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A "Hyper-Recency" Bias in Memory Characterizes Both Psychoticism and Déjà Vu Experiences

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Psychosis is characterized by salient conflicts between reality and one's experience of it. Many people in the general population experience similar conflicts, albeit to a lesser extent—including during déjà vu, in which one is struck by the feeling that they have lived through the present moment before, despite not being able to pinpoint why or knowing that this cannot be true. The cognitive processes underlying these conflicts between reality and experience in psychosis and the general population remain poorly understood. Identifying shared cognitive correlates of psychosis-like symptoms and déjà vu is a compelling starting place for better understanding how such conflicts arise. Here, we hypothesized that psychosis-like symptoms and déjà vu might be related to breakdowns in memory for *when* events happened. Across two preregistered experiments (N = 500), we found that members of the general population endorsing higher levels of psychoticism (i.e., paranoia, positive, and disorganized symptoms) judged correctly recognized stimuli to have occurred *more recently in time* relative to ground truth. A similar illusion of recency was apparent for falsely recognized stimuli. These same participants were less sensitive to actual stimulus recency when making recognition memory judgments, exhibiting reduced differentiation between recently presented and novel stimuli. Similar patterns were found in association with déjà vu, but not negative (i.e., mood-related) symptoms, suggesting specificity to uncanny subjective experiences. These findings suggest that a "hyper-recency" bias in memory—wherein remotely encountered events are perceived as having happened recently—might represent one salient source of conflict between experience and reality.

Public Significance Statement

Psychosis is characterized by striking conflicts between reality and one's experience of it, which can manifest as delusions and hallucinations. Similar conflicts can be seen among the general public, in the form of subthreshold psychosis-like symptoms (e.g., paranoia) and everyday tricks of the mind (e.g., déjà vu). Understanding the cognitive processes that are associated with these experiences may help us to understand their more acute counterparts (i.e., the symptoms of schizophrenia). Here, we used behavioral experiments to reveal a specific memory bias among members of the general population who scored higher in self-reported psychoticism (e.g., delusional ideation, anomalous perceptual experiences, and disorganized thought) and/or reported more frequent and intense déjà vu. Specifically, high-psychoticism and high-déjà-vu participants showed a "hyper-recency" bias in memory, such that they remembered events as having occurred more recently in time—even if those events did not occur during the experiment at all. These results suggest that both psychosis-like symptoms and other uncanny experiences like déjà vu may involve illusions of recency—memory errors that may challenge our ability to determine what is real and what is not.

Keywords: psychosis, schizotypy, déjà vu, memory, temporal memory

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Data and code that support the findings reported in this article are available on the Open Science Framework at https://osf.io/5m4dx. The experiments reported in this article were preregistered (see https://osf.io/328g5; https://osf.io/wbj2p). This study's protocol (2000026576) was deemed exempt by the Yale University Institutional Review Board. Certain data in this article have been previously published as part of an unrelated omnibus analysis (Koller & Cannon, 2023b); all analyses reported herein are original and have not been previously published. Portions of the data and ideas presented in this article were previously disseminated at a virtual poster session at the 55th Annual Convention for the Association for Cognitive and Behavioral Therapies (2021), as well as in oral presentations at the Brain and Mind: Delusion Workshop at St. Hilda's College, University of Oxford, Oxford, United Kingdom (2023), and the Congress of the Schizophrenia International Research Society in Florence, Italy (2024). The authors have no conflicts of interest to disclose.

continued

> Wherever, in fact, the recalled event does appear without a definite setting, it is hard to distinguish it from a mere creation of fancy … For example, I enter a friend's room and see on the wall a painting. At first I have the strange, wondering consciousness, "surely I have seen that before," but when or how does not become clear. There only clings to the picture a sort of penumbra of familiarity.
>
> —William James, *The Principles of Psychology* (p. 658)

Psychosis is a debilitating condition that affects between 0.5% and 1% of the population (McGrath et al., 2008; Regier et al., 1993) and has significant personal and societal costs (Charlson et al., 2018). Many more individuals experience subthreshold psychosis-like symptoms without necessarily meeting criteria for a psychosis spectrum disorder per se (e.g., often referred to as "schizotypy"; Lenzenweger, 2010). While these symptoms are less severe than in schizophrenia, they are nonetheless associated with significant distress (Freeman et al., 2011). A key feature of experiences across the psychosis spectrum is a conflict between consensus reality and that which one believes (as in delusions) or perceives (as in hallucinations) to be true (Cannon, 2015). In the early stages of psychosis, people begin to report fundamental changes to their experience of the world (Fusar-Poli et al., 2013). These can range from a pervasive sense of unreality to the feeling that time has been suspended, leading one to "live in an elusive and pregnant 'now,' in which what is most important is always about to happen" (Fusar-Poli et al., 2022, p. 171). To the average reader, such severe challenges to "reality monitoring" may seem quite distant from their daily experiences. However, many of us have likely felt some aspect of this conflict between perception and reality—even if just for a fleeting moment.

For example, consider the phenomenon of déjà vu—the uncanny feeling that one has lived through the present moment before, despite not being able to pinpoint why or despite knowing that this is impossible (Brown, 2003; Cleary & Brown, 2022a). Déjà vu is characterized by a sense of conflict between what we feel and what we know—"I feel like I have already experienced this exact moment, *but I know this cannot be true*" (Aitken et al., 2023; Urquhart et al., 2021). These experiences can be unsettling: In the words of William James, déjà vu can evoke a "strange, wondering consciousness" that is "hard to distinguish … from a mere creation of fancy." What is more, this conflict often demands some sort of resolution (McNeely-White & Cleary, 2023). Some may—if only briefly—entertain fantastical explanations for this strange sense of familiarity (e.g., considering it to be a memory from a past life; Meyersburg et al., 2009). In this way, déjà vu is analogous to psychosis, in which an individual is confronted with salient instances of conflict (Howes et al., 2020) that challenge their sense of reality (Castiello et al., 2024) and prompt a search for meaning (Carter et al., 2017; Garety et al., 2001). Yet unlike déjà vu, which is typically defined as a fleeting trick of the mind, psychosis is characterized by more marked departures from consensus models of reality in the form of delusions: beliefs that can help to explain unsettling subjective experiences (Maher, 1999) yet tend to be the source of significant distress and impairment (Peters et al., 2004).

Connecting Psychoticism and Déjà Vu

What might give rise to these initial conflicts between reality and our experience of it in psychosis and déjà vu? One possibility lies within our imperfect memory systems: What we remember does not always reflect what is true (Schacter, 2022). In line with this notion, contemporary theories suggest that déjà vu is an illusion of memory. According to "familiarity" accounts, déjà vu arises from familiarity-based recognition in the absence of episodic recall (i.e., "recognition without identification"; Brown, 2003; Cleary, 2008). Accordingly, presenting participants with novel scenes that share high degrees of configural similarity with familiar scenes can evoke feelings of déjà vu (Cleary & Claxton, 2018; Cleary et al., 2009, 2012; Okada et al., 2024), and participants who are more sensitive to similarities between such scenes report more frequent real-life déjà vu experiences (Sugimori & Kusumi, 2014). The idea that unspecified familiarity can drive illusions of memory is further corroborated by Jacoby and Whitehouse (1989), who demonstrated that implicit presentation of a familiar word during a memory test is sufficient to cause false recognition of subsequent test items. Another theory, however, suggests that déjà vu may involve not only an undefined sense of familiarity but also the metacognitive awareness that this sense of familiarity is *inappropriate*. This "metacognitive monitoring" account holds that the uncanny feeling of déjà vu is triggered by the *detection of conflict* in the memory system (Aitken et al., 2023; Urquhart et al., 2021). According to this view, déjà vu may ultimately reflect an adaptive process, in that it represents a corrective response to a memory error.

Interestingly, these accounts seem to make opposite predictions about the connection between psychoticism and déjà vu. From the standpoint of familiarity accounts of déjà vu, those on the psychosis spectrum should be *more* susceptible to déjà vu (Cleary & Brown, 2022b), given that schizophrenia is characterized by impaired episodic recollection but relatively spared familiarity-based memory (Libby et al., 2013; van Erp et al., 2008)—a pattern that should plant the seeds for frequent instances of undefined familiarity (i.e., recognition without identification). On the other hand, individuals on the psychosis spectrum tend to exhibit less accurate metacognition

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(Rouy et al., 2021) and reduced conflict processing (Bronstein et al., 2019). From a metacognitive perspective, then, this should result in *fewer* déjà vu experiences as these individuals would be less likely to engage in the conflict monitoring necessary to flag errors in the memory system. Given these competing predictions, it is perhaps not surprising that reports of the relationships between psychoticism and déjà vu have historically been mixed. On one hand, there is some evidence that those who go on to develop psychosis spectrum disorders experience more frequent déjà vu (Cleary & Brown, 2022b; de Jong et al., 2018) and qualitative research on the lived experiences of individuals with schizophrenia indicates frequent reports of déjà vu and its more intense counterpart déjà vécu (Stanghellini et al., 2016). Other work, however, points to *reduced* rates of self-reported déjà vu in chronic schizophrenia (Adachi et al., 2006, 2007). How might we explain this inconsistency? One possibility is that individuals on the psychosis spectrum are in fact prone to the type of familiarity-based memory errors that *could* go on to be explained as déjà vu yet exhibit considerable variability in whether they engage in the metacognitive monitoring necessary to describe those experiences using this language. This would imply that task-based experimentation (vs. self-report alone) may be necessary to reveal whether déjà vu and psychoticism are related to similar underlying patterns of memory dysfunction.

