Theory and Decision
https://doi.org/10.1007/s11238-026-10141-8

Uncertainty amplifies the impact of scarcity on delay of gratification: evidence from a serious game experiment

Juan P. Arroyave[1,2] · Alonso R. Molina[3] · Miguel Rotter-Zimbrón[4] · Gino Carmona-Díaz[5]

Received: 1 September 2025 / Accepted: 15 April 2026

Abstract

Individuals facing economic scarcity often struggle with delaying gratification, a pattern typically attributed to cognitive load, self-control, or risk preferences. However, the role of uncertainty remains underexplored. This study tests the preregistered hypothesis that uncertainty intensifies the negative effects of scarcity on delay of gratification. In a between-subjects experiment with Colombian participants (N = 230; M age = 24.4; 58% female), we used a web-based serious game simulating economic decision-making under resource scarcity or abundance. After condition exposure, participants received one of three interventions: (1) direct resource provision, (2) insurance to reduce uncertainty, or (3) no intervention. Delay of gratification was assessed using real monetary incentives aligned with participants' economic choices. Results showed that participants in abundance were significantly more likely to delay gratification than those in scarcity. Among scarcity-exposed participants, uncertainty reduction significantly improved delay of gratification, matching the effect of resource provision. In contrast, participants in abundance were unaffected by uncertainty-reducing interventions. These findings suggest that uncertainty amplifies the effects of scarcity rather than influencing future-oriented decision-making universally. Reducing uncertainty may thus serve as a scalable behavioural intervention to support future-oriented decision-making in economically vulnerable populations.

✉ Juan P. Arroyave
juan.arroyavehurtado2024@my.ntu.ac.uk

1 Nottingham Trent University, 50 Shakespeare St, Nottingham NG1 4FQ, UK

2 Universidad Cooperativa de Colombia, Medellin, Colombia

3 UCLA University of California Los Angeles, 390 Portola Plaza, Los Angeles, CA 90095, USA

4 UNAM Universidad Nacional Autónoma de México, Circuito Interior s/n, C.U., 04510 Coyoacán, Ciudad de México, CDMX, México

5 Universidad de los Andes, Carrera 1 # 18A-12, Bloque Cp, Bogotá, Colombia

Published online: 07 May 2026

Keywords Uncertainty · Scarcity · Delay of gratification · Serious games · Economic decisions

1 Introduction

Why do individuals facing economic scarcity struggle with delaying gratification? This question has profound implications for understanding poverty's psychological mechanisms and designing effective interventions. While poverty is commonly conceptualized as material deprivation, it simultaneously comes with pervasive uncertainty about income stability, employment prospects, and access to necessities. This uncertainty represents a distinct but underexplored dimension that may critically influence economic decision-making. Despite extensive research on scarcity's cognitive effects, the specific role of uncertainty in how scarcity's impact on delay of gratification remains poorly understood. The present study addresses this gap by investigating whether uncertainty serves as a key mechanism through which scarcity undermines future-oriented decision-making. Specifically, we test whether reducing uncertainty can improve willingness to delay gratification under scarcity conditions, potentially offering insights for more effective anti-poverty interventions.

Poverty is a global phenomenon that affects millions of people. Those who live with tight budgets do not only lack material resources, but also suffer from a wide range of social, psychological, and cognitive impacts (Banerjee & Duflo, 2011; Bartos et al., 2018; Braveman et al., 2010; de Almeida et al., 2024; Duggan et al., 2007; Shah et al., 2012, 2019). Research has shown that people living in poverty face a higher risk of mental health problems, chronic illnesses, higher mortality, and a lower life expectancy (Mode et al., 2016; Singh & Siahpush, 2006). Furthermore, poverty is also associated with frequent debt accumulation (Griskevicius et al., 2011, Kim et al., 2006; Lempert et al., 2016; Mendel, 2005), low levels of savings, and investments in high-risk alternatives that eventually perpetuate the cycle of poverty (Barr, 2012; Blank & Barr, 2009; Banerjee & Duflo, 2011).

Importantly, previous work has highlighted that a crucial characteristic of those living in poverty is their tendency to delay gratification less (de Bruijn & Antonides, 2021; Yang, 2016). When facing scarcity, individuals often prioritize immediate rewards over future benefits (Hilbert et al., 2022). This behavioural pattern raises the important question of why individuals living under scarcity conditions struggle to delay gratification.

