of reciprocal self-disclosure. Research has shown that self-disclosure is inherently rewarding (Tamir & Mitchell, 2012). Just sharing about oneself with others feels good, and if we feel good in an interaction with someone, we feel more connected to that person. Self-disclosure also tends to elicit reciprocity, that is self-disclosure from the other person in the conversation (Miller & Kenny, 1986). Reciprocity is also rewarding and can lead to the development of trust (Phan, Sripada, Angstadt, & McCabe, 2010). Reciprocal self-disclosure is especially important for how much people like one another in initial interactions where they are just getting acquainted (Sprecher, Treger, Wondra, Hilaire, & Wallpe, 2013). Early research on reciprocal self-disclosure found that people reciprocate one others' levels of intimacy in self-disclosure but not the content of what they disclose (Ehrlich & Graeven, 1971). For inductive identity formation at least, it should matter more how personal the memories are as opposed to how similar they are. We thought that self-defining memories would meet these criteria – important for personal identity but not necessarily similar across participants –and lead to group identity formation via the bottom-up route.

Top-down. On the other hand, groups can also form an identity through pre-existing social identities they have in common. For the top-down route to identity formation, having similar experiences and shared background knowledge could be especially important. Shared knowledge forms a baseline level of common ground on which people can start their conversation, knowing that they will be able to understand one another (Stalnaker, 2002).

Common ground and understanding lead people to like and affiliate with one another (Enfield, 2008).

One of the challenges in new relationships is establishing common ground. At this stage, people often resort to using their own self-knowledge as a heuristic to try to understand others (Zhao, Sened, & Tamir, 2023; Zhao, Thornton, & Tamir, 2022). At least among college students, this strategy can lead to the accurate prediction of others' mental states. In cases where people know they share a social identity and are discussing experiences related to that identity, this strategy might be especially effective in helping people mentalize their partners' prior knowledge in order to tailor conversation appropriately (Todd & Tamir, 2024). In the current study, we expected that participants who discussed Princeton-related memories would have more common ground and more similar memories to talk about, leading to group identity formation via the top-down route.

Social network structure

Naturally occurring groups have a social structure, or pattern of connections among their group members, such that some individuals are more central to the group structure, whereas others are more peripheral. Central individuals have more social ties to others in the group, whether because they are friends with more of their group members, they communicate with more of their group members, or other members of their group look to them for influence. Do these central individuals identify more strongly with their group given their prominent position in the group's social structure?

Research on teams has looked into how the centrality of individuals to the team's social network relates to their identification with their teams. Members of a sports team who have more friendships and outside socialization with their teammates identify more strongly with the team as a whole (Graupensperger, Panza, & Evans, 2020). This is also the case for networks of

communication within a team during actual sports matches. Team members who communicate more with the other players during the games identify more strongly with the team (Shah, Fransen, Slater, & Barker, 2023). There are limitations to utilizing existing social networks like sports teams for this type of research, however. Perhaps the most central individuals in natural groups are most chatty, most invested in the group, most likeable, most similar to other group members etc. Here we experimentally manipulated participants' network position in their group to test whether there is a causal effect of the conversational centrality of an individual within their group on their identification with the group.

Differences in social position may be especially important in smaller groups like teams or friend groups where it is theoretically possible to know or connect with every single group member. On the other hand, in "groups" that represent larger social categories or social media networks like Instagram, it is practically impossible to directly connect with all group members. In these larger, amorphous groups, small differences in the number of direct interactions people have might be less influential, especially where the most central individuals have "connections" on the order of millions. In these cases, it is not possible for those central individuals to have actual meaningful direct conversational connections with all their followers. Being connected to 5 groups members versus 1 group member in a group of 10 (as is the case in our study), on the other hand, will likely have an impact on group identification because those really do represent meaningful differences in the structural centrality of someone to the group.

The current study

In this study, we manipulated the type of memories people talked about with others within a minimal group paradigm to test whether activating different levels of identity via the types of memories people talk about would lead to different levels of identification with their newly formed groups. In our two memory sharing conditions, we asked people to discuss either self-defining memories or group-relevant autobiographical memories (there was also a control

condition where people shared information rather than memories). In each conversation that took place in the conversational network, participants were directed to share one memory each, experimentally creating the scenario of reciprocal self-disclosure. After each conversation we measured the degree to which the partners identified with one another and how similar they thought the content was that they shared in their conversation. This design allowed us to test whether activating personal or social levels of identity via autobiographical memory led to group identity formation via the inductive or deductive route.

We also manipulated people's social network position in the group's conversational network by varying the number of conversations – and thus the number of personal ties to their fellow group members – each participant had. Across five conversational rounds, participants had either one, two, three, four, or five conversations, allowing us to test the effect of the cumulative social transactions (to use Tilly's words; Tilly, 2005) that participants had. If people "are" the accumulation of these transactions, we hypothesized that people who were more central to the group's conversational network would come to identify more strongly with the group as a whole.

Method

Participants

Members of the Princeton University community (N = 200; 73 male, 126 female, 1 self-reported "jedi"; age 18-54, *M* = 20.43; 43% White, 29% Asian, 10.5% Latinx, 10% Black, 7.5% Other) were recruited via SONA, an online recruitment platform, to participate in a study on group communication. The majority of participants were undergraduates (N = 184). A small number of graduate students/post-docs (N = 11) and staff (N = 3) working at the University also participated. Two participants recruited via the paid University subject pool reported being unaffiliated with Princeton University. Both of these participants were in the self-identity salient condition and were kept in the sample.

Participants were recruited in groups of 10, yielding a total of 20 groups (7 self-identity, 7 Princeton-identity, and 6 informational control groups). Initially, we planned to collect 8 groups per condition (or N = 240 participants across 24 groups). Instead, data collection ran from March 2018 until March 2020, when it was stopped early due to COVID-19 restrictions on in-person data collection.[8] Participants were compensated with either course credit or cash according to the standards of the Department of Psychology (1 credit or $12 per hour). They were also invited to participate in one-week and one-month follow-up surveys and were compensated with a $5 Amazon gift card for completion of each follow-up. The study protocol was approved by the Institutional Review Board at Princeton University.

Materials

Group logos. Each group was assigned one of eight animal logos (Kartashev, accessed 2017). Logos were randomly assigned within condition (without replacement), such that each logo would appear once and only once per condition. Logos were printed on a sheet of paper placed at each participant's computer station during the in-person study session as a way to emphasize that, although they were completing the task on separate computers, all members present in the room with the same logo were part of the same group. The logos were also used by the researchers to identify participants as members of their group during the follow-up surveys.

Informational passages. Thirty informational passages were selected from an online repository of English reading comprehension worksheets (EnglishForEveryone, accessed 2018) to serve as the conversational content for the control condition. Each passage was about a different

[8] Prior to implementing the informational control condition, we also collected data from 3 control groups who discussed food-related memories (N = 30). We presumed food memories would not be identity salient (e.g., "what I had for breakfast this morning"), but many of the memories participants provided were identity salient (e.g. "cooking at Princeton"). Because the goal of the control condition was to have participants discuss non-identity-salient experiences, we replaced this condition with the informational control condition. The informational control condition also served as more of a true control condition in that it did not involve autobiographical thought.

topic ranging from history to science. To mimic the idiosyncratic nature of memories in the identity-salient conditions, the 10 members of the informational control groups were each assigned to read three informational passages, then recall and discuss their three unique passages throughout the study.

Procedure

The study consisted of three separate sessions: a mandatory initial *in-lab session* and two optional online *follow-up surveys*. During the initial session, participants rated their group identification before and after discussing their autobiographical memories with one another as part of a larger conversational network structure. They also "contributed" to their group's predictions about future events, which was our cover story for the purpose of the study. One-week and one-month later, they were invited to further contribute to these group predictions, at which time we again measured how strongly they identified with their group.

In-lab session. For the first session (Time 1), participants met in a computer lab space in groups of 10. They were seated at individual computer stations with their group logo at each station to remind them that they were part of the same group. Before beginning the survey, they were asked to create a unique code which would be used to link their survey responses, conversations, and follow-up survey responses.

Cover story. As a cover story, participants were told we were interested in studying the wisdom-of-the-crowd. We informed them that research shows groups of individuals make more accurate predictions than individuals on their own, and they would be using a chat software to converse with their fellow group members in order to form a better sense of their group before making predictions about upcoming events. We told them we would follow up with them and their fellow group members to make more predictions and that the group with the most accurate

predictions would be awarded an unspecified prize. They were told there would be 8 groups involved in the study, corresponding to the 8 group logos.

Group logo verification. Before the pre-conversational ratings but after reading the cover story, participants verified their group logo by choosing the one that matched the one on their sheet from a list of all 8 logos. This was done to affirm their group identity, emphasize the presence of other groups, and link surveys across group members.

Pre-conversation group ratings. Participants then provided baseline measures for our primary and secondary outcome variables. First, they rated their group's ability to make more accurate predictions than other groups and than themselves as individuals, on two separate rating scales ranging from 1 ("Strongly Disagree") to 7 ("Strongly agree"). These ratings mainly served to strengthen the cover story and to mask our interest in group identification as the primary outcome variable, but they were also examined as secondary exploratory outcomes. Then, participants rated their agreement with the statements "I identify with my group" and "I am similar to my group members" on the same seven-point scale from "Strongly disagree" to "Strongly agree". These group identification and group similarity ratings were the primary dependent variables in the study.

Memory generation. To generate content for their conversations, participants recalled and described three events from their past (in the self-identity and group-identity conditions) or read and recalled three informational passages (in the no-identity control condition).

Group-identity salient memory condition. In the group-identity condition, participants first thought of three events from their past that captured a Princeton-related experience. The term "event" was explicitly defined for participants as "something that occurred at a single place and time, with a clear beginning and end." They provided a brief title for each event that would be used to prompt them about that event later in the study.

Self-identity salient memory condition. In the self-identity condition, participants first thought of three events from their past that captured who they are as a person. The term "event" was explicitly defined for participants as "something that occurred at a single place and time, with a clear beginning and end." They provided a brief title for each event that would be used to prompt them about that event later in the study.

No-identity salient informational control condition. In the informational control condition, participants first read three short informational passages about different topics. They were informed that they would be conversing about these passages later in the study and that they were the only participant who was reading those particular passages. After reading the passages, on a separate page, participants provided their own brief title for each passage (similar to the memory conditions).

Memory recall and ratings. In all conditions, participants were then prompted with their three self-generated titles one at a time. For each title, they first described their memory of the corresponding event/passage in a few sentences. Participants then rated how emotionally positive and negative the event/passage was (on two separate scales ranging from 1 "Not at all positive/negative" to 5 "Extremely positive/negative"). They also rated how personally central the event was using three items adapted from the Centrality of Event scale (CES; Berntsen & Rubin, 2006), by rating their agreement with each statement on a scale ranging from 1 ("Totally disagree") to 7 ("Totally agree"). For the two memory conditions, the CES statements were: "I feel this event has become a central part of my life story."; "This event has colored the way I think and feel about other experiences."; and "I often think about the effects this event will have on my future." For the informational control condition, the CES items were rephrased to: "The passage is personally relevant to my life."; "The passage is related to other information I know."; and "The information in the passage could be useful for the future." After completing their description and ratings for one title, they were then presented with the next title.

Group logo verification. After memory generation/recall and before entering the conversations, participants were shown the group logo that had selected during the first group logo verification and indicated whether that logo matched the one they were assigned on the sheet at their computer station. If not, they were asked to select the logo that corresponded to the one they were assigned. This step served to minimize errors when matching participants' surveys and to re-emphasize their group identity before entering the conversations.

Conversational phase. Participants were then directed to a separate browser window where the conversations took place using the Software Platform for Human Interaction Experiments (SoPHIE; Hendriks, 2012). In SoPHIE, each participant first selected an anonymous nickname from a list of 10 unique options. These nicknames were used to maintain participant anonymity during the conversations and to control for possible effects of individual names across groups as the same set of nicknames were used for all groups. To emphasize their group identity, the nicknames for each group were paired with the group's logo as an avatar. Nicknames and group logos were displayed during all conversations.

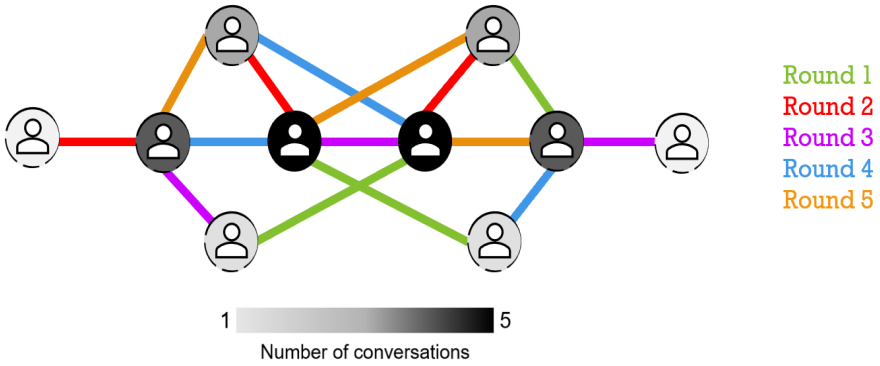
In total, there were five two-minute rounds during the conversational phase. For each round, a given participant was either assigned to a chat-box with another group member (conversation task) or to a text box alone (individual recall task). Participants were not told how many conversations they would have, but they were told it was possible they would not be matched with a conversational partner for all of the rounds.

Within groups, we manipulated the number of conversations each participant had, ranging from one conversation to five conversations, using the network structure shown in Figure 14. In this network structure, participants who had conversations during all five rounds are the most central, and those who had just one conversation are the most peripheral. We were interested in whether more central individuals would identify more strongly with their group after

the conversational phase compared to the more peripheral individuals. The conversational network structure was the same for all groups.

Figure 14.

Conversational network structure for Study 4



Note. The network structure shown was used for all groups in the study to vary social network position within-participants. Circles represent participants (shaded by the number of conversations they have, 1-5) and lines represents conversations (colored by the temporal order of conversational rounds, 1-5).

Conversation task. For rounds when the participant was assigned to the conversation task, they were entered into a chat box with one other group member. They were each instructed to discuss one of their memories or information passages from the first part of the study with their conversation partner. They were free to choose whichever memory/passage they wanted to discuss as long as both partners shared.

After each conversation, participants rated how much they identified with the group member they just conversed with (on a scale ranging from 1 “Did not identify with them at all” to 7 “Strongly identified with them”) as well as how similar the memories/passages that they discussed with their conversational partner were (on a scale from 1 “Not at all similar” to 7 “Extremely similar”).

Individual recall task. For rounds when they were not matched with a conversational partner, participants were instructed to recall one of their three memories/passages on their own in a blank text box. They had two minutes to do so. There were no rating scale items after individual recall rounds.

Prediction task. Participants were then directed back to the Qualtrics survey where they made three predictions on their own: (1) the temperature in Princeton on a specified date (3 weeks in the future) given the previous day's temperature, (2) the price of a major company's stock on a specified date (~10 days in the future) given the previous day's closing price, and (3) the amount a movie would gross at the box office its opening weekend (the next weekend) given a fact about the film. The specific content for each prediction item was updated prior to each study session, but the general domain and format of the predictions was the same for all groups.

Participants were told that their individual predictions would be combined with their group members' predictions to assess the overall group's accuracy after the events had occurred. This task served as a common task/goal for the groups and as a cover story to mask the true research question.

Post-conversation group ratings. After submitting their individual predictions, participants rated their agreement or disagreement with the same four items from the pre-conversation baseline measures: whether their group could make more accurate predictions than other groups, whether their group could make more accurate predictions than they could as an individual, whether they identify with their group, and whether they are similar to their group (all on a scale from 1 "Strongly disagree" to 7 "Strongly agree").

Memory recall. Finally, participants were asked to describe their own and their group members' memories/passages in as much detail as they could in two separate open-ended text

boxes (one for themselves and one for their group members). They were told the purpose of this task was to assess the degree to which their group shared knowledge with one another.

Demographics. At the end of the survey, participants provided information about their age, gender, ethnicity, native language, and affiliation with Princeton University. They were also directed to a separate page where they could enter their email address if they wanted to be contacted about the follow-up surveys.

Follow-up surveys. One week (Time 2) and one month (Time 3) after the initial lab session, participants were invited by email to participate in optional follow-up surveys to complete more predictions to contribute to their group's prediction accuracy. At the beginning of each survey, they were asked to provide the unique code they created during the initial lab session (Time 1) so we could match their responses.

Group logo verification. First, participants verified the group logo they were assigned during the first session by choosing their logo from a list of all 8 logo images. After selecting their group logo, participants were asked how sure they were that their selection was the logo they had been assigned (on a 5-point scale from 1 "Not at all sure" to 5 "Totally sure").

Group identification ratings. Next, participants rated the same outcome items that were rated pre- and post-conversation during the initial lab session: belief in group accuracy (relative to other groups and relative to the self), identification with their group, and similarity to their group members.

Memory recall. Prior to the prediction task, participants were asked to describe their own and their group members' memories/passages from the initial study session (in two separate text boxes). They were told the purpose of this task was to remind them of their group's shared knowledge before they made their predictions.

Prediction task. Lastly, participants provided their own individual predictions about the outcomes of three future events: the temperature in Princeton in 3 weeks, the price of a given stock in approximately 10 days, and the opening weekend gross for a moving coming out the next weekend. The format of these predictions was the same as during the initial study session, just with novel dates and details.

Demographics. At the end of each follow-up, participants again reported their demographic information (age, gender, ethnicity, native language, and affiliation with Princeton University) and were directed to a separate page to enter their email address for delivery of their gift card compensation for completing the follow-up survey.

Results

Identity-salience manipulation check

To check whether the identity salience manipulation produced the intended effect, we tested whether the memories recalled by the participants in the Self and Princeton conditions were rated as more central on the Centrality of Events scale than the information passages in the information condition. A one-way ANOVA testing the effect of condition on mean CES scores revealed significant differences between groups, $F(2, 197) = 35.81$, $p < .001$. Post-hoc pairwise comparisons revealed significant differences between all three conditions, such that Self memories ($M = 5.11$, $SD = 1.11$) were more central than the Princeton memories ($M = 3.59$, $SD = 1.26$), $t(118.74) = 4.39$, $p < .001$. Self memories were also rated as more central than the informational passages ($M = 4.41$, $SD = 0.71$), $t(118.74) = 4.39$, $p < .001$. As intended, self-defining memories were the most identity-salient. Unexpectedly, Princeton memories were rated lower on the CES scale than the informational passages, $t(118.74) = -4.64$, $p < .001$, but this could be due to the rephrasing of the CES items in the information condition.

We intended for the Princeton memories to contain more similar content across the participants than the self-defining memories, and for the informational passages to be varied in their content as well. To test this part of the manipulation, we computed each participant's mean response to the item assessing how similar the events/passages they discussed were for all their conversational partners. We did this to get a single content similarity score for each participant that we could compare across conditions using a one-way ANOVA, which revealed a significant difference among conditions, $F(2, 197) = 7.08$, p = .001. Post-hoc pairwise comparisons revealed that both memory conditions ($M_{self} = 2.51$, $SD_{self} = 1.33$; $M_{pton} = 2.76$, $SD_{pton} = 1.32$) contained more similar content than the information condition ($M_{info} = 1.94$, $SD_{info} = 1.12$), $t(127.96) = 2.67$, $p = .009$ (Self vs. Info) and $t(127.99) = 3.86$, $p < .001$ (Princeton vs. Info). The memory conditions, however, did not significantly differ from one another in their mean similarity, $t(137.98) = -1.12$, $p = .26$. Contrary to our intention, Princeton memories were not more similar than self-defining memories. Also note that the mean conversation content similarity ratings are all well below the midpoint (4 on the 7-point scale from "Not at all" to "Extremely"), indicating that the content was not very similar in either memory condition.