Moving From "What" to "When"

This line of thinking raises an important question: What particular aspects of memory might be connected to both déjà vu and psychoticism? Research testing intuitively appealing theories of déjà vu has struggled to identify individual differences in memory functioning that are associated with real-life déjà vu experiences (O'Connor & Moulin, 2013). At the same time, in the psychosis literature, while memory impairment has increasingly become recognized as a core feature of disorders like schizophrenia (Guo et al., 2019), our understanding of the connections between particular aspects of memory function and distinct symptoms of schizophrenia remains equivocal. This is especially true for symptoms that involve disruptions to reality monitoring (i.e., positive symptoms, such as hallucinations and delusions; Koller & Cannon, 2023a). For instance, some studies connect memory dysfunction to disrupted reality monitoring (Brébion et al., 1999), while others indicate that memory impairment is most closely related to the negative symptoms of psychosis (e.g., low mood, amotivation; Aleman et al., 1999). This pattern calls into question our assumption that memory dysfunction can, at times, challenge our sense of reality as in cases of déjà vu.

One possibility, however, is that this missing link is to be found in other aspects of memory performance than are typically measured. Notably, prior work on these topics has overwhelmingly studied memory for *what*—that is, how well people recognize or recall content presented during an earlier encoding phase—rather than memory for *when*. And while we typically think of memory in terms of its contents (i.e., the objects and properties that compose our perceptual experiences), equally important is memory for how those properties are situated in the first place—especially how they are situated in time. Indeed, even if we perfectly remembered *what* we encountered, experience would still be incoherent if we could not also remember *what happened when*. This fact becomes immediately apparent when we consider populations with severe memory disorders—for instance, individuals with brain lesions that give rise to spontaneous confabulation (Schnider, 2003). While these individuals are relatively spared in learning new information (i.e., recognizing *what* was recently studied), they struggle to suppress the retrieval of material from prior contexts that are no longer relevant (i.e., discriminating *when* something occurred; Ptak & Schnider, 1999; Schnider & Ptak, 1999; Schnider et al., 1996). As summarized by Schnider (2003), spontaneous confabulation can thus be described as a preoccupation with "presently irrelevant memories [which] dominate thought in such a way that they are perceived as ongoing reality" (Schnider, 2003, p. 664)—highlighting how disturbances in our memory for time may uniquely challenge our ability to make sense of the world around us.

Psychoticism and Déjà Vu as Disturbances of Temporal Memory

While more is known about the systems that are involved in processing one's position in *space* versus in *time* (e.g., Maguire & Mullally, 2013; Rubin, 2022; Ruiz et al., 2020), there is growing evidence that the medial temporal lobe may be involved in both spatial and temporal relational processing (Buonomano et al., 2023; Eichenbaum, 2017; Ekstrom & Ranganath, 2018) and that impairments in processing of space and time are often linked (Saj et al., 2014). Intriguingly, both déjà vu and schizophrenia are related to disruptions within these regions. For instance, frequent déjà vu is a common correlate of temporal lobe epilepsy (Bancaud et al., 1994; Cleary, Neisser, et al., 2021; Guedj et al., 2010) and reduced gray matter volume within the medial temporal lobe has been associated with déjà vu frequency (Brázdil et al., 2012). At the same time, hippocampal dysfunction and gray matter volume reductions are among the most common brain abnormalities associated with schizophrenia (Heckers & Konradi, 2002; Roeske et al., 2021).

At a phenomenological level, too, both déjà vu and psychosis seem to be tied to one's experience of time. Déjà vu, for instance, has been described as a feeling of "mental time travel" that lacks specific information about where or when you are traveling to (Neisser et al., 2023)—a transportation to an "undefined past" (Neppe, 1983). Individuals with schizophrenia frequently describe aberrant subjective experiences of time, wherein time appears to move too fast or too slow, or to repeat itself—as in experiences of déjà vu (Coull & Giersch, 2022; Stanghellini et al., 2016; Vogel et al., 2019). Individuals with psychosis spectrum disorders also exhibit more variability in their "internal clocks," showing less precision in tasks relying on time perception (e.g., time production/reproduction and duration discrimination) and temporal processing (e.g., judgments of simultaneity, temporal order judgments, and gap detection; Ciullo et al., 2018; Thoenes & Oberfeld, 2017). There are some clues that temporal *memory* may similarly be disrupted across the psychosis spectrum. For instance, those experiencing the positive symptoms of psychosis are particularly likely to make "interlist errors," wherein words presented in a prior context are mistaken as having occurred in the currently tested list (Brébion et al., 1999, 2002, 2020)—a pattern that could stem from temporal context confusion. Further, during free recall, both individuals with schizophrenia (Polyn et al., 2015) and first-episode psychosis (Murty et al., 2018) show reduced temporal clustering, such that the order of recalled items is less influenced by their original order of presentation. Finally, among

members of the general population, paranoia has been found to be differentially associated with false alarm errors to word stimuli that frequently appear in other contexts (i.e., real words, as opposed to pseudowords; Koller & Cannon, 2021)—a pattern that implies an attenuated use of temporal information (i.e., "*When* did I last see this stimulus?") to discriminate between targets and lures.

The Present Studies

Despite these characteristics, however, the relationship between psychosis, déjà vu, and temporal memory has never to our knowledge been directly tested. Indeed, it is noteworthy that in *none* of this aforementioned research is temporal information ("when") directly measured. Rather, temporal information is inferred by way of testing memory for "what" (e.g., with interlist errors being interpreted as a temporal memory error). While this strategy is not without merit, it allows only for the detection of *whether* an error occurred, offering minimal information about the degree or directionality of this error within the temporal dimension. This limits our ability to understand the dynamics of how people organize their experiences in time—and whether our sense of reality is challenged when this organization goes awry.

Here, we suggest that an *attenuated ability to organize one's memories in time* could pose a particular challenge to our reality monitoring systems by giving rise to salient conflicts between memory and reality that demand explanation. Depending on how people make sense of such conflicts, this breakdown could be described as déjà vu and/or become incorporated into more acute psychotic-like interpretations (e.g., thought insertion, a "sixth sense," or recovered memories of a past life). In the present studies, we sought to address the limitations of past work that has relied on "memory-for-what" paradigms by turning to "memory-for-when." Namely, we ask whether disruptions in "memory-for-when" are (A) characteristic of psychosis-like symptoms (i.e., those concerning reality monitoring difficulties) over and above mood or motivation-related symptoms and (B) associated with individual differences in the frequency and intensity of déjà vu. To address these questions, we devised a novel timeline-based recognition memory task in which participants were asked not only to perform recognition judgments (i.e., "Is this old or new?") but also to use a timeline slider to indicate *when* they remembered seeing a given item. Critically, this task allowed us to differentiate between three possible profiles of "memory-for-when" dysfunction:

1. *Generally disorganized* memory. When unsure of the source of a recognized item, a participant might simply respond randomly on the timeline, resulting in a normal distribution of error.
2. Memory that is *biased toward the past* (i.e., hypo-recency). This pattern involves systematic judgment that recognized items occurred more distally than they did in reality.
3. Memory that is *biased toward the present* (i.e., hyper-recency). This pattern involves systematic judgment that recognized items occurred more recently than they did in reality.

Those higher in psychoticism and déjà vu could reasonably be expected to fit within any of those profiles of dysfunction. For example, considering associations with generalized memory impairment, psychoticism and déjà vu may be related to nonspecific deficits in judging recognized items in time (i.e., responding poorly, with no systematic pattern of error). Alternatively, as memory strength and episodic detail can act as a cue to timing (D'Argembeau & Van der Linden, 2004; Grove & Wilding, 2009; Hinrichs, 1970; Trope & Liberman, 2003), impaired memory could cause all recognized items to feel hazy and distant (i.e., hypo-recency: "This must have happened a while ago"). Finally, if memory impairments make episodic detail a poor cue to temporality, then events may tend to be judged as *more recent*, given that there is no gradient of detail by which to place them in the more distant past (Brown et al., 2007). Under such conditions, any items that are sufficiently familiar to be recognized may also be judged as having been presented recently (i.e., hyper-recency: "This must have happened just now"). In this case, a reliance on familiarity-based memory (Libby et al., 2013; van Erp et al., 2008) would be expected to leave one prone to these hyper-recent memory errors.

