Check for updates

aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Current Directions in Psychological Science
1–9
© The Author(s) 2023
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/09637214221143053
www.psychologicalscience.org/CDPS
SAGE

Psychological Momentum

Christopher J. Honey[1], Abhijit Mahabal[2], and Buddhika Bellana[3]
[1]Department of Psychological & Brain Sciences, Johns Hopkins University; [2]Content and Discovery, Pinterest, San Francisco, California; and [3]Department of Psychology, Glendon Campus, York University

Abstract
Our mental experience is largely continuous on the scale of seconds and minutes. However, this continuity does not always arise from a volitional carrying forward of ideas. Instead, recent actions, thoughts, dispositions, and emotions can persist in mind, continually shaping our later experience. Aspects of this fundamental property of human cognition—*psychological momentum*—have been studied under the rubrics of mindset, mood, memory, task set, and mind wandering. Reviewing these largely independent threads of research, we argue that psychological momentum needs to be understood from an integrated perspective as an adaptation that, although sometimes costly, carries forward thoughts and dispositions that respond to the current and future environment.

Keywords
interference, memory, mind wandering, mindset, mood, replay, rumination, task set

Our thoughts are connected, not only on the scale of seconds, as one thought flows into another, but also on the scale of many minutes, as recent thoughts and associations return to mind. For example, we might review relevant material to ensure it is "fresh in mind" before an interview or test. But the persistence of mental content does not require such volition. We may struggle to focus on a work meeting if an earlier personal conversation is "stuck in our head" or is "on our minds." Similarly, we may read a story or watch a movie and then find that themes, characters, or moods effortlessly linger in our minds after the narrative ends (Fig. 1). Readers have coined the term "book hangover" to describe the lingering immersion that shapes their thoughts and feelings for minutes (or days) after finishing a novel (v1ncetta, 2017).

What is shared across these examples? We posit that the common thread is a fundamental property of human psychology: that contentful mental states can effortlessly persist and return to mind for several minutes or more, even in the absence of external cues or overt goals. We will refer to this phenomenon as *psychological momentum* and ask the following questions: Does it have an adaptive or a rational explanation? How can it be prevented or magnified? After reviewing research on memory, task switching, and mind wandering, we will sketch the outlines of a model that could generate testable predictions.

In a recent study, we observed psychological momentum by measuring the content of spontaneous thought after reading a story (Bellana et al., 2022). Each participant in our study generated free-associate word chains, both before and after reading a 2,000- to 3,000-word narrative (Fig. 2a). General story themes (e.g., "death" or "love") and specific narrative entities (e.g., "river" or "spy") were overexpressed in free-associate chains generated after, compared with before, they read each story (Fig. 2b). The lingering phenomenon increased among participants who felt "transported" by the text they had read, the lingering was reduced among those who read a version of the story with sentence order randomly scrambled, and the lingering was eliminated in participants who read the story's words in a scrambled order in the context of a verbal working memory task (Fig. 2c). Finally, most participants reported that the narrative lingering occurred without volition, with many describing it as an unwanted interference in their subsequent thought (Fig. 2d). For example, one participant wrote,

> I think I almost tried to not use words/themes that were in the text as I didn't want to have been

Corresponding Author:
Christopher J. Honey, Department of Psychological & Brain Sciences, Johns Hopkins University
Email: chris.honey@jhu.edu

Fig. 1. Our thoughts and actions at one moment (e.g., watching a movie; left) effortlessly persist to shape thoughts and actions minutes later, even when those former ideas are not obviously relevant to the later context (e.g., outside of the movie theater; right). Illustrated by Rita Terra (@ritzz_ritzz_).

> influenced by the text. I realised I was coming up with blanks/dead ends a little more the second time as I didn't want to go towards darker themes or water based themes [from the story].

Another participant wrote,

> In the first round, the words I typed were considerably more organic than those in the second round, as I could not really get the story out of my head after reading it, so many of the associations were related to extraneous thoughts or associations with the story itself.

With these results in mind, we provide the following working definition of psychological momentum: the lingering of contentful mental states over several minutes, even in the absence of external cues or goals. By *contentful*, we mean that a lingering mental state must be related to specific features of a recent experience (e.g., thoughts of "spying" and "spies" after reading a story involving these topics).

