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Curiosity evolves as information unfolds

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When people feel curious, they often seek information to resolve their curiosity. Reaching resolution, however, does not always occur in a single step but instead may follow the accumulation of information over time. Here, we investigated changes in curiosity over a dynamic information-gathering process and how these changes related to affective and cognitive states as well as behavior. Human participants performed an Evolving Line Drawing Task, during which they reported guesses about the drawings' identities and made choices about whether to keep watching. In Study 1, the timing of choices was predetermined and externally imposed, while in Study 2, participants had agency in the timing of guesses and choices. Using this dynamic paradigm, we found that even within a single information-gathering episode, curiosity evolved in concert with other emotional states and with confidence. In both studies, we showed that the relationship between curiosity and confidence depended on stimulus entropy (unique guesses across participants) and on guess accuracy. We demonstrated that curiosity is multifaceted and can be experienced as either positive or negative depending on the state of information gathering. Critically, even when given the choice to alleviate uncertainty immediately (i.e., view a spoiler), higher curiosity promoted continuing to engage in the information-gathering process. Collectively, we show that curiosity changes over information accumulation to drive engagement with external stimuli, rather than to shortcut the path to resolution, highlighting the value inherent in the process of discovery.

curiosity | information seeking | uncertainty | emotion | decision-making

Curiosity, the desire to know, is a fundamental driver of human behavior. Curiosity guides our behavior toward reducing the uncertainty in our environment (1–5) and toward the pursuit of new knowledge (6–8). Across a variety of studies that have examined the subjective state of curiosity, a clear pattern emerges: Curiosity directs choice to obtain information, when the alternative is to forgo information (9–13). While this experimental work has advanced our understanding of curiosity's influence on information seeking, it has also led to a predominant theoretical view of curiosity as a state that hastens the resolution of uncertainty (14–16).

Theoretical accounts of curiosity as motivating an urgent need to resolve uncertainty (e.g., seeking outcomes or answers) stand in contrast with real-world examples where prolonged anticipation and uncertainty are paradoxically preferred (17, 18), such as in narratives (17), close contests in sports, (19) and video games (20, 21). In fact, people even specifically avoid early resolution (22, 23) by adopting self-control mechanisms to decrease the likelihood of information exposure (24, 25). Willingness to prolong uncertainty has been supported by recent experimental work showing that participants often preferred hints to the full answer when curious (26). The desire to avoid premature resolution of uncertainty is so ubiquitous that we explicitly label such information via "spoiler alerts." We propose that examining the dynamics of curiosity as information accumulates could provide key insights for understanding this paradox.

Understanding the temporal dynamics of curiosity in response to an evolving state of knowledge could offer insight not only into the behavioral manifestations, but also the subjective experience of curiosity. Curiosity has been associated with both positive and negative affect (6, 16, 27, 28), but with unclear determinants. By querying curiosity across information gathering, it becomes possible to explore whether, for example, people simply tolerate delays because attaining the answer is rewarding (26, 29–31), or whether there is joy to be experienced in the state of curiosity itself (27, 28). Characterizing the dynamic affective experience of curiosity during information gathering could clarify when curiosity reflects aversive deprivation and when curiosity encourages joyous exploration.

Examining the dynamics of curiosity requires an expanded approach to assessing information seeking in behavioral experiments. Often, curiosity can be elicited by withholding a single piece of critical information (e.g., a trivia answer or the outcome of an anticipated gamble) that, when revealed, instantaneously resolves uncertainty (5, 10, 11, 13, 32–34). Moreover, in paradigms that involve a delay between the induction and relief of curiosity, no new information is gained during the delay period, such that waiting is simply an

Significance

Many of our everyday experiences unfold over time (e.g., watching a movie), and even when we are curious about the outcome, we often avoid information that would lead to immediate resolution (e.g., spoilers). In contrast, most theoretical accounts suggest that curiosity motivates gaining information as soon as possible. We examined curiosity while participants watched videos of drawings that resolved into familiar objects. We found that over evolving information, curiosity is dynamic and shares variable relations with emotions and confidence. Moreover, rather than being an aversive state to be tolerated until resolution, curiosity can be experienced as both negative and positive. Throughout these dynamic relationships, higher curiosity reliably promoted the patience to let information unfold over time.

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aversive cost (11, 35–37). Yet, many everyday experiences evolve over time—as in movies, novels, and sporting events—and information progresses irregularly toward a resolution. Thus, to capture changes in curiosity, its subjective experience, and its behavioral manifestations, a task that would allow information to evolve and move across time was necessary.

We developed a dynamic perceptual task, the Evolving Line Drawing Task (ELDT), in which participants watched videos of line drawings that slowly resolved into objects. During video watching, participants periodically provided subjective ratings of their experience, made guesses about the identity of the drawing, and made choices to stop the video early or keep watching the drawing unfold. Probing these states across ongoing information gathering provided insights into how curiosity evolves in concert with informational states to guide choice behavior. We also manipulated the consequence of stopping a video early between participants. In one group, stopping a video meant receiving no further information about the drawing (Forgo Resolution), akin to previous studies examining the choice between receiving information or not (10, 11, 13). In another group, stopping early meant participants could immediately jump to the end of a video, revealing the full drawing without having to wait (Jump-to Resolution) (26).

The design of the ELDT was built to address three open questions about the mechanisms of curiosity. First, to understand how curiosity develops, we tested how changes in curiosity relate to changes in the amount and quality of information available to an individual. Second, we investigated whether curiosity embedded within an evolving informational state would drive preferences for continued information seeking or immediate resolution of uncertainty. Third, we explored how the affective experience of curiosity interacted with informational states during ongoing information gathering. We addressed these questions across two experiments. In Study 1, the timing of the choices to continue watching or stop early was externally imposed (Predetermined Timing), and in Study 2, participants had agency over exactly when to make these choices (Free Timing). Across both studies, we demonstrated curiosity's dynamic relationship with informational state, we revealed a clear curiosity-driven preference to delay receiving resolution, and we provided evidence that curiosity can embody either positive or negative affect depending on one's confidence and agency.

Results

To examine how curiosity directs information seeking as information evolves, we developed the Evolving Line Drawing Task (ELDT) where participants watched animated continuous single-line drawings unfold over time. Participants (N = 2,043) watched a minimum of 25 videos, each between 20 and 30 s in length (See *Materials and Methods* for participant exclusions and demographics). During video watching, participants submitted Mid-Video Decisions that included using analog scales to report on their curiosity, their confidence about the drawing's identity, and one of three randomly determined affective states (enjoyment, tension, or frustration) assigned between participants (Fig. 1*A*) (*Materials and Methods*). They also provided a guess about the identity of the drawing given their current informational state.

After providing responses to all four questions, participants chose whether to continue watching or stop that video and move to the next trial. We manipulated the Stop Outcome between participants, such that in one group (Forgo Resolution), stopping the video ended information gathering and moved subjects to the Post-Video ratings. In the other group (Jump-to Resolution), stopping brought participants immediately to the end of the video to see the final drawing fully revealed before moving to the Post-Video ratings. If a participant chose to continue watching a video on their first Mid-Video Decision, they could be probed with the same questions at a later time point. Participants were told that their choices and guesses would not impact their compensation. Updating guesses was described as an expected part of the video-watching process and participants would not be penalized for wrong guesses.

The agency for when Mid-Video Decisions occurred was manipulated between Study 1 (Predetermined Timing, N = 1,033) and Study 2 (Free Timing, N = 1,010) (Fig. 1*A*). The aim of Study 1 was to uniformly sample time points across the entire video-watching timeline. As such, participants were informed that there would be intermittently placed pauses (determined by the computer) throughout the video (1 to 3 per video) where they would be asked to answer Mid-Video Decisions. The aim of Study 2 was to investigate whether the experience of information gathering changed if participants had agency over the timing of when to submit Mid-Video Decisions. Here, instead of experiencing randomly placed pauses, a textbox remained visible underneath the video, and participants could freely submit guesses and Mid-Video Decisions. Participants in both studies were divided into the two Stop-Outcome conditions (Forgo Resolution: Study 1 N = 501, Study 2 N = 485; Jump-to Resolution: Study 1 N = 532, Study 2 N = 525). Study 2 was otherwise identical to Study 1.

As the key findings were consistent across both studies, we first present combined results from Study 1 and Study 2. We then directly compare the Studies to test the effects of timing agency on choice behavior.

