

Observing Transitions: Bitcoin, Cognition & Event Perception

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Events are the units of reality and are defined by their space, time, and content. But, how do these units arise? Event Segmentation Theory describes how humans, automatically during perception, segment continuous streams of activity into meaningful events by relying on prediction error signals to highlight event boundaries (Zacks et al., 2007, 1). This segmentation “scaffolds later memory and learning,” meaning those who better identify event boundaries remember and learn events better (Zacks et al., 2007, 1). Notably, “segmenting” and “chunking” exists in many other domains, such as linguistics, as an adaptive strategy to “cope with information overload” (Hard et al., 2011, 601; McCauley and Christiansen, 2019). Further, as this paper is concerned with transitions as future-based events, Endel Tulving’s 1985 distinguishing of episodic memory, the recalling of past experiences, from semantic memory, the recalling of factual knowledge, is relevant (Radvansky & Zacks, 2014, 6). Episodic memory is important for maintaining the ability to imagine future events and make future-based decisions (Brunette & Schacter, 2021; Zhang et al., 2021). Critically for this study, current research suggests that “episodic memory in the hippocampus is critical for adaptive behavior...[and] supports deliberation during value-based economic choice task[s]” (Zhang et al., 2021, 2). In aggregate, event cognition is a means of understanding, navigating, and thriving in our reality. However, event cognition is not siloed without external influence.

Language, technology, and money are tools we use to interact with reality, and, by extension, they impact and influence how we engage with events and our cognition. For instance, the printing press enhanced our ability to find and disseminate truth, the lightbulb altered our biological rhythms, and money, an abstraction of humans’ time and energy, sits at the base layer of society and impacts everything it touches. Further, Loh and Kanai describe how our ability to “process environmental information and produce adaptive behavior,” our cognition, is influenced by technological inventions such as language, writing systems, and the internet (Loh & Kanai, 2016, 506). Further, Hecht et al. show that technical skills and tools can affect brain structure (Hecht et al., 2023). Lupyan and Bergen also “argu[e] that language is a powerful tool for programming the mind by helping to activate more abstract/categorical representations by affecting modal mental states” (Lupyan & Bergen, 2016, 417). Today, we find ourselves living in a world with something that uniquely embodies these three tools of language, technology, and money, in a single system providing a new structure for studying how they might impact our cognition, perception, and event segmentation.

Background & Review that Motivates the Question, Hypothesis, and Approach

Currently, our perception of reality is flawed as the dominant language of economic communication is broken. Bitcoin is the first communication language of value that all 8 billion people can speak, structured in a way that aligns economic incentives in the vector of truth and that is systematically programmed to be a based money. Breaking this idea down, if language is an interface of reality which can program our mind, money impacts societal structures, and bitcoin is a monetary language technology that economically incentivizes the projection and programming of truth, then will humans living on a bitcoin standard (spending and saving in bitcoin), be able to segment events and see transitions in reality better than humans on a fiat standard? Or, for instance, would bitcoin, sometimes considered the “internet of money” reduce our attentional scope and ability to segment as the internet has done? (Peng et al., 2018; Sun et al., 2009).

Three factors motivate the above question. First, in their book *The Sovereign Individual: Mastering the Transition to the Information Age*, written in 1997, William Rees-Mogg and James Dale Davidson note that “history’s great transformations are perceived, or rather, misperceived as they happen” (Davidson & Mogg, 1997, 59), and “the fourth stage of human development is coming...[but] only a few heretics have bothered to think about how transitions...unfold” (Davidson & Mogg, 1997, 54-55). Second, building off of “human development,” “to be able to delay immediate satisfaction for the sake of future consequences has long been considered an essential achievement of human development” (Shoda & Peake, 1990, 978). Finally, in parallel, the idea of delayed gratification or low time preference is prevalent throughout the Bitcoin space and Austrian Economist, Dr. Saifedean Ammous argues that sound money, such as bitcoin, fosters low time preference (Ammous et al., 2022). However, does sound money lead to low time preference, aiding human development, and helping to see the fourth stage of human development coming?