Why is psychological momentum worthy of study? Consider that each waking moment of our lives is embedded in a stream of thought whose content shapes what we think about next. As human thought is marked by this history dependence, psychological momentum implies that the degree of history dependence is not fixed. Instead, some inputs have the potential to shape our subsequent thought and behavior more than others (Faber & D'Mello, 2018). Characterizing the kinds of inputs and ways of thinking that give rise to this momentum will be critical for any complete understanding of human cognition. Moreover, because the persistence of negative mental content (e.g., rumination) is a hallmark of posttraumatic stress, depression, and anxiety disorders (Spinhoven et al., 2018), a model of how such processes arise and can be modulated will be relevant to advances in mental health. On the other hand, mental persistence can also be beneficial, enabling us to find creative solutions to open-ended problems even when we are ostensibly focused on a separate task (Gable et al., 2019). If we wish to develop intelligent machines that can learn and solve open-ended problems, it may help to understand how humans revisit their recent thoughts and experiences (Wittkuhn et al., 2021).

We intend the term *psychological momentum* to operate by rough analogy with physical momentum. Though this terminology is imprecise, we hope it captures the intuitive notion that thoughts can possess direction (toward a particular question or region of semantic space) and intensity (enabling them to resist control and to outcompete other thoughts). When a ball is set in motion in a direction, it acquires momentum and continues to move in the original direction after

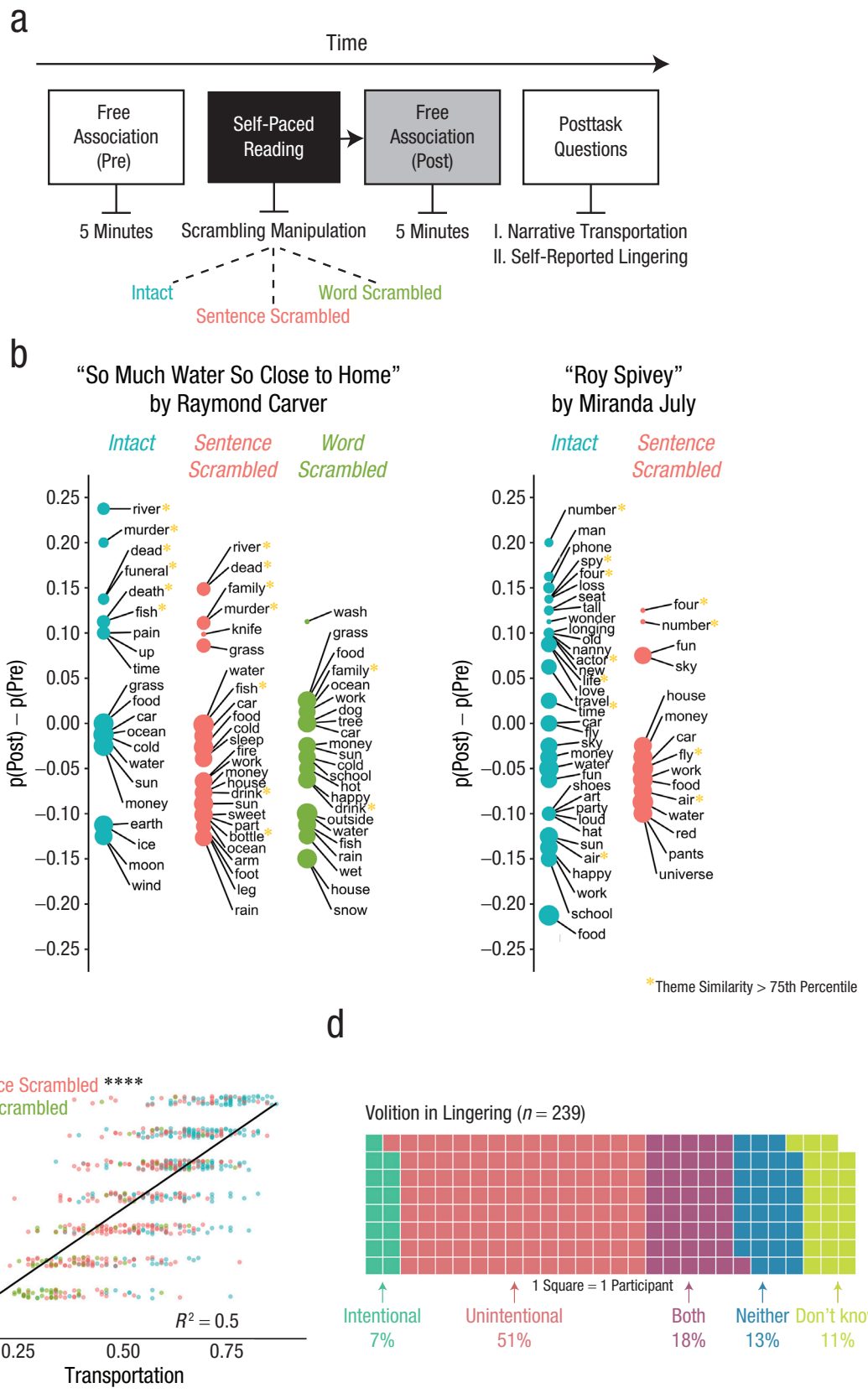
a
Time
Free Association (Pre)
Self-Paced Reading
Free Association (Post)
Posttask Questions
5 Minutes
Scrambling Manipulation
5 Minutes
I. Narrative Transportation
II. Self-Reported Lingering
Intact
Word Scrambled
Sentence Scrambled
b
"So Much Water So Close to Home" by Raymond Carver
"Roy Spivey" by Miranda July
Intact
Sentence Scrambled
Word Scrambled
p(Post) − p(Pre)
*Theme Similarity > 75th Percentile
c
Intact
Sentence Scrambled ****
Word Scrambled
Self-Reported Lingering
Transportation
$R^2 = 0.5$
d
Volition in Lingering ($n = 239$)
1 Square = 1 Participant
Intentional 7%
Unintentional 51%
Both 18%
Neither 13%
Don't know 11%

