

# Simulating Other People Changes the Self

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The self is not static. Our identities change considerably over development and across situations. Here, we propose one novel cause of self-change: simulating others. How could simply imagining others change the self? First, when simulating other people's mental states and traits, individuals access self-knowledge; they do so while concurrently considering information about the other person they are trying to understand. Second, episodic and semantic knowledge is malleable and susceptible to incorporating new, postevent information. If self-knowledge is similarly malleable, then simulation may change self-knowledge such that it incorporates information about the simulated person (i.e., "postevent information"). That is, simulation should render the self more similar to the simulated other. We test this hypothesis in 8 studies. In each study, participants (a) recalled personal information (e.g., traits and episodic memories), (b) simulated other people in similar contexts, and (c) re-recalled personal information. Results consistently demonstrated that simulating others changed self-knowledge, such that the self becomes more similar to the simulated other. This effect occurred for both traits and memories, spanned self-report and linguistic measures, and persisted 24 hr after simulation. The findings suggest that self-knowledge is susceptible to misinformation effects similar to those observed in other forms of semantic and episodic knowledge.

**Keywords:** social cognition, simulation, memory, self, memory malleability

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The sense of self is a hallmark of human experience. Each of us maintains a constellation of personal memories and personality traits that collectively define "who we really are." A cohesive sense of self adds meaning to our lives (Schlegel, Hicks, Arndt, & King, 2009) and is associated with mental health (Bauer, McAdams, & Pals, 2008; Bigler, Neimeyer, & Brown, 2001). Indeed, self-knowledge holds a privileged place in our knowledge structures, in terms of both its function and underlying mechanisms (Kelley et al., 2002; Klein & Kihlstrom, 1986; Rogers, Kuiper, & Kirker, 1977). That is, the self comprises a special class of information (Sui & Humphreys, 2015).

At the same time, the self is not a fingerprint. Our psychological identities are not fully formed upon our entry into the world; they can change considerably over time and across situations. Personality traits and autobiographical memories change over development (Harris, Brett, Johnson, & Deary, 2016; McAdams et al., 2006; Roberts, Walton, & Viechtbauer, 2006); even within a developmental period, the self changes as we transition between social roles (e.g., manager vs. mother; Moskowitz, Suh, & Desaul-

niers, 1994) and receive feedback from our peers (Markus & Kunda, 1986). Social psychological accounts suggest that information from the external environment, particularly our interactions with others, changes self-knowledge: we believe we are clever if others convey to us we are clever (Cooley, 1902), and we reshape our autobiographical memories by listening to how other people recount theirs (Coman, Manier, & Hirst, 2009). Here, we test the novel possibility that external sources are not the only catalysts to changed selves. Instead, simply engaging our imagination—a completely internal *process*—may be sufficient to change self-knowledge. How might simply simulating other people alter our own privileged self-knowledge?

## Simulating Others

People often consider self-knowledge when inferring other people's mental states and traits—a process referred to as simulation (Goldman, 2006; Mitchell, Banaji, & Macrae, 2005; Tamir & Mitchell, 2010). For example, when trying to understand how your friend Claire may feel about a romantic rejection, you may recall how you felt the last time you were rejected (e.g., "I was embarrassed when I got dumped last year."). According to the simulation theory of mindreading, individuals use multiple aspects of themselves as a starting point for understanding other people. That is, people draw on what they know about themselves—their personal experiences, preferences, traits, and beliefs—to make inferences about others (Allport, 1924; Camerer, Loewenstein, & Weber, 1989; Keysar, Ginzler, & Bazerman, 1995; Nickerson, 1999; Ross, Greene, & House, 1977).

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People are more likely to recruit information about themselves when simulating similar, compared to dissimilar, others. For example, we are more likely to assume that our friend Claire feels similarly about her romantic rejection than a distant stranger. People more strongly project their own behavioral tendencies, social preferences, and even political attitudes onto similar others than dissimilar others (Ames, 2004; Tamir & Mitchell, 2013). Neuroimaging research likewise shows that similar others amplify self-referential processing: Thinking about the self preferentially activates certain brain regions, such as the medial prefrontal cortex (Kelley et al., 2002); thinking about similar others likewise activates these brain regions, and to a significantly greater degree than thinking about dissimilar others (Denny, Kober, Wager, & Ochsner, 2012). Thus, people engage brain mechanisms associated with self-referential processing to a greater extent when thinking about similar versus dissimilar others. (Denny et al., 2012; Jenkins, Macrae, & Mitchell, 2008; Mobbs et al., 2009; Rilling, Dagenais, Goldsmith, Glenn, & Pagnoni, 2008).

To date, research on the simulation strategy of mindreading focuses on the consequences of this strategy for understanding others. A host of egocentric biases result from the strategy, such as the tendency to assume other people know the same information and share the same attitudes as us (Epley, Keysar, Van Boven, & Gilovich, 2004; Krueger & Clement, 1994; Ross et al., 1977). Yet, to our knowledge, no research has examined the consequences of this strategy for shaping the self. How might simulating others—a completely internal process—reshape self-knowledge? When individuals access self-knowledge when simulating other minds, they do so at the same time that they consider nuances about the other (e.g., “Claire tends to be pretty thick-skinned”; Tamir & Mitchell, 2010, 2013). Here, we test whether information considered about the other person (e.g., “Claire is pretty tough-skinned”) alters the self-knowledge that is simultaneously retrieved (e.g., “I was embarrassed when I got dumped last year”). This possibility derives from well-established findings on knowledge malleability.

### Knowledge Malleability

Research from cognitive psychology demonstrates that considering new information can reshape preexisting knowledge. Reading false information can overwrite our knowledge of basic facts (Fazio, Barber, Rajaram, Ornstein, & Marsh, 2013), hearing other people describe their memories can alter one’s own (Coman & Hirst, 2015; Coman et al., 2009; Cuc, Koppel, & Hirst, 2007), and entertaining alternatives to the past (e.g., counterfactual thinking) can modify our memory of it (De Brigard, Hanna, St. Jacques, & Schacter, 2018). Episodic and semantic knowledge are both susceptible to misinformation (Loftus, 2005; Schacter, 1999), and can change to include postevent information. Misinformation effects have been seen in eye-witness testimony, where the presentation of new information about a crime scene distorts memories of the original crime scene (Loftus, Miller, & Burns, 1978). Even general knowledge, such as the capital of a country, is susceptible to misinformation (Fazio et al., 2013; Fazio, Brashier, Payne, & Marsh, 2015). For example, in one study, participants completed a general knowledge test. Two weeks later, they read a story that included misinformation relevant to test items and completed the general knowledge test again. Participants demonstrated misinfor-

mation effects for questions that they answered correctly only 2 weeks prior (Fazio et al., 2013).

Memory retrieval may facilitate misinformation effects because during retrieval, memories become labile and susceptible to newly presented material (Lindsay & Johnson, 1989; Loftus et al., 1978; Nader, Schafe, & Le Doux, 2000; Roediger & Geraci, 2007; Schacter, 1999; Schiller & Phelps, 2011; Soeter & Kindt, 2015; Tulving & Thomson, 1973). For example, when participants retrieve a list of previously studied words, the memory for those words becomes labile, such that if experimenters next present a new set of words, participants will incorporate the new words into their original memory (Hupbach, Gomez, Hardt, & Nadel, 2007). The tendency to incorporate newly presented information into a retrieved memory—a process referred to as reconsolidation—has been shown in multiple memory domains and across a variety of paradigms, including procedural (Walker, Brakefield, Hobson, & Stickgold, 2003), episodic (Forcato et al., 2007; Hupbach et al., 2007), and associative (Schiller et al., 2010) memories. Even autobiographical memories can be amended to include new perspectives introduced during retrieval (De Brigard et al., 2018; St. Jacques, Szpunar, & Schacter, 2017). For example, retrieving an autobiographical memory from a third-person visual perspective (i.e., as an observer of the past event) corresponds with later remembering the autobiographical memory with less emotional intensity (St. Jacques et al., 2017). Reconsolidation requires that a memory changes only if it is first retrieved (and thus made labile) prior to the presentation of new information (Schiller & Phelps, 2011). However, reconsolidation is only one way to alter memories, as episodic and semantic knowledge are subject to misinformation through multiple routes (see Schacter, 1999).

Moreover, engaging our imagination has been shown to alter some aspects of the self, such as one’s motives and behavior. Imagining yourself perform an action, such as voting or helping a person in need, increases your intention to act, as well as your likelihood of actually acting (Gaesser & Schacter, 2014; Libby, Shaeffer, Eibach, & Slemmer, 2007). Thus, simply imagining events can have meaningful consequences for the self’s cognition and behavior. What remains to be tested is whether simulating another’s experiences, states, or traits reshapes self-knowledge to be more similar to the target of simulation.

Here, we bring together work on simulation and knowledge malleability to propose that people are subject to simulation-induced malleability (SIM). If semantic and episodic memories are susceptible to incorporating postevent information, and if simulating other minds entails considering knowledge about the self, then during simulation, information about the other person may become incorporated into one’s self-knowledge. That is, the simulation should change the self to become more similar to the other. Moreover, given that similar others increase self-referential processing (Denny et al., 2012; Jenkins et al., 2008; Mobbs et al., 2009; Rilling et al., 2008), SIM may be amplified for similar others. Consistent with this possibility, past work finds that imagining a similar other behave prosocially increases one’s own prosocial intentions more so than imagining a dissimilar other (Gaesser, Horn, & Young, 2015). Thus, SIM may be most pronounced when simulating the experiences, states, and traits of similar others.