Problem Investigating

The present study aims to understand how might a language, technology, and monetary protocol such as bitcoin shape our cognition of reality around us to better understand transitions underway? The testable question is: How does experience in a sound or broken money standard, through the case study of bitcoin and fiat currencies, affect cognitive processes related to time preference and event segmentation? In particular, does a sound money actually make us more “low time preference” (better able to think more long term about the future and delay gratification)? Does a broken money actually give us more “high time preference?” Then, does low-time preference increase and high-time preference decrease our ability to segment events and perceive transitions in our reality? Notably, only bitcoin is suitable to adequately study the effects of a sound money standard. Long-term saving goals are insufficient as they are denominated in a currency systematically programmed to lose value over time as governments will continually spend more than they make and expand their money supply. Further, bitcoin improves upon gold, being finite in supply and more verifiable, portable, and divisible.

Hypothesis

By affording people private property rights through their ability to own their money, and preserving individuals’ purchasing power having achieved digital scarcity, on a sound money standard such as bitcoin, people do become more low time preference and cognizant of the events unfolding around them. It is hypothesized this study will show participants in the bitcoin standard group to experience greater delayed gratification and as a result higher capital formation across the 11 variables and greater self-regulation throughout ages 12, 17, 27, and 37 compared to those on the mixed or fiat standards. Further, bitcoin standard participants are expected to perform better on the Event Segmentation Tasks than the mixed and fiat standard groups, respectively.

Methods

The methods for this study will be largely derived from earlier studies to better compare across different studies (Kreps et al., 2026; Benjamin, Laibson, & Mischel et al., 2020; Zacks et al., 2001; Johnson et al., 2024).

Participants

300 persons will be recruited for this study. Efforts will be made to ensure participants represent an equal balance of genders and have no damage to their prefrontal cortex. As discussed, episodic memory is critical for future-based decision making amidst uncertainty, and there is evidence of changed “episodic simulation in psychiatric populations” (Brunette & Schacter, 2021; Allé et al., 2019). Notably, participants will be in the age range of 13 - 27, or Generation Z, and do not need to be familiar with bitcoin or “crypto or blockchain.” Participants will come from Generation Z for four main reasons. First, patch foraging strategies across development show youth are more likely to “explore” in decision-making problems (Lloyd et al., 2023). Second, episodic memory decreases with age as the hippocampus declines and youth tend to segment events more frequently as they encounter more novel information, making time feel like it passes longer than adults who consider time to “be flying” (Week 11 and 10 Notes). Third, to minimize the effects of confounding factors such as “sunk-cost fallacy,” youth are chosen to have a greater chance of a more neutral level of (experiential) financial knowledge. Finally, to operationalize the definition of “youth,” it is fitting to focus on the generation bitcoin was born in. In the following measures, participants will be divided into three groups. Those living on a bitcoin standard, those living on a fiat standard, and those living in both systems on a mixed standard. “Living on” means their monetary decisions are denominated in satoshis (100,000,000 satoshis = 1 bitcoin), dollars, or both. These groups were created to acknowledge that bitcoin is not yet universal, yet you cannot adequately measure or perceive a new system from within an existing system (Jeff Booth).

Measures

Basic Knowledge & Demographic Questionnaire

To begin, all participants will take the survey from the forthcoming study done by Professor Sarah Kreps and Ella Hough in the Cornell Brooks Tech Policy Institute, which is being used by Morning Consult to survey 25,000 persons across 25 countries on their financial literacy levels, knowledge of bitcoin, and demographic information.

Capital Formation as a Measure of Delayed Gratification Task

Arguably the most famous test of delayed gratification is that of Walter Mischel et al. at the Bing Nursery School of Stanford University, highlighting that greater success comes to those who can resist eating the marshmallow (Gill). However, follow-up studies show that might not necessarily be the case, or rather, the whole story. Benjamin, Laibson, and Mischel et al., using the same Bing cohort, showed that “delay of gratification [did] not predict the 11 capital formation variables” (Benjamin, Laibson, & Mischel et al., 2020). Rather, it was the repeated delayed-gratification throughout life that indicated likelihood of success, highlighted through “survey measures of self-regulation collected at ages 17, 27, and 37,” predicting “10 of the 11 capital formation variables” (12). Notably, they acknowledge the limited generalizability given their small sample size and that 97% had a college degree (Benjamin, Laibson, & Mischel et al., 2020, 12).