Different empirical and theoretical approaches have attempted to explain this phenomenon, showing the impact of poverty on these types of economic decisions. For instance, some findings suggest that poverty leads to attentional focus that privileges information related to scarce goods, leading to neglectful behaviours that discount the future, such as overborrowing (Mani et al., 2013; Schilbach et al., 2016). Moreover, it has been argued that the increased cognitive load -either directly, due to the need to make constant trade-offs (Deck & Jahedi, 2015; Mullainathan & Shafir, 2013), or indirectly, as a mediator of self-control (Mani et al., 2013) may make it harder for individuals facing scarcity to delay gratification.

Other scholars also suggest that poverty can increase both risk aversion (Deck & Jahedi, 2015) and, in some cases, risk-seeking behaviour (Dalton et al., 2020). Haushofer and Fehr (2014) propose that negative moods and stress associated with poverty may significantly influence economic decision-making processes. Additionally, Lewis (1966) introduced the concept of a "culture of poverty", proposing that the behaviours and preferences of individuals living in poverty are shaped by distinct norms, attitudes, and values that may impact in a very specific way how these individuals make decisions. Finally, Morton (2017, 2022) posits that in certain contexts, behaviours often labelled as counterproductive may in fact be ecologically rational for people living in poverty. However, such behaviours can become self-defeating, reinforcing the cycle of poverty and contributing to a "pessimistic trap" on the future and one's ability to achieve goals.

While these findings and theoretical proposals are valuable, there is a barely explored variable that may contribute to our understanding of what happens when people in scarcity fail to delay gratification, namely, uncertainty. Researchers in psychology and economics characterize uncertainty as a mental condition where individuals making decisions lack clarity about what might result from their choices (Botelho et al., 2023; Platt & Huettel, 2008; Sniazhko, 2019). Essentially, uncertainty arises when people have not been provided with sufficient relevant information, leading to inaccurate assessments of potential outcome likelihoods. Therefore, gathering information regarding the probability of various results would diminish the level of uncertainty linked to a specific decision. Similarly, Wang et al. (2015) describe uncertainty in terms of circumstances where outcome possibilities remain unclear, with probability patterns that may be clearly established (as in risk situations) or entirely undefined (as in ambiguous situations).

Unlike risk, which refers to situations where outcome probabilities are known or can be estimated, uncertainty involves contexts where such probabilities are unknown or incalculable (Knight, 1921). Several scholars have classified uncertainty into dimensions particularly relevant to decision-making: *temporal uncertainty,* which refers to not knowing when an outcome will occur (Lempert et al., 2023); *outcome uncertainty,* the possibility that the promised result may not happen at all (Keren & Roelofsma, 1995); *environmental uncertainty,* involving volatility in external decision-making conditions (Fawcett et al., 2012); and *cost uncertainty,* referring to the unpredictability of the resources required for future decisions (Sharma & Ranjan, 2021).

Although a universal phenomenon, people living in poverty are often exposed to higher levels of these various types of uncertainty (Banerjee & Duflo, 2011; González-Jiménez, 2024; Lachman & Weaver, 1998). In economically scarce environments, these forms of uncertainty frequently coexist and amplify each other (Haushofer & Fehr, 2014). Individuals living in poverty may not only experience uncertainty about their future income (*outcome uncertainty*) but also about the timing of unexpected expenses (*temporal uncertainty*) and the general volatility of their economic environment (*environmental uncertainty)*. For that reason, uncertainty may play a crucial role in shaping how people facing scarcity decide whether to delay gratification.

The connection between uncertainty and delayed gratification lies in the inherent unpredictability of future outcomes (Lipshitz and Strauss, 1997). Delaying an immediate reward in exchange for a greater future reward involves navigating an uncertain

terrain (Chateauneuf et al., 2007; Chew & Sagi, 2008; Choi et al., 2007). This perceived uncertainty is amplified by additional factors, such as whether the reward will actually occur or whether the person offering it can be trusted to deliver. Such uncertainty often leads to a stronger preference for immediate, smaller rewards over larger, delayed ones. This tendency is especially pronounced in unstable or unpredictable environments, where the future feels less secure and delaying gratification becomes more difficult (Göllner et al., 2018; Li, 2017; Michaelson et al., 2013).