Determining such directionality is important given that these biases may correspond to different profiles of memory retrieval that map on to distinct symptoms of psychosis. For instance, hypo-recency in temporal memory could correspond to a more "forgetful-like" profile, wherein memories feel hazy and disconnected from the present moment. By contrast, hyper-recency could correspond to a more "intrusive-like" profile, wherein memories feel particularly connected to the present moment despite pertaining to more distant events. There is emerging evidence that distinct psychosis-like symptoms may relate to different profiles of recognition memory performance. For instance, in both historic and more recent studies, positive symptoms seem to be differentially related to intrusion errors (i.e., "false alarms") in recognition memory (Brébion et al., 1999; Koller & Cannon, 2021; Sahakyan & Kwapil, 2019), while negative symptoms are either negatively correlated with intrusion errors (as in Brébion et al., 1999) or positively correlated with forgetful-like errors (i.e., "misses"; as in Sahakyan & Kwapil, 2019). Whether a similar dissociation manifests itself in temporal memory remains an open question, the answer to which could prove useful in improving the precision of future prediction, prevention, or treatment efforts (e.g., Brewin et al., 2010; Ernst et al., 2021). However, as this study was the first to our knowledge that tested temporal memory performance in this population, our initial hypotheses were agnostic to directionality of error (see https://osf.io/328g5) and focused on differentiating between the three possible patterns of responding described above. We then sought to replicate observed patterns in a follow-up study that additionally assessed déjà vu experiences (see https://osf.io/wbj2p). In line with this framework, we assessed the following research questions:

1. Are both psychoticism and déjà vu characterized by disruptions in memory-for-when?
2. If so, does this reflect poor memory in general? Or are there systematic misjudgments in one direction or the other?

Method

Transparency and Openness

The experiments reported in this article were preregistered (see https://osf.io/328g5 for Study 1; https://osf.io/wbj2p for Study 2).

Data and code that support the findings reported in this article are available at https://osf.io/5m4dx (Koller et al., 2023). Stimuli used in the memory paradigm were retrieved from https://bradylab.ucsd.edu/stimuli.html (Brady et al., 2008). Data were analyzed using R, Version 4.2.1 (R Core Team, 2022). We conducted an a priori power analysis based on pilot data using the R package "simr" (Green et al., 2016), which indicated that a final sample size of 250 participants per study would achieve roughly 90% power for effects of interest (see preregistrations for more details on this analysis).

Of note, during the analysis of Study 2, several participants were identified who seemed to respond to the slider-based measures in a stereotyped manner (e.g., selecting the same response many times in a row, regardless of the prompt). As this likely reflected inattentive responding that could inappropriately bias our results, we opted to exclude participants who made the same response on a slider measure on more than 10% of trials during recognition testing (i.e., 8 trials in Study 1; 12 trials in Study 2). This resulted in the additional exclusion of 18 participants from Study 2; no such participants were found in Study 1. To reach the preregistered sample size of 250, we collected an additional 18 usable participants using the same methods described below. As this represented a minor deviation from our preregistered exclusion practices, we report the results associated with the original sample in the Supplemental Material (see Supplemental Section S9). Importantly, results were consistent across these two sets of analyses (i.e., these participants did not account for our original results).

Participants

For Study 1, 333 MTurk workers were recruited to take an online survey using the CloudResearch platform (Litman et al., 2017). Only those over the age of 18 and located in the United States were recruited. The survey was only open to workers who had completed at least 1,000 tasks on the crowdsourcing platform with at least a 95% success rate. Participants were excluded ($n = 83$) based on criteria established in the preregistration (described in detail in Supplemental Section S1). For Study 2, 491 MTurk workers were recruited via the same means as Study 1, with the additional stipulation that they could not have already participated in Study 1. Participants were excluded ($n = 241$) based on criteria established in the preregistration (described in detail in Supplemental Section S1), plus the additional exclusion of participants who selected the same response on a slider measure more than 10% of the time (as noted in the Transparency and Openness section). See Supplemental Section S2 (Supplemental Table S1) for a full report of demographic information for Study 1 and Study 2. Importantly, across studies, results remained consistent after reanalysis using the full sample without exclusions (see Supplemental Section S9), indicating that the observed pattern of findings cannot be explained by exclusion practices.

Measures

Revised Green Paranoid Thoughts Scale

In both studies, self-reported paranoia was measured using the Revised Green Paranoid Thoughts Scale, Part B (R-GPTS-B; Freeman et al., 2019). The R-GPTS-B consists of 10 items concerning thoughts and feelings one has had about others in the past month, using statements such as "I was convinced there was a conspiracy against me." Participants were instructed to indicate the extent to which they experienced these feelings on a scale of 0 (*not at all*) to 4 (*totally*), with the sum of each participant's responses indexing paranoid ideation. Thirty-four percent of the Study 1 sample (85 participants) and 60.40% of the Study 2 sample (151 participants) scored above the threshold for moderate paranoia (11; Freeman et al., 2019), suggesting oversampling of individuals higher in paranoia (which has an estimated 20% prevalence rate in the general population; Freeman et al., 2011), especially in Study 2.

Multidimensional Schizotypy Scale

Schizotypy was measured using the 38-item Multidimensional Schizotypy Scale, Brief (MSS; Gross et al., 2018). The MSS contains three subscales, each assessing a different cluster of schizotypy symptoms: negative (MSS-N), disorganized (MSS-D), and positive schizotypy (MSS-P). The scales include statements such as "I tend to have few interests" (MSS-N), "My thoughts often feel so jumbled that I have difficulty doing anything" (MSS-D), and "I have had experiences with seeing the future, ESP or a sixth sense" (MSS-P). Participants were instructed to respond with "True" or "False" depending on whether the statement accurately described them. Schizotypy was indexed via the total number of "True" (or reverse-coded "False") responses reported within a given subscale.

Déjà Vu

In Study 2, we additionally collected questions pertaining to experiences of déjà vu. Participants first read a definition of déjà vu ("… the feeling of having been someplace or done something before, without being able to pinpoint why and despite knowing that the current situation is new"). Then, participants used a 4-point scale ranging from 0 (*never*) to 3 (*all the time*) to respond to the following questions: "How often would you say that you have déjà vu experiences in real life?" (i.e., déjà vu frequency) and "When you have déjà vu in real life, how often is it accompanied by a feeling of knowing what is going to happen next?" (i.e., déjà vu prescience, which has been found to be associated with the intensity of a given episode of déjà vu; Cleary, McNeely-White, et al., 2021). A standardized composite score for déjà vu was formed by averaging responses to both questions and z-scoring the resulting metric. (See Supplemental Table S2 for frequencies of responses to the individual déjà vu questions.)

Standardized Psychoticism and Negative Schizotypy Variables

We used these scales to create standardized variables that allowed us to contrast symptoms that have more to do with disrupted reality monitoring (i.e., positive and disorganized symptoms) versus symptoms that have more to do with mood and motivation (i.e., negative symptoms). The psychoticism variable was created by averaging the z-scores of the R-GPTS-B, MSS-P, and MSS-D for each participant and restandardizing the output (via z-score). The negative symptom variable was created by z-scoring the MSS-N. In this way, these scales represent counterpoints that capture distinct characteristics of psychosis spectrum disorders, with the psychoticism scale reflecting bizarre thought content (i.e.,

persecutory, supernatural), psychotic-like experiences (i.e., hallucinations), and disordered thought and with the negative symptom scale reflecting low mood, amotivation, and asociality. This represents a minor deviation from the preregistration (which refers to paranoia alone as the primary independent variable of interest). Our focus on psychoticism versus negative schizotypy was both empirically and theoretically motivated: In addition to circumventing multicollinearity caused by highly correlated symptom scales (i.e., paranoia, positive schizotypy, and disorganized schizotypy; see Supplemental Section S5), these standardized composite scales allowed us to answer a more nuanced question. Namely, by using negative symptoms as a sort of within-sample control, we were better positioned to make a claim about whether effects of interest are more closely related to reality monitoring per se, as opposed to more general aspects of mood and motivation. Importantly, preregistered analyses showed identical patterns in association with paranoia alone (reported in full in Supplemental Section S6).

Internal Consistency

The internal consistency of questionnaire measures was indexed using omega total (McDonald, 1999), which can be interpreted using similar cutoffs as Cronbach's α (i.e., values .90 reflecting excellent internal consistency). All scales were acceptable ($\omega_t \geq 0.70$), with the majority displaying excellent internal consistency (see Supplemental Table S3).