Temporal Dynamics of Informational State

We first explored how participants' informational state changed as a video progressed by leveraging the unique properties of each video. We characterized informational state by how close a participant was to identifying the drawing using features of each individual stimulus (stimulus entropy) and based on subject-specific measures (guess accuracy and confidence). Stimulus entropy was computed using the number and frequency of unique guesses made at each time point (across all participants) (33), allowing for the examination of variance in guessing and the change in variance as participants approached resolution (*Materials and Methods*). In Study 1, participants made an average of 1.5 guesses per video (SD = 0.6, Range = 1 to 3) and in Study 2, participants made an average of 1.3 guesses per video (SD = 0.6, Range = 1 to 6). For more descriptive measures about guessing see *SI Appendix, Guessing Descriptive Information for Study 1 and Study 2*. To visualize the unique dynamics reflected in each line drawing, we pooled the data across Study 1 (Predetermined Timing) and Study 2 (Free Timing) (Fig. 1 *B* and *C*); the patterns for each individual study are nearly identical (*SI Appendix, Temporal Dynamics of Guess Accuracy and Stimulus Entropy*).

We first examined changes in stimulus entropy across time, hypothesizing that entropy should decrease as more information about the stimulus identity was revealed. We indeed found that stimulus entropy decreased significantly across time ($\beta = -0.59$, 95% CI [−0.59, −0.58], $z = -307.65$, $P < 0.001$). Additionally, we saw substantial variation in stimulus entropy and its temporal evolution within our stimulus set. To illustrate this point, we present the collection of unique guesses for two sample videos at a single time point (Fig. 1*B*).

We next tested whether participants would report more correct guesses as the video progressed and stimulus entropy decreased. We found that guess accuracy increased across time ($\beta = 2.31$,

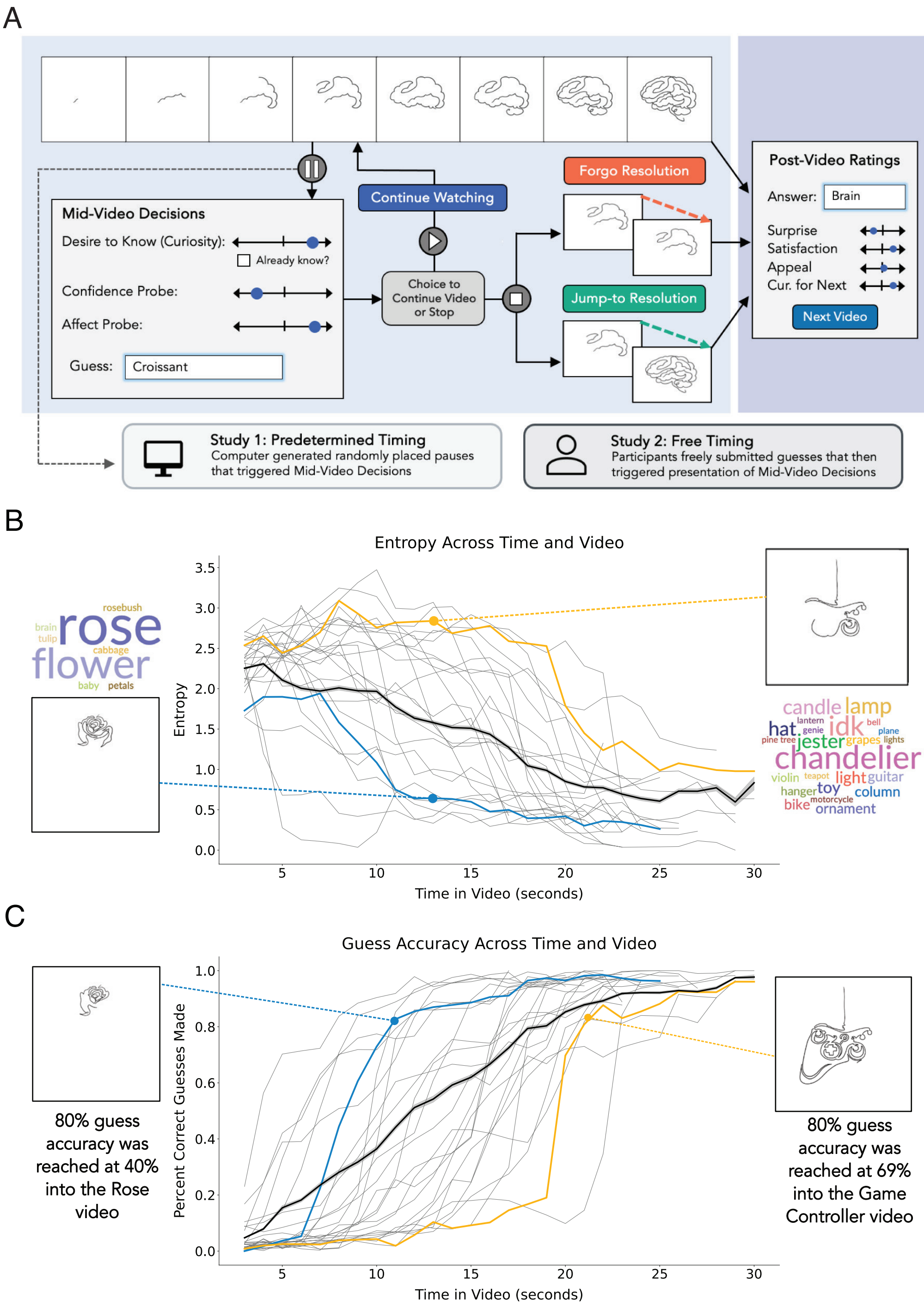

Fig. 1. Evolving Line Drawing Task and temporal dynamics of videos. (*A*) Participants watched a series of videos of a single-line drawing unfold over time. During video play, participants experienced Mid-Video Decisions where they guessed the identity of the drawing and provided ratings about their curiosity, confidence, and one of three affective states assigned between subjects (frustration, enjoyment, or tension). Participants were then given the choice to continue watching the video or stop the video and move to the next trial. The consequence of stopping the video early (Stop-Outcome) was manipulated between subjects. In the Forgo Resolution condition, stopping a video early cut off further information gathering, and participants moved to the next trial without seeing the complete drawing. In the Jump-to Resolution condition, stopping a video early transported the participant to the end of the video, revealing the completed drawing immediately. At the end of each trial, participants reported their experience in Post-Video ratings and provided a final guess. Control over the timing of Mid-Video Decisions was manipulated between Study 1 and Study 2. In Study 1 (Predetermined Timing), the video would pause at predetermined random times and required the participant to provide a guess and ratings before they could continue watching. In Study 2 (Free Timing), participants could pause to submit Mid-Video Decisions whenever they wanted. (*B*) Stimulus entropy, a measurement of the variance and frequency of identities guessed, across the reported guesses for each video (gray lines) as a function of time. To highlight the variance across videos, an example time point is displayed for the “Rose” and “Game Controller” video. At 13 s into the “Rose” video, there were nine unique guesses made across a total of 281 guesses, while in the “Game Controller” video, there were 44 unique guesses made from a total of 116 guesses. Word clouds were generated using the aggregated guesses from all participants that reported a guess at that time point. For visualization purposes only, guesses that occurred less than two times and guesses of “I don’t know” were excluded from the word-cloud. (*C*) The proportion of correct guesses made at each time point for each video (gray lines). To highlight the variance in the time course to resolution across videos, we used the same example videos to illustrate the time it took to reach 80% guess accuracy. For the “Rose” video, it took 11 s (40% of video length), and for the “Game Controller” video, it took 21 s (69% of video length). For both (*B*) and (*C*), the black line represents the mean across all videos. The yellow and blue lines depict the two example videos, “Game Controller” and “Rose” respectively, with points and screengrabs marked to demonstrate the difference in entropy for a single time point (*B*) and difference in time to reach 80% resolution between the two videos (*C*). For more information, see *SI Appendix, Temporal Dynamics of Guess Accuracy and Stimulus Entropy*.

95% CI [2.28, 2.35], z = 127.59, $P < 0.001$), indicating that participants were indeed reaching resolution about the identity of the drawings. This was further confirmed by the participant's confidence ratings (β = 0.50, 95% CI [0.49, 0.51], z = 149.58, $P < 0.001$), which also increased over time (*SI Appendix*, *Temporal Dynamics of Subjective States*). However, like entropy, this varied substantially across videos (Fig. 1*C*). Collectively, our results illustrate that participants are reaching resolution about the identities of these drawings, but the path to resolution varies as a function of the specific video properties (i.e., how a drawing unfolds). Our next series of analyses investigated how curiosity relates to such evolving informational states.