## Self-Knowledge

Although the knowledge malleability literature is consistent with the SIM hypothesis, there is reason to believe that simply considering another person's mind is unlikely to restructure self-knowledge. The self is "special." That is, the self is a knowledge structure that is functionally and structurally distinct from other forms of knowledge (Kelley et al., 2002; Klein & Kihlstrom, 1986; Sui & Humphreys, 2015). Information related to the self is deeply encoded and tightly stored in memory (Rogers et al., 1977; Sui & Humphreys, 2015); such well-learned information is less susceptible to alteration (Lee, Nader, & Schiller, 2017). Indeed, it is more challenging to unlearn associations made about the self than associations made for other individuals, including friends (Wang, Humphreys, & Sui, 2016). Such findings have led to the proposal that self-knowledge has a special "memorial glue" that is resilient to updates (Sui & Humphreys, 2015; Wang et al., 2016). Of course, it is unlikely that self-knowledge never changes to incorporate new information. However, the "self is special" account suggests this occurrence should be rare, given that self-knowledge is distinct from other forms of knowledge, deeply encoded, and tightly stored in memory. As such, the misinformation effects that occur for other knowledge may not necessarily extend to self-knowledge as a consequence of simulation.

Yet there is evidence that the boundary between the self and others can be blurred in memory. The self-reference effect—or the tendency to remember self-relevant information—preferentially extends to similar others (Allan, Morson, Dixon, Martin, & Cunningham, 2017). In two studies (Benoit, Gilbert, Volle, & Burgess, 2010; Bergström, Vogelsang, Benoit, & Simons, 2015), participants rated themselves and another person along distinct personality dimensions. In a subsequent surprise memory test, participants who were similar to the other person showed greater difficulty discriminating which traits had been paired with the self versus the other. These findings are consistent with the possibility that another person's traits could become confused with one's own and, furthermore, that this effect is amplified for similar targets. However, to date, such findings are limited to source errors: Participants could not remember which information was paired with the self or similar other. It remains unknown whether simulating other minds changes the content of self-knowledge.

## Current Studies

Individuals access self-knowledge to simulate others. What are the consequences of this process for self-knowledge? Here we test two possibilities: On the one hand, research on misinformation suggests that postevent information can be incorporated into existing knowledge structures. In this account, simulating others may change self-knowledge to become more similar to the simulated other, and SIM would be most pronounced when simulating similar compared to dissimilar others. On the other hand, the "self is special" literature suggests that self-knowledge is structurally and functionally distinct from nonself knowledge, and is better preserved in memory. In this account, self-knowledge may be immune to SIM. That is, people's memories and traits should remain intact and unchanged after simulating others'.

In the current studies, we pit these hypotheses against one another, testing SIM for the first time. Across eight studies, which span multiple types of self-knowledge (episodic memories and

traits) and methods (self-report and linguistic), we test whether simulating others' minds changes self-knowledge to be more similar to the other. Study 1 tests for SIM with episodic memories, by assessing how one feature of a memory—valence—changes after simulating others. Studies 2a and 2b test the generalizability of SIM, by assessing whether trait knowledge becomes more similar to the traits of a simulated person. Study 3 rules out anchoring as an alternative mechanism for SIM. Studies 4a and 4b test whether SIM persists 24 hr post simulation. Study 5 tests whether SIM can be observed naturalistically, by testing whether the language people use to describe their memories becomes more similar to the language they use to describe how a target would experience a similar event. Finally, Study 6 tests whether SIM is influenced by the desire for social connection.

## Study 1: Episodic Memories

### Method

Study 1 tests whether (a) simulating others incorporates information about the others (hereafter referred to as "target") with self-knowledge or (b) whether self-knowledge is immune to such a misinformation effect. Participants first recalled a series of personal memories and rated the valence of each memory (i.e., how positive/negative they felt at the time of the event). Next, participants simulated how a similar target would feel during the same event, for one-third of these memories. For another third of the memories, participants simulated how the average American would feel during the same event. The final third of the memories were not presented with either target. Finally, participants rerated the valence of the original episodic memories (see Figure 1). Thus, we were able to examine whether participants' ratings of their own memories converged with their ratings for the simulated target, as well as the extent to which this depended on feeling similar to the target.

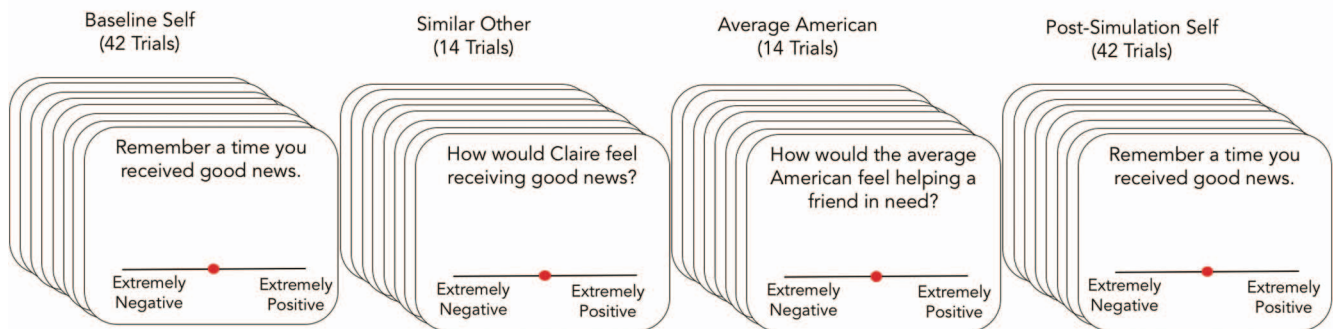
**Participants.** Participants ( $N = 185$ ) were recruited from Amazon Mechanical Turk (116 = female; Mean age = 41.35,  $SD = 12.47$ ). This sample size provides 99% power to detect a Medium Target  $\times$  Time interaction effect. In this and all subsequent studies, we report all data, participant exclusions, manipulations, and measures. Participants in this and all subsequent studies provided informed consent in accordance with the Princeton University Institutional Review Board. Participant data and analysis code for this and all subsequent studies can be accessed here <https://osf.io/5v83s/>.

### Procedure.

**Baseline self.** Participants were first prompted to recall experiences from their past (e.g., 'remember a time you received good news'). For each experience, participants rated how they felt during these past events, using a continuous scale anchored on *extremely negative* and *extremely positive* (see Figure 1). The scale did not display any numerical values associated with each increment, so as to protect against the possibility that participants would attempt to remember the values they input for this or any subsequent rating. Participants completed 42 unique ratings (21 positive and 21 negative events), presented in a random order across participants.

**Target.** Immediately after completing the baseline self-ratings, participants completed two blocks in which they were prompted to

# Study 1



*Figure 1.* Task schematic for Study 1. Participants began their session rating 42 personal memories. Next, they rated a similar other and the average American (order counterbalanced across subjects) in a subset of the memory events. Finally, participants rated their 42 personal memories again. See the online article for the color version of this figure.

imagine how two targets, respectively, would feel during a variety of experiences. One target was described as the “average American.” The second target was selected to be similar to the participant. Prior to completing the similar other trials, participants were asked to provide the name of a friend to whom they feel similar, in terms of their personality, temperament, major likes and dislikes, beliefs, and values. The friend’s name was subsequently shown for each similar other trial.

On each trial, participants were asked to think about how one of the targets would feel if they experienced the events recalled at baseline (see Figure 1). For example, a participant who nominated their friend “Claire” as the similar other would see “How would Claire feel receiving good news?” Participants used the sliding scale to indicate how the target would feel in response to the given event. Target order was counterbalanced across participants.

Of the 42 events from which participants recalled personal memories, 14 events (7 positive, 7 negative) were paired with a similar other, another 14 (7 positive, 7 negative) with the average American, and 14 (7 positive, 7 negative) were not presented with either target. The 14 events that appeared in each condition were counterbalanced across participants and presented in a random order within conditions.

**Postsimulation self.** Immediately after making target ratings, participants saw the original memory prompts and were instructed to rate how they felt during each experience for a second time. For each prompt, participants were instructed to recall the same memory that they recalled during the baseline self block. The 42 memory prompts were presented in a random order across participants. Stimuli for each study can be found here <https://osf.io/5v83s/> on the Open Science Framework.

**Perceived similarity measures.** Finally, participants reported how similar they felt to the similar other and to the average American. Participants used a 0–100 scale to indicate how similar they felt to each target, in terms of their personality, temperament, major likes and dislikes, beliefs, and values. Past work has shown that people rely more on self-knowledge when simulating similar rather than dissimilar targets (Ames, 2004; Benoit et al., 2010;

Mitchell, Macrae, & Banaji, 2006; Tamir & Mitchell, 2013). These ratings therefore served both as a manipulation check, to assure that participants perceived themselves to be more similar to their nominated similar other than the average American, and also to be used to test whether SIM is moderated by perceived psychological similarity to the target.

## Results

To ensure that participants indeed perceived that they were more psychologically similar to the similar other than the average American, we compared self-reported perceived similarity to each target using a paired-samples *t* test. As expected, our manipulation was successful, and participants reported greater psychological similarity to the similar other ( $M = 81.3$ ,  $SD = 16.94$ ) than the average American ( $M = 50.23$ ,  $SD = 22.67$ ;  $t(184) = 17.00$ ,  $p < .0001$ , Cohen’s  $d = 1.27$ ).