Fig. 2. Immersive stories linger in mind. (a) Schematic of the experimental paradigm from Bellana et al. (2022). Online participants performed free association (i.e., typing whatever words came to mind as they came to mind) for 5 min before and after reading a short story. To manipulate the coherence of the story, we randomly assigned each participant to read an intact version, a version with sentence order randomly scrambled, or a version with word order randomly scrambled. Participants in the word-scrambled condition were intermittently probed with a verbal working memory task concerning the sentence they had just read. (b) Specific themes and words from the story were overexpressed in poststory free association. "So Much Water So Close to Home" is about a wife who suspects her husband may have murdered a young girl while on a fishing trip. "Roy Spivey" is about a woman who sits beside a celebrity (a famous actor in spy movies) on an airplane. The two find that they like one another, and the celebrity shares his phone number—withholding one number that he asks her to commit to memory: four. The overexpression of a word in free association, or bias, was calculated by subtracting the proportion of prestory free-association chains containing a given word, p(pre), from the proportion of poststory free-association chains that contained the same word, p(post). Positive values reflect words that were more likely to occur in poststory than in prestory free association. Negative values reflect words that were more likely to occur in prestory than in poststory free association. Asterisks denote theme words that showed the strongest semantic similarity with participant-generated story themes for each story, calculated using word embeddings. For more details about how theme similarity was calculated, see Bellana et al. (2022). For readability, only free associates that occurred in at least 16% of free-association chains or showed a 10% bias for pre- or poststory are displayed. The size of the points reflects p(pre). (c) The extent to which an individual feels as if the story lingers in their mind after reading is strongly predicted by the extent to which they found themselves transported into the world of the story. Each point represents one participant. Data are collapsed across all stories in Experiment 1 from Bellana et al. (2022). The diagonal line indicates the best-fitting linear regression (**** = $p < .001$). (d) A separate group of participants ($n = 239$) performed this paradigm and were asked to describe the intentionality of lingering, if they experienced any. Most participants endorsed lingering as unintentional. Figure panels adapted from Bellana et al. (2022).

the initiating force is removed. Similarly, when we are cued to consider a particular idea or event, we continue to consider that idea or event even after the initial cue is removed. And just as the momentum of a ball is increased when its mass or velocity is increased, psychological momentum is increased when the number of thoughts or the intensity of each thought is increased in a particular direction.

Below, we will argue that psychological momentum is understudied and that understanding it requires the integration of psychological, neuroscientific, and computational ideas. First, we will ask how psychological momentum can be understood in relation to existing ideas about mindsets, memory, task sets, and mind wandering. Second, we will consider the functional consequences of psychological momentum and the key ingredients required for a testable process-level model of this aspect of our thinking.

Momentum as a Mindset

Can psychological momentum be understood as an induced mindset? It appears that mindsets can be induced, and they do persist over time. For example, Herz et al. (2020) marshaled a large literature to argue that we continually shift between "narrow" and "broad" states of mind, in which our perception varies between sensory driven and expectation driven, our attention from global and local processing, our thoughts from expansive to constrained, and our moods from positive to negative. Similarly, in the domain of memory, instructing people to recall and describe precise details can induce a specific mode of recollection that lasts for minutes and affects the divergence of subsequent thought (Madore et al., 2015). It is also possible to induce affective states that linger over time, in turn shaping the affective quality of spontaneous thought (Andrews-Hanna et al., 2022) and the way that unrelated material is encoded into memory (Tambini et al., 2017) or used to update predictions of reward (Eldar et al., 2016).