Procedure

Study 1

Study 1 began with an encoding phase, in which participants viewed a stream of 144 images depicting common objects and animals and responded to a trial-wise attention check (using a keypress to indicate whether each image was "natural" or "man-made"). Participants then completed a recognition phase during which they were tested on 80 images, half of which appeared during encoding (i.e., "targets") and half of which never appeared during the experiment (i.e., totally new "lures"). For each image, participants judged whether it was "Old" (i.e., seen during encoding) or "New" (i.e., not seen during encoding). After judging an image to be "Old," participants were asked to use a horizontal "timeline" slider scale to indicate *when* during encoding they remembered that image as having appeared ("Mark the point on the line corresponding to the approximate time during the first part of this experiment when this image appeared"; adapted from methods described in Jenkins & Ranganath, 2010). The left and right endpoints of the slider were labeled as "Start" and "End," respectively. After judging an image to be "New," participants instead used a similar slider to respond to a control question ("Mark the point on the line corresponding to how familiar you are with this object"). In this case, the left and right endpoints of the slider were labeled as "Very Unfamiliar" and "Very Familiar." This question allowed us to examine whether any slider biases were present in a condition that did not ostensibly require temporal memory judgments (although familiarity judgments may also rely on mnemonic processes; an issue which we address in Study 2 by using a different control question). Participants were asked to do their best to use the entire length of the sliders when making their responses. Finally, participants responded to questionnaires (R-GPTS-B and MSS) and demographic questions before receiving a debriefing form.

Study 2

Study 2 was similar to Study 1, with the exception that participants completed *two* encoding and *two* recognition phases in the following order: Encoding I, Recognition I, Encoding II, and Recognition II. During both Encoding I and Encoding II, participants viewed a stream of 64 images while responding to the same trial-wise attention check described above. During Recognition I, participants judged 64 images (32 targets, 32 lures) to be either "Old" or "New," using a timeline slider following a judgment of "Old" (identical to Study 1) and a control question following a judgment of "New." Instead of making a judgment about the tested image, this control question presented participants with a numeric prompt that varied semirandomly between 0% and 100% and instructed them to "Mark the point on the line corresponding to X% [of the total slider length]." For example, participants asked to mark the point corresponding to 50% should select the middle of the slider. This spatial control slider allowed us to uniformly distribute test prompts across the length of the slider and to establish a "ground truth" with which to calculate a nonmnemonic displacement score (i.e., with the same technique used to calculate the temporal displacement score for recognition hits). As such, performance on this control slider provided a clear readout of a participant's attention to spatial position, helping to identify inattentive or spatially biased responders. On both the timeline and spatial slider, participants received a readout of their cursor's current position on the slider that updated as they moved their mouse, in the form of a percentage of the total slider length.

Recognition II had this same general structure, except that half of the lures ($n = 16$) were images that had already appeared once during Encoding I (but were not tested during Recognition I); the other half ($n = 16$), as before, never appeared during the experiment (i.e., were totally new). Thus, while the former set of lures evoked a recent memory trace from the earlier phase of the experiment, the latter did not. Going forward, we refer to these as "Initial" and "Novel" lures, respectively. Importantly, participants were instructed to only respond with "Old" to images that they remember seeing in the *most recent* phase of the experiment (i.e., Encoding II). In this way, the participants' goal was to respond to both Initial and Novel lures with "New," even if they remembered seeing the image during Encoding I (see Supplemental Table S4 for a summary of these trial types).

At the end of the experiment, participants responded to an additional control slider involving aesthetic judgments about 20 new stimuli (i.e., "Mark the point on the line corresponding to how colorful this object is"; with left and right endpoints ranging from "More Colorful" to "Less Colorful," respectively). This served as an additional test of whether participants showed systematic differences in how they used slider-based measures outside the context of mnemonic or spatial judgments. Further, as in Study 1, participants responded to questionnaire (R-GPTS-B, MSS, déjà vu questions) and demographic questions before receiving a debriefing form. For additional details on procedure, see Supplemental Section S4.

Analyses

For both studies, attention during encoding was indexed using average performance on the trial-wise attention checks (i.e., natural vs. man-made), ranging from 0.51 (following exclusions) to 1.00. We additionally created a variable representing timeline displacement of recognition "hits" (i.e., items that appeared during the earlier encoding phase and that were correctly recognized as such), which was indexed using the difference between each item's original position during encoding and its estimated timeline position during recognition. This variable ranged from −100 to 100, expressed as a percentage of the total timeline. Here, lower displacement values indicate items that were misjudged to have occurred more *distally* than they actually did (hypo-recency); higher values indicate items that were misjudged to have occurred more *recently* (hyper-recency). A value of zero represents a perfect score. For recognition "false alarms" (i.e., items that did *not* appear during the corresponding encoding phase but that were falsely recognized as such), temporal memory performance was indexed using timeline *placement* (as opposed to *dis*placement, as false alarms had no "true" position from which to calculate displacement). This variable ranged from 0 to 100, expressed as a percentage of the total timeline. In all models described below, we used Akaike information criterion-based model selection to determine whether to include variables for various demographic factors (e.g., age, gender, education, and race).

Models 1A and 1B: Psychoticism and Temporal Memory for Recognition Hits

We used the glmer function (lme4 package; Bates et al., 2015) to create mixed-effects linear regression models of timeline displacement of recognition hits as a function of psychoticism (*z*-scored), with attention during the encoding phase and negative schizotypy (MSS-N) included as covariates (Model 1A). We subsequently sought to confirm whether psychoticism was differentially related to timeline displacement in the hyper- versus hypo-recent direction by creating a mixed-effects linear regression model of *absolute* timeline displacement (ranging from 0 to 100, expressed as a percentage of the total timeline) as a function of psychoticism (*z*-scored), displacement direction (positive vs. negative), and their interaction, with attention during the encoding phase included as a covariate (Model 1B). Both models were initially implemented in Study 1 before being tested for replication in Study 2.

Model 2: Psychoticism and Temporal Memory for Recognition False Alarms

We conducted analogous analyses to assess whether a similar pattern was evident for recognition false alarms. To this end, we created mixed-effects linear regression models of timeline placement of recognition false alarms as a function of psychoticism (*z*-scored), with attention during the encoding phase and negative schizotypy (MSS-N) included as covariates. Note that in Study 2, this analysis drew from *all* recognition false alarms, agnostic to lure type (Initial vs. Novel).

Model 3: Psychoticism and Sensitivity to Lure Recency

In Study 2, we additionally sought to assess how lure recency affected participants' recognition memory judgments. Namely, we anticipated that Initial lures would be falsely recognized at higher rates than Novel lures among lower psychoticism participants (indicating an intact, though misleading, relationship between stimulus recency and recognition judgments). Yet among higher psychoticism participants, we wondered whether this relationship might be disrupted, such that both Initial and Novel lures would be falsely recognized at similar rates—reflecting a failure to discriminate between lures on the basis of recency. To this end, we used the glmmTMB function (Brooks et al., 2017) to create a mixed-effects β regression modeling the proportion of lures that were falsely recognized (ranging from 0 to 1, with 1 denoting a participant who falsely recognized every lure as "Old") as a function of psychoticism (*z*-scored), lure type (Initial vs. Novel), and their interaction, with attention during the encoding phases and negative schizotypy (MSS-N) included as covariates. To accommodate values of 1 and 0, we squeezed the proportion variable using methods described in Smithson and Verkuilen (2006).

Models 4–6: Déjà Vu and Temporal Memory

In Study 2, we reran Models 1–3 using déjà vu (*z*-scored) as the independent variable of interest instead of psychoticism, to assess whether similar memory performance was seen in association with both constructs. These models were identical to those described above, with the exception that they did not covary for negative schizotypy.

Control Slider Analyses

Finally, we conducted a series of regressions assessing the relationships between psychoticism and responses to a range of control sliders, including judgments of familiarity, spatial judgments, and judgments of colorfulness. For more details on these analyses, see Supplemental Section S8.