Dynamics of Curiosity

In general, both Studies elicited moderate to high levels of curiosity (Study 1: M = 70.54/100, SD = 27.12; Study 2: M = 69.90/100, SD = 26.10). Curiosity ratings of 0 (out of 100) were extremely rare across both studies (2% of trials). At the beginning of a video (within the first 3 s), curiosity ratings started relatively high (Study 1: M = 70.00, SD = 28; Study 2: M = 67.28, SD = 5.44), while confidence ratings (out of 100) about the identity started relatively low (Study 1: M = 16.00, SD= 24.65; Study 2: M = 35.13, SD= 34.83). For more descriptive information about ratings see *SI Appendix*, *Temporal Dynamics of Subjective States*.

We first aimed to investigate how an evolving informational state could shape changes in curiosity. To test this, we constructed a linear mixed-effects model for each Study with participant as a random intercept to examine how confidence, guess accuracy, and stimulus entropy predicted curiosity ratings. These models also included Stop-Outcome condition (Forgo vs. Jump-to) to see whether curiosity was also dependent on the information-seeking choices available to a participant. Additional model information and all parameter estimates are provided in *SI Appendix*, Tables S3 and S6.

Based on prior findings, we hypothesized that curiosity would be positively associated with factors that signaled uncertainty (33) and would be negatively related to factors that signaled a resolution of uncertainty (5, 31, 38). Indeed, we found that curiosity was positively related to stimulus entropy (Study 1: β = 1.15, 95% CI [0.79, 1.51], z = 6.19, $P < 0.001$; Study 2: β = 1.84, 95% CI [1.43, 2.25], z = 8.74, $P < 0.001$) and negatively related to confidence (Study 1: β = −3.63, 95% CI [−4.02, −3.23], z = −17.82, $P < 0.001$; Study 2: β = −3.21, 95% CI [−3.68, −2.75], z = −13.64, $P < 0.001$); however, we did not find a main effect for guess accuracy (Study 1: β = −0.46, 95% CI [−1.04, 0.11], z = −1.58, $P = 0.113$; Study 2: β = −0.20, 95% CI [−0.79, 0.39], z = −0.66, $P = 0.508$).

We further tested whether these features could modulate one another's impact on curiosity. We found a significant interaction between stimulus entropy and subjective ratings of confidence (Study 1: β = 1.67, 95% CI [1.38, 1.97], z = 11.00, $P < 0.001$; Study 2: β = 1.28, 95% CI [0.98, 1.59], z = 8.21, $P < 0.001$) (Fig. 2*A*). Post hoc analyses indicated that across both studies, high stimulus entropy dampened the relationship between confidence and curiosity (Study 1: β = −3.35, z = −11.00, $P < 0.001$, Study 2: β = −3.35, z = −11.00, $P < 0.001$), suggesting that high stimulus uncertainty can sustain curiosity even when confidence of knowing is high. We also found a significant interaction between confidence and guess accuracy (Study 1: β = −2.89, 95% CI [−3.50, −2.28], z = −9.30, $P < 0.001$; Study 2: β = −1.48, 95% CI [−2.08, −0.89], z = −4.86, $P < 0.001$), such that when confidence is low, people reported more curiosity for correct compared to incorrect guesses (Study 1: β = 2.38, z = 5.46, $P < 0.001$; Study 2: β = 1.26, z = 3.25, $P = 0.006$) but when confidence is high, people reported less curiosity for correct compared to incorrect guesses (Study 1: β = −3.39, z = −7.98, $P < 0.001$; Study 2: β = −1.71, z = −3.71, $P = 0.001$) (Fig. 2*B*). This suggests that curiosity is not only evoked during the experience of uncertainty (i.e., low confidence) but can also arise before high confidence errors. Finally, in both Studies, we did not find a difference in curiosity ratings between Stop-Outcome conditions (Study 1: β = 0.17, 95% CI [−2.17, 2.52], z = 0.14, $P = 0.886$; Study 2: β = −1.67, 95% CI [−0.86, 4.19], z = 1.30, $P = 0.196$).

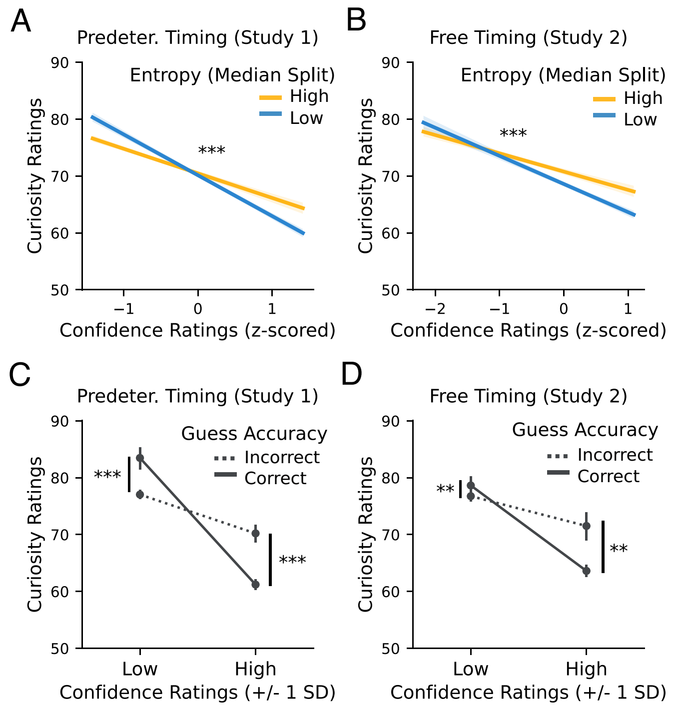

Fig. 2. High stimulus entropy weakened while accuracy strengthened the negative relationship between curiosity and confidence. Stimulus entropy, a measurement of the variance and frequency of identities guessed, modulated the relationship between confidence (z-scored) and curiosity in Study 1 (*A*) and Study 2 (*B*). When stimulus entropy is high, confidence shared a weaker negative relationship with curiosity than when stimulus entropy is low. For visualization purposes only, stimulus entropy was binned into high and low through a median split. Curiosity was also shaped by an interaction between confidence and guess accuracy in both Study 1 (*C*) and Study 2 (*D*). When confidence was low, curiosity was lower for incorrect compared to correct guesses, but when confidence was high, curiosity was higher for incorrect compared to correct guesses. For visualization purposes only, confidence was binned into plus one and minus one SD. Error bars denote 95% CI. (*) $P < 0.05$, (**) $P < 0.01$, and (***) $P < 0.001$.

We followed up these analyses to specifically examine how the updating of guesses shaped the growth and subsidence of curiosity using trials where participants reported more than one guess (*SI Appendix*, *Intra-Trial Analyses*). We found that curiosity declined when updating from an incorrect to a correct guess (Study 1: β = −3.60, z = −20.04, $P < 0.001$; Study 2: β = −2.41, z = −13.9, $P < 0.001$) but increased in Study 1 (Study 1: β = 1.12, z = 9.86, $P < 0.001$) and was unchanged in Study 2 (Study 2: β = 0.25, z = 1.24, $P = 0.216$) when participants updated from an incorrect to another incorrect guess. This suggests that curiosity can be sustained or even grow as participants continue to explore potential (but ultimately wrong) identities.

Taken together, these results demonstrate that curiosity can change across an evolving informational state, that curiosity is impacted both by factors internal to a specific participant (here, subjective confidence and guess accuracy) as well as externally driven features of the informational landscape (here, stimulus entropy), and that curiosity is not a one-dimensional reflection of subjective uncertainty. Finally, agency over the occurrence of Mid-Video Decisions, whether through Predetermined pauses or Freely by the participant, did not alter the interactions among curiosity and informational state, suggesting that these observed relationships are unlikely to be an outcome of specific probing intervals/timing.

Curiosity and Continuous Information Seeking

We next investigated across our two Studies how curiosity influenced choices to continue or stop a video as information evolved. For our Forgo Resolution condition, we hypothesized that, consistent with prior research on discrete information seeking (e.g., trivia Q&A paradigms), high curiosity would predict continuing to watch a video since this was the only path to receive resolution (Fig. 3A) (11, 36). For our Jump-to Resolution condition, we hypothesized that high curiosity would either predict a decreased probability of continuing to watch a video, demonstrating a sensitivity to the costs of delays and thus a preference for the fastest path to resolution (outcome-focused) (14, 15, 39), or that curiosity would predict an increased probability of continuing to watch a video, signaling that experiencing the process of information unfolding may also confer value (process-focused) (17, 26) (Fig. 3A).