Although taking on a mindset can be a part of our experience of psychological momentum, a mindset (e.g., broad vs. narrow) does not involve the persistence of specific content from a past event. After two children see their favorite fantasy action movie in the theater (Fig. 1, left), they may run around the lobby happy, energetic, and with an expansive mindset. However, psychological momentum is meant to capture not only this induced mindset but also how the specific episodic and conceptual content of the film persists in mind. For example, the children may repeat their favorite character's catchphrase; they may find themselves thinking about bravery, about shields, about the brilliant crimson of dragon fire; they may spend time imagining what it is like to possess magical powers; and they may play-act counterfactual variations of their favorite scenes (Fig. 1, right). In sum, although mindsets and moods do persist and are a part of any model of psychological momentum, we must look to further neural and psychological processes to understand how specific events and concepts spontaneously persist in mind.

Momentum as Memory

Because psychological momentum involves the persistence of specific mental content (i.e., thoughts,

memories, emotions, and dispositions) over time, it is natural to think of it as a form of memory. Should we understand it as a manifestation of working memory, long-term memory, or another mnemonic process?

If we define working memory as the maintenance of a limited amount of information in a state of heightened availability for ongoing processing (Cowan, 2017), then working memory appears to be an appropriate repository for lingering mental content. However, verbal and visual working memory are highly capacity limited and sensitive to interference (Oberauer et al., 2016), which does not seem to be compatible with detailed episodic content that lingers for minutes and forces itself to mind. In fact, our experiments with narrative lingering revealed little lingering of content when the words constituting the story were processed in a verbal working memory task; instead, the lingering effects were most prominent when participants were able to extract situation-level meaning from the words (Bellana et al., 2022). Concretely, this means that if a participant read the word "bread" and focused on its rhyming properties, then the notion of bread would not linger. If they focused on the semantics of the word, then it might linger in mind somewhat. However, if they understood bread as the object of desire of a hungry family, then the notion of bread would be very likely to linger in their mind.

Because processing information in a deep and meaningful way is important for psychological momentum, we should consider how neural and cognitive memory processes are modulated by meaningfulness. Cognitively, Craik and Lockhart (1972) introduced a "levels-of-processing" framework that distinguished deep from shallow processing and proposed that memory is improved when participants attend to what an input means rather than its surface-level physical properties. More recently, we have learned that situationally meaningful information may be represented in a large-scale brain network that includes the medial prefrontal cortex, the posterior cingulate cortex/precuneus, and the angular gyrus. These high-level brain regions, generally known as the default mode network (DMN), are thought to represent and simulate "scenarios," composed of agents (self and other), the goals and outcomes of those agents, and the environments in which they interact. Within the "process-memory" framework, DMN regions are thought to spontaneously integrate past and present information from tens of seconds up to minutes of time (Hasson et al., 2015). Thus, psychological momentum could arise from processing within DMN regions as new information spontaneously interacts with and is contextualized by our recent past.

The processes underlying psychological momentum may also be intertwined with those supporting memory consolidation. It has been known for more than a century (Müller & Pilzecker, 1900) that after we study a series of sounds or images (such as pairs of syllables) they exhibit a "perseveration tendency," spontaneously reentering awareness for several minutes. If we perform another task during this period of perseveration, our memory for the original materials (syllable pairings) is impaired. These seminal observations motivated the idea that information is consolidated into more durable memory in the minutes immediately following the original experience while the information is perseverating (Dewar et al., 2007).

Advances in our understanding of memory consolidation continue to support a potential link between consolidation and momentum. For example, the consolidation of memories into durable storage is thought to rely on memory reactivation in association with high frequency rhythmic events ("sharp-wave ripples") in the hippocampus (Buzsáki, 2015; Wittkuhn et al., 2021). Importantly, the spontaneous reactivation of the neural ensembles associated with past experiences (often referred to as *replay*) is not limited to sleep: Brain states are reactivated in the awake human brain for minutes after an original experience (Higgins et al., 2021; also see potential benefits of postencoding quiescence on memory: Humiston et al., 2019). Moreover, these replay events not only may assist in consolidation and generalization of memories but also may involve reinstatement of lingering mental contexts (Howard & Kahana, 2002), which can bias subsequent decision making (Bornstein & Norman, 2017; Mattar & Daw, 2018; Schuck & Niv, 2019) and might also return previous ideas into our ongoing stream of thought.

It is unclear whether psychological momentum requires the hippocampus. One hippocampal amnesic participant was able to update and integrate episodic information in DMN regions on the scale of a minute (Zuo et al., 2020). Therefore, there may be reverberatory processes within the DMN that can support lingering episodic contexts in the absence of the hippocampus. However, it is also likely that process memory in real-world settings involves a continual interplay between DMN regions and episodic memory systems, such that particular episodic memories are cued by high-level situational contexts and the retrieved information from episodic memory serves to refresh and update the context (Howard & Kahana, 2002). Therefore, measuring lingering mental contexts in amnesic participants will provide critical constraints on theories of psychological momentum.