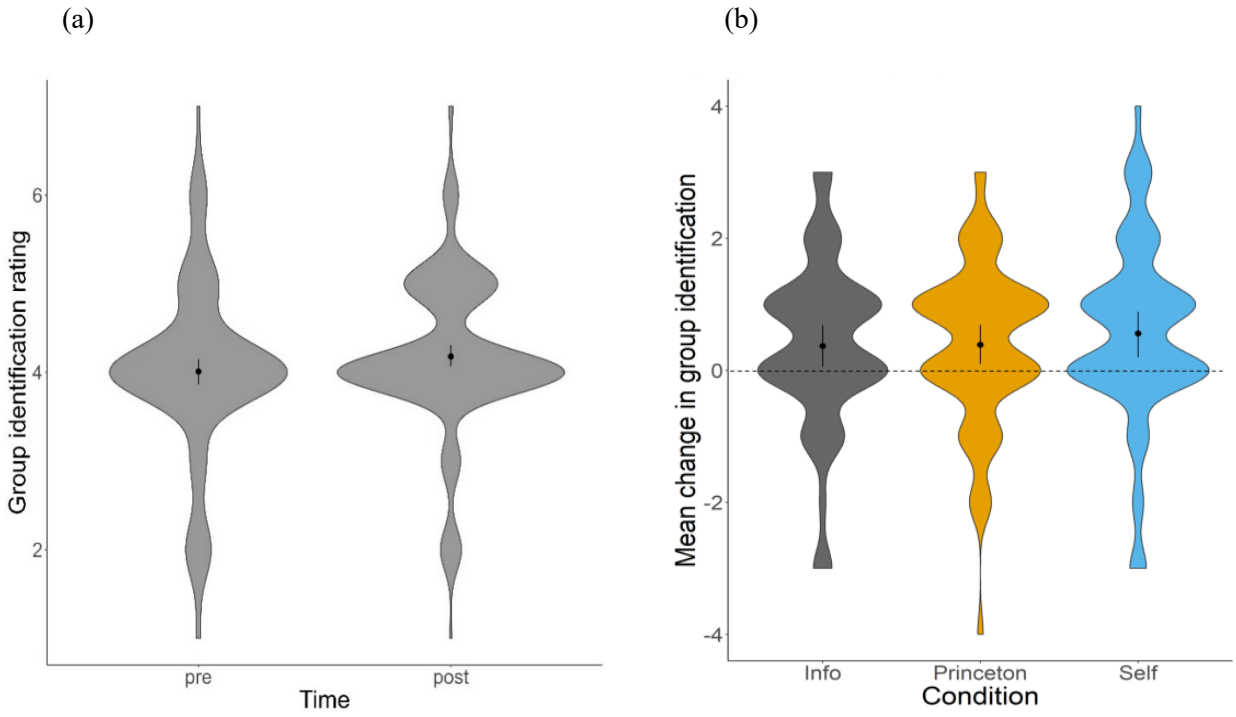
Primary analysis

Our primary hypothesis was that group identification would increase from pre- to post-conversation, and this effect would depend on the identity salience of the conversations and/or a person's position in the conversational network. To test the multiple parts of this hypothesis using one omnibus analysis, we ran a three-way mixed-model ANOVA predicting group identification from time (pre- or post-conversation), condition (self-identity salient, Princeton-identity salient, or informational control), and conversational network position (number of conversations ranging from 1 to 5) plus their two- and three-way interactions. To account for the repeated measure of

group identification over time, we included an error term for participant[9]. Statistics for the three-way mixed ANOVA are presented in Supplementary Table B3.

Figure 15.

Mean change in group identification ratings from pre- to post-conversation in Study 4



Note. Panel a shows overall mean group identification ratings pre- and post-conversation during the lab session. Panel b shows the mean change in group identification from pre- to post-conversation across the three conversational conditions: self-identity salient memory condition (Self), group-identity salient memory condition (Princeton), and no-identity salient control condition (Info). Points represent means and error bars represent 95% confidence intervals. Panel b also includes a dotted line at zero as a reference.

Conversations increase group identification regardless of identity salience. First, we examined whether having conversations led to stronger group identification overall. In the mixed ANOVA, there was a significant main effect of time indicating that on average group

[9] Given the nested structure of the data, we initially ran a mixed model including a random effect of network with participants nested in networks. The estimated effect of network was 0, so we dropped it from the model and report just the mixed model with the random intercept for participant. Given that we randomly assigned participants to networks, it makes sense and is reassuring that there were no meaningful network-level differences.

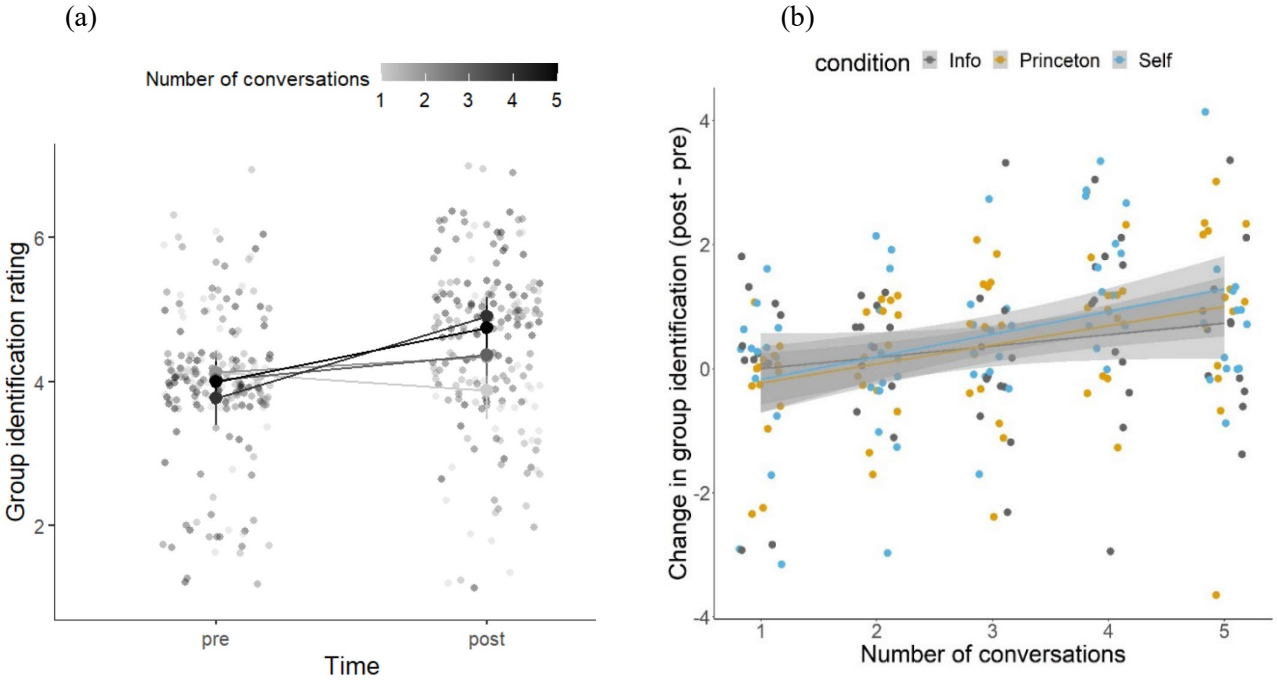
identification changed from pre- to post-conversation, $F(1, 387) = 16.95$, $p < .001$. To assess the direction and magnitude of this change, we followed up with a paired *t*-test comparing pre- and post-conversation group identification ratings. As shown in Figure 15 (panel a), people identified more strongly with their group after conversations than they did before, $t(199) = 4.78$, $p < .001$, Cohen's $d = 0.34[0.20, 0.48]$. Overall, the conversational phase increased participants' group identification scores by about half a point on the 7-point rating scale, constituting a small, but significant, effect.

To test whether the identity salience of the conversation topic contributed to how strongly participants came to identify with their group, we next looked at the interaction between time and condition in the mixed ANOVA analysis. As shown in Figure 15 (panel b), there were no differences in the increase in group identification among the informational control ($M = 0.37$, $SD = 1.30$), Princeton-identity salient ($M = 0.39$, $SD = 1.23$), and self-identity salient ($M = 0.56$, $SD = 1.38$) conditions, $F(2, 387) = 0.33$, $p = .72$. That is, participants who discussed informational passages identified just as strongly with their group after the conversations as those who discussed self-defining or group-relevant autobiographical memories.

Structurally central individuals form the strongest group identification. Further, we examined whether participants who were more central to the conversational network structure identified more strongly with their groups after the conversations than those who were structurally peripheral (see structure shown in Figure 14). To test this relationship in the mixed ANOVA, we looked at the interaction between time and the number of conversations the participant had in the network. The degree to which participants came to identify with their groups from pre- to post-conversation significantly depended on their position in the conversational network, $F(1, 387) = 14.72$, $p < .001$.

Figure 16.

Relationship between conversational network position and group identification in Study 4



Note. Panel a shows the mean group identification rating pre- and post-conversation for participants in each conversational network position (ranging from 1 to 5 conversations, gradient from light gray to black). The large points represent means and error bars represent 95% confidence intervals. Panel b shows the correlation between change in group identification score (from pre- to post-conversation) and number of conversations (conversational network position) for each of the three conditions. Confidence bands represent 95% confidence intervals.

We followed up on this finding using a Pearson product-moment correlation test predicting participants' change in group identification rating from pre- to post-conversation from the number of conversations they had during the conversational phase. As shown in Figure 16, the more conversations a participant had with other group members, *i.e.,* the more central the participant was to the network structure, the more their group identification rating increased post-conversation, $r = .32[.19, .44]$, $t(198) = 4.68$, $p < .001$. Overall, this constitutes a medium-sized effect, and it did not vary by condition, as evidenced by the non-significant three-way interaction in the mixed ANOVA, $F(2, 387) = 0.48$, $p = .62$, depicted in Figure 16, panel b.

There was also a significant main effect of network position, indicating that participants who had more conversations rated their group identification higher in general, $F(1, 387) = 5.18$, $p = .02$. Given the interaction effect described above, we expected that the overall main effect was likely driven by the central individuals' higher group identification ratings post-conversation, rather than any unintended differences in the baseline group identification ratings prior to conversation. To check that this was indeed the case, we conducted another follow-up Pearson's product-moment correlation test predicting participants' pre-conversational group identification rating from the number of conversations they were randomly assigned to have later in the study. Reassuringly, there was no significant relationship between participants' conversational network position and their initial group identification rating at baseline, $r = -.08$, $t(198) = -1.19$, $p = .24$.

The time by network position interaction also qualifies our interpretation of the main effect of time. Did all participants identify with the group after conversation or just the central ones? To explore this question, we conducted paired *t*-tests comparing pre- and post-conversational group identification ratings for participants in each of the five network positions, corresponding to the number of conversations they had (see Supplementary Table B4, Appendix B). Post-conversational group identification ratings were only significantly higher than pre-conversational ratings for participants who occupied the more central positions of the network (see Figure 14).

Secondary analyses

Given the finding that more conversations led to stronger group identification, we were interested in whether aspects of a participant's conversations, such as identification with their specific conversation partners or the similarity of conversation content, predicted the degree to which they came to identify with the group as whole. Although mean partner identification and content similarity ratings were directly correlated with one another, $r = 0.25[0.12, 0.38]$, $t(198) = 3.64$, $p < .001$, this was only a small-to-medium sized relationship so the two could potentially

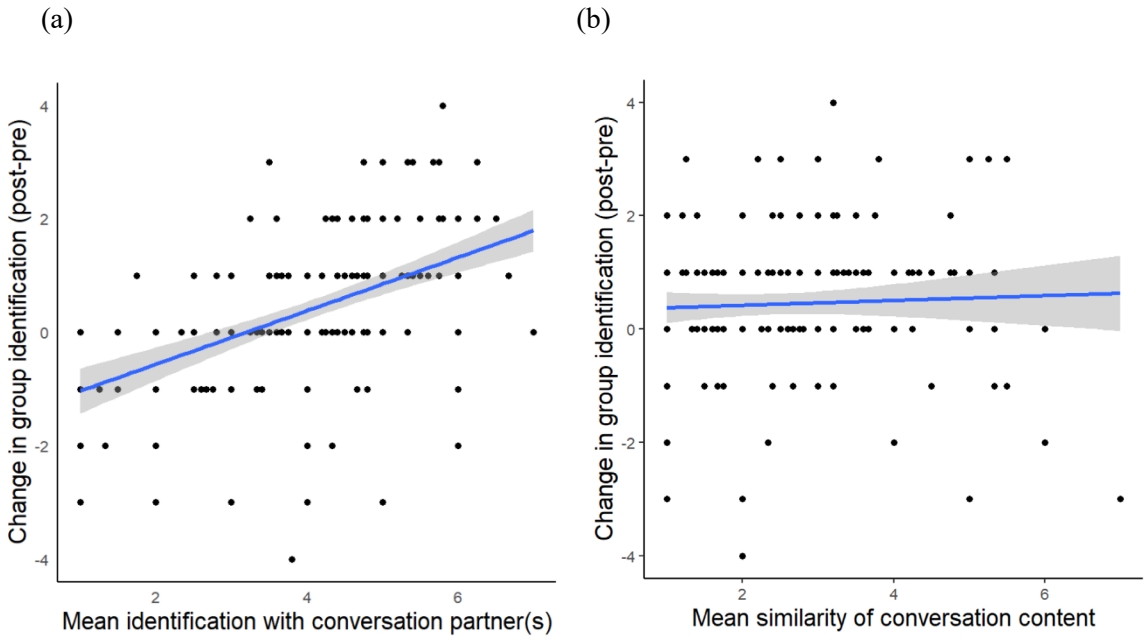
predict group identification to differing degrees. If identification with conversation partners predicted increased group identification, it would indicate that group identity formed via the bottom-up, inductive route of connecting with individual group members. On the other hand, if similarity predicted increases in group identification, it would indicate more of a top-down, deductive route to group identity formation based on pre-existing common ground.

To test these routes to group identity formation, we conducted an omnibus mixed ANOVA predicting group identification from time (pre- or post-conversation) and participants' average ratings of similarity and identification with their conversation partners. We included all possible interaction terms as well as an error term for participant to account for the repeated measures in our data. The results of this mixed ANOVA are reported in Supplementary Table B5, with the main findings reported below.

Identification with conversation partners predicts identification with group. First, we tested whether the experience of identifying with one's specific conversation partners predicted their group identification. To test this idea, we looked at the interaction term between time and mean partner identification. As shown in Figure 17 (panel a), participants came to identify with their groups more when they identified with their conversation partners and *less* when they did not identify with their conversation partners, $F(1, 391) = 41.72$, $p < .001$. The overall correlation between mean identification with conversation partners and change in group identification was moderately strong, $r = .49[0.38, 0.59]$, $t(198) = 7.99$, $p < .001$.

Figure 17.

Relationship between partner identification/similarity and group identification in Study 4



Note. Panel a shows the relationship between partner identification ratings and increases in group identification during the initial lab session. Panel b shows the relationship between content similarity ratings and increases in group identification. Confidence bands represent 95% confidence intervals.

On the other hand, the average similarity rating across conversations did not predict changes in group identification, as indicated by the non-significant interaction between time and mean chat similarity, $F(1, 391) = 1.21$, $p = .27$, and non-significant correlation between mean similarity of conversation content and change in group identification, $r = .04$, $t(198) = 0.60$, $p = 0.56$ (Figure 17, panel b). These results suggest that common ground, at least in terms of the perceived similarity of the conversation content, did not underly the formation of group identity. The observed effect of partner identification on change in group identification also did not depend on the similarity of the content being discussed, as indicated by the non-significant three-way interaction, $F(1, 391) = 2.52$, $p = .11$.

Discussion

In this study, we found that group identification increased from pre- to post-conversation regardless of the content of the conversation, specifically for people who were connected to multiple members of their group . This is consistent with previous work showing that individuals identify with their groups more with increasing interaction (Jans, Leach, Garcia, & Postmes, 2015). Furthermore, the degree to which people identified with their specific conversation partners – but not the similarity of the content shared during the conversations – predicted the formation of group identity. This suggests that the strengthening of group identity had more to do with forming bonds with individual group members than finding common ground with them, suggesting a bottom-up inductive route to group identity formation.

Further supporting this common-bond mechanism, the more conversations (*i.e.*, social bonds) a person had with their group members, the more they identified with their group. Peripheral individuals who chatted with just one or two of their group members did not end up identifying with their group any more than they did at the beginning of the study. On the other hand, central individuals, who conversed with more of their group members, did identify more strongly with their group after conversation than they did before.

Why did information-sharing strengthen group identity as much as memory-sharing?

Not only did the similarity of the content not matter for group identity formation, but the nature of the content also did not matter. Group identification increased regardless of whether people were sharing their most personal memories or talking about random information they had just read. What was it about reading and discussing random informational passages that led to increased group identification in the current study? We propose three possible explanations for this finding: (1) a *conversational* explanation that the act of communicating in and of itself strengthens identification with others, (2) a *developmental* explanation that young adults are still

in the process of forming their own self and group identities, and (3) a *student identity* explanation that all three conditions activated a social identity common to all participants: being a student.

Conversational explanation. The first and most obvious explanation for why information-sharing led to similar increases in group identification compared to memory-sharing is that conversation itself is the driving factor contributing to identification. This explanation is further supported by our finding that people who had more conversations identified more strongly with their group. Previous research similarly finds that the act of conversation alone leads to the formation of shared identity. The smoother the conversation, with shorter the gaps between turns, the more people like each other (Koudenburg et al., 2011, 2013; Koudenburg, Postmes, & Gordijn, 2017a; Templeton, Chang, Reynolds, Cone LeBeaumont, & Wheatley, 2022). It is the form, rather than the content, of conversation that seems to affect the formation of a shared identity among conversation partners and groups (Koudenburg et al., 2011; Koudenburg, Postmes, & Gordijn, 2017b).

Although we did not have a pure non-conversational control condition in the current study, Study 3 found overall higher ratings of shared identity in the conversation relative to the introspection condition (reported in Koudenburg, Jetten, Enz, & Haslam., 2024). In the current study, the variability in the number of conversation vs. introspection rounds that people had also mattered. People who only had one or two conversations did not, on average, increase their group identification, which also supports this conversational explanation.

Developmental explanation. The relationship between memory and identity appears to change across the lifespan. It is possible that the identity salience manipulation did not affect identification in our study because the participants had not yet formed a strong connection between their memories and their identity. A recent study found that recalling important autobiographical memories did not strengthen identity for emerging adults (under age 25),

whereas it did for mature adults (over age 25) (Beike, Cole, & Merrick, 2023). Given our sample was made up of primarily undergraduates with a mean age of 20 years old, this developmental difference could help explain why talking about information was just as effective at inducing group identification as memory sharing in our study.

This explanation is also in line with classic theories of identity development, including Erikson's (1959) stages. According to Erikson, adolescents are faced with the primary challenge of forming their basic identity before they can move onto the next stage of forming bonds with others. If the college students in our study were still forming their own identity, our memory-sharing manipulation might not have had the intended effect on making salient different aspects of their identity in a way that would facilitate forming a shared identity with others beyond the effects of conversation alone.

It is possible, then, that sharing personally experienced self- and group-identity relevant memories might serve more of a social identity formation function later in life. A robust finding in the autobiographical memory literature is the reminiscence bump, which is the overrepresentation of autobiographical memories for events experienced during emerging adulthood, perhaps because this is a key stage for identity development (Demiray, Gülgöz, & Bluck, 2009; Glück & Bluck, 2007; Munawar, Kuhn, & Haque, 2018). If emerging adults are still in the midst of experiencing identity-forming events, they might still be forming these key memories and integrating them into their self-memory system, whereas older adults could more readily draw from these memories to discuss them with others. Future research could conduct similar studies on group identity formation via memory sharing in the later years of adulthood.

Student identity explanation. Another possibility is that all three conditions activated a general "student" identity. Given that the majority of our participants were undergraduates, studying and then talking about informational passages might be consistent with this identity. Although the chats themselves were anonymous in an attempt to mask any pre-existing shared

identities between the conversation partners, identity-relevant characteristics could have been revealed in the conversations. Even participants who discussed self-defining memories or informational passages – which were intended to *not* activate group identity – could have made small talk during their chats about their day (at Princeton) in addition to completing the memory- or information-sharing part of the conversation.

It is also possible that undergraduate participants in all conditions could have inferred their shared student identity by looking around the room and seeing other students. As counter-evidence to this idea however, baseline-level agreement the statement "I identify with my group" before engaging in conversation was at the midpoint of the scale: "Neither agree nor disagree". If participants had deduced their shared student identity from looking around the room, one might expect them to at least "Somewhat agree" that they identified with their group at the outset of the experiment. Without a comparison group of participants who did not share a common identity, however, we cannot know whether people would otherwise have started out by slightly *disagreeing* with the statement that they identify one another when assembled as a minimal group. Although there was a small minority of participants who were not undergraduates in the current study, we do not have enough data from non-students in the current sample to make any kind of statistical comparison.

Suggestions for future research. Future research could include a set of older adult participants who do not have an underlying common social identity in an attempt to rule out the developmental and student identity explanations while testing our preferred conversational explanation. To test the conversational hypothesis – our preferred explanation – we could run a similar study in an online recruitment platform rather than a University subject pool with just two levels of identity salience (identity-relevant memories vs. informational passages) and an additional no-conversation condition (participants who were totally disconnected from their group members). In the current study, we saw that people who only had one or two conversations did

not increase their group identification, so it would be especially interesting to compare these participants with those who had no conversations at all. This comparison could also help us answer our second question:

Why did central but not peripheral individuals identify with their group?

There are at least two possible explanations for why central – but not peripheral – individuals formed an identification with their group as a whole after conversing with a subset of their fellow group members: (1) a *generalization* explanation that people need to "see" multiple group members before they can draw conclusions about the group as a whole and (2) a *social inclusion* explanation that people need to "feel" like they are part of the group in order to identify with the group as a whole. Because social structure was manipulated by the number of conversations the individual had in the network, a limitation of the current study is that we cannot disentangle the effect of cumulative conversations from the effect of one's social position - and being aware of one's social position - in the group. However, we use the evidence we have to evaluate these two explanations and suggest ways to test them in future research.