Results

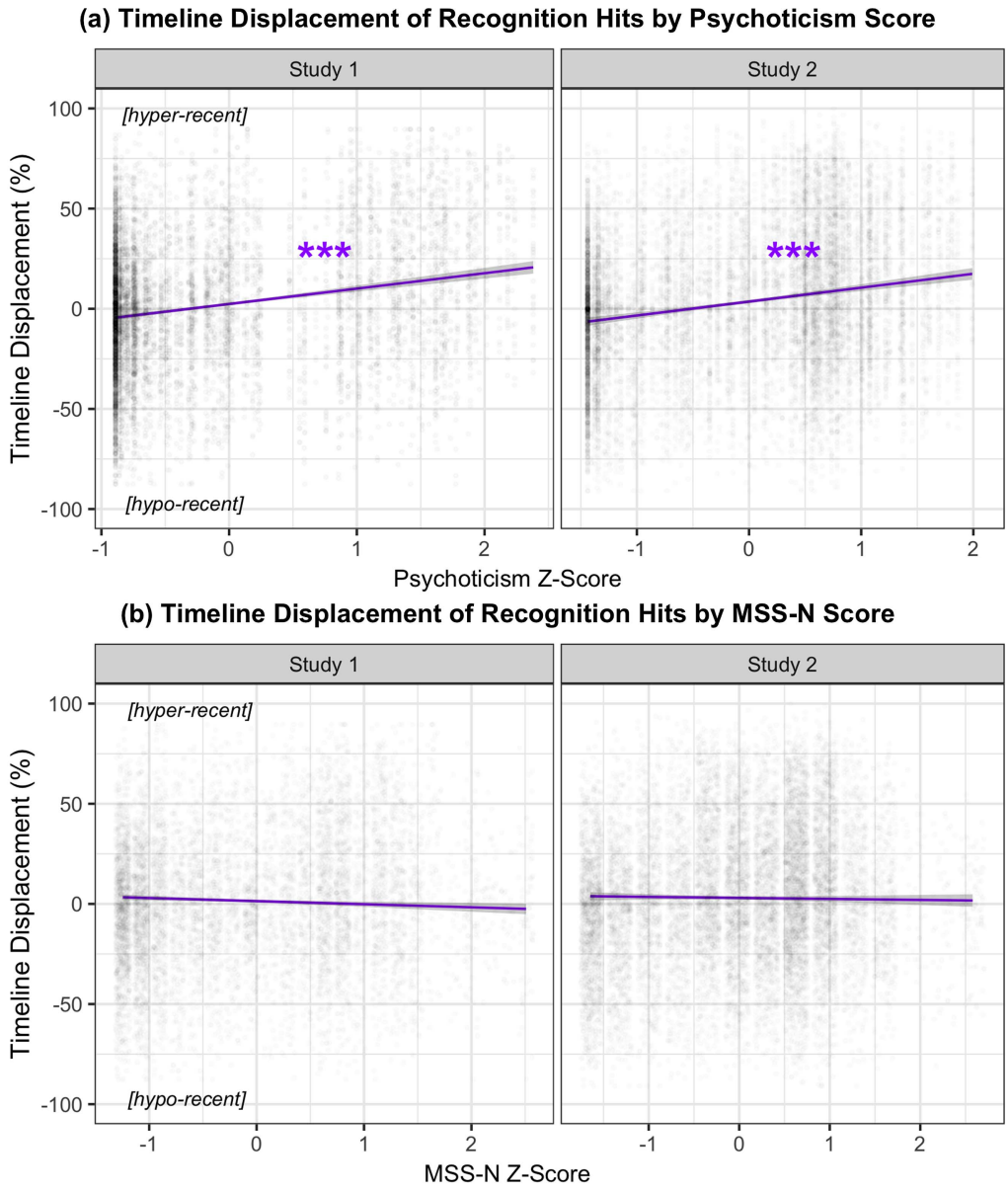
Zero-order correlations from Study 1 and Study 2 can be found in Supplemental Section S5 (Supplemental Tables S5 and S6, respectively).

Actual Events Are Remembered to Have Occurred More Recently Among Those Higher in Psychoticism

Across both studies, our results indicated that those higher in psychoticism estimated actual events (i.e., recognition hits) to have occurred *more recently* than they did in reality (see Figure 1a). This pattern was specific to psychoticism, with no parallel effect evident in negative schizotypy (see Figure 1b). What is more, this pattern was highly *directionally specific*: Those higher in psychoticism were not simply worse at the timeline task in general. With increasing psychoticism, the absolute displacement associated with hyper-recency errors increased, while the absolute displacement associated with hypo-recency errors decreased, as depicted in Figure 2.

These impressions were verified by the following analyses: First, Model 1A revealed a statistically significant main effect of psychoticism on timeline displacement of recognition hits in Study 1, $t(226.68) = 6.31$, $p < .001$, $\eta_p^2 = 0.15$, 95% CI [0.07, 0.24]. This effect was replicated by Study 2, $t(225.46) = 5.07$, $p < .001$,

Figure 1
Timeline Displacement of Recognition Hits

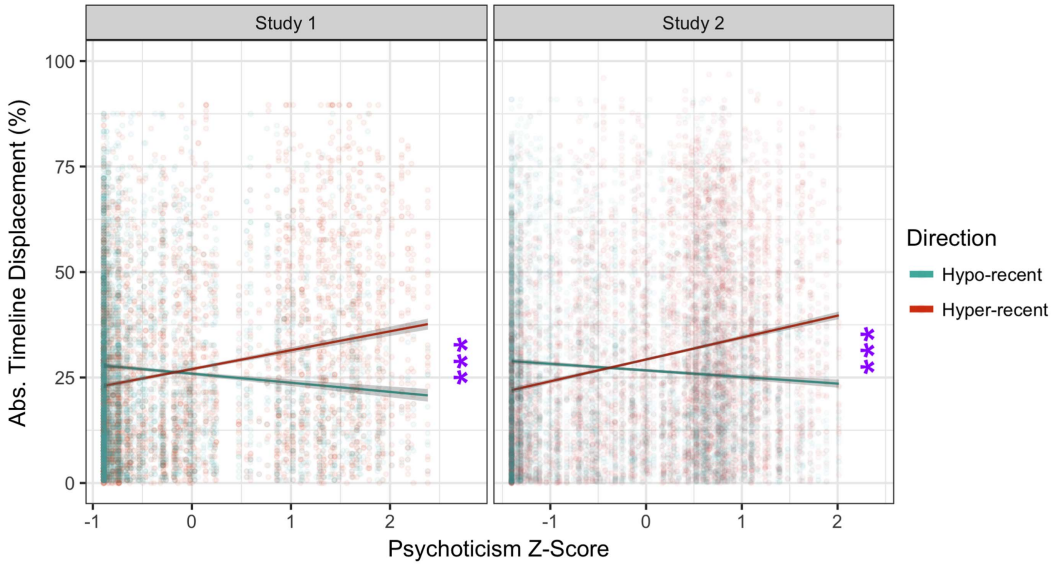


Note. The shaded area represents standard error. Negative values denote items misjudged as having occurred more distally (hypo-recency); positive values denote items misjudged as having occurred more recently (hyper-recency); zeros reflect perfect scores. MSS-N = Multidimensional Schizotypy Scale–Negative. See the online article for the color version of this figure.
*** $p < .001$.

$\eta_p^2 = 0.10$, 95% CI [0.04, 0.18], as seen in Figure 1a. In contrast, a significant main effect of MSS-N score emerged in neither Study 1, $t(214.82) = -1.56$, $p = .120$, $\eta_p^2 = 0.01$, 95% CI [0.00, 0.05], nor Study 2, $t(220.28) = -0.44$, $p = .660$, $\eta_p^2 = 0.00$, 95% CI [0.00, 0.02] (see Figure 1b). In Model 1B, we sought to confirm that psychoticism was differentially related to timeline displacement in the hyper-recent, as compared to the hypo-recent, direction. Accordingly, both Study 1, $t(7433.57) = 12.91$, $p < .001$, $\eta_p^2 = 0.02$, 95% CI [0.02, 0.03], and Study 2, $t(11433.93) = 17.01$, $p < .001$, $\eta_p^2 = 0.02$, 95% CI [0.02, 0.03], revealed a statistically significant Psychoticism × Direction interaction, such that those higher in psychoticism tended to exhibit *larger* displacement errors in the more recent direction but *smaller* displacement errors in the hypo-recent direction (see Figure 2).

Figure 2

Timeline Displacement of Recognition Hits by Psychoticism Score and Error Direction



Note. The shaded area represents standard error. Higher values denote greater degrees of displacement error. Abs = Absolute. See the online article for the color version of this figure.
*** $p < .001$.

Falsely Recognized Events Are Remembered to Have Occurred More Recently Among Those Higher in Psychoticism

Next, we sought to assess whether this same hyper-recency pattern was present for *falsely recognized events* (i.e., recognition false alarms). Again, across both studies, our results indicated that those higher in psychoticism similarly estimated falsely recognized events to have occurred *more recently* than those lower in psychoticism (see Figure 3a). And again, this pattern was specific to psychoticism, with no parallel effect evident for negative schizotypy (see Figure 3b). Thus, those higher in psychoticism seemed to attribute recency even to events that were either *not seen during the most recent encoding phase* (Initial lures in Study 2) or *not seen during the experiment at all* (all lures in Study 1 and Novel lures in Study 2)—indicating that the propensity to judge recognized stimuli as recent extends even to (contextually) novel stimuli.