Thus, on the scale of seconds to minutes, psychological momentum may be mediated by the continual integration and reverberation of episodic information within long-timescale cortical regions of the DMN. On

the timescales of minutes and hours, the same processes that mediate memory consolidation (i.e., tagging and hippocampal replay of memories) may lead to spontaneous reentry of information into DMN systems.

Momentum of Task Sets and Goals

In parallel with the literature on human memory, scientists studying goal-directed thinking and task switching have measured how earlier tasks affect later behavior. A consistent finding is that people are slower and less accurate in task performance immediately after the switch from one task to another. These *switch costs* have been attributed to two sources: first, *task-set reconfiguration* (i.e., the time required for control processes to establish the mental contingencies to perform the new task) and, second, *task-set inertia* (i.e., the interference of prior input–output contingencies with new ones; Wylie & Allport, 2000). Task-set inertia denotes our tendency to carry forward a specific disposition to act, cognitively or motorically, which resonates with the notion of psychological momentum. However, the switch costs reported in the literature decay within a few trials following the switch, and tasks are not usually thought to carry forward specific mental content (i.e., thoughts, memories, and emotions). Still, perhaps task-set inertia could apply to persistent internal tasks that are not yoked to exogenous cues but instead to our persistent goals as self-interested agents (e.g., deriving coherence, finding affection, preserving our self-image).

Of special importance to models of psychological momentum is the proposal that spontaneous human thoughts center on (and return to) a collection of "current concerns" or not-yet-achieved goals (Klinger, 1978). Klinger argued that an individual's current concerns (e.g., working toward a career in health care) can be understood to upweight the features of our external environment or internal thoughts that are relevant to this goal (Klinger & Cox, 2011). These goal-relevant features are then more likely to be noticed, to trigger related thoughts or dreams, or to be remembered. This pioneering work addresses the question of why some experiences are more likely to induce psychological momentum than others (i.e., personal goal relevance), in the tradition of long-standing theories from Gestalt psychology concerning the resolution of psychic tension and "unfinished business" (e.g., Zeigarnik, 1927). This framework could provide the basis of a model of psychological momentum, but it faces difficulties in concretely predicting what content can and will linger. For example, to explain why semantic content lingers after one reads a short story, we need to be able to specify the concerns that will become poststory thoughts: Are they the concerns for a character in the story? Or are they the reader's concern for closure and understanding? Or could they even include general concepts associated with the narrative, such as love?

Momentum as Mind Wandering and Rumination

In the literature on mind wandering and rumination, authors have also proposed accounts of how past thoughts influence those of the future (Christoff et al., 2016; Smallwood & Schooler, 2015). For example, Amir and Bernstein (2022) have modeled the trajectories of cognitive states as arising from transactions among working memory, emotion, and internal/external attentional orientations. Although such models do not predict precisely what will linger in mind, they can explain how patterns of thought can recursively interact so that negative affect at one moment can lead to self-reinforcing patterns of ruminative negative thinking (Andrews-Hanna et al., 2022). But rumination may not be limited to basic affective biases and semantic associations: Bargh (2011) and Dijksterhuis and Strick (2016) have argued that higher cognitive processes can proceed outside of awareness to elaborate and answer unfinished thoughts. Importantly, multiple empirical findings in support of this view have failed to replicate (Nieuwenstein et al., 2015). Still, in light of the anecdotal and empirical evidence for the creative and practical benefits of incubating an idea (Gable et al., 2019), we require concrete models of how thoughts and goals can persist in mind, even when we do not overtly intend or attend them.

What Is the Purpose of Psychological Momentum?

If we want to understand how mindsets, memories, and goal states interact to generate psychological momentum, it can be helpful to first consider the problem normatively: What are the adaptive costs and benefits of lingering? We are familiar with settings in which psychological momentum seems to be maladaptive, as when a conversation has moved on to a new topic, but our thinking is pulled back to an earlier topic. In such settings, past information interferes with present processing. Indeed, a key principle of event-segmentation theory is that only the current "event model" is in working memory (Radvansky & Zacks, 2017), which minimizes interference between past information and current processing. So in what ways can psychological momentum be adaptive?

If the past properties of the world are likely to persist into the future, then it could be adaptive for us to allow previously important information to persist in mind.