Using a greater sample size and more representative population, this study will replicate the methodology from the Benjamin, Laibson, and Mischel et al. paper, using their 11 capital formation measures: net worth, permanent income, wealth-income ratio, high interest-rate debt, credit card misuse, delay choice (money later vs. money sooner), savings rate, financial health, educational attainment, forward-looking behaviors (including consideration of future financial consequences), and social status as well as one of their two self-regulation measures:

rank-normalized self-regulatory index (RNSRI), which includes “four components: RND and survey measures of self-regulation measured at ages 17, 27, and 37” from the California Child Q-Set (Benjamin, Laibson, & Mischel et al., 2020). Notably, this study will include a measure at age 13 to reflect all participants in the study and will not use the rank-normalized delay (RND) measure as pre-school data is not applicable.

The results of the 11 capital formation measures and the self-regulation measure will be compared across the three groups of the participants. Additionally, there are three relevant confounding factors to mention. First, participants from less trusting societies may experience a lesser ability to delay gratification. Second, fiat currencies have a lifespan of 27 - 48 years and the participants in the study have never lived in a world on a sound money standard such as gold (De Mint, 2024). Despite efforts to limit the effect of a “reinforced debasing currency standard,” all participants will have still grown up thus far in an arguably “high-time preference” environment. Third, as bitcoin is only sixteen years old, short-term volatility does exist, which could impact time-preference; however, that is why measurements will occur at four periods in participants life.

Event Segmentation Task

Next, at each of the self-regulation measures at ages, 13, 17, 27, and 37, participants will also do an event segmentation task. With learnings from the previous measure, this task is also repeated four times to acknowledge reinforcement is critical. Considering bitcoin as a language, proficiency increases through continued use, continued reinforcement. This event segmentation tasks will closely resemble that of Zacks et al. from 2001. The 300 participants will each watch “four movies of everyday activities during fMRI scanning:” making a bed, doing the dishes, fertilizing a houseplant, and ironing a shirt (Zacks et al., 2001, 654). Similarly, the stimuli will be presented three times each with the first for participants just to view and the second (coarse units) and third (fine units) for the participants to segment with a handheld button (Zacks et al., 2001, 654). This study chooses to maintain the same videos because this study is understanding how savings behaviors impact one’s ability to engage with reality, if at all. In this regard, it is important to choose “neutral” activities that don’t necessarily relate to finance. In this task, the count, speed, and accuracy of determining event boundaries will be measured for the three groups of participants. Further, this study will adopt the “mean hit probability” introduced in Gerwien & von Stutterheim’s 2018 study. This measure was introduced to measure the “observed differences between French and German participants,” and this study will want to do the same for bitcoin standard, fiat standard, and mixed standard participants (Gerwien & von Stutterheim, 2018, 231).

Conviction Narrative Theory

It would be remiss to not mention Conviction Narrative Theory (CNT), a model used to understand “the role of economics’ impact on cognition and decision-making” and for decision-making under uncertainty, which incorporates episodic and semantic memory, offering itself as a more holistic way of seeing cognition (Johnson et al., 2024; Week 13 Notes). This paper centers on understanding future transitions, which is an endeavor of “radical uncertainty,” making CNT a prudent framework for evaluation. Notably, CNT excludes probabilities and “proposes that people use narrative - structured representations of causal, temporal, analogical, and valence relationships...as the currency of thought that unifies our sense-making and decision-making faculties” (Johnson et al., 2023, 1).

Regarding the concept of low time preference and delayed gratification task, in their 2016 paper, Daniel et al. describe how people frequently “engage in intertemporal decision-making” (Daniel et al., 2016, 352). They found that “[episodic] prospection [imagining future experiences] reduced future discounting,” “[episodic] retrospection [remembering the past] reduced past discounting,” and that “retrospection and prospection are most effective for the congruent temporal discounting compared to recent thinking. This means that imagining future events made people more likely to value future rewards over present ones, showcasing low time preference. Similarly, remembering past events increased appreciation for past rewards, reducing the tendency to devalue them in favor of present rewards. With these results, it could be hypothesized that the 100 participants on a bitcoin standard which systematically reinforces the preservation of value, may be more likely to engage in episodic prospection and retrospection and make low time preference decisions, valuing future rewards and their past efforts over instant gratification. Conversely, the 200 participants on the fiat and mixed standards, which systematically reinforces the loss of value, might find it harder to engage in episodic prospection and retrospection, favoring instant gratification and undervaluing future rewards and their past efforts. Episodic memory is a long-term memory that stores information of events or experiences tied to a particular time and space (Rubin, 2006). Money owned by you is an abstraction of your past time and energy. Similarly, it’s a way to store information of past experiences tied to a particular time and space. The Daniel et al. paper shows how reimagining the past or the future can influence how one makes a decision. If episodic thinking (traditionally) can reduce future discounting, then perhaps episodic thinking (monetarily) can also influence more low time preference actions. CNT provides a framework for that consideration. Additionally, CNT’s exclusion of probabilities and emphasis on narrative finds greater methodological alignment with the school of Austrian economics, which is more prevalent under a bitcoin standard and favors theoretical analysis over empirical results. Finally, bitcoin adoption often relies on narratives such as “sound money,” “protection against inflation,” “digital property,” “freedom technology,” or “gold 2.0,” and a CNT framework, which values the importance of narrative for decision-making and that is structured and emotionally engaging could help to build conviction in bitcoin’s long-term value, navigating uncertainty and encouraging low time preference actions.