Our primary question is whether simulating others may change self-knowledge to become more similar to the simulated target (i.e., evidence for SIM). To test this possibility, we computed two values for each memory prompt: (i) baseline similarity: the absolute difference between ratings of the baseline self and a target (e.g., la personal memory of receiving good news – simulating a target receive good news) and (ii) postsimulation similarity: the absolute difference between ratings of the postsimulation self and the corresponding target. Once each of these absolute difference scores were computed for each prompt, we next computed the average of these values across all prompts to create a variable representing each of the four variables of interest: (1) baseline similarity to the similar target, (2) baseline similarity to the average American, (3) postsimulation similarity to the similar target, (4) postsimulation similarity to the average American. Smaller values indicate greater similarity between the self and target, as this means that there is a smaller discrepancy between the self and the other.

We tested for SIM using a 2 (target: similar other vs. average American)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures analysis of variance (ANOVA; Figure



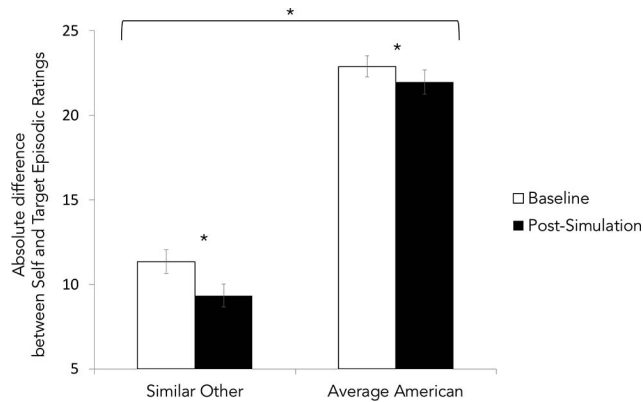


Figure 2. Results from Study 1. Participants rated their own memories as more similar to two targets after they simulated those targets in the same events. This effect was strongest for similar others. \* $p < .05$ .

2). If personal episodic memories become more similar to simulations of a target, we would expect a change in similarity over time, such that memories increase in similarity postsimulation compared to baseline. In line with this prediction, this ANOVA revealed a main effect of time, with greater postsimulation similarity ( $M = 15.66$ ,  $SD = 7.34$ ) than baseline similarity ( $M = 17.12$ ,  $SD = 6.97$ ),  $F(1, 184) = 48.70$ ,  $p < .0001$ ,  $\eta_p^2 = .21$ . We also observed a main effect of the target, such that participants rated their own memories as more similar to ratings of the similar other ( $M = 10.34$ ,  $SD = 4.96$ ) than the average American ( $M = 22.43$ ,  $SD = 13.95$ ),  $F(1, 184) = 111.91$ ,  $p < .0001$ ,  $\eta_p^2 = .38$ .

A change in similarity over time provides initial evidence of SIM and suggests that while the self may be “special,” it is nonetheless susceptible to misinformation effects. We next explored whether simulation-induced changes in self-knowledge are greatest for similar others. If SIM depends on self-referential processing, it should occur most robustly after simulating similar targets—who elicit the greatest self-referential processing—and less so for dissimilar targets. This should occur even though participants are already more similar to the similar than dissimilar target. As expected, an ANOVA revealed a significant Target  $\times$  Time interaction,  $F(1, 184) = 10.23$ ,  $p = .002$ ,  $\eta_p^2 = .05$ , such that simulation induced a greater increase in similarity to the similar other (baseline similarity  $M = 11.34$ ,  $SD = 5.65$ ; postsimulation similarity  $M = 9.34$ ,  $SD = 4.88$ ) than the average American (baseline similarity  $M = 22.89$ ,  $SD = 13.57$ ; postsimulation similarity  $M = 21.97$ ,  $SD = 14.55$ ). Next, we examined whether individual differences in SIM depended on individual differences in perceived psychological similarity to each target. In other words, we tested whether perceived similarity moderates SIM. Although we observed greater SIM—on average—for the similar other than the average American, a linear mixed-effects model testing whether perceived similarity to the targets moderates SIM was not significant,  $F(1, 304) = .86$ ,  $p = .355$ ,  $\omega^2 < .001$ .

Finally, we explored whether SIM was specific in a change toward the simulated target, rather than reflecting general changes in rating the self at baseline versus postsimulation. To this end, we computed the absolute change in each episodic self-rating from baseline to postsimulation, and averaged these change scores separately for episodic memories that were (a) paired with the similar

other, (b) paired with the average American, and (c) not paired with any target. A repeated-measures ANOVA revealed a significant interaction such that episodic memories paired with the similar other changed ( $M = 4.00$ ,  $SD = 2.69$ ) more than memories paired with the average American ( $M = 2.90$ ,  $SD = 2.97$ ) or not paired with any target at all ( $M = 2.97$ ,  $SD = 2.64$ ),  $F(2, 368) = 10.46$ ,  $p < .0001$ ,  $\eta_p^2 = .05$ . The overall change in episodic memory ratings for memories paired with the average American and not paired with any target at all were not significantly different from one another,  $t(184) = .28$ ,  $p = .782$ , Cohen’s  $d = .02$ .

Together, these results provide initial support for the hypothesis that simulating others can change our own episodic memories to become more similar to how we imagine the simulated target and, moreover, that this effect is stronger for targets that are on average more similar to the self. More broadly, such findings suggest that although the self may be “special,” self-knowledge can still be altered by simply imagining others.

## Study 2: Trait Knowledge

### Study 2a: Personality Traits

**Method.** Study 1 suggests that simulating a target’s experience changes our own episodic memories of the same experience to become more similar to how we imagined the target. In Study 2, we aim to generalize this phenomenon to two new aspects of the self: personality traits (Study 2a) and physical traits (Study 2b). Research on trait knowledge suggests that trait assessments about the self (e.g., “Am I a confident person?”) are particularly distinct from other forms of semantic knowledge (Meyer & Lieberman, 2018; Mitchell et al., 2005) and remain intact even in the face of other memory deficits (Klein, Chan, & Loftus, 1999; Klein & Lax, 2010; Klein, Loftus, & Kihlstrom, 1996). Thus, trait self-knowledge provides an even stricter test of SIM, as the “self is special” account suggests that trait self-knowledge should be the least susceptible to misinformation effects.

We also aim to generalize this phenomenon using new control targets. In Study 1 it is possible that greater SIM toward the similar other is due to the fact that the similar other is a specific person, while the average American is a more abstract target. To determine that the effect is driven specifically by similarity, rather than concrete versus abstract targets, here we include a specific American (Study 2a) and a specific physical object (Study 2b) as two additional control targets. In both studies, we expect to replicate findings from Study 1, such that simulating another target changes the self to become more similar to the target and, moreover, that this effect is strongest for similar targets.

**Participants.** Participants ( $N = 180$ ) were recruited from Amazon Mechanical Turk (106 female; Mean age = 36.92,  $SD = 12.97$ ). This sample size was estimated to provide 99% power to detect the Target  $\times$  Time interaction effect size observed in Study 1.

**Procedure.** Participants first rated themselves on 60 traits. For each trait, participants judged the extent to which the trait applied to them, using a continuous scale anchored on *not-at-all* to *extremely*. Half of the traits were positive in valence (e.g., “charming”) and the other half were negative in valence (e.g., “unreliable”). Traits were selected from a set of trait adjectives matched on familiarity, frequency of use, and valence (Dumas, Johnson, &

Lynch, 2002). As in Study 1, participants did not see the numerical values associated with each increment on the sliding scale. The 60 traits were presented in a random order across participants.

Participants next completed two blocks in which they rated the personality traits of two targets, respectively. One target was a similar other, nominated by the participant as a friend to whom they felt similar in terms of personality, temperament, major likes and dislikes, beliefs, and values. The second target was Walter Cronkite, a former American news anchor used in past work on self-referential processing (Bower & Gilligan, 1979). To ensure all subjects knew Walter Cronkite, prior to making these ratings they viewed a photograph of Walter Cronkite along with a summary of his personality and description of his work as a news anchor. Of the 60 traits for which participants previously rated themselves, 20 traits (10 positive; 10 negative) were shown with one target and 20 traits (10 positive; 10 negative) were shown with the other target. The set of 20 traits shown for each target was counterbalanced across participants. Target order was counterbalanced across participants.

Participants then rerated themselves on the 60 traits shown during their baseline self-rating block. Trait order was randomized across subjects. Finally, as in Study 1, participants rated their perceived psychological similarity to the similar other and to Walter Cronkite, using a 0–100 scale.

**Results.** As in Study 1, our manipulation of similarity was successful: Participants reported greater perceived psychological similarity to the similar other ( $M = 74.033$ ,  $SD = 17.26$ ) than Walter Cronkite ( $M = 32.76$ ,  $SD = 24.46$ ),  $t(179) = 18.265$ ,  $p < .0001$ , Cohen's  $d = 1.38$ .

Results fully replicate the findings from Study 1 (Figure 3A). The 2 (target: similar other vs. Cronkite)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a

main effect of time,  $F(1, 179) = 55.84$ ,  $p < .001$ ,  $\eta_p^2 = .24$  (baseline similarity  $M = 17.56$ ,  $SD = 6.80$ ; postsimulation similarity  $M = 16.03$ ,  $SD = 6.52$ ), such that the similarity between the self and target was greater postsimulation than at baseline. We also observed a main effect of target,  $F(1, 179) = 37.03$ ,  $p < .001$ ,  $\eta_p^2 = .17$ , such that participants rated their own personality traits as more similar to the similar other's traits ( $M = 14.82$ ,  $SD = 7.70$ ) than Cronkite's traits ( $M = 18.77$ ,  $SD = 7.98$ ).