Generalization explanation. It is possible that the most peripheral individuals did not identify with their groups because they did not feel like they could generalize to the group as a whole after just one conversation. Knowing that their group comprised of ten members total, participants who only had one or two conversations might have felt like they did not have a good enough sense of who the other group members were. Thus, they could still neither agree nor disagree with the statement that they identified with their group even after the conversational phase of the study.

On the other hand, the most central individuals had a chance to talk to a majority of their fellow group members (5 out of the other 9 individuals). As a result, they might have felt like they could generalize from these group members to the rest of the group. If they identified

strongly with these group members, it was reasonable to infer that they would also identify with the rest of the group members they did not get a chance to talk to. In this explanation, the observed effect is driven by central individuals having more information about and more experiences with their fellow group members than the peripheral individuals.

In the area of social categorization, there is evidence that people generalize from their experiences with specific individuals to novel individuals (Verosky & Todorov, 2010) and to groups as a whole (Glaser & Kuchenbrandt, 2017). The current findings could suggest that people similarly learn about their own groups via generalized learning. More research would need to be done to test this explanation, however, as central participants in the information condition also identified more strongly with their groups, despite presumably learning less about their group members during their conversations.

Social exclusion explanation. It is also possible that the peripheral individuals might otherwise have come to identify with their group after just one or two conversations, but they felt socially excluded given the social context. During the initial lab session, all participants were present in the room and seated next to one another at computers, so they likely had a sense of what others were doing. Even though everyone was aware that they might not have conversations for all five rounds and no one knew how many conversations they would have, peripheral individuals could have gotten a sense that they were assigned to fewer conversations than the other participants. By seeing that others were having conversations while they were writing about their memories on their own, peripheral individuals could have felt like they were not really part of their group. As suggestive evidence for this explanation, participants who only had one conversation numerically on average decreased their group identification rating by about a quarter of a point on the 7-point scale after the conversational phase.

Previous research has used the Cyberball paradigm to study the effects of social exclusion. In this method, participants play a game tossing a ball among a group, but the other

players do not throw the ball to the participant (Ruggieri, Bendixen, Gabriel, & Alsaker, 2013; Williams & Jarvis, 2006). Being socially excluded is painful, activating responses typically associated with physical pain (Canaipa, Treister, & Lang, 2016; Sleegers, Proulx, & van Beest, 2017). It also activates the default mode network, which as you might recall from Chapter 1, is associated with autobiographical thought, as well as mentalizing other's thoughts (Mwilambwe-Tshilobo & Spreng, 2021). Thus, being socially excluded might lead people to feel worse about themselves and their group members, thereby limiting the degree to which they identify with their group as a whole.

Implications for real groups. The explanations posed above are not necessarily mutually exclusive and could represent complementary social processes at play in naturally occurring groups. In real-world social settings such as parties, people can see others interacting and have a sense of their own social position in the group. If someone notices that they are having fewer conversations than others, they could feel a sense of social exclusion. Social exclusion likely plays an even larger role in these contexts compared to the one set up in our lab study. In real social contexts, conversations have more of an element of choice. Not having conversations in real social contexts could indicate that others are actively not interested or choosing to talk with you.

In real social settings, there are also opportunities for group conversations, which we did not allow for in this study. Group formation does not occur only through separate dyadic conversations, but rather a combination of one-on-one conversations as well as interactions among subsets of group members and, in some cases, the group as a whole. The social structure or real groups also involves more than just the number of people a person is connected to, but also their social role within the group. Central individuals often tend to have more responsibility for the group, which would likely increase group identification even beyond what we saw in the current study.

Group formation in naturalistic environments also intersects with other social categories and identities such as race, gender, and social class that were intentionally masked in this study. By controlling for these identities and making conversations fully "anonymous," we could isolate our identity salience manipulation to just the type of memory being discussed. In this controlled environment, however, the identity salience of people's autobiographical memories did not affect their group identification. In real groups, such as the workplace, *a priori* social identities likely affect how people interact with one another and subsequently identify as a group.

Chapter Conclusion

In this chapter, we saw that discussing autobiographical thoughts with other people, even strangers, helps to strengthen identity at multiple levels. Talking about personal experiences and self-views enables us to form shared identity with one another (the social function) and creates an opportunity for us to validate one another's autobiographical thoughts. Compared to introspection – which most people agree is the best way to "finding yourself" – sharing autobiographical thoughts is equally effective at strengthening personal identity (Koudenburg, Jetten, Enz, & Haslam, 2024). What is it about voicing – rather than just thinking – our autobiographical thoughts that connects us to ourselves and others?

In Study 3, conversation strengthened sense of self by increasing one's shared identity with others, whereas introspection supported the self via another, likely nonsocial, process. Voicing autobiographical thoughts to others offers the opportunity for social validation, via affirming partner responses like "I agree" or even just a simple "Yes" or "Yeah". In the context of specific groups in Study 4, we again found that conversation fostered shared identity, both with specific conversation partners and one's group in general. In this case, it appeared to be the cumulation of multiple interactions that fostered group identification. In Study 3, which did not involve a specific group, having just one conversation was enough to increase the sense of shared identity with other people. In the group setting, however, just one conversation was not enough to

get people to identify with the other 9 people in their group. Thus, the effect of conversation on shared identity appears to be contingent on the social context in which those conversations are embedded.

The two studies in this chapter also differed in the types of autobiographical thoughts people discussed. In Study 3, people answered more general questions about their lives: what is important to them, what they are (dis)satisfied with in life, and what their hopes are for the future. The answers to these questions operate more at the level of the conceptual self (the higher level of the self-memory system). On the other hand, in Study 4, participants shared specific autobiographical memories including episodic details like time and place (the lower level of the self-memory system). Although we did not directly compare these two forms of autobiographical thought, previous research has shown that reciprocal disclosure of both general self-related content and specific autobiographical memories leads people to feel close to one another (Beike et al., 2016).

Taken together, the studies in this chapter point to the social function of conversation in general, not necessarily conversations about autobiographical thoughts. In Study 3, conversation (vs. introspection) led to stronger shared identity (Koudenburg et al., 2024). In Study 4, the more conversations a person had, the stronger their group identification, regardless of the content of the conversations. Even discussing non-autobiographical informational passages led people to identify with one another. The flow and number of conversations is likely more important for social bonding than the conversation content, at least in initial interactions.

4

Simulation-Shaped Autobiographical Decisions

For the third and final empirical chapter, we turn our attention to the directive function of autobiographical thought. How does episodic simulation of the personal future guide present choice behavior? Recall from Chapter 1 that one of the functions of future thought is decision-making (Hallford & D'Argembeau, 2022). Here, in Chapter 4, we present six studies testing how simulating an option for an upcoming decision influences people's likelihood of choosing that option. The first three studies were about personal decisions participants reported from their own lives. Much like the autobiographical memories from the previous chapters, these personal decisions showed considerable variability across participants. We followed up these personal decision studies with three controlled experimental studies where participants chose between pre-selected snack and video options. In all studies, we found that simulation affected choice.

People face countless decisions each day, from the mundane to the meaningful: what to eat, where to vacation, whom to marry. These decisions can be complex, involving multiple options, each with multiple relevant features. Personal decisions do not always have a correct answer, their options cannot be compared side-by-side, and their resolutions have lasting implications for one's future. Thus, people spend significant time and energy playing out future options using a process called episodic simulation. We propose that these future-oriented simulations are not merely epiphenomenal; instead, they can drive decisions.

Thinking about the future

Future thinking is pervasive. People think about the future once every two to four minutes (Gardner & Ascoli, 2015), reporting as many as one hundred future-oriented thoughts per day (D'Argembeau, Renaud, & Van der Linden, 2011). At least 30% of spontaneous thoughts are future-oriented (Andrews-Hanna, Reidler, Sepulcre, Poulin, & Buckner, 2010), about two times the prevalence of past-oriented spontaneous thoughts (Branch & Zickar, 2021; Busby Grant & Walsh, 2016; Jason, Schade, Furo, Reichler, & Brickman, 1989; Smallwood & Schooler, 2015) Future thoughts focus on current concerns and serve important planning, goal-setting, and decision-making functions (Berntsen, 2019; Cole & Berntsen, 2016; Hallford & D'Argembeau, 2022). Approximately 18% of future thoughts are about decisions (D'Argembeau et al., 2011). These simulations could be a byproduct of the decision-making experience with no causal effect on behavior. Yet, they could also play an active role in shaping one's decisions. Can thinking about the future actually influence the future?

The process of episodic simulation involves constructing detailed mental scenes and imagining experiencing specific possible events (Schacter et al., 2007; Schacter, Addis, & Buckner, 2008). People essentially pre-live an event they have not yet experienced by activating episodic details, recombined into novel future events (Schacter & Addis, 2007; Schacter et al., 2017). Simulating future events is therefore remarkably similar to remembering past events; both require episodic activation and recombination (Addis, Wong, & Schacter, 2007; Spreng, Mar, & Kim, 2009; Yeshurun et al., 2021).

Episodic simulation can shape judgments, intentions, and behaviors. Simulating a future event increases the perceived plausibility of the simulated event (De Brigard, Szpunar, & Schacter, 2013; Szpunar & Schacter, 2013). Imagining helping increases prosocial intentions and behavior (Gaesser & Fowler, 2020; Gaesser, Keeler, & Young, 2018; Gaesser, Shimura, & Cikara, 2019; Gaesser & Schacter, 2014). Simulating spending money reduces temporal

discounting, helping people opt for larger, long-term rewards over smaller, more immediate ones (Ballance et al., 2022; Benoit, Gilbert, & Burgess, 2011; Bulley et al., 2019; Bulley & Schacter, 2020). These behavioral effects of simulation suggest that future thoughts are likely not toothless, internal chatter; they might impact how people make decisions in their day-to-day lives.

The role of simulation in decision-making

If humans were purely rational, there would be little need to imagine the future to make decisions; one could simply analyze the options on all relevant features, weight the importance of each feature, then choose the optimal option. For example, how might one pick a new apartment? Apartments have many attributes, including size, cost, and commute time. People instructed to approach apartment selection analytically sought information one attribute at a time, compared across all apartments, and accumulated roughly equal amounts of information about each apartment (McGill & Anand, 1989). Yet, for many personal decisions, too many options exist to consider each fully, and multiple options can be "optimal" in qualitatively different ways (Johnson, Bilovich, & Tuckett, 2022).

When left to their own devices, people make decisions that appear less-than-rational; they are risk-averse, weighing negative outcomes over positive ones, and myopic, weighing near outcomes over far ones (Kahneman & Tversky, 1984). When making decisions, people spontaneously use mental images – such as those generated during episodic simulation (Śmieja, Zaleskiewicz, Sobkow, & Traczyk, 2023). Such mental images serve as a proxy for information that people are unable to acquire directly (Blaisdell, 2019). By using simulation to gain information, however, people might inadvertently bias their choices.

When using mental imagery to make decisions, people are more likely to seek out information about a few select options before choosing one (McGill and Anand, 1989). When picking an apartment, imagery led people to think holistically, collecting all attributes for one

apartment before moving on to the next. Gathering information in this way makes it easier to conjure an image of an apartment. This approach, however, led people to ignore some apartment options entirely. Why not create images for all apartments and then choose the best? The imagery approach may prioritize efficiency; once the mental image meets threshold, there is no need to look at another. For real-life decisions with non-finite sets of options and different information about each, efficiency is especially necessary.

Naturalistic decision-making often elicits episodic simulation. According to the recognition-primed decision model, people use simulation when they need to make efficient decisions and have prior experience. Experts under constraints to decide quickly begin by activating actions they used in similar situations (Klein, 1993, 1997, 2005; Klein & Crandall, 2018). If there is uncertainty about the first option, the decision-maker simulates possible outcomes, and if necessary, generates a second option. Other work likewise suggests that decision-makers initially consider the best, most likely, or most accessible options from previous experience, then deliberate among them (Phillips, Morris, & Cushman, 2019). These theories both suggest that simulation directs people to think about options they are already likely to choose, increasing the efficiency of the decision-making process. These theories do not, however, speak to whether simulation changes choice.

Query theory likewise posits that decision-makers start with the most viable option, but retrieving reasons from memory *changes* the choices people make (Johnson, Häubl, & Keinan, 2007; Weber & Johnson, 2011). The mere act of considering the first option leads people to stick with the status quo and inhibits accessibility of alternatives. A candidate mechanism for this inhibition of alternatives is retrieval-induced forgetting (Anderson, Bjork, & Bjork, 1994; Murayama, Miyatsu, Buchli, & Storm, 2014). In list-learning tasks, retrieving an item from memory (e.g., “apple”) increases its accessibility while decreasing the accessibility of categorically related items (e.g., “orange” relative to unrelated ones (e.g., “hammer”). In the

decision-making context, the reasons for and against different options are related, so the act of recalling reasons in favor of one option makes it more difficult to think of reasons in favor of another option.

We propose that simulation, like retrieval, might actively shape decision-making: imagining an option should make it *more* likely to be chosen. Simulating an option might make it easier to continue simulating that option over harder-to-imagine alternatives. Indeed, retrieval-induced forgetting impacts personal memories, such that people find it harder to recall details of an experience if it is related to a recently recalled memory (Hauer & Wessel, 2006). Episodic simulation relies on similar neurocognitive processes as episodic memory (Schacter & Addis, 2007; Schacter et al., 2008); thus, selective simulation of one option might make simulating other options more difficult.

Simulation makes the imagined future feel more plausible (Szpunar & Schacter, 2013), possibly creating a feedback loop in which simulated options become more viable, and thus, more likely to be re-simulated. Spontaneous simulation starting with options people are already likely to choose might not change the outcome, just help people get there faster. This cycle could potentially be co-opted, however, to change the choices people make. Directing simulation toward another option, rather than allowing it to naturally gravitate toward already-likely ones, might cause people to choose the simulated option.

Overview of studies

Does simulation change choice or is it just a byproduct of the choice people would otherwise make? Six studies tested whether thinking about one option over others changes the decisions people make. In each study, we examined how episodic simulation of a decision option influenced its likelihood of being chosen. Studies 5 and 6 measured the impact of simulation on personal life decisions. Studies 7 and 8 measured its impact on controlled decisions in the

laboratory. We hypothesized that participants would be more likely to choose the option they simulated over the option they did not.

Study 5: Thinking about Personal Decisions

Study 5 assessed the relation between spontaneous simulation and decision-making in people's daily lives. Participants reported an upcoming decision and the options they were considering. We collected naturalistic data across two weeks, measuring how much people thought about each option and how likely they would be to choose each option. We hypothesize that simulation shapes decision-making, such that the more a person spontaneously simulates an option, the more likely they will choose it later.

Method

Participants

Participants (N = 170) were recruited to participate in a two-part weeklong study about decisions through the online recruitment platform TurkPrime, now CloudResearch. Based on exploratory findings from Study 6a, we set a target sample size of 155, which offers 80% power to detect a correlation of $r = .22$ between spontaneous simulation and likelihood to choose at a significance level of .05. Participants were excluded based on the pre-registered exclusion criterion of providing nonsense text responses to the decision (n = 5), or not completing the follow-up at Time 2 (n = 16), leaving a final sample size of 149 (age 18-72, $M = 37.62$; 72 female, 75 male, 2 non-binary; 79% White, 7% Asian, 6% Black or African American, 3% Hispanic or Latino, 5% Mixed race or Other).

Participants in this and all subsequent studies provided informed consent and were compensated in a manner approved by the Institutional Review Board of Princeton University. Pre-registrations, materials, and analysis code for this and all other studies in this chapter can be found on OSF (https://osf.io/2mf74/), with the exception of Study 6a.

Procedure

Participants completed two questionnaires about an upcoming decision and the options they were considering for the decision: an initial questionnaire (Time 1) and a follow-up one week later (Time 2). At both times, participants rated their likelihood of choosing each option, and their spontaneous thought about each option. We assessed the extent to which participants' spontaneous thoughts about each option related to their likelihood to choose that option.

Time 1.

The Decision. In the initial questionnaire, participants first reported a decision they anticipated making in more than one week's time. They provided a brief title for the decision, which we used to remind them of the particular decision at later points in the study. As exploratory measures, participants reported the expected timing of the decision (with 8 options ranging from "less than one week from now" to "more than 5 years from now"), the importance of the decision (from 0 "not at all" to 10 "extremely") and the amount they had thought and talked about the decision over the past week (from 0 "not at all" to 10 "all the time").

Decision Options. After reporting on the decision overall, participants listed up to 5 options they were considering for their decision, giving each a brief title that was used to remind them of that option later on. They then completed the following ratings about each option. The options were presented in a random order for all rating scales.

Likelihood to Choose. Participants rated how likely they would be to choose each option if they were to make the decision that day. For each option, likelihood to choose was rated on a scale of 0 to 100 percent. These ratings were made independently so the sum of a person's ratings for all their options would not necessarily sum to 100. This value was used to calculate our primary measure of interest: change in likelihood to choose from Time 1 to Time 2.

Spontaneous Simulation. Next, participants reported how much they thought about (i.e., mentally simulated) and talked about (i.e., socially simulated) each option over the past week using two separate rating scales (from 0 "not at all" to 10 "all the time"). The sum of a participant's mental and social simulation ratings was taken as the overall spontaneous simulation score for that option.

Option Valence. Participants rated the positive and negative valence of each option. Option valence was rated on separate scales for positive and negative valence (from 0 "not at all" to 10 "extremely"). These were combined into an overall valence score for each option by reverse scoring the negative rating and summing the two (positive rating + (10 - negative rating)). We used this to test whether the effect of simulation depended on initial feelings toward the option (making negative options less appealing over time and positive options more appealing), or simply made all options more likely.

Time 2.

The Decision. At the beginning of the follow-up questionnaire, participants were prompted with the decision title they provided during the first part of the study. They re-rated this decision using all the same scales collected at Time 1, including the expected timing of the decision (with an additional option to indicate that they had already made the decision), the importance of the decision, and how much they had thought/talked about the decision over the past week. At Time 1, we specifically asked participants for decisions that were more than one week away, so that at Time 2 they would not yet have made the decision and would still be considering multiple options. Participants who had already made the decision at Time 2 were not included in the main analyses. For exploratory purposes they were asked to select the option they chose from a list of all the options they provided at Time 1 plus an "Other: specify____" option and rate how satisfied they were with the outcome of their decision (from 0 "Not at all" to 10 "Extremely").

Decision Options. Participants were prompted with each of the option titles they provided on the initial questionnaire. Participants then completed the same ratings of each option as in Time 1, allowing us to compare ratings across time.

Likelihood to Choose. For each option, participants rated their likelihood of choosing each option if they were to make the decision that day. Our primary dependent variable was change in likelihood to choose from Time 1 to Time 2, computed as the difference between Time 1 and Time 2 ratings for each option.

Spontaneous Simulation. Participants rated how much they thought and talked about the decision over the past week, which was combined into a spontaneous simulation score by averaging these two items. Change in spontaneous simulation was computed as the difference between the Time 1 and Time 2 simulation scores for each option. This was our primary predictor variable.

Option Valence. Participants rated the valence of each option. Positive and negative ratings were combined into an overall valence score by reverse scoring the negative rating and summing the two. Option valence at Time 2 was included as an exploratory outcome measure.

Results

These and all subsequent analyses were conducted in R version 4.2.3, and linear mixed effects models were run using the lme4 package version 1.1-32 (Bates, Mächler, Bolker, & Walker, 2015). Supplementary results for this and all subsequent studies are presented in Appendix C.