Across both Studies, we found that high curiosity predicted continuing to watch a video in the Forgo Resolution condition (Study 1: β = 0.81, 95% CI [0.76, 0.87], z = 27.02, $P < 0.001$, Study 2: β = 0.87, 95% CI [0.79, 0.95], z = 21.05, $P < 0.001$) (Fig. 3 *B* and *C*), suggesting that curiosity encourages uncertainty resolution during continuous information gathering, similar to that observed during discrete information seeking (10, 11, 36). Crucially, we found that even when participants had the option to receive immediate resolution (Jump-to Resolution), higher curiosity still increased the likelihood of continuing a video (Study 1: β = 0.64, 95% CI [0.59, 0.70], z = 22.59, $P < 0.001$; Study 2: β = 0.50, 95% CI [0.43, 0.57], z = 13.55, $P < 0.001$) (Fig. 3 *B* and *C*). These results suggest that people do not always seek immediate resolution for their curiosity and that curiosity can instead encourage prioritizing the process of information gathering over instant obtainment of the outcome (26).

We next sought to contextualize the relationship between curiosity and choice behavior alongside the changes in informational state and to test whether the potential interplay between curiosity and informational state would be dependent on choice outcome (Forgo vs. Jump-to). We fit a mixed-effects logistic regression with participant as a random intercept that included the participant's curiosity ratings, confidence ratings, guess accuracy, stimulus entropy (at the time of the Mid-Video Decision), as well as all two-way interactions with the Stop-Outcome condition (*SI Appendix*, Tables S4 and S7 for full model information and all parameter estimates). Consistent across both Studies, we found that even when accounting for informational state, curiosity remained a significant predictor of continuing a video (Study 1: β = 0.50, 95% CI [0.41, 0.60], z = 10.54, $P < 0.001$; Study 2: β = 0.50, 95% CI [0.37, 0.63], z = 7.41, $P < 0.001$). In addition to curiosity, stimulus entropy also increased the likelihood of continuing a video (Study 1: β = 0.11, 95% CI [0.03, 0.18], z = 2.75, $P = 0.006$; Study 2: β = 0.33, 95% CI [0.27, 0.40], z = 10.31, $P < 0.001$). Conversely, correctly guessing the identity of the drawing (Study 1: β = −2.08, 95% CI [−2.24, −1.91], z = −25.14, $P < 0.001$; Study 2: β = −1.94, 95% CI [−2.16, −1.73], z = −17.66, $P < 0.001$) and high confidence (Study 1: β = −0.79, 95% CI [−0.88, −0.70], z = −17.53, $P < 0.001$; Study 2: β = −0.78, 95% CI [−0.90, −0.67], z = −13.59, $P < 0.001$) both predicted stopping a video early (Fig. 4).

We followed up this analysis to test whether curiosity would still predict continuation when participants had reached resolution (defined as correct guesses with subjective confidence ratings in the top 25 percentile). Indeed, even when examining only highly confident, correct guesses, curiosity predicted continuing a video not only when it was the only path to view the entire video (Study 1 Forgo Resolution: β = 0.96, z = 9.92, $P < 0.001$; Study 2 Forgo Resolution: β = 0.71, z = 7.42, $P < 0.001$) but even when the completed drawing was immediately accessible (Study 1 Jump-to Resolution: β = 0.62, z = 7.23, $P < 0.001$; Study 2 Jump-to Resolution: β = 0.27, z = 3.25, $P = 0.001$). In sum, high curiosity can promote continuing a video beyond simple resolution, encouraging an investment in experiencing the entire unfolding of information.

We then compared our two Stop-Outcome conditions and we found that participants in the Jump-to Resolution condition were overall less likely to continue videos compared to the Forgo Resolution

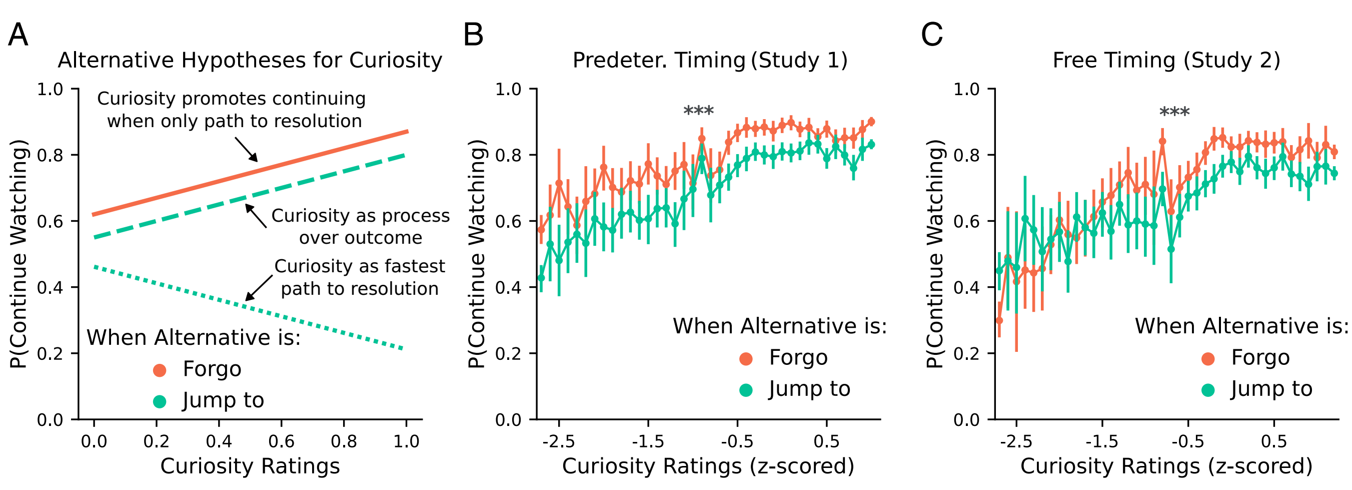

Fig. 3. Curiosity promoted decisions to continue watching videos even when the alternative was to receive immediate resolution. (*A*) Hypothesized results for curiosity across Stop-Outcome conditions based on different predictions of curiosity and uncertainty resolution. During the Forgo Resolution condition, since continuing to watch was the only path to receiving resolution, high states of curiosity would encourage choices to continue. Under the Jump-to Resolution, if curiosity is outcome focused, high states of curiosity would predict stopping videos early to receive immediate resolution. In contrast, if curiosity values the process toward resolution, high states of curiosity would promote choices to continue watching information unfold. Mean continuation rates as a function of subjective reports of curiosity (z-scored), split by Stop-Outcome condition for Study 1 (*B*) vs. Study 2 (*C*). Across both studies, curiosity ratings predict continuation both when that was the only path to resolution (Forgo Resolution) and even when there was a choice to immediately resolve uncertainty (Jump-to Resolution).

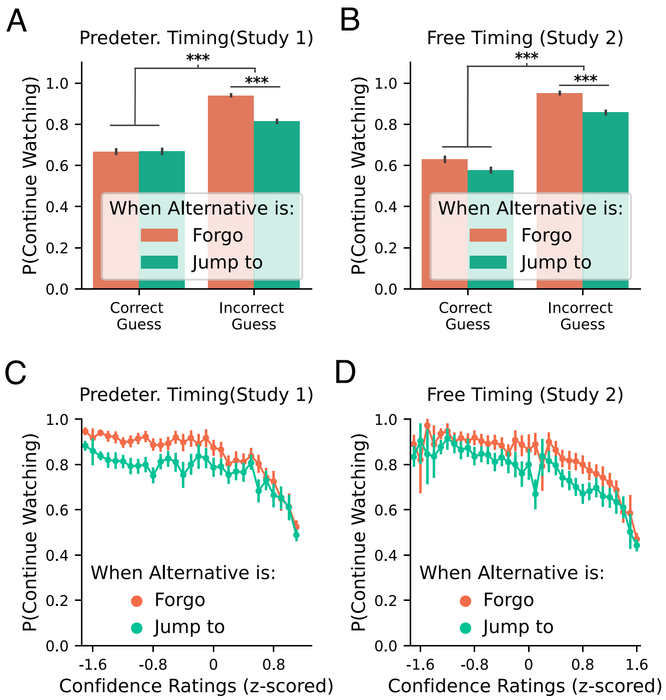

Fig. 4. Accurate guessing and higher confidence decreased the likelihood of continuing to gather information. Mean continuation rates as a function of guess accuracy for Study 1 (*A*) and Study 2 (*B*). Correctly identifying the drawing decreased rates of continuing to watch videos. This was further modulated by the Stop-Outcome condition (Forgo vs. Jump-to) such that participants in the Jump-to-Resolution condition had decreased rates of continuing to watch a video specifically after reporting incorrect but not correct guesses. Higher subjective reports of confidence (z-scored) predicted a lower likelihood of continuing to watch a video in both Study 1 (*C*) and Study 2 (*D*). This was consistent across both Stop-Outcome conditions. Of note, reaching resolution decreased but did not abolish continuation, even when the alternative was Jump-to-Resolution. Moreover, alongside these effects, curiosity still predicted the choice to continue watching (see Fig. 3). Error bars denote 95% CI. (*) $P < 0.05$, (**) $P < 0.01$, and (***) $P < 0.001$.