This ANOVA also revealed a significant Time  $\times$  Target interaction,  $F(1, 179) = 6.07$ ,  $p = .015$ ,  $\eta_p^2 = .03$ , such that simulation induced a greater increase in trait similarity for the similar other (baseline similarity  $M = 15.78$ ,  $SD = 8.18$ ; postsimulation similarity  $M = 13.85$ ,  $SD = 7.66$ ) than for Cronkite (baseline similarity  $M = 19.33$ ,  $SD = 8.08$ ; postsimulation similarity  $M = 18.21$ ,  $SD = 8.19$ ). Moreover, a linear mixed-effects model testing whether perceived similarity to the targets moderates SIM was significant,  $F(1, 257) = 11.145$ ,  $p = .001$ ,  $\omega^2 = .03$ , suggesting that when considering personality traits SIM depends, in part, on the degree of perceived similarity to the target.

As in Study 1, we computed the absolute change in each trait self-rating and averaged these change scores separately for traits that were (a) paired with the similar other, (b) paired with Walter Cronkite, and (c) not paired with any target during simulation. A repeated-measures ANOVA revealed a significant interaction,  $F(2, 358) = 8.32$ ,  $p < .0001$ ,  $\eta_p^2 = .04$ , such that traits paired with the similar other changed ( $M = 5.23$ ,  $SD = 4.34$ ) more than traits paired with Walter Cronkite ( $M = 3.79$ ,  $SD = 3.32$ ),  $t(179) = 4.08$ ,  $p < .0001$ , Cohen's  $d = .29$ ; traits paired with Walter Cronkite changed less than traits not paired with any target at all ( $M = 4.66$ ,  $SD = 4.58$ ),  $t(179) = 2.33$ ,  $p = .02$ , Cohen's  $d = .14$ . This latter result is in contrast to the finding in Study 1 that overall change toward the average American was not significantly differ-

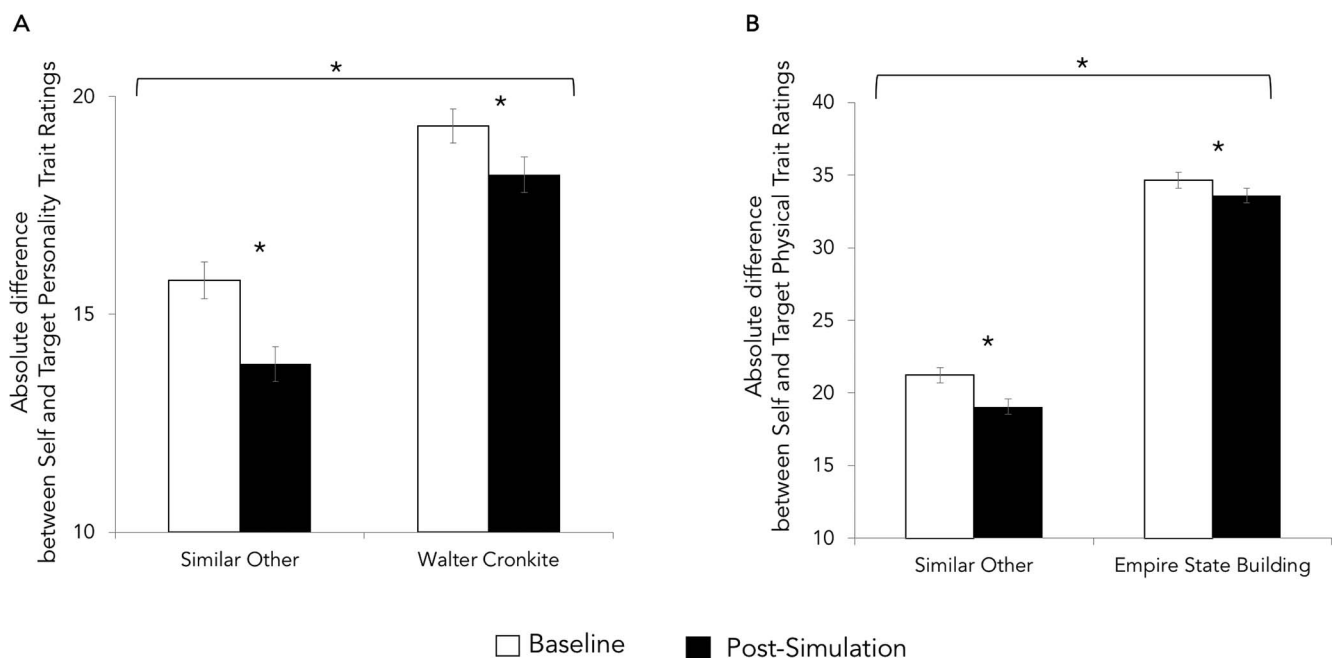


Figure 3. Results from Studies 2a and 2b. Participants rated their own traits as more similar to how they simulated the targets' traits. This effect was strongest for similar others. \* $p < .05$ .

ent from overall change in trials paired with no target. Critically, however, across Studies 1 and 2a, SIM for the dissimilar target and overall change are not correlated ( $r_s < .12$ ,  $p_s > .10$ ). Thus, whatever drives overall change occurs independently of change toward the dissimilar target (i.e., SIM). Because self-ratings that were never paired with a target did not provide insight above and beyond the two target conditions, we removed this no-target condition from all subsequent studies.

Together, these results demonstrate that thinking about others' traits can change perceptions of a person's own traits to become more similar to the target. The more similar a person feels to that target, the greater this effect. Even though trait knowledge about the self is protected against certain memory deficits (Klein et al., 1996, 1999; Klein & Lax, 2010), it is nonetheless vulnerable to change, simply by thinking about others' traits.

## Study 2b: Physical Traits

### Method.

**Participants.** Participants ( $N = 201$ ) were recruited from Mechanical Turk (Mean age = 36.19,  $SD = 12.58$ ; 105 females). This sample size was estimated to provide 99% power to detect the Target  $\times$  Time interaction effect size observed in Study 1.

**Procedure.** The paradigm used in Study 2b was similar to that used in Study 2a, with four changes. First, since participants rated themselves to be somewhat similar to the average American in Study 1 ( $M = 50.23$ ) and Walter Cronkite in Study 2a ( $M = 32.76$ ), we sought to determine the extent to which simulation changes self-knowledge even when the target is highly dissimilar to the self. Thus, Study 2b used a maximally dissimilar target: The Empire State Building. Second, since Studies 1 and 2a required that participants consider internal features, here we examined whether simulation might also alter perceptions of one's own external features. In Study 2b, participants rated themselves, a similar friend, and the Empire State Building on physical traits. For example, participants rated the Empire State Building in terms of how "clean" and "symmetrical" it is. Third, to ensure our effects were not facilitated by the inclusion of baseline self prompts that are not paired with either target, participants rated themselves on only 40 physical traits, 20 of which were paired with the similar other target and 20 of which were paired with the Empire State Building. Finally, participants rated their perceived physical similarity to both the similar other and the Empire State Building. Participants rated their perceived psychological similarity only to the similar other target, as it is hard to interpret the meaning of psychological similarity to the Empire State Building.

**Results.** Our manipulation of similarity was successful: Participants rated themselves to be more physically similar to the similar other ( $M = 48.28$ ,  $SD = 26.20$ ) than the Empire State Building ( $M = 11.52$ ,  $SD = 20.21$ ),  $t(200) = 16.58$ ,  $p < .0001$ , Cohen's  $d = 1.18$ .

Results from Study 2b fully replicate the prior studies (Figure 3B). The 2 (target: similar other vs. Empire State Building)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a main effect of time,  $F(1, 200) = 49.29$ ,  $p < .001$ ,  $\eta_p^2 = .20$ , such that the postsimulation self was more similar to the targets ( $M = 26.75$ ,  $SD = 8.75$ ) than the self at baseline ( $M = 28.32$ ,  $SD = 8.86$ ). We also observed a main effect of target,  $F(1, 200) = 271.84$ ,  $p < .001$ ,  $\eta_p^2 = .57$ , such that

participants rated their own physical traits as more similar to the similar other's traits ( $M = 20.62$ ,  $SD = 9.88$ ) than to the traits of the Empire State Building ( $M = 34.45$ ,  $SD = 11.09$ ).

This ANOVA also revealed a significant Target  $\times$  Time interaction,  $F(1, 200) = 7.61$ ,  $p = .006$ ,  $\eta_p^2 = .04$ , such that simulation induced a greater increase in similarity to the similar other's physical traits (baseline similarity  $M = 21.73$ ,  $SD = 10.31$ ; post-simulation similarity  $M = 19.52$ ,  $SD = 9.96$ ) than the Empire State Building's physical traits (baseline similarity  $M = 34.92$ ,  $SD = 11.27$ ; postsimulation similarity  $M = 33.98$ ,  $SD = 11.37$ ). Although we observed greater SIM—on average—for the similar other than the Empire State Building, a linear mixed-effects model testing whether perceived physical similarity to the targets moderates SIM was not significant,  $F(1, 358) = .218$ ,  $p = .641$ ,  $\omega^2 < .001$ . Looking just within the similar other target condition, perceived psychological similarity also did not moderate SIM,  $F(1, 199) = .80$ ,  $p = .371$ ,  $\eta_p^2 = .004$ , although this latter analysis is limited by a restricted range of similarity since participants did not rate their psychological similarity to the dissimilar target.