Spontaneous simulation predicts changes in choice ratings

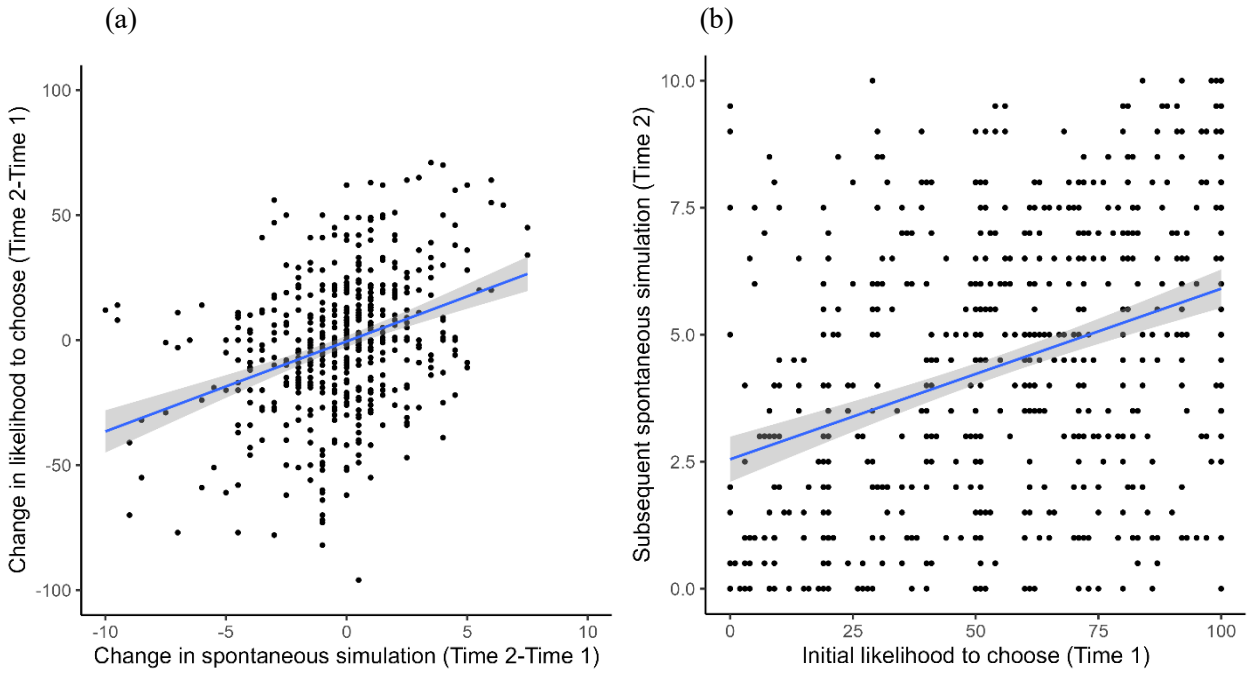
Our primary preregistered analysis tested whether people became more likely to choose options they thought about more over the course of one week. We ran a linear mixed effects

model testing whether increases in spontaneous simulation of one option over one week predicted increases in the likelihood of choosing that option. Each participant reported on multiple options, so to account for the nested structure in our data, we included a random intercept for participant. As expected, we found that spontaneous simulation was significantly related to the likelihood of choosing an option, $b = 4.04$ [3.18, 4.89], $\beta = .39$ [0.30, 0.47], $t(510.65) = 9.22$, $p < .001$ (Figure 18, panel a). People who thought about an option more over the course of the week increased their likelihood to choose that option, whereas people who thought about an option less over the course of the week decreased their likelihood to choose that option.

We next tested whether simulation impacts choice likelihood differently for options that people initially like vs. do not like. On the one hand, simulation might uniformly increase the likelihood to choose an option. On the other hand, simulation might only increase the likelihood to choose an option that a person already feels positively toward, whereas simulation may decrease one's likelihood of choosing a more negative option. We conducted a second preregistered analysis using a linear mixed effects model to test whether the interaction between an option's initial valence rating and the change in its spontaneous simulation score predicted the change in its likelihood-to-choose rating. Again, we included participant as a random intercept to account for the repeated measures in our data. As shown in Figure 18 (panel b), there was a small but significant interaction effect between initial valence and change in spontaneous simulation on change in likelihood to choose rating, $b = 0.15$ [0.00, 0.31], $\beta = .08$ [0.00, 0.16], $t(508.54) = 1.98$, $p = .048$, offering preliminary support that simulation might have a stronger effect on options people initially feel good about. That said, the direction of the effect remained the same regardless of the initial valence of the option. That is, people became more, not less, likely to choose options they simulated more, even for initially negative options. This interaction effect had mixed support in subsequent studies; we report all other option valence analyses in the Supplementary Results.

Figure 18.

Relationship between Simulation and Likelihood to Choose in Study 5



Note. Results from Study 5. Panel (a) shows the change in spontaneous simulation from Time 1 to Time 2 predicting change in likelihood to choose rating from Time 1 to Time 2 for each of the options provided by the participants. Panel (b) shows the initial likelihood of choosing the option at Time 1 predicting the degree of spontaneous simulation reported at Time 2. Confidence bands reflect 95% confidence intervals.

Initial choice likelihood predicts subsequent spontaneous simulation

We were also interested in which options people naturally simulated over the course of the week, with the idea that choice likelihood and spontaneous simulation might be mutually reinforcing. Specifically, we hypothesized that over the course of the week people would engage in more spontaneous simulation for options that they were *initially* more likely to choose. Our next preregistered analysis tested this hypothesis using a linear mixed effects model to assess the cross-time association between the likelihood of choosing an option at Time 1 and the amount of spontaneous simulation the participant reported for that option at Time 2, with participant as a random intercept. As predicted, participants reported significantly more spontaneous simulation

at Time 2 for options that they were initially more likely to choose at Time 1, $b = 0.03$ [0.02, 0.03], $\beta = .28$ [0.21, 0.35], $t(587.51) = 8.05$, $p < .001$ (Figure 1, panel b).

Discussion

These findings offer preliminary support for the hypothesis that simulation shapes decision-making. Simulation might be part of a feedback loop whereby people spontaneously simulate options they are already likely to choose, and additional simulation further increases their likelihood of choosing simulated options. These findings, however, are correlational. Study 6 tests the possibility that simulation's role in decision-making is causal.

Studies 6a & 6b: Simulating Personal Decision Options

Simulating an option could increase its choice likelihood. However, it is also possible that simulation is epiphenomenal: people think about the option they ultimately choose regardless. Studies 6a and 6b tested the causal impact of simulation on decision-making. Participants directly simulated one of two options they were considering for a personal decision. Study 6b was a direct replication of 6a, except for a one-week follow-up included in 6a only. We expected participants would be more likely to choose the simulated option.

Method

Participants

The samples for Studies 6a and 6b were recruited on Mechanical Turk via the TurkPrime (now CloudResearch) platform and were compensated for their participation. Participants who had participated in Study 6a were not eligible to participate in Study 6b.

Study 6a. Participants (N = 371) were recruited to participate in a two-part weeklong study about decisions through the online recruitment platform TurkPrime. We collected data from the first 20 participants before collecting the remainder of the sample in order to write our

primary analysis scripts and test that the survey was working properly. Participants were excluded for providing nonsense text to the open-ended questions (n = 31), leaving a final sample of 340 (age 20-81, *M* = 39.94; 147 female, 193 male; 75% White, 11% Black or African American, 6% Asian, 3% Hispanic or Latino, 4% Mixed race or Other). Study 6a was conducted prior to the other studies and was not preregistered. We based the pre-registered exclusion criteria and power analyses in the preregistrations for Study 5 and Study 6b on this sample.

Study 6b. Study 6b was a pre-registered replication of Study 6a. Using the effect size estimated from Study 6a, a power analysis yielded a target sample size of 230 to detect an effect of d = .185 at a significance level of .05 with .80 power. We *a priori* decided to stop data collection when we reached 250 participants (before exclusions) in order to achieve the target sample size. As a result of an error with the recruitment platform, only 249 of the 250 requested participants completed the survey. We excluded participants who provided nonsense responses to the open-ended simulation item (n = 26), yielding a final sample of 223 participants (age 18-75, *M* = 34.62; 85 female, 136 male, 1 non-binary, 1 prefer not to say; 67% White, 20% Black or African-American, 6% Asian, 6% Hispanic or Latino, and 2% Mixed race or Other).

Procedure

In both Study 6a and Study 6b, participants completed a questionnaire in which they were instructed to simulate the experience of having chosen one of two options they were considering about an upcoming decision. Participants rated their likelihood of choosing each of the two options both before and after the simulation. We assessed the extent to which participants became more likely to choose the simulated option compared to the non-simulated option. Unless otherwise noted, each step of the procedure listed below applies to both Studies 6a and 6b, and the steps of the procedure are listed in the order they occurred. In Study 6a, we also followed up one week later with an additional questionnaire to see which option, if any, they ultimately chose

in their daily life. The hypotheses and analyses for Study 6b were pre-registered based on the exploratory results of Study 6a. Study 6b was conducted three months after Study 6a.

Pre-simulation.

The Decision. Participants were instructed to think of a decision they anticipated making within the next week that had at least two options they were considering. First, they provided a brief title for the upcoming decision and reported when they expected to make the decision (in "days from now") as well as how important the decision was for their life (from 0, "not at all important," to 10, "Extremely important").

Decision Options. After reporting on the decision overall, participants provided brief titles for exactly two options they were considering for their upcoming decision. They then completed the following ratings about each option. The options were presented in a random order for all rating scales.

Likelihood to Choose. As a baseline measure of our primary variable of interest, participants rated how likely they would be to choose each option if they were to make the decision that day. For each option, likelihood to choose was rated on a scale of 0 to 100 percent. These ratings were made independently and on a separate page for each option. In addition to assessing the likelihood-to-choose ratings separately for each option, we also computed a polarization score for each participant, by taking the absolute value of the difference between the likelihood-to-choose ratings for the two options.

Option Valence. Participants also rated how positively and how negatively they felt about each option, on two separate scales (from 0, "Not at all" to 10 "Extremely").

Simulation.

Option Simulation. After generating and rating the two options, participants simulated having already made their decision and choosing one of the two options. They were randomly assigned to either simulate the first or the second option they listed. The simulation instructions were as follows:

Now we would like you to imagine that you have already made the decision about [personal decision text] and you chose the following option: [personal option text].

In the space below, describe your experience having chosen this option from your own point of view. Please include as much detail as possible.

Participants typed their response to the simulation instructions in an open-ended text box and were free to move on to the next page whenever they finished their simulation. The amount of time that each participant spent on the simulation task was recorded.

Vividness. On a separate page, participants rated the vividness of their simulation using a 5-item measure with three forward-scored items (e.g., "To what extent did you see what you imagined in your mind's eye?") and two reverse-scored items (e.g., "How difficult was it for you to describe with words what you imagined?"), adapted from Meyer, Hershfield, Waytz, Mildner, and Tamir (2019). Each item was rated on a Likert-type scale ranging from 1 ("Not at all") to 10 ("Extremely"), and an overall vividness score was computed as the mean rating (after reverse scoring) on the 5 items.

Post-simulation.

Likelihood to Choose. After completing their simulation, participants again rated how likely they would be to choose each option if they were to make the decision that day. Again, the two options were presented in a random order and on separate pages. As in Study 5, our primary

dependent variable was change in likelihood to choose from pre- to post-simulation, computed as the difference between pre- and post-simulation ratings for each option. We computed polarization as the absolute difference between the likelihood-to-choose ratings for the two options.

Option Valence. Lastly participants re-rated the positive and negative valence of each option using the same two scales as the pre-simulation rating. These were combined into an overall valence score for each option by reverse scoring the negative rating and summing the two (positive rating + (10 - negative rating)).

One-week follow-up (Study 6a only).

The Decision. On a separate questionnaire administered one week after the initial questionnaire, participants were prompted with their decision title from the initial questionnaire and indicated whether or not they had already made the decision. Participants who had made the decision (Deciders) were asked a different set of questions about their decision than those who had not made the decision (Non-deciders).

Decision Outcomes. For deciders, our outcome variable was which option they chose. Participants who had already made the decision were asked which option they chose (from the two option titles they provided on the initial questionnaire plus an "Other: specify____" option). As exploratory measures, deciders also reported when they made the decision by selecting from a list of dates and rated how satisfied they were with the outcome of their decision on a scale from 0 "Not at all satisfied" to 10 "Extremely satisfied". This information allowed us to explore whether simulation was more impactful for decisions made in the first few days following the initial survey compared to decisions made later in the week.

For non-deciders, our outcome variable was which option they would hypothetically choose in the future. First, non-deciders indicated whether or not they still intended to make the

decision. Then, regardless of their intention, participants selected the option they would choose if they were to make the decision that day (from a list of their two option titles and an "Other, specify" option). This information allowed us to differentiate possible effects of simulation on non-deciders' hypothetical choices as compared to deciders' actual choices, and to explore counterfactual choices (i.e., hypothetical choice data for non-deciders who no longer intended to make the decision) from plausible future choices (i.e., hypothetical choice data for non-deciders who still intended to make the decision).

Decision Importance. Both deciders and non-deciders then rated how important the decision was for their life on a scale from 0 "Not at all important" to 10 "Extremely important".

Spontaneous simulation. Similar to Study 5, participants rated how much they spontaneously simulated over the course of the week. For both the decision overall and the two options they provided on the initial questionnaire, participants rated how much they thought and talked about it over the course of the week (from 0 "Not at all" to 10 "All the time". The options were presented in a random order for this and all subsequent ratings.

Option valence. Lastly, participants rated the positive and negative valence of each option on two separate scales ranging from 0 "Not at all" to 10 "Extremely".

Results

Directed simulation polarizes choice ratings in favor of the simulated option

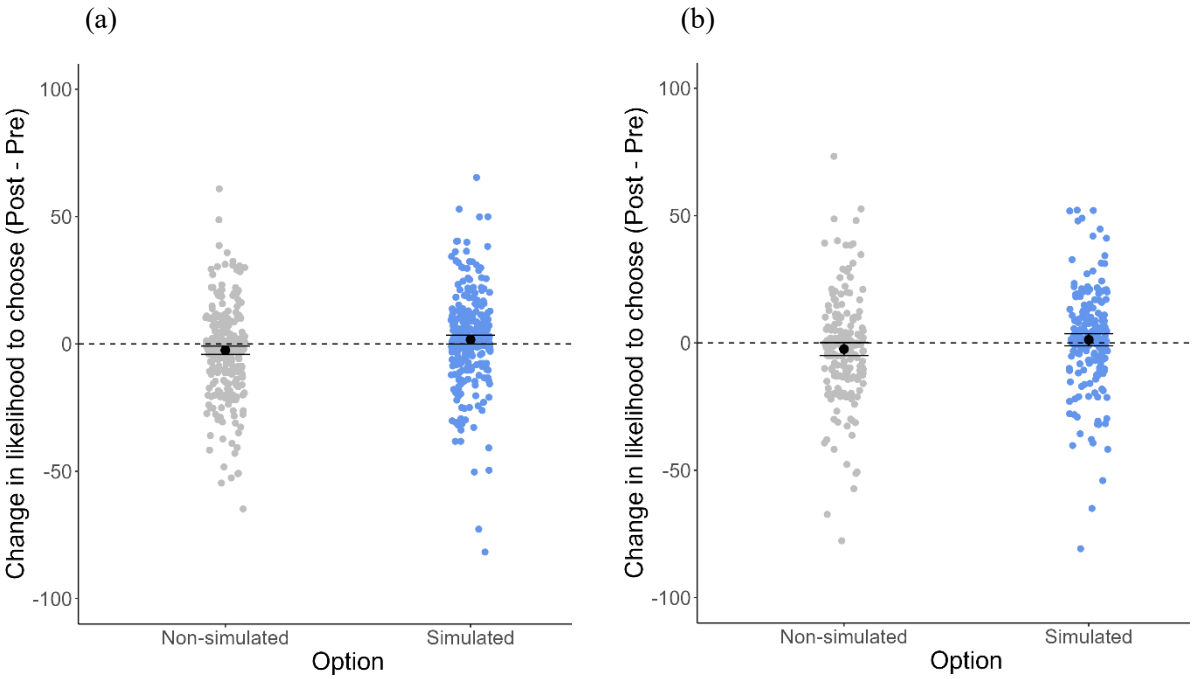
In Study 6a, our primary analysis explored whether simulation increased participants' likelihood-to-choose ratings for the option they were randomly assigned to simulate. Specifically, we used a linear mixed effects model predicting the change in likelihood-to-choose ratings for each option from whether or not the option was simulated, including a random intercept for participant to account for repeated measures. As shown in Figure 19 (panel a), simulation had a significant effect on change in likelihood-to-choose ratings for people's personal decision

options, b = 4.17 [1.77, 6.57], β = .26 [0.11, 0.41], t(678.00) = 3.40, p < .001, corresponding to a 4-point difference between the simulated option (M_{sim} = 1.67, SD_{sim} = 16.36, 95% CI [-0.07, 3.42]) and the non-simulated option (M_{non} = -2.50, SD_{non} = 15.59, 95% CI [-4.16, -0.83]) on the 100-point scale. To explore whether simulation enhanced the simulated option, inhibited the non-simulated option, or both, we followed up our primary analysis with two one-tailed, one-sample *t*-tests comparing the observed change in likelihood-to-choose ratings to zero, separately for each option. Simulation significantly increased likelihood-to-choose ratings for the simulated option, t(339) = 1.89, p = .030, d = .10, and significantly decreased likelihood-to-choose ratings for the non-simulated option, t(339) = -2.95, p = .002, d = .16, consistent with an inhibition-based polarization effect. Based on these findings, we pre-registered hypotheses and analyses for Study 6b.

Study 6b supported our primary hypothesis, replicating the finding that simulation increased participants' likelihood-to-choose ratings for the simulated option relative to the non-simulated option (see Figure 19, panel b). Using the same mixed-model analysis as Study 6a, we found a greater change in likelihood-to-choose ratings for the simulated option (M_{sim} = 1.22, SD_{sim} = 18.10, 95% CI[-1.16, 3.62]) compared to the non-simulated option (M_{non} = -2.43, SD_{non} = 19.01, 95% CI[-4.94, 0.08]), b = 3.66 [0.21, 7.10], β = .20 [0.01, 0.38], t(444.00) = 2.08, p = .038. The follow up *t*-tests showed that simulation did not significantly increase likelihood-to-choose ratings for the simulated option, t(222) = 1.01, p = .156, d = .07, but it did significantly decrease the likelihood to choose the non-simulated option, t(222) = -1.91, p = .029, d = .13, again consistent with an inhibition-based account. These results offer evidence that episodic simulation leads to the polarization of decision options such that the simulated option is more likely to be chosen relative to the non-simulated option.

Figure 19.

Change in Likelihood to Choose from Pre- to Post-Simulation in Study 6



Note. Results from Study 6a (panel a) and 6b (panel b). Both panels show the change in likelihood to choose ratings from pre- to post-simulation for the simulated option (blue) compared to the non-simulated option (gray). The dotted line represents zero change or no effect of simulation on the likelihood to choose a given option. The mean change in likelihood to choose is indicated by the black dot. Error bars represent 95% confidence intervals.

Spontaneous simulation predicts actual and hypothetical choice

In Study 6a, we followed up with participants to assess whether option simulation – both our one-time simulation manipulation and their own spontaneous simulation – impacted their actual and hypothetical choices one week later. Of the initial sample of 340 participants who completed the initial questionnaire, 80% (N = 271) completed the follow-up at Time 2. Of the follow-up participants, 86% (N = 233) had already decided one week later, consistent with our instruction that they select a decision they anticipated making within the week. The remaining 14% (N = 38) had not made the decision at the time of the follow-up.

We tested how simulation impacted both actual decisions in deciders, and hypothetical decisions in non-deciders. For these analyses, we included deciders (N = 222) and non-deciders (N = 36) who chose one of the two options they provided on the initial survey and not a new option. First, we tested whether deciders chose the simulated option more often than the non-simulated option, using a chi-square goodness-of-fit test to determine whether the observed number of participants who chose the simulated option was higher than the expected number due to chance, that is, 50% of the participants in each analysis. Our one-time simulation manipulation did *not* affect deciders' actual choices, as reported one week later, $\chi^2(1, N = 222) = 0.29$, $p = .59$, Cohen's $w = .04$ [.00, .17]. We similarly tested whether non-deciders, even though they had not actually made the decision, would choose the simulated option more than the non-simulated option when faced with the hypothetical choice between the two options. Again, our one-time simulation manipulation did not affect participants' hypothetical choice behavior one week later, $\chi^2(1, N = 36) = 0.11$, $p = .74$, Cohen's $w = .06$ [.01, .39]. In both cases, the proportion of participants who selected the option they simulated was around 47% (106 out of 222 for deciders; 17 out of 36 for non-deciders).

We did, however, find that spontaneous simulation predicted participants' choice behavior. Study 6a was also the basis of Study 5. We used the longitudinal data in Study 6a to explore whether spontaneous simulation predicted likelihood-to-choose ratings over the course of the week. First, we explored whether increases in spontaneous simulation from Time 1 to Time 2 predicted corresponding changes in choice ratings one week later. As in Study 1, we ran a linear mixed effects model predicting changes in likelihood-to-choose ratings from changes in spontaneous simulation ratings. Each participant reported on two options, so to account for the nested structure in the data, we included a random intercept for participant. As in Study 5, we found that spontaneous simulation was significantly related to the likelihood of choosing, $b = 4.04$ [3.18, 4.89], $\beta = .39$ [0.30, 0.47], $t(510.65) = 9.22$, $p < .001$. Spontaneously simulating an

option more over time went hand-in-hand with becoming more likely to choose that option, and vice versa; less spontaneously simulated options became less likely to be chosen.

We further tested whether this spontaneous simulation predicted deciders' actual choice behavior. Specifically, we conducted a mixed binomial logistic regression predicting whether or not an option was chosen from its spontaneously simulation rating, with participant included as a random intercept to account for repeated measures. Indeed, people were more likely to choose options that they spontaneously simulated more over the course of the week, $z = 5.86$, $p < .001$, odds ratio = 1.24 [1.15, 1.33]. For every one-unit increase in spontaneous simulation, people were 24% more likely to choose that option as opposed to the alternative.