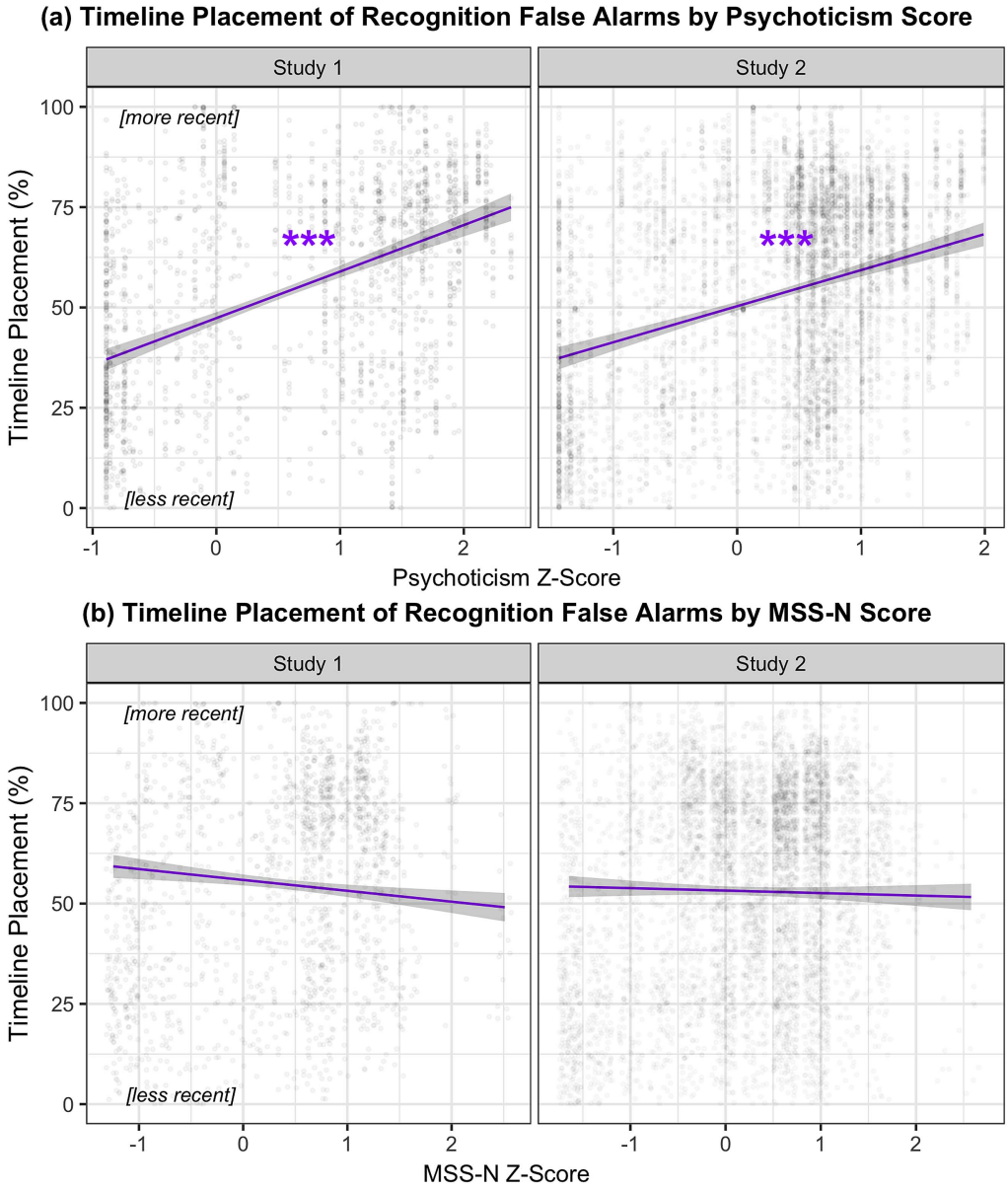
These impressions were verified by the following analyses. Model 2 revealed a statistically significant main effect of psychoticism on timeline placement of recognition false alarms in Study 1, $t(195.33) = 6.77$, $p < .001$, $\eta_p^2 = 0.19$, 95% CI [0.10, 0.29]. This main effect was replicated by Study 2, $t(238.88) = 5.80$, $p < .001$, $\eta_p^2 = 0.12$, 95% CI [0.06, 0.20], as seen in Figure 3a. In contrast, a significant main effect of MSS-N score emerged in neither Study 1, $t(249.67) = -1.72$, $p = .09$, $\eta_p^2 = 0.01$, 95% CI [0.00, 0.05], nor Study 2, $t(245.60) = -0.47$, $p = .64$, $\eta_p^2 = 0.00$, 95% CI [0.00, 0.02] (see Figure 3b).

Reduced Differentiation Between Initial and Novel Lures Among Those Higher in Psychoticism

In Study 2, we were additionally able to assess how the recency of lure stimuli impacted the likelihood of falsely recognizing a given item. We took advantage of the fact that Initial lures had been presented earlier in the experiment (and thus had a recent memory trace) while the Novel lures were totally new to the experimental context. Thus, participants who made use of an objective recency signal to guide memory judgments should have been more likely to falsely recognize Initial lures than Novel lures. Sure enough, at the lowest levels of psychoticism, this pattern was clearly evident (see the leftmost side of Figure 4): Participants falsely recognized Initial lures (in gray) at a much higher rate than Novel lures (in purple). However, as psychoticism increased, this differentiation decreased (see the rightmost side of Figure 4). Here, the odds of falsely recognizing even Novel lures increased drastically, such that participants at the highest levels of psychoticism tended to falsely recognize both lure types at *nearly identical rates*. This indicates that those higher in psychoticism tended to be *less sensitive* to the actual recency of lure presentation when making recognition memory judgments.

This pattern was confirmed by Model 3, which revealed a statistically significant Psychoticism × Lure Type interaction effect on proportion of falsely recognized lures, $z(491) = -6.68$, $p < .001$, $OR = 0.55$, 95% CI [0.46, 0.66] (see Figure 4). This model also showed a significant main effect of lure type, $z(491) = 16.95$, $p < .001$, $OR = 5.11$, 95% CI [4.23, 6.17], such that participants in general falsely recognized Initial lures at a higher rate than Novel lures. Further, a significant main effect of psychoticism, $z(491) = 5.26$, $p < .001$, $OR = 1.75$, 95% CI [1.42, 2.15], indicated that those higher in psychoticism made more false alarm errors overall, collapsing across lure type. Finally, there was no significant main effect of MSS-N score, $z(491) = 0.07$, $p = .95$, $OR = 1.00$, 95% CI [0.86, 1.18], indicating that negative schizotypy was *not* associated with proportion of falsely recognized lures above and beyond psychoticism.

Figure 3
Timeline Displacement of Recognition False Alarms



Note. The shaded area represents standard error. Higher values denote items judged as occurring more recently. MSS-N = Multidimensional Schizotypy Scale–Negative. See the online article for the color version of this figure.
*** $p < .001$.

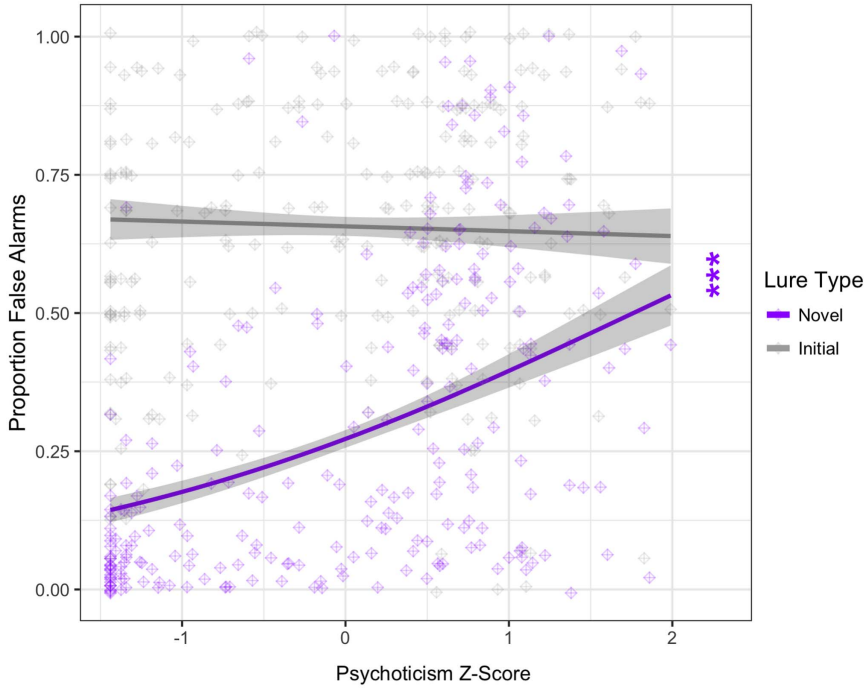
Déjà Vu Is Similarly Associated With Hyper-Recency

To assess whether déjà vu may be related to similar hyper-recency effects, we reran all models with déjà vu in the place of psychoticism as the main independent variable of interest. Here, we observed strikingly consistent results with the analyses reported above: As seen in Figure 5, those endorsing more frequent and intense experiences of déjà vu (i.e., a composite score of déjà vu frequency and feelings of prescience during déjà vu) also tended to remember items as having occurred more recently (Figure 5a and 5b), even if those items were not seen in the first place (i.e., recognition false alarms; Figure 5c). Further, they seemed to show similarly reduced differentiation between Initial and Novel lures, falsely recognizing both lure types at high rates (Figure 5d).