## Study 3: Ruling out Anchoring

### Method

One potential alternative explanation for the SIM effects seen thus far is that target ratings create a superficial anchor for subsequent self-ratings. More specifically, it is possible that making an other-referential judgment provided an anchor, which, in turn, influenced participants' ratings during the second phase of self-referential judgments. We argue that such anchoring, while potentially contributing to the effect, is not sufficient for SIM to occur. For example, anchoring could not account for the observation in the previous studies that SIM is influenced by the similarity between the self and target. Nonetheless, in Study 3, we directly pit the anchoring and SIM accounts against one another.

To adjudicate between the SIM and anchoring account, we draw from previous research demonstrating that internally generated and externally provided information differentially influence subsequent judgments, such that individuals anchor on and sequentially adjust away from internally generated but not externally provided anchors (Epley & Gilovich, 2001). If SIM is due to retrieved self-knowledge during simulation, it should occur only when target ratings are internally generated, but not when target ratings are externally provided. Alternatively, the anchor account would predict SIM regardless of whether the target-related information was internally or externally provided.

In Study 3, we tested these possibilities using a paradigm paralleling the previous studies. During the target judgment phase, participants made ratings as in the previous studies on half of the trials (internal condition). On the other half, we provided participants with ratings made, ostensibly, by the target (external condition). We predicted that increases in self-other similarity post-simulation should only be observed for items in the internal condition, but not in the external condition.

**Participants.** Participants ( $N = 168$ ; Mean age = 36.93,  $SD = 12.19$ ; 95 females) were recruited from Amazon Mechanical Turk. This sample size was determined using the effect size of the Target  $\times$  Time interaction effect from Study 1 and provides 99% power to detect an effect.

**Procedure.** The paradigm used in Study 3 was similar to that used in the prior studies. Participants first rated the valence of 28 experiences from their past. Before a response was made, no cursor was shown on the scale, and therefore no external anchoring point was available. Participants made a response by clicking anywhere on the scale. The stimuli used in Study 3 are a random subset of 28 items selected from the stimuli in Study 1.

Participants next read a paragraph about a sex-matched target who was described as a previous participant in the study. The paragraph was modified from a similarity manipulation used in previous research (Tamir & Mitchell, 2013). It included information about the target such as their religious and political affiliation and general areas of interest, and has been shown to robustly manipulate a sense of similarity to the target. All participants received the same paragraph. Because this is a within-subject design and the same target was used in each condition, similarity to the target was constant across conditions. After reading the paragraph, participants were asked to imagine the target going through each of the 28 events. Half of the trials were randomly assigned to the internal condition, and the other half were assigned to the external condition. For the internal trials, participants provided ratings of how positive or negative the target would feel, as in Studies 1 and 2. For the external trials, they were told that the target had also seen the same question and provided a response. The target's response was marked next to the scale, and participants were asked to make a manual mouse-click where the scale was marked. In reality, the target was fictional and the external responses were generated by the experimenters, such that the internal and external conditions were matched on self–other similarity at baseline. Absolute difference scores between target ratings and self ratings at baseline were calculated for each internal trial. The difference score for each internal trial was randomly signed and assigned to one external trial. The target ratings always began with four consecutive internal trials; afterward, internal and external trials were presented pseudorandomly. With this design, we ensured that internal and external trials have identical absolute difference score distributions, and that any observed differences between the two conditions are not confounded by baseline differences.

Next, participants were asked to recall the 28 experiences from their own memory, and provide the valence ratings again. Finally, participants rated their perceived similarity to the target.

## Results

Consistent with the SIM account, the analysis revealed a significant interaction between time and condition,  $F(1, 167) = 103.87, p < .001, \eta_p^2 = .38$ , such that in the internal condition, self–other similarity increased from baseline to postsimulation (baseline similarity  $M = 10.46, SD = 11.35$ ; postsimulation similarity  $M = 8.91, SD = 10.38$ ), whereas self–other similarity did not increase in the external condition (baseline similarity  $M = 10.46, SD = 11.35$ , postsimulation similarity  $M = 11.53, SD = 12.52$ ). Follow-up analyses revealed an increase in self–other similarity in the internal condition,  $F(167) = 57.83, p < .001, \eta_p^2 = .26$ , but a decrease in the external condition,  $F(167) = 27.60, p < .001; \eta_p^2 = .14$  (see Figure 4). Critically, overall change (as opposed to directed change captured by SIM) in ratings was significantly greater for the external ( $M = 11.53$ ) versus internal

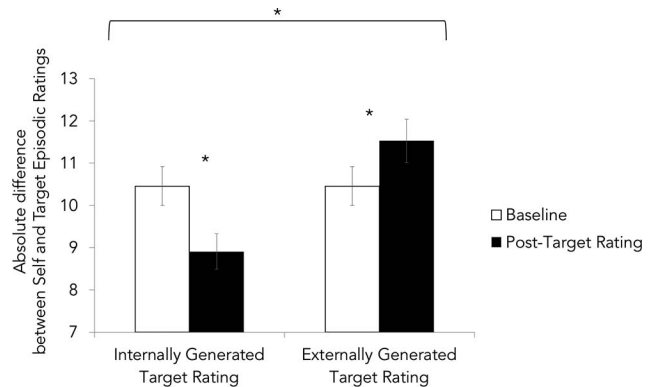


Figure 4. Results from Study 3. Increased similarity between the self and target occurs when target episodic ratings are internally generated, but not when target ratings are made by externally provided information. \*  $p < .05$ .

condition ( $M = 8.91, t = 10.19, p < .0001$ ), even though SIM was only observed in the internal condition. This finding provides further evidence that the overall change that results from pure repetition cannot explain SIM. We did not test whether similarity to the target moderates SIM here, since the same target was used in both conditions.

These results corroborate our hypothesis that simulation is necessary for SIM, and that externally provided anchors are not sufficient to elicit this effect. If anything, externally provided anchors seemed to only exacerbate differences between self and other.

## Study 4: 24-hr Change

### Study 4a: 24-hr Change

**Method.** Results from Studies 1–3 support the SIM hypothesis, that simulating others alters self-knowledge to become more similar to the simulated target. In order to demonstrate that memories are preserved in their altered state, here we test whether memories remain altered at least 24 hr post reactivation. Increased similarity between self and target ratings postsimulation after such a delay would strongly suggest that participants' personal memories were changed to include characteristics of the target. We preregistered our hypotheses and analyses for Study 4 through Open Science Framework here <https://osf.io/5v83s/>.

**Participants.** Participants ( $N = 310$ ) were recruited from Amazon Mechanical Turk. Of the participants who completed Day 1, 136 participants completed Day 2 (Mean age = 32.95,  $SD = 8.60$ ; female = 79). This final sample size provides 99% power to detect an effect, based on the Target  $\times$  Time interaction effect size observed in Study 1. There were no statistical differences between self, similar other, and average American ratings, between participants who completed the full study versus those who completed only Day 1 ( $ps > .19$ ). Likewise, there was no statistical difference between how similar participants who did and did not complete Day 2 felt to the similar target and average American ( $ps > .56$ ).

**Procedure.** Study 4a replicates the design of Study 1 with two changes. First, we imposed a 24-hr delay ( $M = 23.26$  hr,  $SD =$



8.88 hr) between participants' target ratings and postsimulation ratings. Second, we measured perceived similarity to the targets prior to the baseline self and simulation tasks, rather than at the end of the study, to ensure that any observed influence of perceived similarity on SIM is not conflated with the possibility that SIM increases perceived similarity.

**Results.** As in the previous studies, our manipulation of similarity was successful: Participants rated themselves to be more psychologically similar to the similar other ( $M = 80.24$ ,  $SD = 14.89$ ) than the average American ( $M = 48.63$ ,  $SD = 19.79$ ),  $t(135) = 16.31$ ,  $p < .0001$ , Cohen's  $d = 1.81$ .

Replicating the prior studies, the 2 (target: similar other vs. average American)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a main effect of time,  $F(1, 135) = 5.62$ ,  $p = .019$ ,  $\eta_p^2 = .04$ , such that the self was more similar to the targets postsimulation ( $M = 12.99$ ,  $SD = 6.18$ ) than at baseline ( $M = 13.71$ ,  $SD = 6.73$ ; Figure 5). We also found a main effect of target,  $F(1, 135) = 6.44$ ,  $p = .012$ ,  $\eta_p^2 = .05$ , such that participants rated their own memories more similarly to simulations of the similar other ( $M = 12.41$ ,  $SD = 6.81$ ) than of the average American ( $M = 14.29$ ,  $SD = 8.25$ ).

Unlike in the previous four studies, we did not find evidence that SIM depended on similarity to the target. There was no significant Target  $\times$  Time interaction,  $F(1, 135) = 1.07$ ,  $p = .304$ ,  $\eta_p^2 = .008$ , and a linear mixed-effects model showed that SIM was not moderated by perceived similarity to the targets,  $F(1, 375) = 1.23$ ,  $p = .268$ ,  $\omega^2 < .001$ .

### Study 4b: 24-hr Change Replication

**Method.** In Study 4a, there was a significant increase in similarity between self-ratings and target ratings for only the similar target, but not the average American. One possibility is that the average American induces only short-term changes in the self. Alternatively, it is possible that because the effect for the average American is relatively small, it is simply harder to detect once a 24-hr delay is introduced. We ran Study 4b to determine which of these possibilities is most accurate. The procedure of Study 4b was identical to Study 4a, except that participants rated perceived similarity to each target on Day 2 to be consistent with Studies 1–3.

**Participants.** Participants ( $N = 321$ ) were recruited from Amazon Mechanical Turk. Participants who completed Day 1 were invited to complete Day 2. Of the participants who completed Day 1, 256 completed Day 2 (Mean age = 36.67,  $SD = 11.60$ ; female = 165). This sample size provides 99% power to detect an effect, based on the Target  $\times$  Time interaction effect size observed in Study 1. As in Study 4a, there were no statistical differences among self, similar other, and average American ratings, between participants who completed the full study versus those who completed only Day 1 ( $ps > .25$ ).