Discussion

Studies 6a and 6b demonstrated that simulation increased self-reported likelihood of choosing the simulated option relative to the non-simulated option. Although this brief manipulation did not alter choices one week later, the degree to which participants spontaneously simulated an option did predict choice. Simulation also polarized options, making the simulated option more likely and the non-simulated option less likely to be chosen. Polarization could expedite decision-making by differentiating options and increasing choice certainty.

Study 7: Simulating Snack Options in the Lab

Studies 5 and 6 focused on decisions participants faced in their lives. These naturalistic decisions reflected a variety of initial preferences, and choice behavior could not be reliably confirmed. Study 7 resolved these issues with a controlled lab study using two novel but equally preferable snack options. After simulating one of the snacks, participants chose a snack to take home. We hypothesized they would be more likely to choose the simulated snack.

Method

Participants

Thirty-four Princeton University students aged 18-22, $M = 19.38$; 7 male, 26 female, 1 non-binary; 41% Asian, 29% White, 6% Black or African American, 6% Hispanic or Latinx, 18% Mixed race or Other participated for course credit between February and March 2020. A power analysis for the chi-square test on the binary decision outcome based on the results of Study 6a yielded a target sample size with a lower bound of 88 (to detect a medium-sized effect, $w = 0.3$) and an upper bound of 197 (to detect a small- to medium-sized effect, $w = 0.2$) at an alpha level of .05 with .80 power. Our preregistered stopping rule was to end data collection when the sample size reached 197 or on the last day of the semester (as long as data had been collected from at least 88 participants by that time). In March 2020, data collection was stopped early due to COVID-19 restrictions. Even though we did not meet our target sample size, we proceeded with analyses given that in-person data collection constraints would not allow for further data collection.

Materials

Snacks. Ten commercially available snacks with unique combinations of flavors, such as "Spicy Cherry Almonds" and "Butterfinger Popcorn," were selected from a set of 25 such snacks, according to ratings from a separate norming sample (see OSF for details of the norming study and a list of the snacks used). Color photographs of the snacks, 150 pixels in width for portrait-orientation images or 150 pixels in height for landscape-orientation images, were used in all survey materials when referring to the snacks. All ten snacks were presented in the pre-screening survey, but for the in-lab survey, only two snacks were presented to each participant, selected according to the participant's individual pre-screening responses. Individually sized packages (*M*

= 3.65 ounces, *SD* = 1.18) of the snacks were used at the end of the study when participants chose which snack, if any, to take.

Procedure

Pre-screening. Before being invited to participate in the lab study, prospective participants completed an online pre-screening survey in which they first reported any known food allergies. Students who reported food allergies were thanked, debriefed, and not invited to participate further. Those respondents who did not report any food allergies were then presented with a photo and description for each of the ten snacks one at a time and in a random order. For each snack, they indicated how much they would like to eat that snack on a scale from 1 ("Definitely would not like to eat this") to 7 ("Definitely would like to eat this") as well as whether or not they had eaten that snack before. See Supplementary Materials for the questionnaire used for pre-screening.

Snack matching. Experimenters used participant's pre-screening preference ratings to select a personalized pair of snacks for them to choose between during the lab session. Specifically, each participant was assigned two snacks that they rated equally on the pre-screening but had not eaten before. If there was more than one potential pair of snacks for a given participant, the experimenter selected the pair that was rated closest to the midpoint of the scale on the question measuring how much they would like to eat the snack. If there were more than two snacks with the same pre-screening preference rating, two snacks were selected based on how many packages we had left in the study materials. This was done to balance the number of times a particular snack item was presented across participants in the study, where possible. Participants were emailed an invitation to participate in the lab study after the experimenters had assigned them a pair of snacks.

Lab survey. All testing took place individually in a small lab room with a single computer. When the participant arrived, the experimenter first confirmed that the participant had no known food allergies and had not previously eaten either of the two snack options chosen for them. The experimenter then left the room while the participant completed the survey portion of the study in a standard web browser.

Option presentation. At the beginning of the survey, participants saw images of their two assigned snacks and were told that they would have the opportunity to take one of the two snacks home with them at the end of the study. Each participant was assigned a unique pair of snacks. The presentation order of the two snack images was randomized to ensure that some snacks were not systematically more likely to appear on one side of the screen.

Simulation. On the next screen, participants were randomly shown one of their two snacks and instructed to simulate the experience of eating that snack. The simulation instructions were as follows: **"**We are interested in understanding how people imagine the taste of new snacks. Please take a moment to think about what it would be like to try this snack." Participants then typed out how they imagined their experience eating this snack, with instructions reminding them to "include as much detail as possible, including what the snack looks, tastes, and feels like as you eat it." The amount of time the participant spent on the simulation task was recorded.

Vividness. On a separate page, participants rated the vividness of their simulation using the same 5 items used in Study 6 but on a Likert-type scale ranging from 1 ("Not at all") to 7 ("Extremely"). Again, an overall vividness score was computed as the mean rating (after reverse scoring) on the 5 items. After the simulation phase, we measured our primary outcome measures.

Like-to-eat ratings. Participants rated how much they would like to eat each of the two snacks (presented in a random order and on separate pages). Snack preference was assessed on

the same scale used in the pre-screening, ranging from 1 ("Definitely would not like to eat this") to 7 ("Definitely would like to eat this").

Snack choice. Participants made a binary choice on the computer screen indicating which snack they would like to take at the end of the experiment. The snacks were presented in a random order.

Snack ratings. As exploratory measures, participants also rated how excited they were to eat the chosen snack and how confident they were in their decision on Likert-type scales ranging from 1 ("not at all") to 7 ("Extremely").

Study completion. Finally, participants completed the demographic information and notified the experimenter that they had completed the study. The final screen also showed the snack they had chosen earlier in the study and informed them that they could take the selected snack. When the experimenter returned to the room, the participant was offered a choice of either or neither of the two actual snack packages to take home with them, then debriefed.

Results

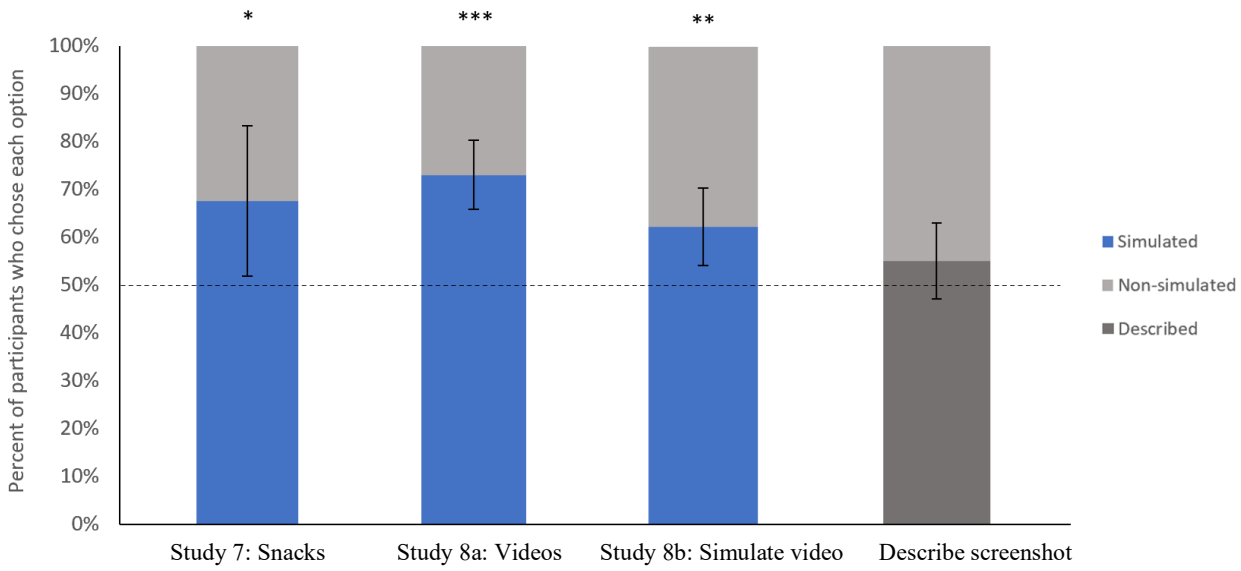
Directed simulation affects snack choice but not preference

In our primary preregistered analysis, we tested whether simulation affected participants' choice behavior. We ran a chi-square goodness-of-fit test on the observed frequency of participants who chose each snack, either simulated or non-simulated, compared to the expected chance frequency of 50% of participants choosing each snack. Participants were significantly more likely to choose the simulated snack (23 out of 34, or ~67%), $\chi^2(1, N = 34) = 4.24$, $p = .04$, Cohen's $w = .35$ [.04, .69] (Figure 20). Consistent with our hypothesis, simulating a novel snack option made participants more likely to *actually* choose that snack to take with them.

In our secondary preregistered analysis, we tested whether simulation impacted how much participants thought they would like to eat each snack. Recall that participants were matched with two snacks they had rated equally on the pre-screening survey so, by design, the initial difference in like-to-eat ratings was exactly zero. Thus, any difference in post-simulation like-to-eat ratings could be attributed to the simulation manipulation. The observed preference ($M_{sim} - M_{non}$ = .41, 95% CI [-.15, .98]) for the simulated snack (M_{sim} = 4.41, SD_{sim} = 1.35) compared to the non-simulated snack (M_{non} = 4.00, SD_{non} = 1.33) was not significant, $t(33) = 1.49$, $p = 0.15$, $d = .25$.

Figure 20.

Binary Choice Outcomes in Studies 7 and 8



Note. Results from Studies 7 and 8. Binary choice outcomes showing the percentage of participants who chose the simulated option (or the described option in the control condition of Study 8b) relative to the non-simulated option. Error bars represent 95% confidence intervals. Significance levels indicate the observed percentage was significantly different from 50%, *p < .05, ** p < .005, *** p < .001.

Discussion

Study 7 demonstrated that simulation impacts choice behavior, not just self-reported intentions. People are more likely to choose – and take – a simulated snack over a non-simulated snack. Simulation did not, however, change participants' relative desire to eat each snack. This null result is difficult to interpret, given that Study 7 was underpowered. It is possible though that simulation affects choice without affecting evaluations such as excitement or enjoyment. We explore this possibility in Study 8.

Studies 8a & 8b: Simulating Video Options Online

Study 7 showed that simulation impacts choices between two equally preferred options. Study 8 aimed to replicate these findings in a larger sample with a new scenario: watching videos. Participants simulated one of two videos based on its title and screenshot – similar to how one might select a video on YouTube — then chose a video. We compared choice behavior in the simulation condition to a control condition to rule out mental imagery (Study 8a) and priming (Study 8b) as explanations for the effect. Participants also watched the chosen video, allowing us to explore how simulation affects decision evaluations.

Method

Participants

For both Study 8a and 8b, we aimed for a target sample size of 290 participants, 145 in the simulation condition and 145 in the control condition. A power analysis based on the results of Study 7 yielded a target sample size of 145 in the simulation condition to achieve .90 power at an alpha level of .05 for the primary chi-square test of the proportion of participants choosing the simulated option. We aimed to recruit an equal number of participants in the control condition as well in order to conduct exploratory analyses comparing the two conditions. Participants who participated in Study 8a were not eligible to participate in Study 8b.

Study 8a. A total of 285 participants (aged 18-80, *M* = 26.86; 174 male, 110 female, 1 non-binary; 78% White, 10% Hispanic or Latinx, 3% Asian, 3% Black or African American, 6% Mixed race or Other) were recruited online via the Prolific platform. Because the assignment to condition occurred when participants started the survey in Qualtrics but the participant count was determined by Prolific when participants finished the survey, there was a slight asymmetry in sample size between conditions, with a final sample of 140 participants in the control condition and 145 in the simulation condition.

Study 8b. A total of 287 participants (aged 18-65, *M* = 26.78; 170 male, 114 female, 3 non-binary; 78% White, 10% Hispanic or Latinx, 3% Asian, 3% Black or African American, 6% Mixed race or Other) were recruited online via the Prolific platform. The final sample had 149 participants in the control condition and 138 in the simulation condition.

Materials

Videos. Two videos, titled "1200 Messages in 1200 Bottles" (hereafter referred to as Bottle Messages) and "Late Night Drama with the King of Infomercials" (hereafter referred to as Info King) from the online YouTube channel *Great Big Story*, were used as the two decision options in these studies. Each video was approximately two and half minutes long (2:34 for Bottle Messages, 2:28 for Info King). Screenshots of the two videos including their titles and length were provided at the beginning of the study and were used as cues for participants' simulations and decisions. Based on ratings from separate norming studies, the two selected videos were closely matched on the following criteria: how much participants reported wanting to watch the video based on the screenshot provided, ease of imagining the video based on the screenshot provided, how much participants actually liked watching the video, and how emotionally intense participants rated the video (see Supplementary Results).

Procedure

The procedures for Study 8a and 8b were almost identical with the exception of their control conditions and some exploratory measures. Unless otherwise noted, each step of the procedure listed below applies to both studies and the steps of the procedure are listed in the order they occurred.

Audio test. For both Study 8a and Study 8b, participants first completed an audio test to ensure that they were able to hear the video later in the study. This audio test was also used to screen out potential bots and ensure participants were paying attention. Participants who did not pass the audio check were not eligible to continue the study.

Option presentation. Prior to simulation, participants were presented with screenshots of the two video options side-by-side (counterbalanced which on which side). They were told that later in the study they would choose one of the videos and watch that video. Unlike in the previous studies, participants did not complete any ratings of the video options prior to simulation, ensuring that the simulation task and post-simulation choices were not influenced by prior consideration of the options.

Task instructions. All participants were then instructed that they would complete an "imagination task" before making their video choice. In both studies, half of the participants were assigned to the simulation condition and the other half were assigned to the control condition. In both conditions, participants typed their response to their respective prompt into a blank text box and were free to move onto the next page whenever they were done typing. The amount of time spent on the task and the content of the text were recorded for all participants.

Simulation condition. In both Study 8a and 8b, participants in the simulation condition were randomly presented with one of the two video screenshots and asked to think about and describe what it would be like to watch that video by typing into a text box. To ensure

participants were simulating episodically rather than just thinking about the video, they were explicitly instructed to “include as much detail as possible, including what the video looks, sounds, and feels like.” The simulation procedure was identical for both Study 8a and Study 8b, although the two studies had different procedures for their respective control conditions, as described below.

Control conditions. In Study 8a, participants assigned to the control condition completed an imagery control. These participants were presented with an optical illusion and asked to describe their experience of seeing the illusion. This task has been used as a control task in previous simulation research because it requires participants to describe an imagery-based experience in words, without the additional components of self-projection and mental time travel involved in the process of episodic simulation (Meyer et al., 2019).To ensure the sensory nature of describing the illusion was as comparable as possible to the simulation condition, we further instructed participants to "include as much detail as possible, including what the image looks, sounds, and feels like."

In Study 8b, participants assigned to the control condition completed a description control task. This task is designed to account for the possible choice-enhancing effect of additional exposure to one of the options. Participants in this condition described one of the screenshots used to represent the video options. Just like in the simulation condition, control participants were shown one of the two screenshots at random; however, instead of imagining the experience of watching the video, they were instructed to look carefully at the screenshot and describe only what was present in the image itself. These instructions were designed to prevent unintended simulation, and participants were further asked to “include as much detail as possible, including the objects, colors, and shapes that you see in the image.”

Vividness. Regardless of condition, participants then used the same 5 items from Studies 6 and 7 to rate the vividness of their experience during the "imagination task" on a scale from 1 "Not at all" to 7 "Extremely".

Video choice. As our primary outcome of interest, participants then decided which of the two videos to watch by selecting one of the two screenshots to indicate their choice. Again, the two screenshots were presented side-by-side, and the order of the screenshots was counter-balanced order across participants. As a secondary decision measure, we also recorded the amount of time it took participants to make their decision.

Pre-watch ratings. After making their decision but prior to watching the video, participants rated how excited they were to watch the chosen video (from 1 "Not at all" to 7 "Extremely") and how certain they were that they chose the better video (from 1 "Not at all" to 7 "Extremely"). These ratings were included to explore possible differences between participants whose expectations matched their enjoyment of the video and those whose expectations did not match.

Video experience. Participants then watched their chosen video. The video was presented as a YouTube video embedded in the online questionnaire browser window. Although the video controls were accessible, participants were instructed to watch the video once and only once and to let the video play through without pausing. The page was set to only allow the participant to advance the screen after the amount of time corresponding to the exact length of the video. We recorded the amount of time participants spent on the video watching page.

Post-watch ratings. After watching the video, participants rated their enjoyment of the video (from 1 "Did not enjoy it at all" to 7 "Extremely enjoyed it"), how certain they were that they chose the better video (from 1 "Not at all certain" to 7 "Extremely certain"), and how much

they regretted their choice (1 “Do not regret it at all” to 7 “Extremely regret it”). We used these ratings to explore whether simulation affected people’s actual experience of watching the video.

Rumination-Reflection Questionnaire (Study 8b). In Study 8b, we also included an exploratory measure of individual differences in the way participants tend to think about themselves. Specifically, the Rumination-Reflection Questionnaire assesses the degree to which self-oriented thought is focused on threats and potential losses (i.e., rumination) or driven by curiosity and general interest in the self (i.e., reflection) (Trapnell & Campbell, 1999).

Interest in non-chosen video. Finally, as a way to assess the possible effect of simulation on evaluation of the non-simulated option, we asked participants how interested they were in watching the video they did not choose (from 1 "not at all interested" to 7 "extremely interested").

Results

Simulation affects video choice

Our primary preregistered analysis tested whether simulation made people more likely to actually choose to watch the video they simulated. For participants in the simulation condition, we ran a chi-square goodness-of-fit test on the observed frequencies of people who chose either the simulated or the non-simulated video. Replicating our finding from Study 7, participants in the simulation condition were significantly more likely to choose the simulated video than would be expected by chance, in both Study 8a (106 out of 145, or ~73%), $\chi 2$ (1, N = 145) = 30.96, $p <$ .001, Cohen’s w = .46 [.30, .62], and Study 8b (86 out of 138, or 62%), $\chi 2$ = 8.38, p = .004, Cohen’s w = .25 [.08, .41] (Figure 20). These results provide strong evidence that simulation does indeed affect choice behavior.

In Study 8b, we also included a control condition in which participants described the screenshot representing one of the video options, rather than fully simulating the experience of

watching the video. We wanted to know whether participants in the description control condition chose the video corresponding to the screenshot they described more than the non-described video. We again ran a chi-square goodness of fit test on the frequencies of participants who choose the described vs. the non-described video. Consistent with the idea that priming and perceptual processing alone are insufficient to sway choice, participants in the describe screenshot control condition were not significantly more likely to choose the described video than would be expected by chance (82 out of 149, or 55%), $\chi 2$ (1, N = 149) = 1.51, p = .22, Cohen's w = .10 [.01, .26] (Figure 20). Thus, merely being re-exposed to an option or describing the visual appearance of the option is not enough to explain the observed effect of simulation on choice.

In our main preregistered analysis for Study 8b, we conducted a more rigorous test comparing the percent of participants who chose the video they simulated in the simulation condition to the percent of participants who chose the video whose screenshot they described in the control condition. We conducted a two-way chi-square goodness of fit test on the frequencies of people choosing the video they simulated/described vs. the one they did not across the two conditions. Although people who merely described the screenshot chose that video at a numerically lower rate than those who simulated, the difference between these two percentages (62% for the simulated video vs. 55% for the described screenshot) was not significant, $\chi 2$ (1, N = 287) = 1.28, p = .26, Cohen's w = .07 [.00, .18].

Simulation increases excitement for but not enjoyment of the chosen video

We also explored whether simulation affected how people experienced their decisions relative to people who decided without simulating beforehand. It is possible that the act of simulation could lead people to be more excited about their choice and to enjoy the chosen video more, given the extra time spent imagining their future experience. Alternatively, simulation could lead to post-decisional regret or less enjoyment of the chosen video, especially if the actual experience did not match their expectations.

First, we examined whether people who simulated a video were more excited about watching their chosen video compared to people who described a visual illusion (Study 8a) or a video screenshot (Study 8b). We conducted independent-samples t-tests comparing mean excitement ratings between the two conditions (simulation vs. control). In Study 8a, participants in the simulation condition (M_{sim} = 4.39, SD_{sim} = 1.40) were more excited ($M_{sim} - M_{con}$ = 0.45, 95% CI[0.11, 0.79]) about the upcoming video compared to those in the imagery control condition (M_{con} = 3.94, SD_{con} = 1.52) , t(279.17) = 2.60, p <.01, d = .31. This finding replicated in Study 8b, t(275.52) = 2.99, p = .003, d = .35. That is, participants who simulated a video option (M_{sim} = 4.43, SD_{sim} = 1.43) were more excited about their chosen video ($M_{sim} - M_{con}$ = 0.48, 95% CI [0.16, 0.80]) compared to those who described a video screenshot (M_{con} = 3.95, SD_{con} = 1.29).