condition (Study 1: β = −1.68, 95% CI [−2.07, −1.29], z = −8.48, $P < 0.001$; Study 2: β = −1.44, 95% CI [−1.93, −0.95], z = −5.76, $P < 0.001$), suggesting that having the option to resolve uncertainty immediately reduced the likelihood of prolonging information gathering. Furthermore, we found that the Stop-Outcome manipulation significantly interacted with guess accuracy (Study 1: β = 1.25, 95% CI [1.03, 1.46], z = 11.42, $P < 0.001$; Study 2: β = 0.97, 95% CI [0.72, 1.23], z = 7.45, $P < 0.001$). Interestingly, post hoc analyses indicated that in the Jump-to Resolution condition compared to the Forgo Resolution, participants were significantly less likely to continue watching a video after an incorrect guess (Study 1: OR = 5.36, z = 8.50, $P < 0.001$; Study 2: OR = 4.01, z = 5.59, $P < 0.001$) but not after a correct guess (Study 1: OR = 1.54, z = 2.16, $P = 0.092$; Study 2: OR = 1.52, z = 1.80, $P = 0.217$) (Fig. 4 *A* and *B*). We also found that curiosity was modulated by Stop-Outcome (Study 1: β = −0.17, 95% CI [−0.26, −0.07], z = −3.35, $P < 0.001$; Study 2: β = −0.32, 95% CI [−0.45, −0.19], z = −4.98, $P < 0.001$), such that curiosity was a stronger predictor of choice in the Forgo compared to the Jump-to Resolution condition indicated by as steeper slope (Study 1: β = 0.17, z = 3.35, $P < 0.001$, Study 2: β = 0.32, z = 4.98, $P < 0.001$), yet remained a significant predictor in both conditions (Forgo: β = 0.59, z = 14.35, $P < 0.001$; Jump-to: β = 0.43, z = 11.77, $P < 0.001$) (Fig. 3 *B* and *C*). To summarize, while the option to receive immediate resolution (Jump-to Resolution) did decrease decisions to continue a video under uncertainty, curiosity remained a positive predictor of continuing a video, consistent across Study 1 and Study 2.

Finally, we examined whether subjective curiosity interacted with a participant's informational state to direct choice, revealing differences between Study 1 and Study 2. In Study 1, we found that curiosity significantly dampened the effect of guess accuracy (β = 0.17, 95% CI [0.06, 0.27], z = 3.14, $P = 0.002$) and confidence (β = −0.10, 95% CI [−0.16, −0.04], z = −3.09, $P = 0.002$) on choice behavior but did not interact with entropy ($P < 0.05$). In contrast to Study 1, there was no significant interaction between curiosity and the individual signals of resolution, guess accuracy, or confidence (all $P > 0.05$) in Study 2; instead, we found a significant interaction between curiosity and stimulus entropy (β = 0.07, 95% CI [0.01, 0.13], z = 2.19, $P = 0.029$), such that curiosity was a stronger predictor of choice when entropy was high (β = 0.13, z = 2.19, $P = 0.029$). Thus, when experiencing greater agency over the timing of their decision, the influence of curiosity (on choice), was more strongly modulated by features related to stimulus uncertainty and less so by the subjective experience of uncertainty.

Affective Experience of Curiosity and Informational States

To start, we explored how affect ratings changed across time. We found that enjoyment increased across time (β = 3.64, z = 15.62, $P < 0.001$), while frustration and tension decreased (Frustration: β = −3.94, z = −13.61, $P < 0.001$; Tension: β = −1.51, z = −5.26, $P < 0.001$) (for figures see *SI Appendix*, *Temporal Dynamics of Subjective States*), suggesting that across the passage of time, positive affect increased and negative affect decreased, consistent with prior work (35). Given the dynamic relationships between curiosity and informational state in driving information gathering, we next explored how these dynamics shaped the affective experience of watching the videos. We fit three mixed-effects linear regression models with participant as a random intercept to investigate the relationships among curiosity, informational state, and these three affective states (See *SI Appendix*, Tables S5 and S8 for full model information and all parameter estimates).

Within these models, we also included Stop-Outcome condition and all two-way interactions with Stop-Outcome condition, to test whether the affective experience of information gathering depended on the outcome of choice behavior (*SI Appendix*, *Affective Experience by Stop Outcome Conditions*).

Enjoyment. Given that the experience of discovery is thought to be positive (29, 40), we first investigated whether the process of reaching resolution would be associated with enjoyment. We indeed found that both confidence (Study 1: β = 3.83, 95% CI [3.28, 4.38], z = 13.67, $P < 0.001$; Study 2: β = 2.80, 95% CI [2.25, 3,36], z = 9.34, $P < 0.001$) and guess accuracy (Study 1: β = 3.39, 95% CI [2.42, 4.36], z = 6.89, $P < 0.001$; Study 2: β = 1.66, 95% CI [0.70, 2.63], z = 3.37, $P < 0.001$) were positively associated with enjoyment. Notably across both Studies, we also found that curiosity was positively associated with enjoyment (Study 1: β = 7.24, 95% CI [6.64, −7.84], z = 23.57, $P < 0.001$; Study 2: β = −1.20, 95% CI [−1.61, −0.78], z = −5.69, $P < 0.001$). This finding provides support for the notion that the state of curiosity is not always experienced as aversive (16, 32, 34) and can be joyful as characterized in trait mappings of curiosity (6, 27, 28). We further found a significant interaction between curiosity and confidence (Study 1: β = −0.84, 95% CI [−1.21, −0.46], z = −4.39, $P < 0.001$; Study 2: β = −1.20, 95% CI [−1.61, −0.78], z = −5.69, $P < 0.001$) (Fig. 5 *A* and *B*). Unpacking this interaction revealed that the relationship between curiosity and enjoyment was stronger under low confidence (Study 1: β = −1.68, z = −4.39, $P < 0.001$; Study 2: β = −2.39, z = −5.69, $P < 0.001$). Collectively, these results reflect that over information gathering, both curiosity and reaching resolution can act to increase the sense of enjoyment.

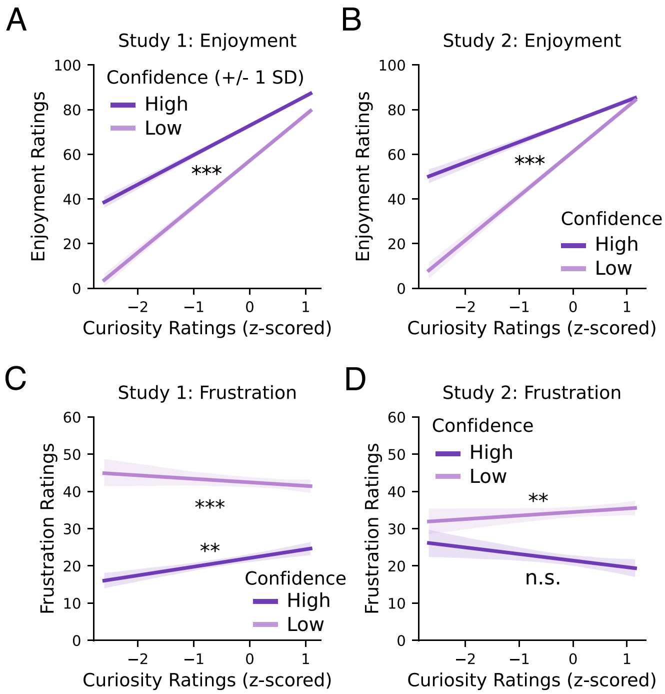

Fig. 5. Confidence modulated the relationship between curiosity and enjoyment, and curiosity and frustration. Curiosity was positively related to enjoyment, but this association was modulated by confidence across Study 1 (*A*) and Study 2 (*B*). When confidence is low, curiosity shared a stronger positive relationship with enjoyment than when confidence was high. The association between curiosity and frustration was driven by confidence in Study 1 (*C*) and Study 2 (*D*), but these effects were in opposing directions depending on agency of timing. In Study 1 with predetermined timing (*C*), when confidence was low, curiosity was negatively related to frustration, but when confidence was high, curiosity was positively related to frustration. In Study 2 with free timing (*D*), when confidence was low, curiosity was positively related to frustration but when confidence was high, curiosity was unrelated to frustration. Of note, because confidence increased with accumulating information, low confidence ratings were more common earlier in a video, while high confidence ratings predominated later. For visualization purposes only, confidence was binned into plus one and minus one SD. Error bars denote 95% CI. (*) $P < 0.05$, (**) $P < 0.01$, and (***) $P < 0.001$.