Anderson and Schooler (1991) argued that items in memory should be kept "available" proportional to the likelihood that they will be needed in the future. They also argued that the likelihood of needing items in the future is predicted by the rate at which those items were encountered in the past. We can extend this rational argument to apply not only to the persistence of mental content but also to broad dispositions and emotions: If the world was dangerous in the past few minutes, then it is likely to be dangerous again in the next few minutes. In this view, then, it becomes adaptive for our mental states to persist in a world where the statistics are slowly changing so that frequently expressed past information and behavioral needs are likely to recur. Conversely, if we are operating in a world of sharply shifting and unrelated contexts (e.g., speed dating or an unbroken series of unrelated work meetings) then it may be maladaptive for information to linger in mind (see also DuBrow et al., 2017).

The idea that lingering mental content is adaptive has not, to our knowledge, been empirically tested in humans. But to determine which information should (ideally) persist in mind and under what conditions, it may be possible to make progress using simulated agents. For example, Lu et al. (2022) modeled memory encoding and retrieval as actions available to an agent learning an optimal policy for making successful predictions about its environment. In this way, their model connects properties of the environment (e.g., how and when the statistics of the environment shift) with optimal policies on memory maintenance and storage. When the model was exposed to sequences of unrelated events, it learned to selectively retrieve past information at moments of higher uncertainty about the immediate future. Future work may connect such a reinforcement-learning model to the brain, perhaps by understanding the regions of the DMN (and their situation-representation circuitry) as components of a high-level control agent endowed with an episodic memory system (Dohmatob et al., 2020; Gershman & Daw, 2017). Critically, when memory is modeled as a resource available to an agent, then we can understand how the agent uses memory not only to predict states of the world but also to act in the world (Goyal et al., 2022). In this way, we may eventually understand how persisting and replayed mental content not only supports memory consolidation (in the service of learning) but also can provide immediate advantages for problem solving and decision making.

In addition to developing the agentive model sketched above, we will briefly mention some important future directions for understanding psychological momentum. First, we must develop interventions that can block or interfere with lingering mental states, not only to properly characterize causal relationships but also to help people manage unwanted lingering in their lives. Second, given the variability across individuals in the experience of psychological momentum (e.g., Fig. 2c), probing individual differences is crucial (Andrews-Hanna et al., 2022; Yeung & Fernandes, 2021). Third, we must understand whether human language is important for psychological momentum: Do the semantics and syntax of language provide a scaffold that allows latent mental states to persist and be elaborated (Clark, 1998). Finally, we must determine whether psychological momentum depends on a self-related task representation (e.g., "current concerns"; Klinger, 1978) possibly distinct from other kinds of task sets and implemented in DMN circuitry.

Conclusion

The phenomenon of psychological momentum (Fig. 1) can be understood through the lens of memory, in relation to consolidation and generalization, as a kind of persistent task set or mindset or as a form of rumination around current concerns. Each of these lenses reveals a part of this basic feature of human experience, but future work should strive toward an integrated view. To this end, we must theoretically and empirically determine how learning agents manage the demands of competing memories and tasks as they try to solve problems and achieve their goals in a continually changing world.

Recommended Reading

Andrews-Hanna, J. R., Woo, C. W., Wilcox, R., Eisenbarth, H., Kim, B., Han, J., Losin, E. A. R., & Wager, T. D. (2022). (See References). Demonstrates that current concerns from our daily lives shape the trajectory of our spontaneously generated semantic associations.

Bellana, B., Mahabal, A., & Honey, C. J. (2022). (See References). Demonstrates that stories persist in our spontaneous thoughts for several minutes after reading, proportional to the depth of meaning extracted from what was read.

Faber, M., & D'Mello, S. K. (2018). (See References). Emphasizes the importance of stimulus complexity and richness for influencing spontaneous thought.

Herz, N., Baror, S., & Bar, M. (2020). (See References). Argues for the central cognitive role of states of mind or overarching dispositions that fluctuate over time and context.

Lu, Q., Hasson, U., & Norman, K. A. (2022). (See References). Determines the moments at which it is normatively optimal to retrieve memories, by framing memory as a computational resource available to an agent optimized toward a task.

Wittkuhn, L., Chien, S., Hall-McMaster, S., & Schuck, N. W. (2021). (See References). Identifies parallels between replay and learning processes in biological and artificial intelligence.

Transparency

Action Editor: Robert L. Goldstone
Editor: Robert L. Goldstone
Declaration of Conflicting Interests
The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.
Funding
The authors gratefully acknowledge the support of the National Institutes of Mental Health (Grant No. R01MH119099 to C. J. Honey).

ORCID iD

Christopher J. Honey https://orcid.org/0000-0002-0745-5089

Acknowledgments

We thank Simon Brown, Aidan Horner, Morris Moscovitch, Robert Goldstone, and our reviewers for their thoughtful suggestions on earlier versions of this article.