We then asked whether participants who simulated a video enjoyed their chosen video more after watching it. We tested this using independent-samples t-tests to compare mean video enjoyment ratings between the simulation condition and the control condition for both studies. Despite their increased excitement, participants who simulated their future experience before deciding did not enjoy the video they chose more than participants who did not simulate, in both Study 8a, t(281.26) = 0.19, p = .85, d = .02, and Study 8b, t(276.76) = 0.74, p = .46, d = .09. There were no consistent differences between the simulation and control conditions on any of the other measures of decision or video experience, including certainty in decision (pre- or post-), post-decisional regret, or interest in the non-chosen video after watching the chosen video (see Supplementary Results in Appendix C). Together these findings suggest that simulation affects which option is chosen without changing one's perception or experience of the options.

Discussion

Studies 8a and 8b replicated Study 7: people chose to watch a video they simulated over one they did not. Describing one of the video screenshots did not alter choice, indicating that the effect of simulation on choice cannot be explained by mere exposure. Participants who simulated

a video were more excited about their chosen video immediately after deciding but before watching it. These positive expectations did not carry over into evaluations of the video *after* watching it. Thus, as in Study 7, there are limits to how much simulation impacts decision evaluations.

Chapter Conclusion

Across six studies, we find support for the hypothesis that simulating a possible future increases the likelihood of choosing that future. Simulation changed people's hypothetical choices for real-life personal decisions and their actual choices in controlled scenarios. When considering options in everyday life, people spontaneously simulated ones they were initially most likely to choose, and simulated options became even more likely to be chosen. When deciding between two novel – but otherwise equally desired – snacks or videos, people chose the one they were directed to simulate. Together, these findings demonstrate the power of mere thought to impact decisions.

The simulation feedback loop

We found evidence that simulation is part of a feedback loop. The loop starts with people simulating options they already think are likely. In our naturalistic study (Study 5), participants spontaneously thought about options they were initially more likely to choose. This is consistent with prior findings that the options that come to mind first are the ones that have been effective before (Klein, 1993, 2005; Morris, Phillips, Huang, & Cushman, 2021) or reflect the default (Johnson et al., 2007; Phillips et al., 2019; Weber & Johnson, 2011). Simulation is one tool people might use to deliberate among their most plausible options.

On the other side of the feedback loop, simulation makes options seem more likely. In Studies 5-6, participants thought they would be more likely to choose options they simulated for their personal decision, consistent with prior findings that repeated simulation increases an

event's perceived plausibility (Szpunar & Schacter, 2013). Here, changes in likelihood occurred after just one simulation. Simulation also decreased people's likelihood of choosing the non-simulated option. If a simulated future is implausible, however, people may be unlikely to enter this feedback loop (Garcia Jimenez, Mazzoni, & D'Argembeau, 2023). For decisions with viable alternatives, however, simulation could be the tipping point that leads one option to be considered further and ultimately chosen.

Memory-based models of decision-making are consistent with this feedback loop. Query theory proposes that thinking about reasons increases their accessibility while inhibiting alternatives (Johnson et al., 2007; Weber & Johnson, 2011). The reasons people mention initially when deliberating continue to be mentioned further as people get closer to the decision. Computational modelling likewise shows that memory is optimized to sample similar thoughts. As people sample "thoughts" from memory, evidence accumulates for the more often sampled option at a faster rate. Sampling then stops when there is sufficient evidence to make a decision (Zhao, Richie, & Bhatia, 2022). We expect that simulation functions similarly by making simulated options more likely to be spontaneously simulated again. Future research could test this possibility using ecological momentary assessment to capture spontaneous simulation as it unfolds over the time leading up to a decision.

Feedback loops are consistent with work on perceptual attention and decision-making. For simple choices with all options visible, people initially direct their eyes toward the best uncertain options (Callaway, Rangel, & Griffiths, 2021). Then, the more one looks at the option, the more likely they are to ultimately choose it (Krajbich, Armel, & Rangel, 2010; Isham & Geng, 2013). Experimentally guiding the eyes to linger on one option longer biases choice in its favor (Armel, Beaumel, & Rangel, 2008; Tavares, Perona, & Rangel, 2017). Our work shows that considering an option in the "mind's eye" before deciding also increases its choice likelihood.

That said, simply looking at and describing a screenshot of a video option did *not* increase choice likelihood, suggesting that simulation goes beyond these purely perceptual effects.

Applying the power of simulation

How can people harness this power of simulation in applied settings? Clinicians already use simulation to help clients align choices with their goals and values. Psychotherapists use imagery-based methods to rescript memories (Arntz, 2012; Holmes, Arntz, & Smucker, 2007) and process emotions (Ji, Heyes, MacLeod, & Holmes, 2016; Lang, 1977). Our studies suggest that simulating specific futures could also help clients make decisions.

Directed simulation is not always good. Imagining committing acts of harm increases – rather than decreases – how likely one thinks they are to actually commit such acts (Morris, Gaesser, & Cushman, 2022). Likewise, in our studies, both positive and negative simulated options became more likely to be chosen. Could the perceived likelihood of choosing a simulated negative option actually translate into choice behavior? Even if people do not act on imagined negative futures, the belief that they *might* do so could have negative effects on mental health and well-being.

Could simulation also impact societal decisions over longer time frames? Prioritizing short term futures at the expense of long-term goals could contribute to continued engagement in unsustainable behaviors (Kunreuther & Weber, 2014). Simulation interventions aimed to motivate behavior change by imagining catastrophic future climate impacts could backfire by making them seem more plausible and harder to avoid. A more effective strategy might be to simulate sustainable short-term behaviors. Policy makers should be aware of the potential impact of spontaneous simulation on longer-term societal decisions (Constantino & Weber, 2021; Johnson et al., 2022).

We find reliable evidence that imagining the future does not just reflect our choices, it changes them. Simulation-induced decision change adds to existing literature on the impact of episodic simulation. Not only can simulation bring fictional stories to life (Tamir et al., 2016), help us see others' perspectives (Vollberg, Gaesser, & Cikara, 2021), and change how we view our selves (Rubin-McGregor, Zhao, & Tamir, 2022), it can help us decide which stories to read, who to spend time with, and which life paths to take.

5

Conclusion

Autobiographical thought helps us to form a sense of self based on our past experiences. It allows us to create stories of our lives and share those stories with others. It is core to our sense of well-being and social connection. Autobiographical thought also allows us to extend the self into the future. The studies presented in this dissertation demonstrated these three core functions of autobiographical thought – self, social, and directive – in dynamic experimental and naturalistic contexts. In this final chapter, we review the main findings of the studies presented in this dissertation, revisit the forms and functions of autobiographical thought, and consider the clinical implications of this research.

Summary

To summarize the main findings of the studies presented in this dissertation, in Chapter 2, we found that more densely connected autobiographical thought structures – particularly across memories *and* self statements – are actually less conducive to a clear and strong sense of self. In Chapter 3, conversing about personal topics with other people strengthened the self via shared identity and led structurally central – but not peripheral – individuals to identify with a newly formed group. Finally, in Chapter 4, we found that simulating options for autobiographical decisions – and common day-to-day choices like what to eat and what to watch – increased

people's likelihood of choosing the future they imagined. Taken together, the studies extend the functional perspective on autobiographical thought.

Revisiting the three functions

Beyond merely demonstrating the self, social, and directive functions of autobiographical thought, the research presented in this dissertation suggests overlap among the functions, particularly the self and social functions. It also points to a possible cognitive mechanism – retrieval induced forgetting – that might underly all three functions, although we did not directly test it across all sets of studies. In this section, we revisit the three functions in terms of this mechanism, then discuss their potential overlap.

Possible cognitive mechanism

Basic cognitive-level processes, such as retrieval-induced forgetting, could be an important mechanism underlying the functions of autobiographical thought. Recall from the discussion section of Chapter 4 that retrieval-induced forgetting is the reduced accessibility of certain memories or information after recalling related information. This process can be triggered by either individual recall (RIF; Anderson et al., 1994) or social interactions (SS-RIF; Coman, Manier, & Hirst, 2009; Stone, Barnier, Sutton, & Hirst, 2013). It allows us to create distinct representations of different events in episodic memory and concepts in semantic memory (Hulbert & Norman, 2015). Although there could be other mechanisms by which autobiographical serves its functions, we focus on RIF here because our *relational* approach allowed us to look at the effect of autobiographical thinking on both the thoughts that people rehearsed as well as the ones they did not.

RIF could help explain the self-function of AM. Selectively recalling positive events from a period of one's life could reduce accessibility of related, negative events from the same period, thus supporting the self-enhancement function (Marsh, Edginton, Conway, & Loveday,

2019). Similarly, telling narratives that include only certain continuity-consistent events could reduce the accessibility of less consistent events, thus supporting the self-continuity function of memory. On the other hand, however, repeatedly recalling negative autobiographical thoughts – as in rumination – could reduce the accessibility of related positive memories, having the opposite effect and disrupting one's sense of self (Small, Kenny, & Bryant, 2011). By perpetuating negative, general autobiographical thoughts, RIF could be the mechanism by which the overall structure of autobiographical thought becomes centralized around negative memories or self-views (Chapter 2). Rumination-induced RIF could also contribute to the formation of overgeneral memory as repeatedly recalling one negative event could lead to difficulty accessing specific memories of other events (Hauer & Wessel, 2006; Matsumoto, Mochizuki, Marsh, & Kawaguchi, 2021).

In terms of the social function, merely listening to a speaker talk about their autobiographical memories can lead to retrieval-induced forgetting of the listener's own memories, making them more aligned with the speaker's (Coman et al., 2009; Stone et al., 2013). Such socially shared retrieval-induced forgetting (SS-RIF) can facilitate social bonding and strengthen group identity among group members (Coman & Hirst, 2015), similar to the effects we found in Chapter 3. An important factor for SS-RIF to occur is concurrent covert rehearsal, that is the listener internally remembering along with the speaker. In the case of autobiographical memory sharing, this covert rehearsal could be in the form of mentalizing and imagining the speaker's experience as they tell their autobiographical stories. People are more likely to engage in these co-remembering processes when they are motivated to relate to one another (Hirst & Echterhoff, 2012) and when the speaker's stories are also self-relevant for the listener (Mao, An, Ji, & Li, 2021). The shared memories resulting from SS-RIF can help to build common ground and shared reality, which are important for building close relationships with others (Echterhoff, 2014; Higgins, Rossignac-Milon, & Echterhoff, 2021).

Lastly for the directive function, the reduced accessibility of certain autobiographical thoughts resulting from retrieval-induced forgetting could influence people's behavior. Thinking about some possible futures reduces the accessibility and plausibility of alternative futures (Szpunar & Schacter, 2013). Our work in Chapter 4 similarly found that simulating a decision option not only enhanced the simulated option but also diminished the non-simulated option. This is consistent with the query theory of decision making in which thinking about reasons for one course of action – usually the status quo – reduces the accessibility of reasons for other options (Weber & Johnson, 2011). The more we "rehearse" one behavior, the less likely we are to engage in another behavior. In the memory domain, suppressing memory for another person's positive or negative traits via retrieval induced forgetting can influence future social behavior, leading people to sit closer or further from the person (Fernandes & Saunders, 2013). This last example demonstrates a potential overlap between functions, specifically the social and directive functions.

Overlap among functions

Although most of the studies in this dissertation tested one specific function of autobiographical thinking, we also found some evidence for overlap among the three functions. For example, we looked at the intersection of the self and social functions in Study 3 (Chapter 3) by testing how sharing personal thoughts with other people leads to shared identity (the social function). In that same study, the degree to which conversation fostered shared identity and social validation – perhaps via statements like "I agree" – led to a clearer sense of self (the self function). Connecting the social and directive functions, behavioral data from Study 4 (Chapter 3) of how many people came back to participate in the follow-ups to contribute to their group could speak to the effect of conversational-memory sharing on future social behavior. We have little data to speak to the overlap between the self and directive functions, but recent research has found that simulating self-defining future events increases feelings of present-future self

continuity that could lead to those events actually occurring (D'Argembeau & Garcia Jimenez, 2023; Garcia Jimenez & D'Argembeau, 2022; Garcia Jimenez, Mazzoni, & D'Argembeau, 2022). Future research could study how imagining possible selves, rather than just simulating future events, affects how people make decisions, especially important, self-defining ones.

In daily life, there is likely even more interaction among the functions of autobiographical thinking than there is in an experimental context. For example, remembering a positive first date at a modern art museum could reinforce one's view of themselves as creative, increase feelings of intimacy with the person they are dating, and lead them to suggest going on a similar date in the future. Memories like this that serve multiple functions might be more central to a person's autobiographical thought structure, a hypothesis that could be tested using the AM-I network procedure we developed in Chapter 2. Having participants rate the functions of each "I remember…" statement using selected items from the *Talking About Life Experiences* scale designed to assess the functions of memories (Bluck & Alea, 2011), researchers could explore how the functions relate to the structure of autobiographical thought.

Some research has even suggested a single overarching goal of all three functions of autobiographical thought: uncertainty reduction (Olivares, 2010; Olivares & Others, 2012). Autobiographical thought helps people reduce uncertainty about events by helping people make choices or deal with unexpected events. By fostering self-continuity and a coherent identity, it also reduces uncertainty about the self. Lastly, autobiographical thought helps us to form stable relationships and even representations of others' lives to help us predict people better. These representations of others' lives could even constitute another form of autobiographical thought.

Other forms of autobiographical thought

In addition to episodic memories, semantic self-knowledge, and future thought, recent work has identified additional forms of autobiographical thought. The structure of our own

autobiographical thought system likely goes beyond the self to integrate representations of other people's lives as well as alternate versions of our own lives. These allobiographical and counterfactual thoughts serve similar functions as the other categories of autobiographical thought. Juxtaposing who we are with who other people are and who we might have been can inform and contextualize our sense of self, our relationships, and our futures.

Allobiographical memory

As alluded to in Chapter 1, people do not just have representations of their own lives, but also the lives of important others. This allobiographical category of thought includes vicarious memories, family narratives, and collective events – either historical or lived through (Thomsen et al., in preparation). Vicarious memories not only connect us to others, they also serve an important self function, strengthening personal identity (Lind & Thomsen, 2018; Pillemer, Thomsen, & Fivush, 2024), suggesting that allobiographical memories are integrated into our own autobiographical representations. For example, knowing about the lives of our family members, group members, or romantic partner – with whom we share important identities – can help us model and find meaning in our own lives. The identity-salience of allobiographical memories likely plays a role in how detailed and influential representations of other people are in our own autobiographical thought structures.

The AM-I network method introduced in Chapter 2 could be applied to the study of allobiographical memories and their role in autobiographical thought. For example, participants could generate personal autobiographical memories ("I remember…"), self-statements ("I am…") and allobiographical memories ("I was told…"), then assess the relations among these types of recollections. This could help us answer the question of *how* people integrate other people's memories into their sense of self. For collective events, researchers could provide a list of group-based events in conjunction with the autobiographical memories and identities that participants generate themselves. Exploring how those collective events are integrated into different people's

autobiographical knowledge base could also be a fruitful line of research linking allobiographical memory and identity to other forms of autobiographical thought.

Counterfactual thought

Another form of autobiographical that could be particularly relevant for both identity and decisions is counterfactual thought. In addition to imagining the future, people can also create simulations of alternate pasts or presents – how things might have been but are not (De Brigard & Parikh, 2019). Like episodic memories, episodic counterfactual thinking primarily serves a self and social function (Özbek, Bohn, & Berntsen, 2018). Positive counterfactuals – "if only" things had been different – can also serve a directive function by motivating people to seek out or restore those positive alternatives in the future (Krott & Oettingen, 2018).

"If only" counterfactuals can also be dysfunctional, however, especially when people contrast their current state with a "better" one that could have occurred had they done something differently. Self-critical rumination on counterfactual thought can lead to feelings of regret and depression (Allaert, De Raedt, Sanchez-Lopez, September, & Vanderhasselt, 2023; Allaert, De Raedt, van der Veen, Baeken, & Vanderhasselt, 2021; Broomhall, Phillips, Hine, & Loi, 2017). In order to better understand how rumination relates to autobiographical thought, it could be important to study counterfactual simulations of the past in addition to episodic memories. People who ruminate might be more likely to center counterfactual thoughts like who they "should be" or things they "could have" done, rather than who they are or what they actually experienced. AM-I networks (Chapter 2) could be a way to study how people integrate counterfactual thoughts into their sense of self.

Counterfactual thinking could also play an important role in how people feel about themselves and their decisions after making them (Chapter 4). When reflecting on important autobiographical decisions from the past, people might wish they had made a different choice.

Similar to simulating the future, imagining alternate pasts can lead people to think those pasts were more plausible (De Brigard et al., 2013). What effect might feeling like you really could have done things differently in the past have on self-views in the present? Future work in line with the studies presented in this dissertation could test how imagining the counterfactual experience of the non-chosen option (vs. the chosen one) for a past autobiographical decision affects how people feel about the option they chose and their sense of self in the present.

Other functions of autobiographical thought

When they first identified the three functions of autobiographical memory described in this dissertation – self, social, and directive – Bluck and Alea (2003) did not claim that these were the only functions. Rather they thought of them as a starting point and hoped that future research would identify and study additional functions of autobiographical thought. Indeed, more recent research, for example, has found that a four-factor model including two social functions – nurturing existing relationships and forming new relationships – is a better for than a three-factor model for the original *Thinking About Life Experiences* scale designed to assess the self, social, and directive functions. In Chapter 3 of this dissertation, we tested this "forming new relationships" function of autobiographical thought, expanding the literature on this less explored social function of autobiographical memory.

Similarity to reminiscence functions

Recent work has also integrated the functions from the autobiographical memory literature with functions identified in the reminiscence literature. Reminiscence, usually studied in older adult populations, includes more than just the self, social, and directive function. The *Reminiscence Functions Scale* (RFS; Webster, 1993) include: "identity," "teaching/informing," "problem-solving," "intimacy maintenance," "conversation," "boredom reduction," "bitterness revival," and "death preparation" functions. When items from the *TALE* and the *RFS* were

combined and factor-analyzed together, researchers found four functions: reflective (similar to the self function), generative (similar to the directive function), social (similar to the social function), and ruminative (Harris, Rasmussen, & Berntsen, 2014). As our findings from Chapter 2 and the addition of a ruminative "function" indicate, autobiographical thought can be both functional and dysfunctional.

To date, the functions of other forms of autobiographical thought, like episodic future and counterfactual thinking, have been studied apart from the functions of autobiographical remembering. In Chapter 4, we applied the directive function to simulation, but future thinking also has its own *Functions of Future Thinking Scale* (FFS; Hallford & D'Argembeau, 2022). The FFS includes some similar functions to the Reminiscence Functions Scale: boredom reduction, death preparation, identity contrasting, negative emotion regulation, positive emotion regulation, social bonding, goal setting, planning, problem solving, decision making. Counterfactual thought has also been shown to serve identity contrasting, affective regulation, and preparatory functions (Roese, 1994). Given the functional similarity of different types of autobiographical thought, it may make sense to study them together in future research, rather than separately, as we did in this dissertation.

Emotion regulation

An important final function of autobiographical thought – emotion regulation – also appears to be common across all forms of autobiographical thought (Barsics, Van der Linden, & D'Argembeau, 2016; Pascuzzi & Smorti, 2017). Both autobiographical memory recall and imagination have been used as effective affect induction procedures in experimental work (Joseph et al., 2020; Schubert, Eloo, Scharfen, & Morina, 2020). Recalling positive memories can help people regulate their negative emotions (Josephson, 1996; Öner & Gülgöz, 2018). García Márquez anticipated this function as well, when he wrote: *"La memoria del corazón elimina los malos recuerdos y magnifica los buenos" ["The heart's memory eliminates the bad and*

magnifies the good"] (García Márquez, 1997). People can also use distancing strategies, such as shifting to an observer visual perspective or using third- pronouns when recalling autobiographical memories, to help regulate intense emotions associated with past negative events (Gu & Tse, 2016; Öner & Gülgöz, 2018). In line with the emotional perspective on the functions of autobiographical thought, in Chapter 2 of this dissertation, we found that the most important predictor of sense of self and mental health was the proportion of positive to negative autobiographical thoughts in a person's AM-I network. This emotion regulation function is especially relevant for clinical applications of research on autobiographical thought.

Clinical implications

Although we did not test its effects directly, psychotherapy is based largely on social interactions discussing the client's life experiences, present behavior, and future goals. The functions of autobiographical thinking are thus important to understand and explore in a clinical context. A major goal of therapy is to help people improve their sense of self and well-being, form a strong client-therapist relationship, and help people engage in more adaptive behavior in the future. All three empirical chapters of this dissertation – and their corresponding functions of autobiographical thought – have important implications for clinical settings.