**Results.** The manipulation of similarity was successful: Participants rated themselves to be more psychologically similar to the similar other ( $M = 78.94$ ,  $SD = 15.98$ ) than the average American ( $M = 49.14$ ,  $SD = 18.71$ ;  $t(255) = 20.25$ ,  $p < .0001$ , Cohen's  $d = 1.38$ ).

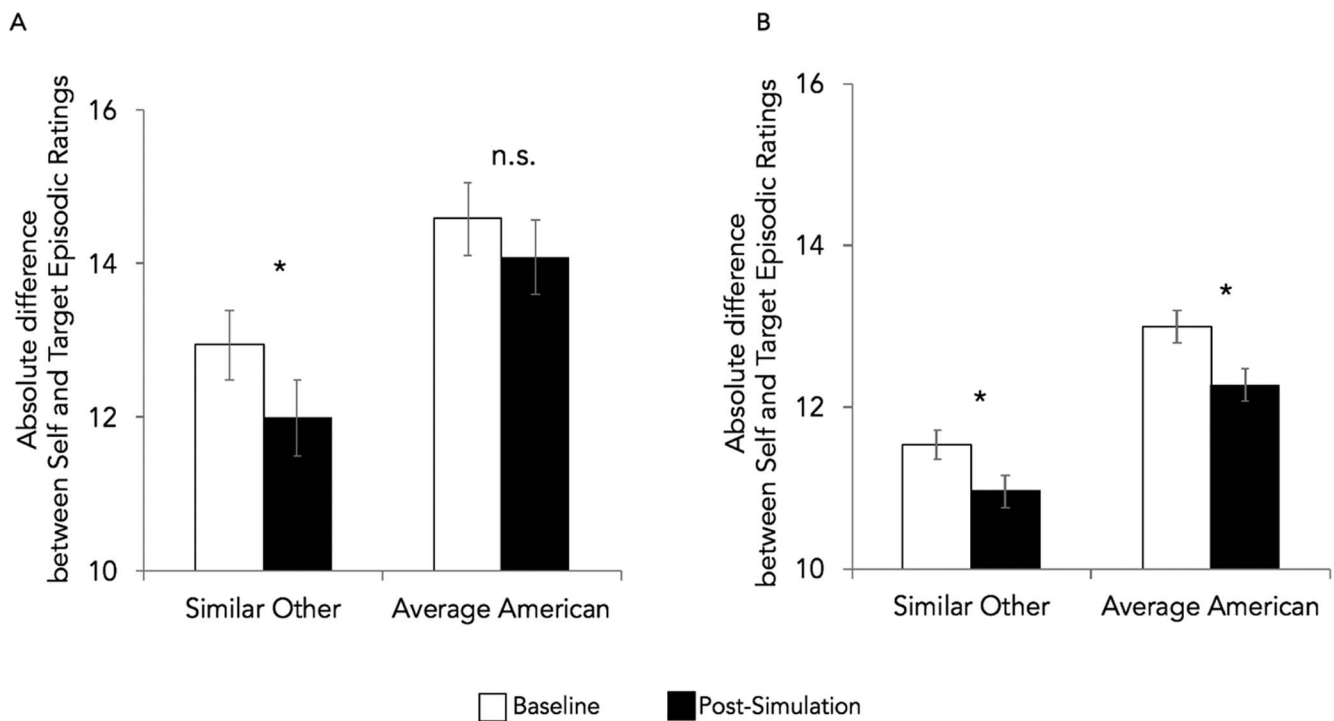


Figure 5. Results from Studies 4a and 4b. SIM persists 24 hr postsimulation in Studies 4a and 4b. In Study 4b, SIM was also observed for the average American target. \*  $p < .05$ .

Replicating our other studies, the 2 (target: similar other vs. average American)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a main effect of time,  $F(1, 255) = 13.01, p < .0001, \eta_p^2 = .05$ , such that the self was more similar to the targets postsimulation ( $M = 12.27, SD = 4.70$ ) than at baseline ( $M = 11.63, SD = 4.53$ ; Figure 5B). We also found a main effect of target,  $F(1, 255) = 18.26, p < .001, \eta_p^2 = .07$ , such that participants rated their own memories more similarly to simulations of the similar other ( $M = 11.26, SD = 4.67$ ) than of the average American ( $M = 12.65, SD = 5.51$ ).

As in Study 4a, we did not find evidence for a significant Target  $\times$  Time interaction,  $F(1, 255) = .29, p = .589, \eta_p^2 = .001$ , and a linear mixed-effects model testing for moderation between SIM and perceived similarity to the targets was not significant,  $F(1, 765) = .08, p = .775, \omega^2 < .001$ .

Together, results from Studies 4a and 4b suggest that simulation-induced changes in self-knowledge can persist up to 24 hr. However, these more durable effects of SIM do not seem to depend on similarity to the target.

## Study 5: Linguistic Evidence for SIM

### Method

Results from Studies 1–4 consistently suggest that simulating others alters self-knowledge to become more similar to the simulated target. The goal of Study 5 was to examine whether SIM generalizes beyond self-report ratings, to more naturalistic forms of self-reflection. To this end, participants wrote descriptive paragraphs about episodic memories and simulations, rather than rating them on a single valence scale. This measure allowed us to test for SIM in the rich language people used to describe personal memories. Participants first wrote about personal memories (baseline self), then wrote about a similar friend and an average American going through similar experiences, and finally wrote a paragraph describing their personal memories again (postsimulation self). The paradigm ensured that participants considered the same memories at baseline and postsimulation: Participants considered four self-nominated memories for which they provided their own labels at baseline (e.g., “break-up”). These labels were presented again during postsimulation recall. We predicted that we would observe SIM in this context, as measured by semantic similarity between retrieved memories and simulations, and again explored whether SIM was stronger for the more similar target. We preregistered our hypotheses and analyses for Study 5 through Open Science Framework here <https://osf.io/5v83s/>.

**Participants.** Participants ( $N = 177$ ) were recruited from Amazon Mechanical Turk (Mean age = 35.09,  $SD = 9.92$ ; female = 108). This sample size provides 99% power to detect an effect, based on the Target  $\times$  Time interaction effect size observed in Study 1.

**Procedure.** First, participants were instructed to describe a memory in response to the following four prompts (half positive, half negative): Recall a time you felt supported by a loved one; recall a time you felt proud of yourself; recall a time you felt rejected; recall a time you felt embarrassed. For each prompt, participants were instructed to describe their memory, be as descriptive as possible, and focus on how they felt at the time of the event. Participants were also asked to provide a short label for their

memory (e.g., “break-up”). Participants were encouraged to pick labels that would help them remember which memories they thought about at baseline. This allowed us to subsequently present each participant their labels in the postsimulation self-reflection stage, to ensure that they thought about the same event/memory in these two stages, respectively.

After baseline self-reflection, participants simulated experiences of two targets. As in previous studies, participants considered the average American and a similar other (in terms of their personality, temperament, major likes and dislikes, beliefs, and values). Participants first rated their perceived similarity to each target and then wrote about how the target would experience the positive and negative events (e.g., “imagine the average American felt supported by a loved one”). Participants considered and wrote a paragraph describing two events (one positive, one negative) for each target. The positive and negative prompts were paired randomly with each target across participants.

Finally, participants wrote about the same four personal memories presented in the beginning of the experiment. The labels participants generated for each memory were shown for each prompt. For example, a participant who labeled a memory “break-up” would be instructed, “Please recall the same memory you previously recalled and labeled ‘break-up’ earlier in the survey. Please describe your memory below and be as descriptive as possible in your entry and focus on how you felt at the time of the event.” Participants were required to write at least 150 characters for each prompt (see Table 1 in the supplemental materials for mean word counts per condition).

To measure the linguistic similarity between self and target paragraphs, we performed latent semantic analysis (LSA; Landauer, 2007) with Coh-Metrix software (Graesser, McNamara, Louwerse, & Cai, 2004). In our LSA analyses, a weighted vector was created for each paragraph that reflects the content of that entry. Using a statistical method referred to as “singular value decomposition”, LSA reduces a body of text to a series of function dimensions, or “co-occurrence matrix”, reflecting the number of times a given word appears in a given text. This matrix is further reduced to a single vector on these dimensions. The similarity in conceptual relatedness between paragraphs was computed as a geometric cosine between the two vectors (e.g., the vector for the baseline self paragraph describing a time the participant felt rejected and the paragraph describing how the participant imagined a similar other would experience being rejected), with values ranging from  $-1$  to  $1$  and higher values indicating greater semantic similarity. Thus, unlike the previous studies, in which lower values reflect greater similarity between the self and target, here higher values reflect greater similarity between the self and target.

### Results

As in the previous studies, participants perceived themselves to be more similar to their friend ( $M = 82.18, SD = 13.19$ ) than the average American ( $M = 53.50, SD = 20.10$ ),  $t(175) = 17.25, p < .0001$ , Cohen’s  $d = 1.69$ .

Conceptually replicating the previous studies, the 2 (target: similar other vs. average American)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a main effect of time,  $F(1, 176) = 8.93, p = .003, \eta_p^2 = .05$ , such that the language used to describe episodic memories was

more similar to the language used to describe the targets in similar events postsimulation ( $M = .18$ ,  $SD = .09$ ) than at baseline ( $M = .16$ ,  $SD = .08$ ; Figure 6). Unlike our previous studies, there was no main effect of target,  $F(1, 176) = .50$ ,  $p = .483$ ,  $\eta_p^2 = .003$  (self-friend similarity  $M = .17$ ,  $SD = .10$ ; self-average American similarity  $M = .18$ ,  $SD = .09$ ).