These impressions were verified by the following analyses. First, Model 4A revealed a statistically significant main effect of déjà vu on timeline displacement of actual events, $t(227.03) = 4.57$, $p < .001$, $\eta_p^2 = 0.08$, 95% CI [0.03, 0.16] (see Figure 5a). Model 4B revealed a significant Déjà Vu × Direction interaction effect on timeline displacement of actual events, $t(11320) = 11.66$, $p < .001$,

Figure 4

Proportion of Recognition False Alarms by Psychoticism and Lure Type



Note. The shaded area represents standard error. Higher values denote greater proportions of falsely recognized lures. See the online article for the color version of this figure.
*** $p < .001$.

$\eta_p^2 = 0.01$, 95% CI [0.01, 0.02], in the same direction as psychoticism (larger displacement errors in the hyper- vs. hypo-recent direction; see Figure 5b). Model 5 revealed a significant main effect of déjà vu on timeline placement of falsely recognized events, $t(227.82) = 4.68$, $p < .001$, $\eta_p^2 = 0.09$, 95% CI [0.03, 0.16] (see Figure 5c). Model 6 revealed a significant Déjà Vu × Lure Type interaction effect on proportion of falsely recognized lures, $z(492) = -2.13$, $p = .03$, $OR = 0.82$, 95% CI [0.69, 0.98], such that participants reporting the most intense experiences of déjà vu tended to falsely recognize both Initial and Novel lures at a more similar rate (see Figure 5d). Finally, analyses were repeated with psychoticism as an additional covariate. These analyses (reported in full in Supplemental Section S7) revealed a similar (though slightly attenuated) pattern of results, suggesting that some degree of association between déjà vu and hyper-recency persists independent of psychoticism.

Hyper-Recency Is Not Just a Matter of Biased Slider Usage

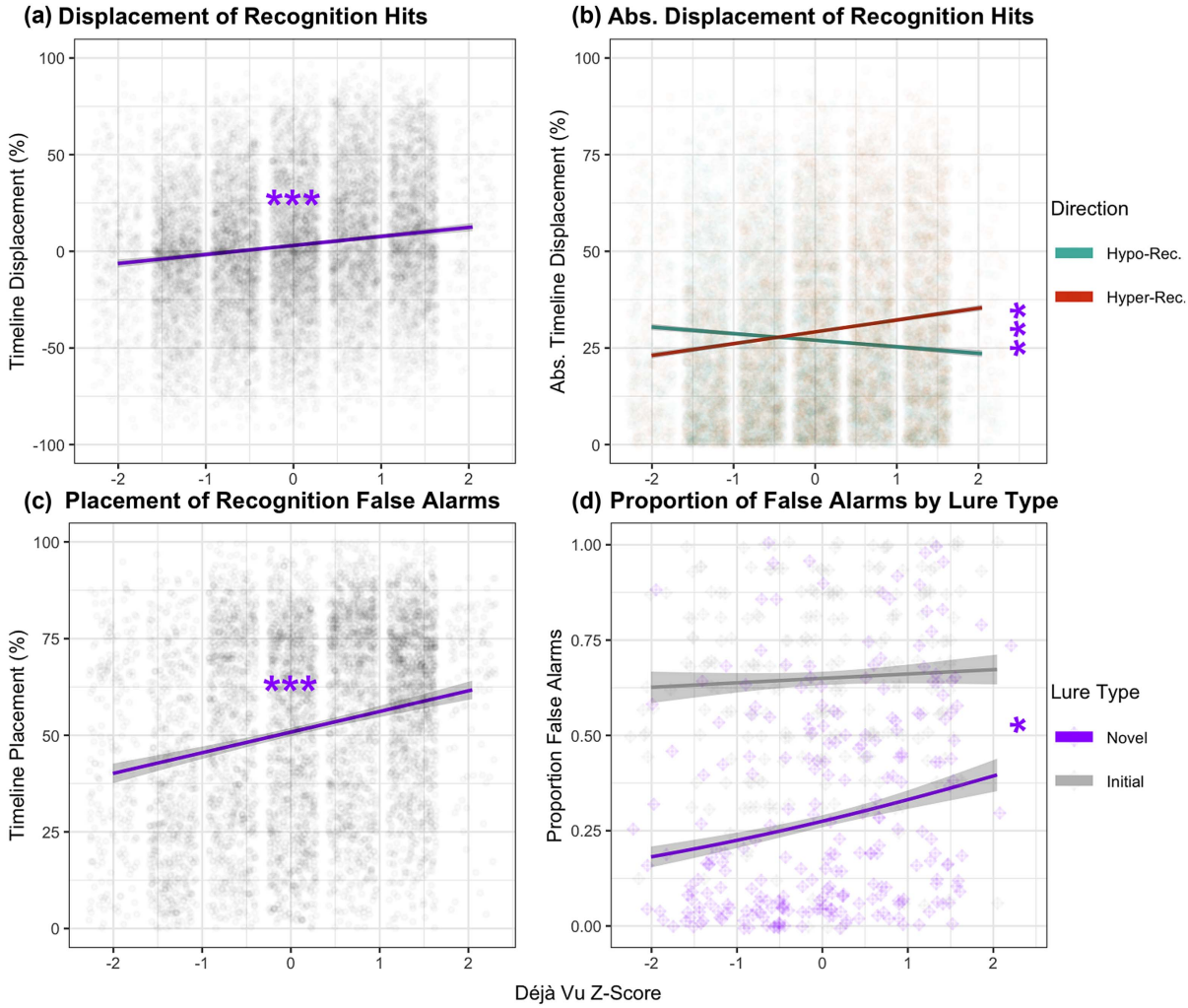
Finally, we sought to confirm the specificity of our findings to mnemonic judgments by assessing whether psychoticism was associated with responses on the three control sliders (judgments of familiarity, spatial position, and colorfulness). Critically, our interpretation was robust to these controls given that psychoticism was associated with a rightward bias on *none* of the three control sliders. Thus, it is unlikely that the hyper-recency effects reported above are better explained by a generalized spatial bias operating on slider-based responses (see Supplemental Section S8 for full results).

Discussion

These studies demonstrate for the first time that members of the general population who endorsed higher levels of psychoticism exhibited a "hyper-recency" bias in memory, such that they systematically misjudged recognized items as having occurred *more recently* in time than they actually did. This illusion of recency emerged regardless of whether items had actually been encountered during the experiment (i.e., the effect held even for recognition false alarms), indicating that judgments of hyper-recency occurred in the absence of a within-experiment priming event. In Study 2, we further established that those higher in psychoticism were less sensitive to the recency of lure presentation when making recognition memory judgments. While all participants tended to be tricked into falsely recognizing "Initial" lures (i.e., items presented in an earlier phase of the experiment), those higher in psychoticism falsely recognized "Novel" lures (which were *never* presented during the experiment) at nearly the same rate. Thus, those higher in psychoticism seem to lack high-fidelity signals of actual stimulus recency (as shown in Study 2) yet are more likely to judge a stimulus as having occurred recently once it is recognized (as shown across Study 1 and Study 2). The fact that a similar pattern was seen in association with déjà vu (which was positively correlated with psychoticism; see Supplemental Table S6) invites the

Figure 5

Analysis of Outcomes of Interest by Déjà Vu Score



Note. The shaded area represents standard error. Abs = Absolute. See the online article for the color version of this figure.
$^{*}p < .05$. $^{***}p < .001$.

interpretation that temporal memory dysfunction may be involved in a spectrum of anomalous experiences. Taken together, these findings suggest that, among those with more intense experiences of psychoticism and/or déjà vu, instances of recognition may be especially likely to be imbued not only with William James's uncanny "penumbra of familiarity" but also with a *penumbra of recency*.