Some studies have explored the relationship between uncertainty and delayed gratification. For example, it has been found that when people are uncertain about when deferred rewards will be received, they tend to give up more quickly if they perceive that the expected reward no longer justifies the remaining time (Lempert et al., 2023). Similarly, another study conducted by Luhmann et al. (2011) suggests that high intolerance of uncertainty predicts shorter waiting times and a greater preference for immediate and risky rewards. Of particular interest is the Milkman's work (2012), which showed that reducing uncertainty may lead to less impulsive choices, on the basis that uncertainty depletes self-control. In her study, Milkman found that under uncertain conditions, individuals tended to choose immediately tempting options (e.g., brownies), whereas under conditions without uncertainty, individuals tended to choose healthier options (e.g., fruit salad). While these studies have generated important findings, they do not evaluate the influence of uncertainty in the context of delayed gratification, nor do they explore the relationship between uncertainty and scarcity. As a result, some key questions remain unanswered: What happens to people facing scarcity and constant uncertainty when dealing with decisions requiring delayed gratification? Is it scarcity itself that leads people to prefer immediate rewards, or does uncertainty contribute to this decision? When uncertainty is reduced in a context of scarcity, do the effects on delayed gratification change? Do people facing uncertainty and scarcity perceive decisions about temptations as more complex? Our work aims to address these questions by exploring a gap that has not been deeply examined before: the role of uncertainty under conditions of scarcity in decisions involving delay of gratification.

We propose that uncertainty may function as an amplifying mechanism that specifically exacerbates the negative effects of scarcity on delay gratification. Uncertainty may disproportionately affect individuals already experiencing resource constraints. Those with abundant resources may possess sufficient buffer to absorb unexpected costs or changes, rendering uncertainty less consequential for their decision-making. In contrast, individuals facing scarcity may be particularly vulnerable to uncertainty's effects, as unpredictable future outcomes threaten their already precarious resource management strategies.

Importantly, we conceptualized delayed gratification in contexts of scarcity not as revealing stable time preferences, but as strategic responses to environmental conditions (Stevens, 2017). Following recent work showing that apparent present bias often reflects liquidity constraints (Cassidy, 2019; Dean & Sautmann, 2021) rather than preference parameters, we examine how uncertainty shapes the relative value of waiting versus taking immediately usable resources.

1.1 The present study

We have adopted a serious game methodology for designing a tool that allowed us to examine the effect of scarcity and uncertainty on the delay of gratification. The use of serious games in research offers significant advantages over traditional methods such as self-reporting and more conventional experimental tasks. Serious games not only provide entertainment but are also powerful, engaging, and safe tools for collecting data on people's behaviour in relation to their environment (Freese & Bekebrede, 2025). These settings allow hypothesis testing and gathering information on decisions, interactions, and choices more dynamically. Additionally, they also improve the quality of data, yielding richer responses and greater participant engagement (Bailey et al., 2015; Looyestyn et al., 2017).

In our game, we gave participants an immersive experience related to everyday economic decisions, with a real monetary reward based on their performance. We designed experimental conditions that manipulate levels of resource scarcity, uncertainty about costs and potential penalties and rewards, as well as interventions that reduce both scarcity and uncertainty (an additional monetary bonus that reduces scarcity, an insurance that reduces uncertainty, and a control condition where participants did not receive any aid). This allowed us to explore how these factors influence decisions about delayed gratification under conditions of induced uncertainty and scarcity. We preregistered the following hypotheses (H):

H1 *Participants in the scarcity condition who receive a stipend or bonus will show more willingness to delay gratification than participants in the scarcity condition without aid.*

H2 *Participants in conditions of scarcity would be more willing to take the immediate reward than those in abundance conditions.*

H3 *Participants in the scarcity conditions would require more time to decide to delay gratification than those in abundance conditions.*

H4 *Those participants in the scarcity condition would find it more difficult to decide whether to defer gratification or not than those in the abundance conditions.*