We did not find evidence for a significant Target  $\times$  Time interaction,  $F(1, 176) = .14$ ,  $p = .71$ ,  $\eta_p^2 = .001$ , and a linear mixed-effects model showed that perceived similarity to the targets did not moderate SIM,  $F(1, 268) = 1.68$ ,  $p = .197$ ,  $\omega^2 < .001$ .

## Study 6: The Role of Liking and Affiliation

### Method

Here we test an additional reason that people might align their own self-knowledge with others: the desire to feel socially connected to others. Humans are strongly motivated to affiliate with others. According to shared reality theory, people adjust their beliefs to match the beliefs of others around them in service of feeling more socially bonded (Echterhoff, Higgins, & Levine, 2009; Sinclair, Huntsinger, Skorinko, & Hardin, 2005). For example, when the motivation to affiliate is high, individuals change their attitudes to match the attitudes of their interaction partner (Sinclair et al., 2005). Likewise, one function of SIM may be to facilitate social connection. In Studies 1–5 we manipulated similarity in order to manipulate self-referential processing. However, similarity has been shown to increase affiliation, in addition to self-referential processing (McPherson, Smith-Lovin, & Cook, 2001). The goal of Study 6 was to test whether the desire to affiliate with and liking for the target of simulation—in addition to or independent of similarity—influences SIM. To this end, in Study 6 participants simulated two dissimilar targets, one of whom they liked and one of whom they disliked. This design thus attempted to differentiate similarity from affiliation motives and test for SIM. Given that both targets were familiar to participants, this paradigm further minimizes the possibility that differences in SIM between targets is driven by differences in our familiarity with them.

**Participants.** Participants ( $N = 401$ ) were recruited from Amazon Mechanical Turk (Mean age = 38.43,  $SD = 12.21$ ;

female = 200). This sample size provides 99% power to detect an effect, based on the Target  $\times$  Time interaction effect size observed in Study 1.

**Procedure.** Participants completed the episodic memory paradigm used in Studies 1, 4a, and 4b (here with no 24-hr delay). However, participants considered two targets matched on similarity; both targets were selected to be dissimilar to the participant. To select dissimilar targets, participants were instructed to nominate “someone who has a different personality, experiences the world differently, and/or has a different background than you.” While both targets were dissimilar, one was selected to be liked by the participant (“someone you like and/or feel positively towards”), while the other was selected to be disliked (“someone you dislike and/or feel negatively towards”). After completing the baseline, simulation, and postsimulation ratings, participants used a 0–100 scale to separately indicate the extent to which they felt similar to, liked, and wanted to affiliate with each target. Four participants did not provide liking ratings, and 1 participant did not provide affiliation ratings.

### Results

Participants reported wanting to affiliate with and liking the liked target (Mean affiliation = 83.56,  $SD = 16.55$ ; Mean liking = 85.87,  $SD = 14.54$ ) more than the disliked target (Mean affiliation = 22.49,  $SD = 24.09$ ; Mean liking = 23.67,  $SD = 22.10$ ), affiliation  $t(399) = 43.62$ ,  $p < .0001$ , Cohen's  $d = 3.04$ ; liking  $t(397) = 40.20$ ,  $p < .0001$ , Cohen's  $d = 3.29$ , suggesting our manipulation was successful. Despite instructions designed to keep similarity constant, participants nevertheless perceived themselves to be more similar to the liked target ( $M = 54.25$ ,  $SD = 25.44$ ) than disliked target ( $M = 16.48$ ,  $SD = 18.83$ ),  $t(400) = 26.65$ ,  $p < .0001$ , Cohen's  $d = 1.69$ . This finding is consistent with the idea that liking and similarity are highly interlinked constructs. Indeed, similarity, liking, and affiliation were all significantly correlated with one another for the liked target ( $r_s > .19$ ,  $p_s < .0001$ ) and disliked target ( $r_s > .57$ ,  $p_s < .0001$ ; see Table 2 in the supplemental materials for all correlations). As such, while this study allows us to measure the effect of liking and affiliation on SIM, these effects cannot be considered independent of similarity.

Conceptually replicating the previous studies, the 2 (target: liked vs. disliked)  $\times$  2 (time: baseline similarity vs. postsimulation similarity) repeated-measures ANOVA revealed a main effect of time,  $F(1, 400) = 199.44$ ,  $p < .0001$ ,  $\eta_p^2 = .33$ , such that the self was more similar to the targets postsimulation ( $M = 15.73$ ,  $SD = 6.38$ ) than at baseline ( $M = 17.05$ ,  $SD = 6.38$ ; Figure 7). We also found a main effect of target,  $F(1, 400) = 105.94$ ,  $p < .0001$ ,  $\eta_p^2 = .21$ , such that participants rated their own memories more similarly to simulations of the liked target ( $M = 13.16$ ,  $SD = 6.09$ ) than the disliked target ( $M = 19.63$ ,  $SD = 9.22$ ).

This ANOVA also revealed a significant Target  $\times$  Time interaction,  $F(1, 400) = 9.05$ ,  $p = .003$ ,  $\eta_p^2 = .02$ , such that simulation induced a greater increase in similarity to the liked target (baseline similarity  $M = 14.01$ ,  $SD = 6.59$ ; postsimulation similarity  $M = 12.30$ ,  $SD = 6.08$ ) than the disliked target (baseline similarity  $M = 20.10$ ,  $SD = 9.17$ ; postsimulation similarity  $M = 19.16$ ,  $SD = 9.64$ ). Furthermore, SIM was moderated by multiple variables of interest: Linear mixed-effects models revealed that across targets, SIM was moderated by liking,  $F(1, 490) = 8.85$ ,  $p = .003$ ,  $\omega^2 = .01$ ; motiva-

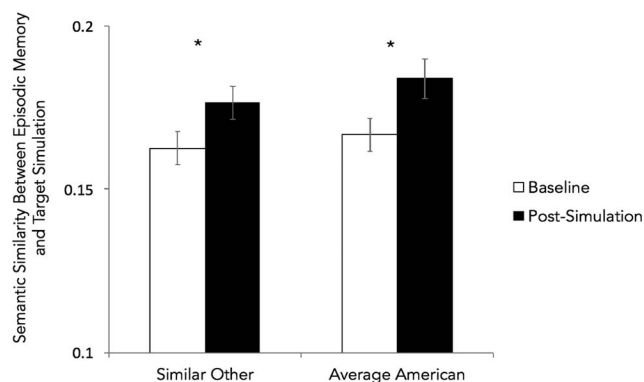


Figure 6. Results from Study 5. The semantic similarity between participants' description of their personal memories and how the target (similar other; average American) would respond to the same event, plotted separately at baseline and postsimulation. Semantic similarity increases for both targets postsimulation. \*  $p < .05$ .

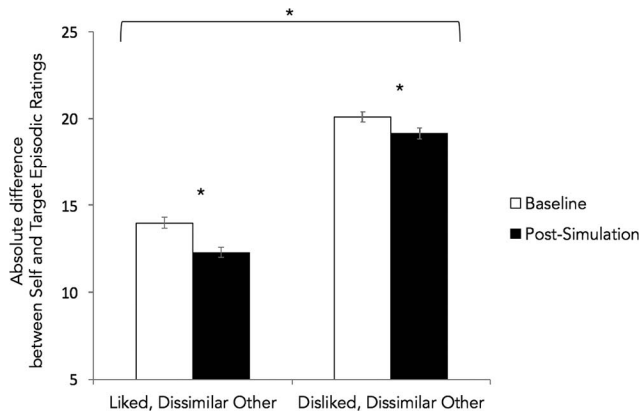


Figure 7. Results from Study 6. Participants rated their own memories as more similar to two dissimilar targets after they simulated those targets in the same events. This effect was strongest for the dissimilar target that the participant liked (vs. disliked). \*  $p < .05$ .

tion to affiliate,  $F(1, 521) = 11.26, p = .001, \omega^2 = .01$ ; and similarity,  $F(1, 713) = 12.97, p < .0001, \omega^2 = .02$ .

## Discussion

Does simply imagining other people change the self? Eight studies provide evidence for SIM, such that simulating a target changes self-knowledge. Participants' personal episodic memories, personality traits, and physical traits all became more similar to how they simulated another person's experiences and traits. These changes could not be attributed to superficial anchoring, remained altered 24 hr after simulation, and emerged in both self-report ratings and in rich linguistic descriptions of memories.

Such findings offer a qualification to the argument that the self is "special." Decades of research in support of the "self is special" account elegantly demonstrates that self-relevant information is uniquely represented in the brain (Kelley et al., 2002), more deeply encoded (Rogers et al., 1977), better remembered (Sui & Humphreys, 2015), and more quickly accessed than other information (Higgins, Bond, Klein, & Strauman, 1986; Meyer & Lieberman, 2018). Trait self-knowledge is supposed to be particularly immune to memory deficits (Klein et al., 1999; Klein & La., 2010; Klein et al., 1996). However, here we consistently found evidence for SIM, for both episodic and trait self-knowledge, suggesting that self-knowledge is susceptible to misinformation effects similar to those observed for other forms of knowledge. One possibility is that the self is special in terms of how self-relevant information is gathered (i.e., encoded) and organized (i.e., stored), yet once it is brought to mind it may be susceptible to the same postevent contamination that plagues other knowledge structures.