This hyper-recency bias was remarkably consistent across two distinct, preregistered studies, and it persisted despite other potential influences (e.g., when covarying attention during encoding, age, etc.). A series of careful controls further helped to establish that this result is unlikely to be attributable to differences in how participants responded to sliders in general (see Supplemental Section S8). The temporal component of this task ("memory-for-when") also proved to be uniquely informative, helping to clarify mixed findings regarding the interrelationships between memory performance, schizotypy, and déjà vu. Indeed, in this case, "memory-for-what" was only weakly discriminative between constructs of interest: d' (a metric of general memory performance) was modestly associated with *all* aspects of schizotypy, as well as déjà vu (rs ranging between −.38 and −.59; see Supplemental Tables S5 and S6). The hyper-recency bias, by contrast, was quite specific to psychoticism per se (i.e., delusional ideation, odd perceptual experiences, and disorganization) as opposed to negative symptoms (e.g., amotivation, asociality, and low mood). This result conflicts with prior conceptualizations of memory dysfunction as being most closely related to negative symptoms (e.g., Aleman et al., 1999). In this way, these results support the notion that breakdowns in memory-for-when may pose unique challenges to our reality monitoring systems, giving rise to salient conflicts between reality and our experience of it.

Implications

The present studies begin to shed light on mnemonic processes that might facilitate uncanny subjective experiences. For instance,

one possibility is that this hyper-recency bias is related to breakdowns in the associative memory system that emerge in the early stages of psychosis (e.g., Avery et al., 2019, 2021) and persist in chronic schizophrenia (e.g., Achim & Lepage, 2003). The associative memory system is responsible for forming representations of events in relation to one another and to the context in which they originally occurred (Eichenbaum, 2017; Mayes et al., 2007; Turk-Browne, 2019). By maintaining a coherent timeline of past experiences, this system may also provide the structure necessary for making accurate judgments of recency (DuBrow & Davachi, 2013; Howard & Kahana, 2002; Howard et al., 2007; Lewandowsky & Murdock, 1989). In the absence of this backbone of interlocking item–item or item–context associations, compensatory strategies may emerge to guide memory judgments—including a reliance on familiarity-based memory (Libby et al., 2013; van Erp et al., 2008). Under such conditions, retrieval processes could become engaged by material that is sufficiently similar to *any* prior experience, even if it is context- or goal-irrelevant—and once recognition occurs, this sense of familiarity may be used as a stand-in for recency (i.e., this feels familiar, therefore it happened recently). In this way, reliance on familiarity-based memory may lead to the compression of one's subjective timeline, as one lacks the episodic detail necessary to discriminate between distant and more recent memories. This is broadly consistent with reports of overactive familiarity-related processing (and/or deficient novelty-related processing) within the psychosis spectrum, with prior work indicating elevated false alarm rates in recognition memory paradigms (Brébion et al., 1999, 2020; Koller & Cannon, 2021; Sahakyan & Kwapil, 2019) and reduced neural (Weiss et al., 2004) or behavioral markers of novelty processing (Koller & Cannon, 2023c).

The present studies build on this work by indicating that those higher in psychoticism (and déjà vu) may be especially likely to *conflate familiarity with recency*, leading to a mental landscape punctuated by memories misplaced in time. So while some degree of contextual memory error seems unavoidable (as in the high false alarm rate for Initial lures among *all* participants, depicted in Figure 5), weaker associative memory function (and a corresponding reliance on familiarity) may leave one particularly vulnerable to retrieving distant memories that feel unduly recent (and perhaps relevant) to the here-and-now (Brewin et al., 2010). As familiarity and recency judgments are dissociable at the neural level in healthy populations (Dudukovic & Wagner, 2007; Tendolkar & Rugg, 1998), future research could assess whether those higher in psychoticism (and déjà vu) may be failing to recruit brain regions which are normatively involved in (and perhaps necessary for) accurate recency decisions (e.g., prefrontal cortex).

We surmise that a hyper-recency bias could plant the seeds for disordered or delusional interpretations of reality by giving rise to uncanny illusions of recency that demand explanation. In the absence of an accurate recency signal that guides the assessment of relevance of a given stimulus to the current context, any and all recognized stimuli may flood into awareness at similar degrees of apparent importance. This is reminiscent of first-person reports of early psychosis, which describe an "elusive and pregnant 'now'" (Fusar-Poli et al., 2022, p. 171) in which the normal boundaries between the relevant and the irrelevant seem to dissolve ("It was shocking the amount of detail I found in this new world. In a day, there are so many things the mind relegates to background information"; Weiner, 2018, p. 707). Furthermore, qualitative research indicates that individuals on the psychosis spectrum experience frequent intrusive memories and mental imagery (Allé et al., 2020; Elua et al., 2012, 2015; Schulze et al., 2013). This raises the intriguing possibility that disrupted temporal memory could contribute to these intrusive experiences, allowing miscellaneous memories to emerge into awareness with *high salience* but *low (or biased) source information* (see also comparisons between déjà vu and involuntary autobiographic memories; Barzykowski & Moulin, 2022; Cleary et al., 2023). This genre of memory retrieval may be particularly ripe for psychotic interpretation, insofar as it demands interpretation yet fails to line up with objective reality (Cannon, 2015; Koller & Cannon, 2023a).

Finally, these studies carries implications for our understanding of déjà vu. Namely, prior theories have suggested that déjà vu is rooted in a failure to identify the source of previously learned information: an impression of familiarity with an "undefined past" (Jacoby & Whitehouse, 1989; Neppe, 1983; Sno & Linszen, 1990). However, this "undefined past" has itself remained undefined: Is déjà vu characterized by a general forgetting of where or when an experience took place? Or do déjà vu experiences involve directionally specific aberrations of temporal memory? The present studies imply the latter—namely, that déjà vu may occur when memories of distant experiences are imbued with an illusory sense of recency. The ensuing conflict between this erroneous sense of recency and the absence of richness of detail that usually accompanies recent memories could contribute to the déjà vu experience (Aitken et al., 2023). As such, continuing to improve our understanding of the systems involved in generating feelings of recency (Jenkins & Ranganath, 2016) may help to shed light on when, how, and for whom déjà vu manifests.

Constraints on Generality

This work was carried out in a general population sample of online workers recruited via the CloudResearch platform. This strategy has both advantages and disadvantages. On one hand, by circumventing limitations typical of patient studies (e.g., medication effects, chronicity, small sample sizes), studies conducted in this population can more easily achieve requisite power to detect effects of interest. On the other hand, questions remain as to whether similar relationships manifest in a clinical context (e.g., among people diagnosed with schizophrenia). If they do, this work could carry implications for cognitive-behavioral therapies for psychosis, which focus on arriving at less distressing interpretations of uncanny or intrusive experiences (e.g., Morrison, 2001). For example, building awareness of the memory system's vulnerability to heuristics (e.g., familiarity) could help an individual come to terms with uncanny mnemonic experiences that might otherwise demand fantastical explanations (Moritz et al., 2014). Further, in Study 2, we probed déjà vu using a simple, two-question scale that is subject to the biases and inaccuracies of retrospection—biases that could be exaggerated for people with temporal memory issues (like, our study suggests, people who experience déjà vu). Future work should replicate this effect in a more direct and comprehensive way (e.g., via a déjà vu manipulation coupled with more immediate reports of participants' resulting experiences). Finally, it is notable that this experiment relied entirely on nonsocial and generally affectively neutral images depicting everyday objects. This bolsters the interpretation that we are capturing a domain-

general aspect of memory function rather than an affective bias pertaining to, for example, delusion-relevant imagery that feels particularly meaningful (and perhaps recent) to those higher in psychoticism. That being said, an interesting topic for future work could be to assess whether judgments of recency are additionally influenced by a stimulus' affective qualities—especially those qualities that might interact with psychopathology (e.g., delusion- or trauma-relevance; Steel et al., 2005).

Conclusion

Psychosis is characterized by salient conflicts between consensus reality and one's experience of it, yet the potential sources of these conflicts are not fully characterized. Similar conflicts are felt by many people in the general population, albeit to a lesser extent—including during experiences of déjà vu, in which one is struck by the feeling that they have lived through the present moment before, despite not being able to pinpoint why, or knowing that this cannot be true. Here, we demonstrated for the first time that both psychoticism (i.e., paranoia, positive, and disorganized symptoms) and déjà vu are characterized by breakdowns in memory for *when* events occurred. More specifically, both psychoticism and déjà vu (but not negative symptoms) share an association with a hyper-recency bias in memory, in which both actual and falsely recognized events are remembered to have occurred *more recently* than they truly did. These illusions of recency underscore how our moment-to-moment experiences of reality may be shaped by the way our memories of past events are organized in time.

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