References

Amir, I., & Bernstein, A. (2022). Dynamics of internal attention and internally-directed cognition: The attention-to-thoughts (A2T) model. *Psychological Inquiry*, *33*(4), 239–260.

Anderson, J. R., & Schooler, L. J. (1991). Reflections of the environment in memory. *Psychological Science*, *2*(6), 396–408.

Andrews-Hanna, J. R., Woo, C. W., Wilcox, R., Eisenbarth, H., Kim, B., Han, J., Losin, E. A. R., & Wager, T. D. (2022). The conceptual building blocks of everyday thought: Tracking the emergence and dynamics of ruminative and nonruminative thinking. *Journal of Experimental Psychology: General*, *151*(3), 628–642.

Bargh, J. A. (2011). Unconscious thought theory and its discontents: A critique of the critiques. *Social Cognition*, *29*(6), 629–647.

Bellana, B., Mahabal, A., & Honey, C. J. (2022). Narrative thinking lingers in spontaneous thought. *Nature Communications*, *13*, Article 4585. https://doi.org/10.1038/s41467-022-32113-6

Bornstein, A. M., & Norman, K. A. (2017). Reinstated episodic context guides sampling-based decisions for reward. *Nature Neuroscience*, *20*(7), 997–1003.

Buzsáki, G. (2015). Hippocampal sharp wave-ripple: A cognitive biomarker for episodic memory and planning. *Hippocampus*, *25*(10), 1073–1188.

Christoff, K., Irving, Z. C., Fox, K. C., Spreng, R. N., & Andrews-Hanna, J. R. (2016). Mind-wandering as spontaneous thought: A dynamic framework. *Nature Reviews Neuroscience*, *17*(11), 718–731.

Clark, A. (1998). Magic words: How language augments human computation. In P. Carruthers & J. Boucher (Eds.), *Language and thought: Interdisciplinary themes*. (pp. 162–183). Cambridge University Press.

Cowan, N. (2017). The many faces of working memory and short-term storage. *Psychonomic Bulletin & Review*, *24*(4), 1158–1170.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*(6), 671–684.

Dewar, M. T., Cowan, N., & Della Sala, S. (2007). Forgetting due to retroactive interference: A fusion of Müller and Pilzecker's (1900) early insights into everyday forgetting and recent research on anterograde amnesia. *Cortex*, *43*(5), 616–634.

Dijksterhuis, A., & Strick, M. (2016). A case for thinking without consciousness. *Perspectives on Psychological Science*, *11*(1), 117–132.

Dohmatob, E., Dumas, G., & Bzdok, D. (2020). Dark control: The default mode network as a reinforcement learning agent. *Human Brain Mapping*, *41*(12), 3318–3341.

DuBrow, S., Rouhani, N., Niv, Y., & Norman, K. A. (2017). Does mental context drift or shift? *Current Opinion in Behavioral Sciences*, *17*, 141–146.

Eldar, E., Rutledge, R. B., Dolan, R. J., & Niv, Y. (2016). Mood as representation of momentum. *Trends in Cognitive Sciences*, *20*(1), 15–24.

Faber, M., & D'Mello, S. K. (2018). How the stimulus influences mind wandering in semantically rich task contexts. *Cognitive Research: Principles and Implications*, *3*, Article 35. https://doi.org/10.1186/s41235-018-0129-0

Gable, S. L., Hopper, E. A., & Schooler, J. W. (2019). When the muses strike: Creative ideas of physicists and writers routinely occur during mind wandering. *Psychological Science*, *30*(3), 396–404.

Gershman, S. J., & Daw, N. D. (2017). Reinforcement learning and episodic memory in humans and animals: An integrative framework. *Annual Review of Psychology*, *68*, 101–128.

Goyal, A., Friesen, A., Banino, A., Weber, T., Ke, N. R., Badia, A. P., Guez, A., Mirza, M., Humphreys, P. C., Konyushova, K., Valko, M., Osindero, S., Lillicrap, T., Heess, N, & Blundell, C. (2022). Retrieval augmented reinforcement learning. In K. Chaudhuri, S. Jegelka, L. Song, C. Szepesvari, G. Niu, & S. Sabato (Eds.), *Proceedings of the 39th International Conference on Machine Learning* (pp. 7740–7765). International Conference on Machine Learning. https://proceedings.mlr.press/v162/goyal22a/goyal22a.pdf

Hasson, U., Chen, J., & Honey, C. J. (2015). Hierarchical process memory: Memory as an integral component of information processing. *Trends in Cognitive Sciences*, *19*(6), 304–313.

Herz, N., Baror, S., & Bar, M. (2020). Overarching states of mind. *Trends in Cognitive Sciences*, *24*(3), 184–199.