Overgeneral memory

In Chapter 2, we saw that people who were experiencing more symptoms of depression made a lot of connections among their memories and sense of self. Overgeneral memories might not occur only at the level of the memory itself, where details are omitted or "avoided" to prevent the person from experiencing a negative emotional response (Hallford, Austin, Raes, & Takano, 2018), but also at the level of the autobiographical thought system as a whole. Overgenerality could occur because depressed individuals perceive everything in their lives to be connected,

making it hard to be specific about their memories when activating one memory also activates a whole host of other memories and views of themselves.

The goal of therapy could then be to sparsify connections in autobiographical thought. Talk therapy often involves discussing life events and narrating connections between them. One way of treating depression could be to reframe interpretations of events (cognitive) but it could also involve not talking about events at all and instead focusing on actions in the moment (behavioral approach). Behavioral therapy has been shown to be more effective than cognitive therapy for treating depression (Dimidjian et al., 2006). In order to sparsify the structure of autobiographical thought, it could help people with depression to focus on one thing in the present moment in line with a mindfulness-based therapeutic approach (Andrews-Hanna et al., 2013; Kabat-Zinn, 2003). Chapter 4 focused on the effect of imagining a single option (rather than all possible options) and found that doing so helps people make decisions. Future research could test the effect of focused simulation on decision making in clinical populations.

Therapeutic alliance

In psychotherapeutic contexts, it is often the relationship between therapist and client rather than any specific theoretical approach (e.g., cognitive-behavioral, psychodynamic, etc.) that best explains the therapeutic outcome (Lambert & Barley, 2001; Wampold, 2015). This is in line with our finding from Chapter 3 that conversing with other people helps us feel more connected to ourselves and others, regardless of whether we talk about autobiographical thoughts or random bits of information. Taken together with our finding from Chapter 2 that too many connections among autobiographical thoughts can actually be worse for sense of self and well-being, therapists might consider focusing less on the content and more on the functions of autobiographical thought in practice.

Limitations and future directions

Autobiographical thought is admittedly a very broad and pervasive topic: it comes in many forms and people do so much of it. Our "default mode" is to think about the world in reference to ourselves and to reflect on our personal past and future as we try to make sense of our present. Given that people spend so much of their daily lives in autobiographical thought, there is an abundance of potential data to collect on this topic. Promising directions for future research could involve the use of modern technology to capture the functions of autobiographical thinking unfolding in daily life.

Ecological momentary-assessment (EMA) methods, which record data from people going about their daily lives, have proven especially useful in the study of autobiographical thought. Over the past twenty years, research using electronically activated recorders to capture ambient sounds in people's natural environment have helped researchers to capture the social function of autobiographical thought unfolding in real conversations (Demiray et al., 2019; Kaplan et al., 2023). Smartphone-based EMA methods have also allowed researchers to characterize naturally occurring autobiographical memories, including involuntary memories, which are difficult to capture in the lab (Colombo, Wrzesien, & Baños, 2024; Finnbogadóttir & Berntsen, 2013; Haag, Philipp, & Kleim, 2023). Such methods also allow for more real-world interventions to extend the findings of the current research out of the lab and into people's lives. Although we included longitudinal follow-ups in the studies in this dissertation, we still only captured two or three moments in time, whereas EMA methods can capture more frequent data and give a better understanding of the temporal dynamics of autobiographical thought.

Research on autobiographical thought could also benefit from more open-science practices, although it poses more ethical concerns than other types of research. For example, it is often difficult to share open data sets of autobiographical thought content because of the personal sensitivity of the responses. Historically, researchers have tried to get around this by telling

participants not to reveal any identifying information in their autobiographical memories, use initials rather than names when talking about other people in their memories, and write their responses in such a way that they know what they mean but they do not necessarily need to be interpretable to others. Modern methods, like the text analysis (Chapter 3) and AM-I networks (Chapter 2) used in this dissertation, can help researchers abstract from specific autobiographical details inherent to raw narrative-type data while still maintaining information about the types of relationships people make in their autobiographical thoughts and conversations.

Concluding remarks

What better way to end this dissertation than with some autobiographical thoughts? In reflecting on the process of conducting these studies and writing this dissertation, I return to the introductory quote, but rephrased to pertain to document in hand:

"My research is not the studies I conducted, but how I remember them in order to share them."

- in the spirit of Gabriel García Márquez

Hopefully you, dear reader, have learned something about the functions of autobiographical thought from this dissertation. I certainly used them all while writing it.

As all authors do, I tried to imagine these words from your perspective as I put them down on the page. First of all, who are you? Are you my committee members, my friends and colleagues, my future children? You might be interested in assessing the quality of the work, or you might just be curious about what I did all those years I was in Princeton. Perhaps you are someone I do not know personally: a fellow researcher conducting your own studies on autobiographical thought or a fellow PhD student seeking an exemplar while in the throes of writing your own dissertation. Whoever you are, thinking about *your* state of mind and reasons for reading this dissertation shaped the words as much as my own intentions while writing it. I

hope this process of mentalizing helped me to succeed in connecting with you on a pseudo-social level.

I also made a lot of decisions while writing, ranging from the most important – should I even keep doing this: yes or no? – to the more mundane – which kind of graphs should I use: violin plots or bar graphs? I have been envisioning finishing this dissertation for many years, and here I am, writing the final paragraph, living the future I imagined. Being a graduate student has been a core part of who "I am" and earning a PhD has been a future event in my "life story" for so long. I am certain I only persisted in writing this dissertation because these things are so central to my sense of self. To my future self – and future readers – I hope you remember this dissertation and integrate it into your own narratives, conversations, and decisions. Even if you recall nothing about the details of the studies, may you at least remember the functions of autobiographical thought and the purpose of life according to García Márquez: "*Vivir para contarla" ["Living to tell the tale"].*

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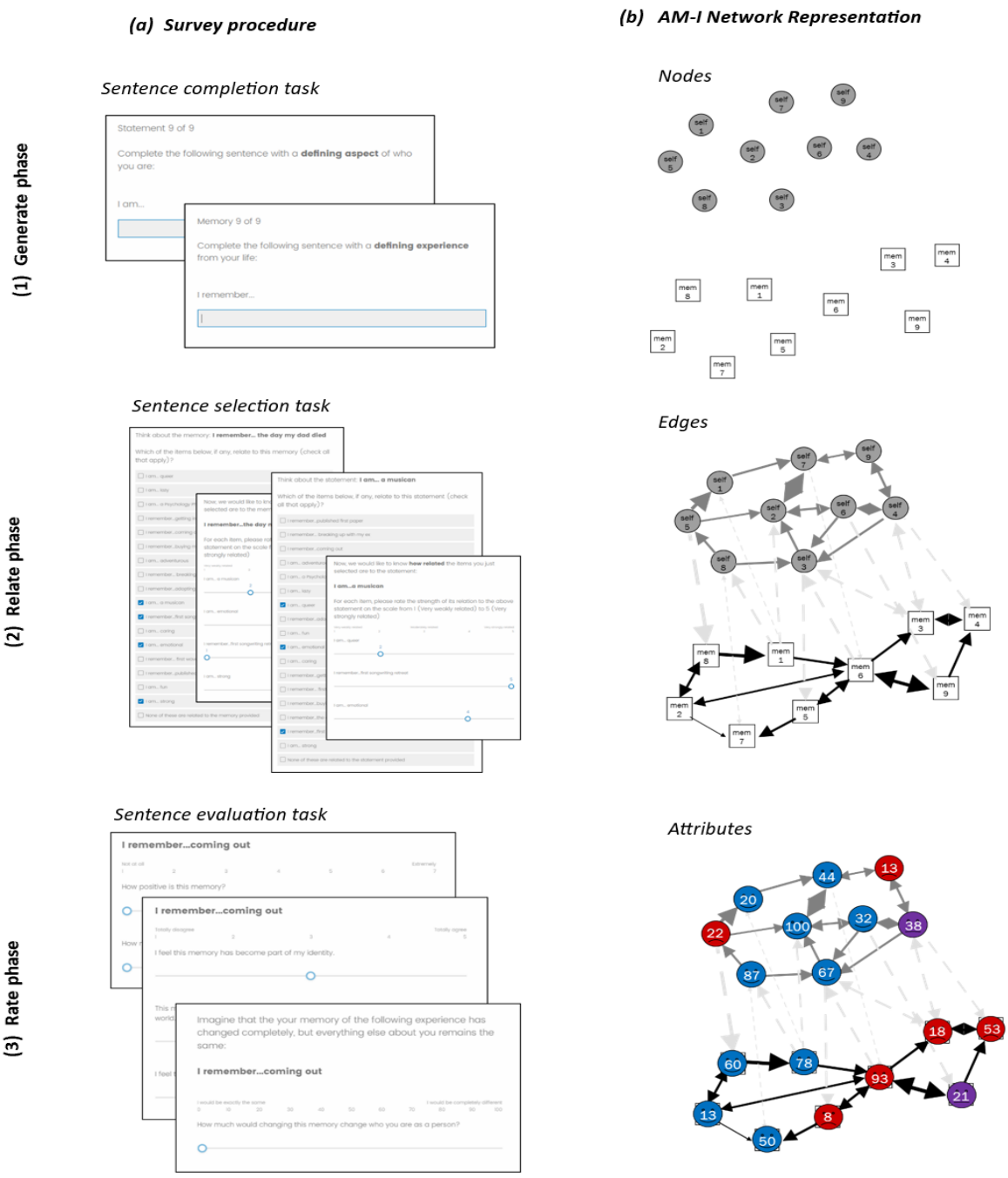
Appendix A

This Appendix contains supplemental results and figures for Chapter 2. The supplemental information is organized and numbered according to the order of the studies presented in the main text (Studies 1-2).

Supplementary Figure A1.

Overview of Autobiographical Memory-Identity Network Procedure



Note. This Figure is a summary of Figures XX – XX in the main text. Survey procedure (side a) and corresponding AM-I network components (side b) for each phase of the AM-I network procedure: (1) generate, (2) relate, and (3) rate. The specific responses shown in this Figure are hypothetical for illustration purposes only.

Supplementary Table A1.

Linear models predicting sense of self, self-referential thought, and mental health outcomes from positive/negative node centrality (network-based or self-reported) and mood in Study 1

	Sense of self		**Self-referential thought**		**Mental health**	
Predictors	Self-concept clarity (SCC)	Personal identity strength (PID)	Rumination (RRQ)	Reflection (RRQ)	Depression (BDI-II)	Anxiety (STAI trait)
Negative model						
Network centrality of most negative node (degree)	-0.31 ***	-0.21 *	0.28**	0.10	0.21 *	-0.15
Centrality rating of most negative node (CES)	-0.12	0.02	0.30**	0.12	0.08	0.25 *
Current negative mood (PANAS)	-0.36 ***	-0.26 **	0.29**	-0.04	0.67 ***	0.36 ***
Multiple R2	**0.32**	**0.13**	**0.42**	**0.03**	**0.54**	**0.25**
Adjusted R2	**0.31**	**0.11**	**0.40**	**-0.01**	**0.51**	**0.22**
	***	***	***		***	***
Positive model						
Network centrality of most positive node (degree)	-0.01	-0.00	0.07	0.23	0.05	-0.09
Centrality rating of most positive node (CES)	0.05	0.23 **	0.02	0.05	-0.08	0.09
Current positive mood (PANAS)	0.19 *	0.23 **	-0.21	0.12	-0.36 **	0.15
Multiple R2	**0.04**	**0.12**	**0.06**	**0.08**	**0.16**	**0.04**
Adjusted R2	**0.02**	**0.10**	**0.02**	**0.03**	**0.12**	**-0.00**
		***			**	

Significance levels: * .05 ** .01 *** .005 ****.001

Note. Standardized beta coefficients for models predicting each outcome measure (SCC, PID, Rumination, Reflection, Depression, or Anxiety) from three valence-based predictors (network centrality of most positive/negative node, centrality rating of most positive/negative node, and positive/negative mood). Bold asterisks at the bottom of the columns indicate whether the overall model significantly predicted the outcome variable.

Supplementary Table A2.

Individual correlations between network-level AM-I measures and primary outcomes in Study 1

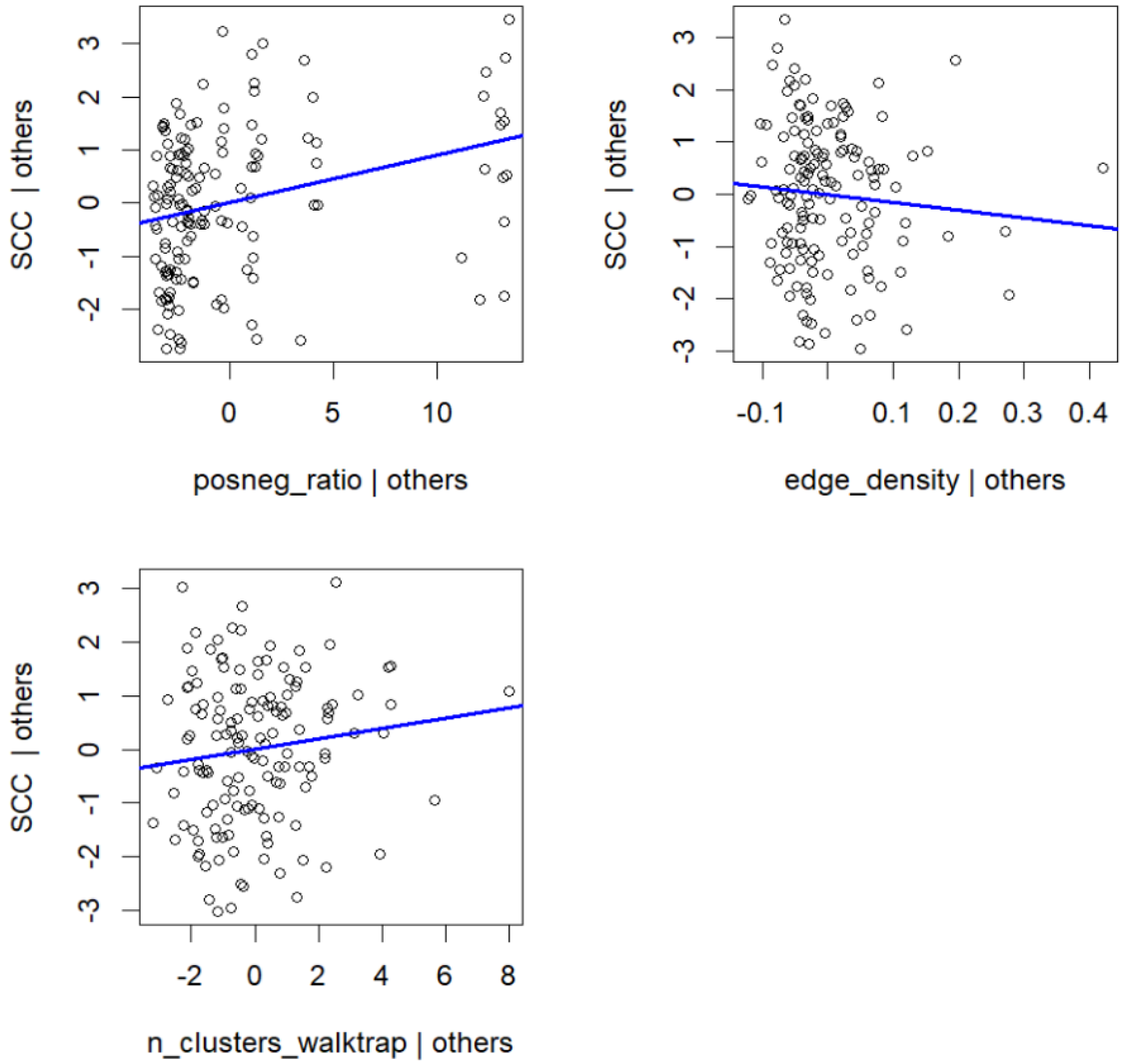
	Sense of self		**Self-referential thought**		**Mental health**	
Predictors	Self-concept clarity (SCC)	Personal identity strength (PID)	Rumination (RRQ)	Reflection (RRQ)	Depression (BDI-II)	Anxiety (STAI trait)
Density	**-.18***	-.08	**.29***	**.32****	**.23***	-.07
Mem ties	-.13	-.05	.11	-.03	.08	-.14
Self ties	-.12	-.03	.12	**.42******	.14	-.01
Cross ties	**-.18***	-.07	**.28***	.14	.20	-.09
Centralization	-.16	-.08	**.32*****	.16	.18	.06
Clusters	**.17***	.01	-.17	-.11	-.12	.05
Pos-neg ratio	**.29******	**.33******	**-.53******	.18	**-.45******	**-.37******

Significance levels: *.05 **.01 ***.005 ****.001

Note. Pearson's *r* values for the correlations between AM-I network-level measures (density, centralization, number of walk-trap clusters, and ratio of positive to negative nodes) with sense of self, self-referential thought, and mental health outcomes.

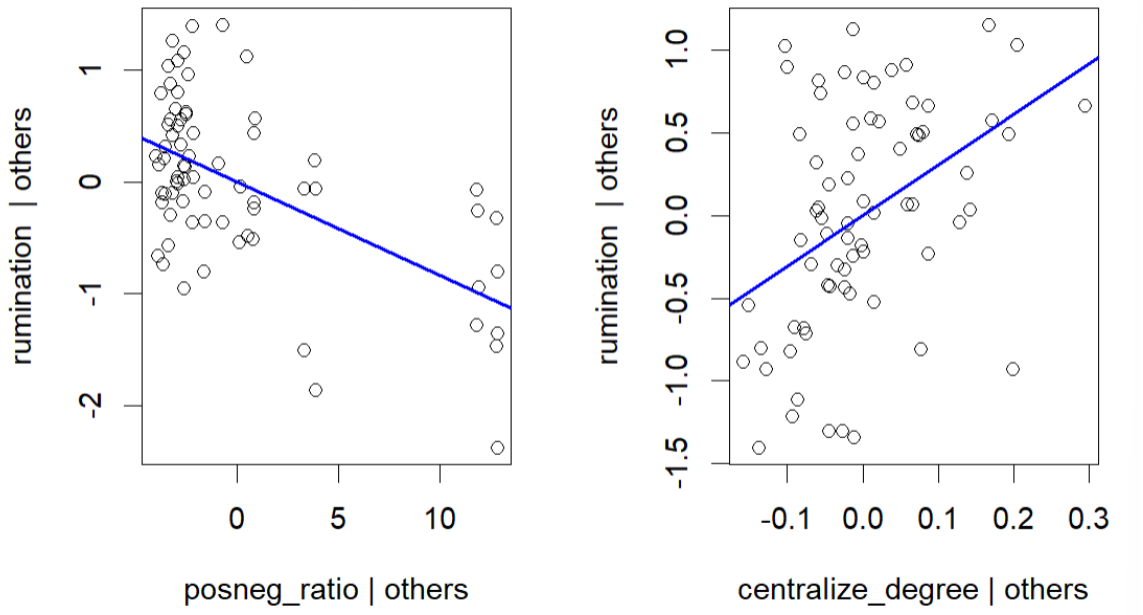
Supplementary Figure A2.

Added variable plots for best subsets model predicting self-concept clarity in Study 1



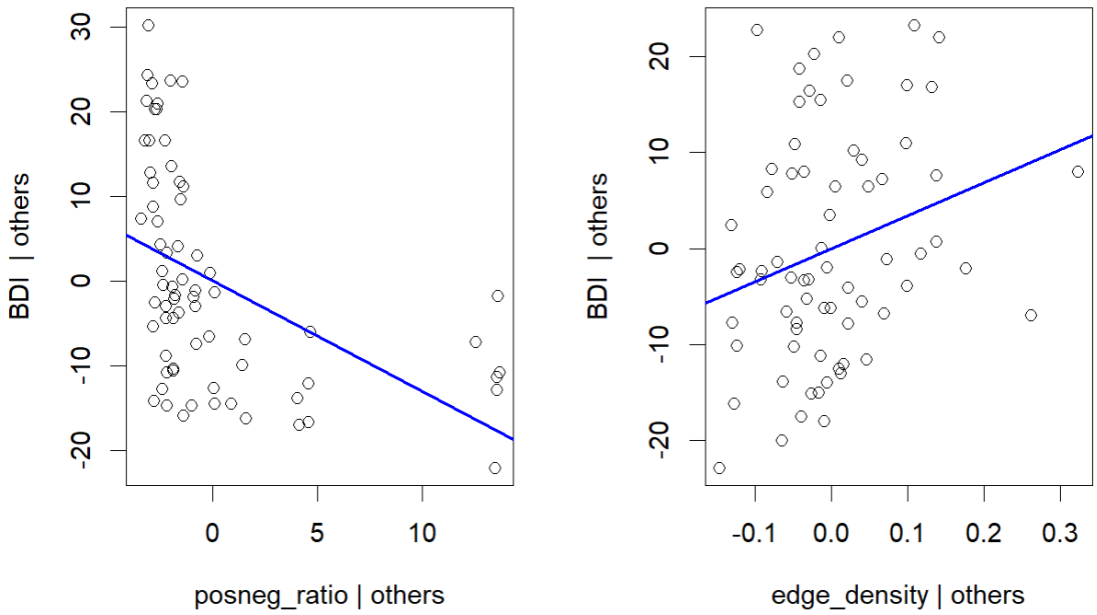
Supplementary Figure A3.