To our knowledge, this is the first research to examine the consequences of simulating other people's mental states and traits for self-knowledge. Traditionally, social psychologists focus on the consequences of the simulation strategy of mindreading for understanding others, noting that this strategy corresponds with a host of egocentric biases in our perceptions of others (Epley et al., 2004; Krueger & Clement, 1994; Ross et al., 1977). Here we show that this strategy may likewise induce *other-centric* biases in understanding the self. To the extent that we consider elements of

ourselves and others when trying to understand the people around us, we may incidentally adjust self-knowledge in the process. This possibility complements and extends past research on social comparison (Festinger, 1954; Markman & McMullen, 2003; Taylor & Lobel, 1989; Tesser, 1988; Suls, Martin, & Wheeler, 2002), which finds that our evaluations of ourselves can shift depending on how we perceive those around us. To date, this literature focuses on how comparing ourselves to others impacts our self-esteem. To our knowledge, no research on social comparison has examined whether thinking about others actually changes the content of our self-knowledge. Future work can assess the extent to which social comparisons are engaged when simulating other minds, and the consequences for SIM.

Importantly, SIM—which measures directed change toward the target of simulation—operates independently of (i) any anchoring effect due to making prior target ratings and (ii) any effect of overall, undirected change in self-ratings from one timepoint to the next. If SIM was simply due to anchoring on prior target ratings, then participants should show similar levels of SIM regardless of whether they internally generated (i.e., simulated) a target to generate their rating or were simply provided, externally, a rating to make for a target. Study 3 shows that SIM occurs only when target ratings are internally generated by the participant, and not when target ratings are externally provided. Moreover, participants in Study 3 showed significantly greater overall, undirected change in self-ratings in the external relative to internal condition, suggesting that overall, undirected change in self-ratings is unrelated to the directed change in self-ratings captured by SIM. Moreover, in Studies 1 and 2a, in which participants showed as much or more overall undirected change in self-ratings for trials paired with dissimilar targets as trials paired with no target, overall change was not significantly correlated with SIM. Taken together, such results suggest that the specific act of simulating another person seems to induce directed change in self-knowledge such that the self becomes more similar to the simulated person.

We observed strong evidence of SIM in multiple studies. However, more research is needed to determine the underlying mechanisms underpinning SIM. For example, it is unclear whether SIM reflects "reconsolidation" of the memory, or memory malleability more generally. Three steps are considered key to demonstrating evidence for reconsolidation: In Step 1, the memory must be retrieved; in Step 2, there should be presentation of new information; in Step 3, the original memory should reflect the incorporation of the new information. Critically, presenting new information (Step 2) without previous retrieval (Step 1) should not induce memory change, because in this case the memory would not have been made labile. One challenge in meeting these criteria with SIM is that the first and second steps are not easily separated. Step 2 is internally generated by the participant (rather than the experimenter) and likely happens quickly and outside of awareness. Thus, the current studies are limited by our inability to directly measure retrieved self-knowledge. The design of Study 3 separates similarity to a target and reactivation of self-information and, in doing so, provides key evidence that SIM occurs only when simulating a target. Nevertheless, this study does not resolve questions about the role of reconsolidation in SIM. For these reasons, we suggest that it may reflect an instance of memory malleability, more generally.



Instead of directly measuring retrieved self-knowledge, here we manipulated similarity between the self and target to test whether and how self-knowledge retrieval corresponds with SIM. Past work suggests that people recruit more self-knowledge when simulating similar others than dissimilar others (Ames, 2004; Tamir & Mitchell, 2013). Greater SIM for similar others is therefore consistent with the idea that simulation renders retrieved self-knowledge labile, and susceptible to change. We observed consistent evidence in six studies that target similarity interacts with SIM, across multiple types of targets (e.g., friend vs. average American and Walter Cronkite), and across self-knowledge type (e.g., episodic memory and traits). The only cases in which target similarity did not influence SIM is when the main effect of target was weaker (Study 4) or nonsignificant (Study 5). In these studies, we would not expect similarity to interact with SIM, since there were only minimal differences in similarity with which to work. That said, none of our studies directly manipulated or measured the amount of self-knowledge participants retrieve during simulation. Instead, we relied on manipulating proxies for self-knowledge retrieval, such as similarity, liking, and affiliation. This is a limitation of the current studies that could be overcome by shifting to methods that can measure self-knowledge retrieval in real time. For example, neuroimaging methods may better assess the use of self-knowledge and reactivated memories during simulation.

In addition to similarity, here we also test the extent to which affiliative motives moderate SIM. In Study 6, participants considered two dissimilar targets, one of whom they liked and one of whom they disliked. We observed a significant interaction such that participants demonstrated more SIM for the liked than the disliked target. These findings suggest that positive feelings toward others may motivate us to align our own self-knowledge with their attributes. That is, both similarity and affiliation motives may influence SIM. That said, it is still unclear whether they do so for the same or different reasons. On the one hand, affiliation may modulate SIM for unique reasons, such as the desire for social connection (Baumeister & Leary, 1995). On the other hand, affiliation may modulate SIM simply because similarity and affiliation are intertwined constructs (McPherson et al., 2001). Indeed, in Study 6 we observed that perceived similarity, liking, and the desire to affiliate with targets were highly correlated with each other. Thus, affiliation may influence SIM in the same way as similarity—by increasing recruitment of self-knowledge. Further work is needed to dissociate these constructs' independent influence on SIM. Here we simply conclude that salient relational factors such as affiliation and similarity can each enhance SIM.

To further clarify the boundary conditions to SIM, future work should identify whether SIM is specific to simulating other people, or whether generating a counterfactual personal event or imagining a future self might likewise induce changes in self-knowledge. Indeed, research suggests that imagining counterfactual past selves and future selves can motivate behavior change (Bartels & Urminsky, 2015; Hershfield, 2011; Landman, Vandewater, Stewart, & Malley, 1995), and that imagining emotional events alters subsequent memory for them (Devitt & Schacter, 2018). As such, imagining alternative selves may make the present self's schemas malleable and susceptible to SIM, in the same way that imagining similar others does. If so, we would likewise expect this effect to be enhanced as a function of perceived similarity to, or affiliation with, the imagined alternative self. Future research should also

determine whether SIM is specific to self-knowledge, or whether simulation also alters our knowledge of others (e.g., after thinking about friend A's reaction to an experience, and then considering friend B's reaction to a similar experience, does information about friend B become incorporated in one's knowledge about friend A?). Here we have focused specifically on determining whether self-knowledge is susceptible to SIM given that it is particularly intriguing that aspects of our identity, despite its "specialness," is so susceptible to SIM. Nevertheless, we suspect that simulation has the potential to alter other forms of knowledge, and look forward to future research on this topic.

Our results contribute to a growing literature on the ways in which other people shape our personal memories. For example, other people can evoke retrieval induced forgetting through conversation (Coman & Hirst, 2015; Coman et al., 2009; Cuc et al., 2007), whereby a person will selectively forget information that a conversation partner fails to reinforce. As we observed here, retrieval induced forgetting is amplified when conversation partners feel psychologically similar to one another (Coman & Hirst, 2015). Yet our findings suggest that live interaction may not be necessary for other people to change our memories. Rather, here we demonstrate that merely thinking about another person within our own minds is enough to restructure our own memories.

Our findings suggest a potential mechanism through which simulation may induce behavior change. Simulation has been shown to change multiple behaviors, from improving academic outcomes (Pham & Taylor, 1999) to increasing the likeliness of voting (Libby et al., 2007). Yet, how simulations translate into behavior change remains unknown, particularly since simulating an experience can also satiate the motivation to seek out similar experiences (Kappes & Morewedge, 2016; Morewedge, Huh, & Vosgerau, 2010). Our findings suggest that simulating oneself experiencing events may infuse the simulated experience with prior self-knowledge, making someone more inclined to see themselves, for example, as "the kind of person who goes to the polls." Future work can explore whether imagining the self going through new experiences changes self-knowledge to be consistent with the simulated experience, in turn changing behavior.

One surprising result from our studies was that participants changed ratings of their own physical traits to become more similar to the physical traits of even a highly dissimilar other, the Empire State Building. In everyday life, it seems unlikely that people would access self-knowledge to make inferences about the Empire State Building, a nonhuman target. However, it is possible that our design artificially heightened the accessibility of the self for use during Empire State Building ratings, which would explain why we observed SIM for the Empire State Building. Indeed, Study 3 demonstrates that SIM occurs only when participants internally generate responses, suggesting that the Empire State Building effect is not likely due to a superficial anchoring on ratings of the target.

It is also noteworthy that in Study 5, we did not observe a main effect of target in the semantic similarity between episodic memories and simulations for the similar other and average American. One possibility is that a person's semantic style may be relatively similar across situations (here, the self and targets), despite being susceptible to influence from SIM. Nevertheless, the lack of a main effect of target may explain why we did not observe a significant interaction between target and time: we would not

expect SIM to differ across targets if the current measure was unable to distinguish between targets to begin with. Instead, as in the prior studies, participants demonstrated SIM in the language they used for both targets. Thus, despite not observing a significant interaction, the results remain consistent with the idea that information about others becomes incorporated with self-knowledge during simulation.

William James once said, “a man has as many social selves as there are individuals who recognize him.” Here we show a person may have as many selves as they have images of others in their head. That is, by simply thinking about another person, we may adapt our self to take the shape of that person. Such findings could have important practical implications. As each of us chooses who to befriend, who to model, and who to ignore, we must make these decisions aware of how they shape not only the fabric of our social networks, but even our sense of who we are.

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