Tension. We next explored the dynamics of subjective tension throughout information gathering. We found that tension was positively associated with curiosity (Study 1: β = 5.07, 95% CI [4.33, 5.81], z = 13.47, $P < 0.001$; Study 2: β = 3.26, 95% CI [2.25, 4.26], z = 6.36, $P < 0.001$) and negatively associated with confidence (Study 1: β = −3.37, 95% CI [−4.08, −2.66], z = −9.34, $P < 0.001$; Study 2: β = −3.41, 95% CI [−4.20, −2.62], z = −8.49, $P < 0.001$). Together, these findings suggest that curiosity is accompanied by feelings of tension, likely a result of the subjective experience of uncertainty.

Frustration. Finally, we explored how curiosity and informational state shaped feelings of frustration. In Study 1, we found that curiosity (β = −0.98, 95% CI [−2.73, −0.80], z = −2.37, $P = 0.018$), confidence (β = −8.23, 95% CI [−2.73, −0.80], z = −20.61, $P < 0.001$), and guess accuracy (β = −1.74, 95% CI [−2.73, −0.80], z = −2.48, $P = 0.013$) were all negatively related to feelings of frustration. Conversely, in Study 2, we found that only confidence (β = −5.44, 95% CI [−2.73, −0.80], z = −12.52, $P < 0.001$) shared a negative relationship with frustration. These findings suggest that feelings of frustration are consistently mitigated as participants move closer to resolution about the drawing's identity.

When we further examined the interplay among curiosity and informational state, we found that confidence significantly modulated the relationship between curiosity and frustration (Study 1: β = 1.53, 95% CI [−2.73, −0.80], z = 6.10, $P < 0.001$; Study 2: β = −0.86, 95% CI [−2.73, −0.80], z = −3.18, $P = 0.001$), but the direction of this interaction differed across Study 1 and Study 2 (Fig. 5 *C* and *D*). In Study 1, we found that when confidence was low, curiosity shared a negative relationship with frustration (β = −1.93, z = −5.25, $P < 0.001$), but when confidence was high, curiosity shared a positive relationship with frustration (β = 1.13, z = −3.03, $P = 0.001$). Opposite to Study 1, in Study 2, we found that under low confidence, curiosity was positively related to frustration (β = 1.14, z = 2.85, $P = 0.004$), but curiosity did not share a relationship with frustration under high confidence (β = 0.58, z = −1.41, $P = 0.159$). Taken together, high curiosity can relate to higher states of frustration, but this is dependent on both the level of confidence and whether the ability to submit Mid-Video decisions is under the control of the participant. Overall, curiosity can be experienced as frustrating when one is confident but does not have agency or when one is not confident but must choose when to submit Mid-Video decisions.

Collectively, these results show that the affective experience of information gathering reflects a dynamic interplay between curiosity, one's momentary informational state, and the control available to relieve it. In particular, curiosity can share associations with both positive (enjoyment) and negative (frustration) affective states.

Comparison of Predetermined vs. Free Timing (Study 1 vs. Study 2)

Across Study 1 (Predetermined Timing) and Study 2 (Free Timing), we demonstrated consistent relationships between curiosity and informational states as well as a persistent role of curiosity in promoting choices to continue a video even when immediate resolution was available. When we investigated the role of affect in information gathering, we saw differences in the patterns of association across Study 1 and Study 2. To better understand how agency over the timing of decisions shapes the information-gathering experience, we directly compared Study 1 and Study 2, first examining differences in reaching resolution and then in the affective experience associated with each Study.

We first investigated whether participants were waiting to reach resolution before they stopped a video early in Study 2. Focusing on the final guess provided during video watching, which signified a participant's most updated idea about the identity of the drawing, we found that the proportion of correct final guesses in Study 2 was higher (more correct guesses reported) than in Study 1 [chi-squared(1, 40,754) = 2,065.1, $P < 0.001$, Study 1: 49.2% correct last guesses; Study 2: 70.6% correct last guesses] (Fig. 6*A*). Given that participants in Study 2 provided overall more correct last guesses, we explored whether participants in Study 2 were gathering more information prior to stopping compared to Study 1. Focusing only on trials where a participant stopped a video early, we found that in Study 2, participants watched more of a video before stopping [F(1, 21,673) = 1841, $P < 0.001$; Study 1: M = 48.9%, SD = 25.6% video watched at stop; Study 2: M = 65.1%, SD = 21.7% video watched at stop] compared to Study 1. Next, we examined whether reaching resolution, as measured by a correct guess, led to different rates of stopping videos early across our two studies. Using a logistic regression, we found a significant interaction between Study and guess accuracy (β = −0.55, 95% CI [−0.63, −0.47], z = −14.00, $P < 0.001$), indicating that continuation rates were lower in Study 2 compared to Study 1 only when there was a correct guess reported (OR = 1.40, z = 16.91, $P < 0.001$). When an incorrect guess was reported, we

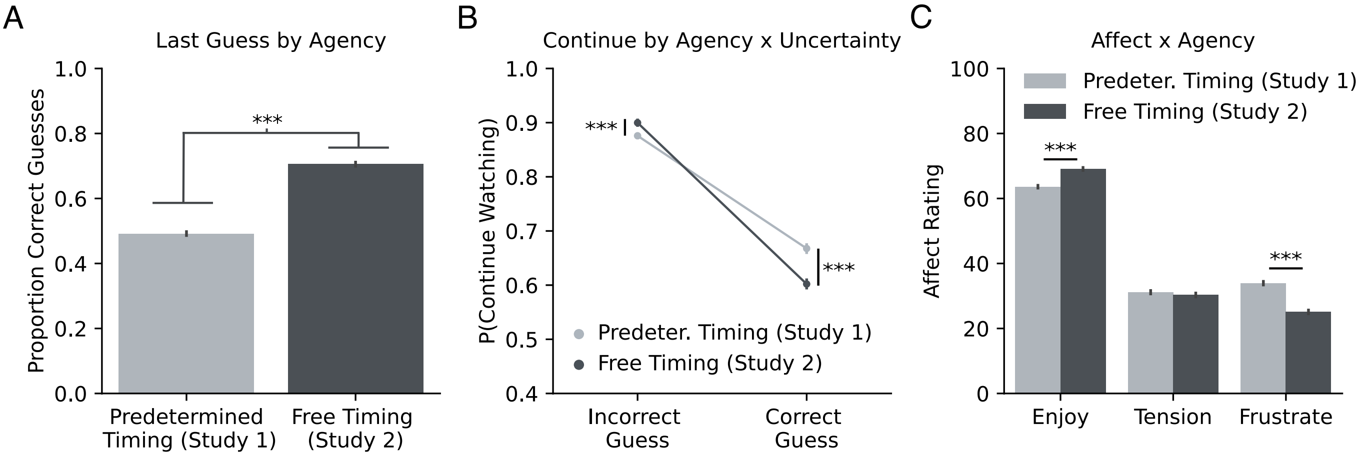

Fig. 6. Comparing Study 1 (Predetermined Timing) and Study 2 (Free Timing) emphasizes the role of reaching resolution. (*A*) Proportion of correct last Mid-Video guesses was significantly greater in Study 2 than Study 1. Proportions were computed as the total number of correct last guesses over the total number of last guesses, across all participants for each experiment. (*B*) Interaction between guess accuracy and agency on continuation rates. Compared to Study 1, participants in Study 2 were more likely to continue when they reported an incorrect guess and less likely to continue once they had reported a correct guess. (*C*) Affective experience across Study 1 and 2 revealed that in Study 2, the average reported enjoyment was higher, the average amount of frustration reported was lower, and there was no difference in the average amount of tension reported. (*) $P < 0.05$, (**) $P < 0.01$, and (***) $P < 0.001$.

found the opposite effect, such that continuation rates were higher in Study 2 compared to Study 1 (OR = 0.81, z = −6.26, $P < 0.001$) (Fig. 6*B*). This suggests that when participants had greater agency over their information-gathering experience, their choices to continue were more sensitive to reaching resolution.

Finally, using a series of linear regressions with Study as our predictor, we compared the overall affective experience between the two studies to assess whether the greater agency impacted how the information-gathering process felt. We found that participants in Study 2 reported overall higher ratings of enjoyment (β = 4.93, 95% CI [4.33, 5.54], t = 15.89, $P < 0.001$) and lower ratings of frustration (β = −8.43, 95% CI [−9.19, −7.67], t = −21.71, $P < 0.001$), with no statistically significant difference in tension ratings (β = −0.65, 95% CI [−1.40, 0.09], t = −1.72, $P = 0.09$) (Fig. 6*C*). These findings suggest that allowing participants to freely decide when to make Mid-Video Decisions further heightened the enjoyment of watching these videos and reduced the experienced frustration, pointing to the additional reward value inherent in exerting agency (41).