Added variable plots for best subsets model predicting rumination in Study 1



Supplementary Figure A4.

Added variable plots for best subsets model predicting depression in Study 1



Appendix B

This Appendix contains supplemental tables and figures for Chapter 3. The supplemental information is organized and numbered according to the order of the studies presented in the main text (Studies 3-4). Additional information about Study 3 can also be found at the OSF link associated with the manuscript version of the chapter.

Supplementary Table B1.

List of custom stop words removed prior to linguistic analysis in Study 3

important	want
life	need
think	hope
feel	get
satisfied	thing
satisfaction	things
dissatisfied	also
dissatisfaction	like
unsatisfied	hello
meaningful	hi
meaning	hey
wish	oh
wishes	well
future	lol
would	bye
could	goodbye

Supplementary Table B2a.

Top 12 most frequent words in the introspection condition of Study 3

Word	***Frequency***
Family	179
Happy	103
People	101
Good	82
Time	77
Money	70
Friends	68
Love	68
Able	66
Better	64
Others	58
Health	57

Supplementary Table B2b.

Top 12 most frequent words in the conversation condition of Study 3

Word	***Frequency***
Family	134
Good	101
Happy	52
Time	47
Agree	46
People	45
Friends	40
Health	39
Yes	37
Happiness	33
Yeah	31
Money	30

Supplementary Figure B1a.

Word cloud of most frequently occurring words in introspection condition of Study 3



Supplementary Figure B1b.

Word cloud of most frequently occurring words in conversation condition of Study 3



Supplementary Table B3.

Mixed-model ANOVA predicting group identification ratings from condition and network position in Study 4

Predictor	df	Sum Sq	Mean Sq	*F* -value	*p*-value
Time (pre- or post-conversation)	1	19.4	19.36	16.95	.00005****
Condition (self, Princeton, information)	2	1.1	0.53	0.46	.63
Network position (number of chats, ranging 1-5)	1	5.9	5.94	5.20	.02*
*Time*condition*	2	0.7	0.37	0.33	.72
*Time*network position*	1	16.8	16.82	16.82	.0001****
*Condition*network position*		3.4	1.71	1.50	.23
*Time*condition*network position*	2	1.1	0.55	0.48	.62
Participant error	1	0.29	0.29		
Residuals	387	442.1	1.14		

Significance levels: * .05 ** .01 *** .005 ****.001

Supplementary Table B4.

Comparison of mean group identification ratings by conversational network position in Study 4

Number of conversations (network position)	Mean group identification		
	Pre-	Post-	Change (post -pre)
(most peripheral)			
1	4.12 (0.91)	3.88 (1.28)	-0.25 [-0.66, 0.16]
2	4.12 (1.04)	4.35 (1.25)	0.22 [-0.11, 0.56] ^{o}
3	4.03 (1.00)	4.38 (1.03)	0.35 [-0.02, 0.72] **
4	3.78 (1.17)	4.90 (0.96)	1.13 [0.71, 1.54]
5	4.00 (0.93)	4.75 (1.01)	0.75 [0.32, 1.18]
(most central)			

Significance levels: ^{o} .1 * .05 ** .01 *** .005 ****.001

Note. Mean group identification ratings (pre-conversation, post-conversation, and the change from pre to post conversation) for participants of each of the five network positions from most peripheral (1 conversation) to most central (5 conversations). Superscripts between two means indicate that they differ significantly at the level indicated. Parentheses contain standard deviations (for the pre- and post- rating). Square brackets contain the 95% confidence interval of the estimate of the mean difference (for the change from pre- to post-).

Supplementary Table B5.

Mixed-model ANOVA predicting group identification ratings from mean partner identification and chat similarity ratings position in Study 4

Predictor	df	Sum Sq	Mean Sq	*F* -value	*p*-value
Time (pre- or post-conversation)	1	19.4	19.36	19.68	.00001****
Mean partner identification	1	40.5	40.50	41.07	< .00001****
Mean chat similarity	1	0.1	0.14	0.14	.71
*Time*mean identification*	1	41.1	41.14	41.72	< .00001****
*Time*mean similarity*	1	1.2	1.19	1.21	.27
Mean identification mean similarity*	1	0.2	0.18	0.19	.67
*Time*mean identification*mean similarity*	3	2.5	2.48	2.52	.11
Participant error	1	0.29	0.29		
Residuals	391	385.6	0.99		

Significance levels: * .05 ** .01 *** .005 ****.001

Appendix C

This Appendix contains supplemental tables and results for Chapter 4. The supplemental information is organized according to the order of the studies presented in the main text (Studies 5-8). It is also available in the OSF link associated with the manuscript version of the chapter. The study numbers and figure numbers have been adapted to match the order of the dissertation.

Supplementary Results

Descriptive Results for Study 5

Mean number of options per decision

The number of options generated in Study 5 was close to ceiling (M = 4.15 options, SD = 1.03), see Supplementary Table C1. All participants (N = 165) generated at least two options, and the majority (N = 113) generated the maximum five options. Of the participants who did not generate five options (N = 52), 8 generated the minimum two options, 24 generated three options, and 20 generated four options.

Mean importance of decision

On average, participants rated their decisions as moderately important, both initially (M = 6.39, SD = 2.88) and one week later (M = 6.39, SD = 2.82), see Supplementary Table C1. The modal decision importance rating was 10 Extremely important at both Time 1 (N = 27) and Time 2 (N = 24). Very few participants rated their decision as 0 Not at all important (N = 4 at both Time 1 and Time 2).

Decision timing

We prompted participants to provide a decision that they anticipated making more than one week in the future, without specifying a maximum time frame. Participants provided decisions that were relatively proximal, with most participants (N = 76) reporting decisions they anticipated making within 1-3 weeks. Very few participants (N = 10) reported decisions they anticipated making in more than a year, with no participants reporting decisions more than 5 years in the future. Despite our instructions, some participants (N = 28) reported decisions they anticipated making in less than one week, and a majority of those participants (N = 23) had already made their decision at the one-week follow-up. We included these decisions in our analyses but analyzed participants who had already decided at Time 2 separately (see analyses for

"deciders" and "non-deciders" in the main text). For those who had made the decision already, they were on average highly satisfied with the decision, see Supplementary Table C1.

Supplementary Table C1

Decision Descriptive Statistics for Studies 5, 6a and 6b

Measure	Study 5		Study 6a			Study 6b	
	Time 1	Time 2	Pre-simulation	Post-simulation	One week follow-up	Pre-simulation	Post-simulation
Importance	*M* = 6.39 *SD* = 2.88	*M* = 6.39 *SD* = 2.82	*M* = 5.63 *SD* = 2.86		*M* = 6.07 *SD* = 3.03	*M* = 5.83 *SD* = 2.89	
Spontaneous simulation	*M* = 5.01 *SD* = 2.38	*M* = 5.40 *SD* = 2.45			*M* = 5.64 *SD* = 2.67		
Thought	*M* = 5.95 *SD* = 2.62	*M* = 6.48 *SD* = 2.64					
Talked	*M* = 4.07 *SD* = 2.85	*M* = 4.32 *SD* = 2.90					
Satisfaction		*M* = 8.13 *SD* = 2.22					
Number of options	*M* = 4.15 *SD* = 1.03		*M* = 2 *SD* = 0			*M* = 2 *SD* = 0	
Option spread	*M* = 48.79 *SD* = 25.95	*M* = 55.50 *SD* = 26.01	*M* = 34.87 *SD* = 27.08	*M* = 39.26 *SD* = 28.34		*M* = 32.35 *SD* = 25.43	*M* = 35.82 *SD* = 29.00

Note. Importance, *thought*, *talked*, and *satisfaction* were rated on Likert-type scales ranging from 0 (not at all) to 10 (extremely). For Study 5, *spontaneous simulation* was computed as the mean of *thought* and *talked* ratings. For Study 6a, a single *spontaneous simulation* item asked about both thinking and talking using the same 0 to 10 scale. In Study 1, *satisfaction* ratings were only provided by participants (N=23) who reported having already made their decision at Time 2. The maximum *number of options* participants could generate for Study 5 was 5. In Studies 6a and 6b, all participants generated exactly 2 options by design. *Option spread* was calculated as the range of likely to choose ratings for the set of options generated for a given decision. The maximum option spread was 100. Blank spaces indicate a measure was not reported in that Study at that time point.

Supplementary Results

Valence Analyses for Studies 6a and 6b

Similar to the valence analysis reported in the main text for Study 5, we were interested in whether the change in likelihood to choose an option from before to after simulation depended on the initial valence of the option in Study 6. For both Studies 6a and 6b, we conducted a preregistered analysis using a linear mixed effects model to test whether the interaction between an option's initial valence rating and whether or not the option was simulated predicted the change in its likelihood-to-choose rating. We centered the continuous predictor (initial valence) because we were testing its interaction with a dummy-coded predictor (simulation). To account for the repeated measures in our data, we included participant as a random intercept. In Study 6a, there was a significant main effect of simulation on change in the self-reported likelihood of choosing an option (see Supplementary Table C2a). The main effect of initial valence and the interaction effect of simulation with initial valence were both non-significant. This pattern was similar for Study 6b (see Supplementary Table C2b).

The robust main effect of simulation on likelihood to choose the simulated option suggests that the overall effect reported in the main Results and Discussion sections for Study 6 in the manuscript holds regardless of the initial valence of the option. That is, simulation increased self-reported likelihood of choosing both positive and negative options. In Study 5, *spontaneous simulation* (i.e., participants' naturally occurring simulation of an option over the course of a week) was associated with larger increases in likelihood to choose for options that were initially rated as more positive (with smaller increases in likelihood to choose negative options that were spontaneously simulated more). Contrary to this finding from Study 5, the effect of *directed simulation* (i.e., our randomly assigned manipulation to simulate one of the two options) in Studies 6a and 6b was not stronger for initially positive options.

Supplementary Table C2a

Coefficients for valence analysis for Study 6a

	Coefficient	S.E.	df	t	Sig.
Intercept	-2.52	0.87	674	-2.91	.004
Simulated	4.22	1.23	674	3.44	.001
Pre-simulation valence (mean-centered)	0.20	0.17	674	1.17	.24
*Simulated*Pre-simulation valence*	0.14	0.25	674	0.55	.58

Supplementary Table C2b

Coefficients for valence analysis for Study 6b

	Coefficient	S.E.	df	t	Sig.
Intercept	-2.43	1.25	442	-1.95	.05
Simulated	3.65	1.76	442	2.07	.04
Pre-simulation valence (mean-centered)	0.01	0.25	442	0.05	.96
*Simulated*Pre-simulation valence*	0.04	0.37	442	0.11	.91

Supplementary Results

Exploration of Simulation Features for Studies 6a thru 8b

In the studies where we directly manipulated which option was simulated, we also explored whether the detail of the simulation predicted the likelihood of choosing the simulated option in the simulation condition. Did longer, more vivid simulations make participants want to choose the simulated option more? Descriptive statistics for simulation word count and vividness ratings across the five studies (6a, 6b, 7, 8a, and 8b) are presented in Supplementary Table C3a.

Word Count

In-person undergraduate participants simulating snacks in Study 7 provided the longest simulations (an average of about 80 words), followed by online participants simulating their own personal decision options in Studies 6a and 6b (an average of about 50 words), and online participants simulating video options in Studies 8a and 8b (an average of about 42 words). Compared to the video simulation condition, online participants describing a visual illusion in Study 8a provided significantly shorter descriptions (an average of about 35 words), $t(249.71) = 3.42$, $p < .001$, whereas those describing a video screenshot in Study 8b provided marginally longer descriptions (an average of about 47 words), $t(282.6) = -1.91$, $p = .06$.

For personal decisions in Studies 6a and 6b, we tested the relationship between simulation word count and the change in likelihood of choosing the simulated option using Pearson's product-moment correlation tests. For personal decisions, simulation length did not significantly predict increases in the likelihood of choosing the simulated option, in either Study 6a, $r = -.04$[-.14, .07], $t(338) = -0.70$, $p = .49$, or Study 6b, $r = .09$[-.04, .22], $t(221) = 1.30$, $p = .20$. For snack and video decisions, we used binomial logistic regression to predict whether participants ultimately chose the option they simulated (vs. the non-simulated option) from the length of their simulation text. Simulation length *did* significantly predict snack choice for our

small sample (N = 34) in Study 7, β = -0.04, *SE* = 0.02, z = -2.13, p = .03. Participants who ultimately chose the non-simulated option wrote longer simulations (M = 94.90 words, *SD* = 23.53) than those who chose the simulated option (M = 71.30 words, *SD* = 27.29). This finding is in the opposite direction of what we would have predicted and did not replicate for video choices in Study 8a, β = 0.01, *SE* = 0.01, z = 1.41, p = .16. In Study 8b, we found the opposite pattern of results: simulation length significantly predicted video choice, β = 0.02, *SE* = 0.01, z = 2.13, p = .03, with participants who chose the simulated video writing longer simulations (M = 44.85 words, *SD* = 22.80) than those who chose the non-simulated video (M = 36.61, *SD* = 17.46).

Vividness

On average, participants rated the simulations for their own personal decision options as about a 7 out of 10 on the rating scale (see Supplementary Table C3). For the simulations of snacks and videos, as well as the descriptions of the optical illusion and video screenshots, participants rated the vividness closer to the middle of the scale, about a 5 out of 10. There was no statistical difference between the vividness ratings for the simulation and control conditions in Study 8a, t(272.48) = 0.89, p = .38, or Study 8b, t(274.71) = 1.33, p = .19.

To test whether the self-reported vividness of participants' simulations predicted the change in likelihood to choose rating for the simulated option in Studies 6a and 6b, we conducted Pearson's product-moment correlation tests. For personal decisions, there was a positive but non-significant correlation between vividness and change in choice for the simulated option (Study 6a: r = .06[-.05, .17], t(337) = 1.10, p = .27; Study 6b: r = .10[-.03, .23], t(221) = 1.53, p = .13). For snack and video decisions, we tested whether participants' simulation vividness ratings predicted whether they ultimately chose the simulated option (vs. the non-simulated option) using binomial logistic regression. Simulation vividness did not significantly predict snack choice in Study 7, β = -0.03, *SE* = 0.44, z = -0.07, p = .95, nor did it predict video choice in Study 8a, β = 0.25, *SE* = 0.17, z = 1.49, p = .14. Simulation vividness, did, however, predict video choice in

Study 8b, $\beta = 0.38$, $SE = 0.17$, $z = 2.16$, $p = .03$, with participants who chose the simulated video reporting more vivid simulations ($M = 5.40$, $SD = 0.97$) than those who chose the non-simulated video ($M = 4.99$, $SD = 1.15$).

Supplementary Table C3

Simulation Descriptive Statistics for Studies 6a thru 8b

Measure	Study 6a	Study 6b	Study 7	Study 8a		Study 8b	
				Simulation condition	Imagery condition	Simulation condition	Describe condition
Word count	*M* = 49.82 *SD* = 27.09	*M* = 50.71 *SD* = 30.18	*M* = 78.94 *SD* = 28.11	*M* = 41.97 *SD* = 21.55	*M* = 34.61 *** *SD* = 14.15	*M* = 41.75 *SD* = 21.26	*M* = 46.99 *SD* = 25.20
Vividness	*M* = 7.41 *SD* = 1.78	*M* = 7.25 *SD* = 1.68	*M* = 5.69 *SD* = 0.84	*M* = 5.29 *SD* = 1.15	*M* = 5.18 *SD* = 0.91	*M* = 5.24 *SD* = 1.06	*M* = 5.08 *SD* = 0.94

*Note. For Studies 8a and 8b, asterisks indicate a significant difference between the means for the two conditions to the left of the asterisks, at the level: *p < .05, **p < .01, ***p < .005*

Supplementary Results

Exploratory Analyses for Studies 8a and 8b

Decision Evaluations

In the main manuscript, we reported the exploratory finding that participants were more excited about the video they chose before watching it when they had simulated a video ahead of time (as opposed to engaging in a control task). We also reported that participants did not actually enjoy the video more after watching it when they had simulated ahead of time, despite feeling more excited initially. Supplementary Table 8a shows the means and standard deviations for all of the exploratory evaluation ratings we collected: decision certainty (before and after watching the chosen video), regret about the choice after watching the chosen video, and interest in the other video at the end of the study.

In addition to being more excited about the video, participants in the simulation condition in Study 8b were more certain about their choice both before and after watching the chosen video compared to those in the control condition. We did not find these differences in Study 8a comparing simulation to an imagery control condition, and they were only significant at the p = .05 level, so we report them with caution given the number of exploratory comparisons we made. Future research on the effect of simulation on decision certainty could be warranted.

Rumination and Reflection

In Study 8b, we also explored whether individual differences in self-referential processing – specifically, thinking a lot about oneself in a positive, welcome way (Reflection) and/or in a negative, intrusive way (Rumination) – related to how participants felt about their decisions after being asked to simulate what it would be like to choose one of their options. As simulation is itself a form of self-referential thought, we thought that participants who tend to

ruminate more might feel worse about their decision after simulating an option, whereas those who tend to reflect more might feel better about their decision after simulation.

To get a sense of how people engage in self-referential processing, we first examined the correlation between Rumination and Reflection scores. Do people tend to ruminate *and* reflect (a positive correlation), or do they tend to ruminate *or* reflect (a negative correlation)? Overall, there was a significant positive correlation between Rumination and Reflection, $r = 0.21[0.10, 0.32]$, $t(275) = 3.57$, $p < .001$, indicating a general tendency for self-referential processing in which people who ruminate also reflect and vice versa. Nonetheless, the small size of the correlation indicated that Rumination and Reflection did not perfectly predict one another, suggesting they are different constructs and could relate to different aspects of decision-making.

Next, we conducted exploratory Pearson's *r* correlation analyses examining how Rumination and Reflection scores predicted each of the decision evaluation ratings we collected (see Supplementary Table 8b). We found that Reflection predicted multiple aspects of the simulation and decision-making process, whereas Rumination did not. Participants who scored higher on Reflection reported more vivid simulations as well as more excitement, certainty, and enjoyment of their chosen video. Contrary to what we would have expected, neither Rumination nor Reflection was predictive of decisional regret or interest in the other video.

Supplementary Table C4a

Mean Decision Evaluation Ratings in Simulation and Control Conditions for Studies 8a and 8b

Measure	Study 8a			Study 8b		
	Simulation condition	Imagery condition		Simulation condition	Describe condition	
Before watching chosen video						
Excitement about video	*M* = 4.39 *SD* = 1.40	*M* = 3.94 *SD* = 1.52	***	*M* = 4.43 *SD* = 1.43	*M* = 3.95 *SD* = 1.29	***
Decision certainty	*M* = 4.40 *SD* = 1.85	*M* = 4.24 *SD* = 1.75		*M* = 4.45 *SD* = 1.82	*M* = 3.95 *SD* = 1.91	*
After watching chosen video						
Enjoyment of video	*M* = 5.30 *SD* = 1.39	*M* = 5.33 *SD* = 1.45		*M* = 5.34 *SD* = 1.51	*M* = 5.21 *SD* = 1.37	
Decision certainty	*M* = 5.28 *SD* = 1.69	*M* = 5.28 *SD* = 1.73		*M* = 5.44 *SD* = 1.77	*M* = 4.99 *SD* = 1.82	*
Regret about choice	*M* = 1.82 *SD* = 1.27	*M* = 1.79 *SD* = 1.19		*M* = 1.85 *SD* = 1.37	*M* = 1.69 *SD* = 1.12	
Interest in other video	*M* = 2.83 *SD* = 1.60	*M* = 2.83 *SD* = 1.49		*M* = 2.48 *SD* = 1.49	*M* = 2.76 *SD* = 1.53	

*Note. Asterisks indicate a significant difference between the means to the left of the asterisks, at the level: *p < .05, **p < .01, ***p < .005*

Supplementary Table C4b

Correlations between Rumination/Reflection scores and Decision Evaluations in Study 8b

Measure	*Rumination*	*Reflection*
Before watching chosen video		
Simulation vividness	*r* = -.02	*r* = 22***
Decision timing	*r* = .02	*r* = .06
Excitement about video	*r* = .07	*r* = .20***
Decision certainty	*r* = .16**	*r* = .16**
After watching chosen video		
Enjoyment of video	*r* = .02	*r* = .15*
Decision certainty	*r* = .06	*r* = .16**
Regret about choice	*r* = .04	*r* = -.02
Interest in other video	*r* = .00	*r* = .08

*Note. Asterisks indicate a significant correlation at the level: *p < .05, **p < .01, ***p < .005*

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