Higgins, C., Liu, Y., Vidaurre, D., Kurth-Nelson, Z., Dolan, R., Behrens, T., & Woolrich, M. (2021). Replay bursts in humans coincide with activation of the default mode and parietal alpha networks. *Neuron*, *109*(5), 882–893.

Howard, M. W., & Kahana, M. J. (2002). A distributed representation of temporal context. *Journal of Mathematical Psychology*, *46*(3), 269–299.

Humiston, G. B., Tucker, M. A., Summer, T., & Wamsley, E. J. (2019). Resting states and memory consolidation:

A preregistered replication and meta-analysis. *Scientific Reports*, *9*, Article 19345. https://doi.org/10.1038/s41598-019-56033-6

Klinger, E. (1978). Modes of normal conscious flow. In K. S. Pope & J. L. Singer (Eds.), *The stream of consciousness* (pp. 225–258). Springer.

Klinger, E., & Cox, W. M. (2011). Motivation and the goal theory of current concerns. In W. M. Cox & E. Klinger (Eds.), *Handbook of motivational counseling* (2nd ed., pp. 3–47). Wiley.

Lu, Q., Hasson, U., & Norman, K. A. (2022). A neural network model of when to retrieve and encode episodic memories. *eLife*, *11*, Article e74445. https://doi.org/10.7554/eLife.74445

Madore, K. P., Addis, D. R., & Schacter, D. L. (2015). Creativity and memory: Effects of an episodic-specificity induction on divergent thinking. *Psychological Science*, *26*(9), 1461–1468.

Mattar, M. G., & Daw, N. D. (2018). Prioritized memory access explains planning and hippocampal replay. *Nature Neuroscience*, *21*(11), 1609–1617.

Müller, G. E., & Pilzecker, A. (1900). Experimentelle Beiträge zur Lehre vom Gedächtnis [Experimental contributions to the science of memory]. *Zeitschrift Fur Psychologie: Erganzungsband*, *1*, 1–300.

Nieuwenstein, M. R., Wierenga, T., Morey, R. D., Wicherts, J. M., Blom, T. N., Wagenmakers, E. J., & van Rijn, H. (2015). On making the right choice: A meta-analysis and large-scale replication attempt of the unconscious thought advantage. *Judgment and Decision Making*, *10*(1), 1–17.

Oberauer, K., Farrell, S., Jarrold, C., & Lewandowsky, S. (2016). What limits working memory capacity? *Psychological Bulletin*, *142*(7), 758–799.

Radvansky, G. A., & Zacks, J. M. (2017). Event boundaries in memory and cognition. *Current Opinion in Behavioral Sciences*, *17*, 133–140.

Schuck, N. W., & Niv, Y. (2019). Sequential replay of nonspatial task states in the human hippocampus. *Science*, *364*(6447), Article eaaw5181. https://doi.org/10.1126/science.aaw5181

Smallwood, J., & Schooler, J. W. (2015). The science of mind wandering: Empirically navigating the stream of consciousness. *Annual Review of Psychology*, *66*, 487–518.

Spinhoven, P., van Hemert, A. M., & Penninx, B. W. (2018). Repetitive negative thinking as a predictor of depression and anxiety: A longitudinal cohort study. *Journal of Affective Disorders*, *241*, 216–225.

Tambini, A., Rimmele, U., Phelps, E. A., & Davachi, L. (2017). Emotional brain states carry over and enhance future memory formation. *Nature Neuroscience*, *20*(2), 271–278.

v1ncetta. (2017, October 25). *What book gave you the biggest book hangover?* [Online forum post]. Reddit. https://www.reddit.com/r/books/comments/78mmsg/what_book_gave_you_the_biggest_book_hangover/

Wittkuhn, L., Chien, S., Hall-McMaster, S., & Schuck, N. W. (2021). Replay in minds and machines. *Neuroscience & Biobehavioral Reviews*, *129*, 367–388.

Wylie, G., & Allport, A. (2000). Task switching and the measurement of "switch costs." *Psychological Research*, *63*(3), 212–233.

Yeung, R. C., & Fernandes, M. A. (2021). Recurrent involuntary memories are modulated by age and linked to mental health. *Psychology and Aging*, *36*(7), 883–890.

Zeigarnik, B. (1927). Das Behalten erledigter und unerledigter Handlungen [Retention of completed and uncompleted actions]. *Psychologische Forschung*, *9*, 1–85.

Zuo, X., Honey, C. J., Barense, M. D., Crombie, D., Norman, K. A., Hasson, U., & Chen, J. (2020). Temporal integration of narrative information in a hippocampal amnesic patient. *NeuroImage*, *213*, Article 116658. https://doi.org/10.1016/j.neuroimage.2020.116658