Collectively, these results reveal that relative to Study 1, participants in Study 2 who were able to control their information gathering reported a more positive affective experience, showed increased sensitivity to reaching resolution in choices to continue, and were more likely to wait longer to resolve the identity of the drawing. With greater agency over when to initiate Mid-Video Decisions, we might expect that participants would only provide guesses upon reaching a certain level of confidence. As such, this may be expected to weaken the association between curiosity and choices to continue. However, we found that participants still maintained the relationship between curiosity and choices to continue a video even when they could control the timing of their Mid-Video decisions.

General Discussion

Using the experimental paradigm, the Evolving Line Drawing task (ELDT), designed to evoke and characterize the dynamics of curiosity, we showed how curiosity can evolve as a function of the information available to a participant. We saw that curiosity rose with stimulus entropy, suggesting that moments of high environmental variance can sustain curiosity. Conversely, curiosity declined as confidence in stimulus identity increased, suggesting that curiosity subsided (but did not dissipate) with the reduction in subjective experience of uncertainty. Crucially, we also demonstrated that within ongoing information gathering, higher curiosity predicted the choice to delay resolution not only when the alternative was to forgo resolution, but even when the alternative was to immediately resolve uncertainty and view the final drawing. The tendency for higher curiosity to prolong information gathering persisted even after participants were confident in the drawing's identity. These findings support the notion that under continuously evolving information, higher curiosity may increase the value of perceiving the temporal progression to completion, prioritizing the process of information gathering over hastening the outcome.

While curiosity encouraged continuing to watch videos, confidence and guess accuracy did promote choices to stop videos early, indicating that the subjective experience of reaching resolution also changed the value of continued information gathering. In both experiments, curiosity shared a consistent positive relationship with enjoyment and tension; however, curiosity could relate both positively and negatively to frustration, depending on the concurrent level of confidence. Moreover, giving participants full agency over when they could guess and choose to continue or stop videos (Study 2) strengthened the relationship between resolution and choice, such that participants were more likely to continue watching when uncertain and more likely to stop once they believed a resolution was reached. Overall, these results demonstrate that curiosity changed over the course of information gathering, yet consistently discouraged truncating the information-gathering process in a context that afforded the opportunity for continued discovery.

Amplifying and extending prior work exploring curiosity using discrete-resolution tasks (e.g., trivia Q&A paradigms), we demonstrate that when information is continuously evolving, curiosity motivates seeking resolution rather than forgoing it (10, 13, 14, 36). Additionally, high levels of uncertainty, as measured through low levels of confidence and incorrect guessing, also increased choices to continue rather than forgo information seeking, supporting past research (11, 32).

Expanding on recent work showing that curiosity encourages a preference for receiving partial information (hints) compared to immediately receiving the answer (26); here, we find that this preference for prolonging uncertainty persists throughout information gathering. Thus, curiosity experienced during information gathering can encourage prolonging the state of uncertainty, similar to how people prefer to experience movies, sports, or narratives that unfold across time (17, 19–22). However, higher curiosity still predicted continuing a video even after participants made correct, highly confident guesses. These findings demonstrate that the process of information gathering also holds value beyond attaining resolution of an event and suggest that curiosity increases the value of experiencing information unfold.

We also provide evidence for how the choice to stop information seeking is made: Once resolution was reached there was a distinct decrease in the desire for more information. Moreover, when participants had full control of time spent watching (Study 2), they were more likely to continue when uncertain but also more likely to stop when they resolved the drawing's identity than when timing was constrained (Study 1). These findings suggest that people use the subjective experience of resolution as a marker of when the process of information gathering can be concluded, providing key insight into how people self-organize their information seeking (7, 42).

Our study contributes to current theoretical accounts aimed at understanding the relationship between curiosity and uncertainty (1, 2, 5, 8, 15, 38, 43). Varying accounts have posited that curiosity is piqued 1) under intermediate levels of confidence as in the "information-gap" hypothesis (13, 15), 2) when uncertainty is maximal, as in prediction error accounts, (10, 33), or 3) when uncertainty is minimal and a person feels they are on the precipice of knowing, as in the Region of Proximal Learning (38, 44). Moreover, recent work has documented that the relationship between curiosity and confidence is contextual; depending on the future utility of information (5). Collectively, these findings suggest that the relationship between curiosity and uncertainty cannot be described in a single functional form, suggesting instead that form is determined both by how curiosity is measured and the structure of the task. Expanding on this notion, we demonstrate that the relationship between uncertainty and curiosity can also change across an evolving informational state. Specifically, curiosity can be piqued by high states of variance or entropy but also when people report correct guesses but are not very confident (33, 45, 46). This suggests that curiosity can flexibly transition from a more diversive curiosity (i.e., what could this drawing be?) to a more specific curiosity (i.e., is it going to be a dog?) (47), providing support to the notion that curiosity is multifaceted even within a single episode (2). Future work is needed to understand when these different mappings between curiosity and uncertainty arise and how both subjective states and stimulus features can direct ongoing information-seeking behavior.

In both of our experiments, information gathering elicited moments of enjoyment, tension, and frustration, depending on the informational state of a participant. Our findings reveal an experience of curiosity that was mainly positive rather than aversive, but complex and dynamic, further suggesting that curiosity can take on a variety of affective flavors even within one episode. The positive relationship between curiosity and enjoyment stands in contrast with previous work characterizing a state of curiosity or prolonging uncertainty as aversive (15, 32, 34) and linked to unhappiness (16). Although the link between curiosity and enjoyment has been explored in personality trait differences in the desire for information (12, 27, 28), understanding within-person changes in the affective experience of curiosity is underexplored. Overall, we found that curiosity and confidence were both related to enjoyment, suggesting that both the state of wanting to know and the state of moving toward knowing can elicit enjoyment.

We found across both studies that curiosity was related to feelings of tension, possibly due to the experience of uncertainty. Interestingly, we found that curiosity shared a complex relationship with frustration, and this relationship also differed across Study 1 (Predetermined Timing) and Study 2 (Free-Timing). In Study 1, curiosity was negatively related to frustration under low confidence but positively related to frustration under high confidence. In Study 2, we found the opposite: Curiosity was positively related to frustration under low confidence and not related under high confidence. We speculate that in Study 1, the positive mapping of curiosity and frustration under high confidence could reflect a more deprivation-like curiosity that is associated with wanting confirmation about the correctness of an answer (28, 48). In Study 2, our findings aligned with prior work reporting feelings of annoyance related to long delays (35). This difference between Study 1 and 2 suggests that when participants have more control over the timing of their guesses and videos, being far away from resolution could feel more agitating, while coming to and validating an answer could coincide with less conflict. However, we found that overall, increasing a person's agency over the timing of choices in Study 2 increased the positive affect experienced and decreased the negative affect, similar to previous work emphasizing the value of exerting control (41, 45). Although these affective relationships with curiosity provide insights into the range of emotional experiences that can be elicited by curiosity, we probed one emotion for each participant, making it challenging to compare the affective experience holistically. Future work will need to further characterize the affective experience of curiosity to unpack how the emotional experience of curiosity can impact behavior.

The divergent effects of curiosity on information seeking generate new questions about boundary conditions: When does curiosity prioritize the process of information gathering over a rapid resolution of uncertainty? Prior work has demonstrated that expectations around the structure of the environment can influence information-seeking choices (36, 46). An individual might deem prolonging uncertainty to be worthwhile when its resolution is definite, but not when resolution may not occur. Another important factor to consider, and a main motivation for this paradigm, is what process is happening while the resolution of uncertainty is being delayed. Within the ELDT, information continued to unfold across time, allowing for active hypothesis testing and updating. This stands in contrast with delay periods in which the participant passively waits for resolution, without the opportunity to gather more information (11, 36, 37). Under conditions where no further information is obtained, receiving immediate information, indeed, seems favored and is linked to anticipatory utility (37). Future studies will need to elucidate under what contexts curiosity promotes immediate uncertainty reduction or engaging in a prolonged gathering process.

What does it mean if curiosity sometimes directs choices toward and other times away from immediate resolution of uncertainty? One implication is that curiosity can prioritize understanding how information fits together. Curiosity has been linked to the process of sense-making (49), explanation-seeking (50–52), and in the creations of knowledge networks (53). All of these conceptualizations emphasize the process of experiencing an evolving informational state in building representations of the world. The choice to suspend resolution in this study, consequently, could reflect curiosity's preference for and valuation of understanding the process of how each drawing comes to fruition. Delaying resolution to experience the process of information gathering can be a rational solution to maximize information gain (5). Thus, curiosity as prioritizing the process of information gathering offers an avenue to extend current theoretical and computational models of noninstrumental information seeking.