Potential Results

If the hypothesis is correct, the 100 participants living on the bitcoin standard will exhibit higher measures of delayed gratification through means of greater capital formation. Further, they will perform better on the event segmentation task than those in the mixed or fiat standard groups. In recent papers of Baker and Levin and Kosie and Baldwin, consistent results were that novelty seems to have an effect on attention and event perception. Baker and Levin showed that we receive more information when we detect a violation to our prediction (influenced by episodic memory) and we are more likely to segment events at these points of novelty, increasing our attention and making us more aware of our environment and better at remembering those details. Notably, this relational information is very important for episodic memory and event segmentation (Baker & Levin, 2015). Combined with Zhang et al.’s study results that “a retrieval of salient episodic memory can promote deliberation in the decision-making process” and influenced “future goal-directed behavior,” the potential results are further supported (Zhang et al., 2021, 9). Similarly, Kosie and Baldwin showed that increased “dwell-time” was spent on boundaries with coarser rather than fine details, guiding segmentation, and longer dwell time

also resulted in better memory (Kosie & Baldwin, 2019). Tangibly, they showed results similar to how in your own life, if you feel pain, you are likely to make a change to alleviate it. In aggregate, viewing bitcoin as a monetary, technological, and linguistic innovation, these results will reinforce Loh and Kanai's results that cognition is impacted by technological innovation, and Lupyan and Bergen's findings that language can program the mind.

Abstracting, the bitcoin standard participants, adopting a more low time preference mentality, better at segmenting events, will perhaps be more likely to perceive reality and transitions underway. Influenced by a system of economically-incentivized truth, bitcoin standard participants, guided by their episodic memory, might be more likely to detect change otherwise concealed by an economically-incentivized dishonest fiat reality. These fine-grained event segmentation tasks connect to large-scale transitions in society because all transitions are composed of many smaller events, and it is impossible to predict transitions if one is not aware of fine-grained events. For instance, so often today, people think their wealth is increasing, and it is in nominal terms, but because they've never asked questions such as "What is money?," they are largely unaware of the erosion of their wealth in real terms through inflation. Since 1971, which marked the end of the gold standard, the dollar has lost 98% of its purchasing power, and on a faster scale, the dollar lost 25% of its value from 2020 - 2024. Language, technology, and money often find themselves at the level of individual action, impacting cognition, and bitcoin embodying those roles, also finds itself poised to be investigated in impacting event cognition and perception.

Discussion

Given the close relationships between event cognition, perception, attention, episodic memory, decision-making, and language, on the cognitive level, living on a bitcoin standard may reframe how individuals segment and perceive events and navigate decision-making under uncertainty. On the societal level, given bitcoin is a language of value all eight billion could speak, widespread adoption could encourage long-term thinking and influence collective, rather than fragmented, perceptions of transitions, fostering a more aware, informed, and engaged society (Gerwien & von Stutterheim, 2018). This means that savings technologies like bitcoin could serve as cognitive tools that extend beyond financial benefits to impact broader aspects of cognition, particularly in event perception and decision-making. On the academic level, showing bitcoin has an effect on decision-making and cognition would have profound implications, taking the narrative of bitcoin outside of just the financial realm, influencing discussion on the cognitive science of technology (Stout, 2021), the evolution of language (Bickel et al., 2024), and the field of cognitive economics where minds and markets are considered complex adaptive systems (Johnson et al., 2024) to name a few.