To conclude, by using the Evolving Line Drawing Task, designed to elicit curiosity over continuous information gathering, we reveal the dynamic evolution of curiosity along with information state. This experience of curiosity could reflect a state where prolonging uncertainty presents opportunities for hypothesis generation, testing, exploration, and wonder. Such curious states may promote information seeking beyond simple resolution to prioritize an understanding of how information fits together to create meaning.

Materials and Methods

Participants. Our study recruited a total of 2,153 US adults (Study 1: N = 1,076, Study 2: N = 1,077) through the online labor marketplace, Prolific, in September of 2020. Participants completed the entire study online. In total, 109 participants were excluded, 27 due to technical errors with the task that impeded reading or matching data files with Prolific IDs, 4 due to completing the task twice, 14 participants had unidentifiable guesses (e.g. "ahefxgfe"), 17 participants could not identify more than 80% of the drawings (final answer = "I don't know" or "none"), and 48 participants due to not providing a Mid-Video Rating on 90% of trials (Study 2 only). This resulted in a final sample of 2,043 participants (Study 1: N = 1,033, Study 2: N = 1,010). Within our sample, 48% of our participants identified as women, 48% identified as men, and 4% identified as gender nonconforming or preferred not to say. The mean age of our participants was 32 y (SD, 11.4 y; range, 19 to 76 y). Our racial demographic breakdown showed that 69% of our participants identified as White, 13% as Asian, 8% as Black, and 10% as either mixed or other. Our study was estimated to take 35 min (or 55 min for the two-part study that included memory, see *SI Appendix, Memory Task and Results*), and participants were paid a flat $5.75 for completion of the study (or $9.00 for the two-part study). The study was approved by the Duke University Campus Institutional Review Board (protocol #2019-0297).

Evolving Line Drawing Task (ELDT). After informed consent and prior to starting the task, participants were randomly assigned to one of two Stop-Outcome conditions: Forgo Resolution and Jump-to Resolution that determined the consequence of choosing to end a video early. In the Forgo Resolution condition (Study 1: N = 501, Study 2: N = 485), participants were told that if they stopped the trial, they would receive no further information about the drawing. In the Jump-to Resolution condition (Study 1: N = 532, Study 2: N = 525), participants were told that stopping the video early would jump them to the end of the video where they would see the completed drawing immediately. Participants were told they would watch animated videos of single-line drawings unfold over time. Single-line drawings were collected through Google Image searches and then hand created into videos and standardized through iMovie (*SI Appendix, Video Stimuli and Apparatus*). They were informed of the expected length of each video as well as how many videos they were to view (minimum of 25 videos). Participants were told that during video watching, they would be expected to answer questions about the drawing as it was unfolding (Mid-Video Decisions). Answering all questions was required to advance through the task. Participants were told that their choices and guesses would not impact their compensation. Updating guesses was described as an expected part of the video-watching process, and participants would not be penalized for wrong guesses (*SI Appendix, Task Instructions*).

Videos played automatically at the start of each trial. In Study 1, participants were informed that there would be randomly placed pauses, between 1 and 3 per video, where they would be asked to answer the Mid-Video Decisions (Predetermined Timing). In Study 2, throughout video play, a textbox was present underneath the video. Participants were told to guess as soon as they thought of an identity for the drawing and to update that identity at least once per video (Free Timing). Once participants submitted a guess, they answered the other Mid-Video Decisions.

At Mid-Video Decisions, participants were asked to report on their curiosity ("How much do you want to know the outcome of the drawing?"), one of two randomly assigned questions gauging their confidence about the drawing's identity ("how confident right now," "how much more time needed to know"), one of three randomly assigned affective states (enjoyment, tension, or frustration), and what they thought the identity of the drawing was given the current information (Guess). Curiosity, confidence, and affect were reported on sliding scales that ranged from 1 to 100 (for the time-needed confidence question, the scale was 0 to 30 s). For our curiosity question only, participants could check a box labeled "Already Know" if they were certain they knew the identity of the drawing. This check could be made in addition to or instead of providing a curiosity rating on the scale, but answering at least one question was required for completing the Mid-Video Decision. Our focus for this manuscript was to investigate the role of curiosity in choice behavior; thus, analyses included only Mid-Video Decisions where a curiosity rating was made regardless of whether participants selected "Already Know" or not. Each question was displayed on top of the sliding scale for that question. Only the lower and upper bounds of the scale were labeled (e.g., Not at all/Very much). For guesses, we instructed participants to use the most descriptive and common single English word. Participants were required to submit a guess that was greater than 1 character.

After providing responses to all four questions, participants then chose whether they wanted to continue watching the video or stop the video and move to the next trial. If a participant chose to continue watching a video on their first Mid-Video rating, on the next Mid-Video rating, they again were presented with the option to continue or stop. Across all Mid-Video Decisions, participants chose to continue watching a video 73% of the time. When participants did choose to stop, it was on average 60% or 14.8 s through a video. At the end of a trial, regardless of whether participants watched the video through or ended the trial early, participants were presented with the Post-Video ratings. Participants were asked to report on their video satisfaction, their surprise at the video outcome, the aesthetic appeal of the drawing, and their anticipated curiosity for the upcoming trial. Similar to the Mid-Video Decisions, all Post-Video ratings were reported on sliding scales that ranged from 1 to 100 with each question displayed on top. Only the lower and upper bounds of the scale were labeled (e.g., Not at all/Very much). Examination of the impact of Stop-Outcome condition and continuation on Post-Video ratings can be found in *SI Appendix, Post-Video Ratings Analysis* but will not be discussed in the main text. Participants also provided a final answer as to what they thought the identity of the drawing was in a text box underneath the video. Feedback about the identity of the drawing was not provided to participants at any time. Participants thereby relied on their own sense of certainty to name the drawings. Each trial ended with the option to move to the next trial or replay the current video. During replay, participants simply watched the video; no pauses or guessing was permitted. Replay choices were made on 1.6% of trials and will not be discussed further.

At the end of the required 25 videos, all participants were given the option to terminate the video-guessing portion of the study or watch up to 10 extra videos. These extra videos were new drawings that were not part of the original set of 25 videos. Participants were informed that watching extra videos would not change their compensation. Each additional video trial functioned identically to the main 25 video trials except that after answering the Mid-Video Decisions or the Post-Video ratings, participants now also had the option to terminate the video-guessing portion of the task. Also, 32% of our participants chose to watch at least one additional video (M = 2.72 additional videos, SD = 2.90 videos, Range: 1 to 10 videos).

Computation of Guess Accuracy and Stimulus Entropy. To compute guess accuracy, we first standardized all participant guesses and final answers (*SI Appendix, Guess Standardization*). In short, final answers were scored as correct if the answer matched the name of the drawing, if it matched a name in a list of alternative identification, or if the answer was provided after the participant had seen the completed drawing (either from watching the video all of the way through in the Forgo Resolution condition or anytime in the Jump-to Resolution condition). Across all final answers provided, accuracy was 98%. Guess Accuracy was then determined by comparing each participant's mid-video guesses to their final answer. Guess accuracy across all Mid-Video Decisions was 47.9%.

To compute stimulus entropy, we leveraged the collection of guesses made across all of our participants to create a crowdsourced measure for how varied the potential identities for a drawing were at any point in time (33, 54). For each second of each video, we counted the number of unique guesses made as well as how often each unique guess was made to compute the probabilities of each potential stimulus identity. These probabilities were then used to compute Shannon's informational entropy with the given formula:

$$H(X) = -\sum P\left(x_i\right) \log\left(P\left(x_i\right)\right),$$

where x_i reflected each unique potential identity. This measurement provided a collective sense of how participants converged on an identity as well as how varied the path was to reaching that identity.

Data Analysis. Before conducting all statistical analyses, predictors were either scaled or factorized. For this manuscript, we collapsed the two confidence questions into a single subjective confidence marker. Analyses were conducted with R v4.0.3 and RStudio v1.3.1093. We created linear and logistic mixed effects regression models with the lme4 package (55) and obtained *P*-values with the lmerTest package (56). All mixed-effects models included random intercepts for participant. For all statistical analyses, we report standardized β values (and 95% CI around the slope estimate). Figures were produced in Python with Seaborn and Matplotlib.

Data, Materials, and Software Availability. Anonymized De-identified data and analyses scripts data have been deposited in Open Science Framework (DOI: 10.17605/OSF.IO/RC73G, https://osf.io/rc73g/) (57).

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