Most concisely, these results would afford empirical grounding to philosopher Knut Svanholm's claim that "Bitcoin is not the signal but the greatest noise remover." Change blindness refers to the concept that change goes unnoticed due to a lack of attention, or rather, attention is prevented from seeing the change. Further, to see the change, one must compare a changed state to its original state and attention is required to retrieve this memory, which still may or may not have sufficient detail to notice the change (Kentridge, 2015, 344). Fractional reserve banking, the printing of money, and the translation of value through ~180 currencies designed to lose value, has masked our ability to give adequate attention to the world around us, obfuscating change. However, key years of change such as 1913, 1933, 1944, 1971, 1975, 2008, and 2020 were not so long ago. Increasing numbers of people who denominate the abstraction of

their time and energy in a fixed supply system have or have acquired knowledge to detect the current state of our world from its original state and have sufficient detail to notice the changes and observe transitions across society. Bitcoin is a transition, an inflection point, a point of novelty violating our models of prediction, and an opportunity to dwell and garner new information. But, will we be able to see it and update our models accordingly?

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- This study examines how measures of self-regulation, including delay of gratification in preschoolers, could predict mid-life capital formation across 11 variables. However, what the researchers acknowledged was that delayed gratification (low time preference) in preschool was not sufficient by itself, rather, using two self-regulation measures across their lifespan showed stronger correlations with economic outcomes, meaning that reinforcements in delayed gratification were critical. In terms of methodology, the study relied on participants from the Stanford Bing pre-school cohort and combined self-regulation measures at 4 life stages with surveys on financial formation. In terms of a tie to bitcoin, this study highlights the importance of reinforcement self-regulation/delayed gratification over time, aligning with bitcoin's potential role in fostering low-time preference behaviors as it is something that is used continually.
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This paper presents a model of language acquisition that is grounded in usage-based theory, which explains how children incrementally learn language through chunking (grouping linguistic input into units). McCauley and Christiansen present that language learning is best understood as “learning by doing,” emphasizing real-time, shallow processing of local information rather than hierarchical grammar (such as Chomsky proposes with the idea of a universal grammar). And, they demonstrate their findings with data from 29 languages. Related to this course and this paper, like with event segmentation, this study emphasizes the role of chunking in making sense of inputs (processing streams of information) and in decision-making.

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In conversation with the famed Stanford “marshmallow study” looking at delayed gratification, this study explores any predictive power of delay of gratification in preschool on later cognitive and self-regulatory abilities. Particularly, they “attempted to identify the particularly psychological conditions in which children’s delay of gratification behavior is more likely to predict relevant individual differences in developmental outcomes” (978). The study compared 4 variations of delay of gratification tasks/ situations, examining the influence of reward visibility (exposed or obscured) and cognitive strategies (with or without ideation suggestions) on behavior. The outcomes were assessed through parental ratings via the adolescent camping questionnaire, the CCQ questionnaire and SAT scores. As the Benjamin et al. paper also showed, this study supports the role of sustained reinforcement of delay strategies in fostering self-regulation, which is again relevant for considering bitcoin as a tool to be continually used.

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This study explores the cognitive functions related to decision-making and inhibition in individuals with Excessive Internet Use (EIU) or Internet Addiction (IA) as EIU has “become a serious social problem around the world” (75). This study highlights similarities between EIU and other addictive behaviors, like drug use and pathological gambling, resulting in impaired cognitive control and decision-making abilities and influences on impulsive behaviors. Further, “EIUsers could hardly suppress their excessive online behaviors in real life” (76). To obtain these results, researchers used a gambling task and a go/no-go task. While this paper is clearly not about bitcoin, economics, or event cognition in blatant form, what it does a good job of priming for consideration is the impact of technology on our ability to engage with reality. It also has a theme of “reinforcement” / “reinforced learning” as we have seen in other papers. This study largely takes the perspective that bitcoin is a net-good on our actions, yet given it is still a form of technology, what are the net-bad, if any, impacts it could have on our ability to engage with reality.

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In this study, researchers present evidence that regions of brain activity are tuned with perceptual event boundaries during passive and intentional observation of events. In this paper, participants

(without any prior knowledge of the task or study) passively viewed video depictions of everyday activities while having their brain activity measured by fMRI. Then, for the intentional portion, they used a button to indicate where they marked perceived event boundaries. Next, this information was applied back to their fMRI data and compared. The researchers summarized their findings along 4 main points, and this paper's findings show segmentation is related to memory and understanding. From these results, for this paper, a foundation is laid to consider how bitcoin (which embodies saving and spending, passive and intentional) could impact event segmentation, given it happens naturally and is ongoing (not task-dependent) and episodic memory and influences how we perceive transitions in reality.

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