2 Methods

2.1 Participants

A total of 240 participants were recruited through social networks and official channels of the Universidad Cooperativa de Colombia (mean age: 24.4; age range: 18–59; 159 female, 65 male, 6 non-binary). The sample size was determined based on prior power analyses from studies examining the effects of scarcity on delay of gratification (e.g., Carvalho et al., 2016; Mani et al., 2013), which reported medium effect sizes. To detect similar effects with 80% power at $\alpha = 0.05$ in a 2×3 between-subjects design,

a sample of this size was deemed sufficient and appropriate. The socio-economic status (SES) of the participants included 41 from high-income, 88 from middle-income, and 101 from low-income households, based on the Colombian SES classification system. Those who either could not advance far enough in the game to provide information about the dependent variable or demonstrated a pattern of response speed 2 standard deviations below the mean and consistently responded the same way to the experimental task questions were excluded (N = 10), resulting in a final sample size of N = 230. All participants received a minimum financial remuneration of USD $5 for their participation, with potential earnings of up to USD $9.5, depending on their performance in the task. Participants first completed a survey where they answered demographic questions. The survey was displayed on the same interface as the game. All participants signed a consent form. The procedure was approved by the ethics committee of the Universidad Cooperativa de Colombia, approval code 0800-45.

2.2 Materials and procedure

2.2.1 The game rationale

To test our hypotheses, we designed a web-based game that simulates various types of decisions people face in everyday life, with varying cost–benefit complexity, such as buying food, paying for health or entertainment services, or hiring legal assistance. The main objective was for participants to "survive" as long as possible by maintaining positive levels of two key indicators: economic resources (money) and well-being. Progress in the game was marked by days of the month, with each day consisting of three decision rounds (see Fig. 1).

Each decision involved a trade-off that influenced both indicators. When participants accepted an option during a round, they spent money to gain well-being. When they declined, they neither gained nor lost money but experienced a decrease in well-being (see Fig. 1). Importantly, no decision ever resulted in monetary gain, only improvements in well-being. If either indicator reached zero, the game ended.

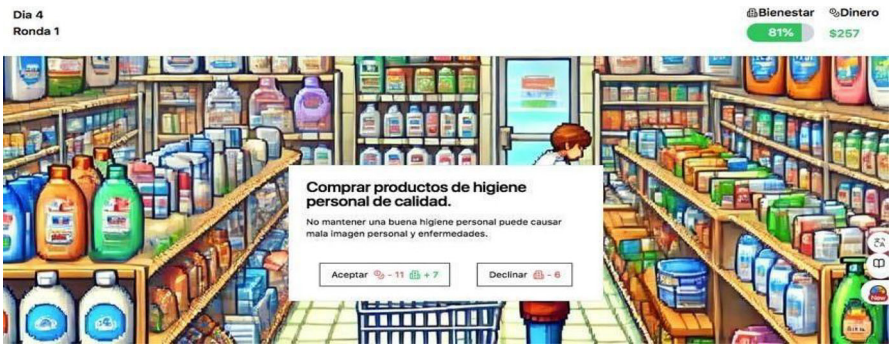

Fig. 1 Example of the game indicators and an in-game decision

For example, in a specific round, participants faced the decision: "Buy personal hygiene products. Poor hygiene can lead to illness and create a poor personal image". If the participant accepted the option, they spent money and increased well-being. If they declined, their budget remained unchanged, but their well-being decreased.

Decisions varied across three cost levels (low, medium, and high). For example, low-cost options required a small expenditure for a modest well-being gain or, if declined, a small well-being loss. Alike, medium- and high-cost options followed the same structure, but with proportionally larger values (See Online Supplementary Materials A section for more details).

In addition, all groups experienced "token events": unpredictable and random events that increased or decreased well-being or money independently of the participant's choices. These events simulated real-life circumstances beyond individual control, such as losing well-being due to illness or gaining money through an unexpected job bonus.

2.2.2 Experimental conditions

We manipulated two key variables: scarcity and uncertainty. First, participants were randomly assigned to either a scarcity condition (starting with \$90) or an abundance condition (starting with \$300). During the initial part of the game (days 1 to 5), participants in the scarcity condition experienced a significant decrease in their money, reinforcing the scarcity manipulation. Additionally, all participants began with 75% of well-being (with 100% being the maximum possible value) to ensure that spending money on well-being improvements early in the game felt reasonable (see Fig. 2).

In our experimental design, we operationalized uncertainty as a combination of cost uncertainty and environmental uncertainty, defined as follows:

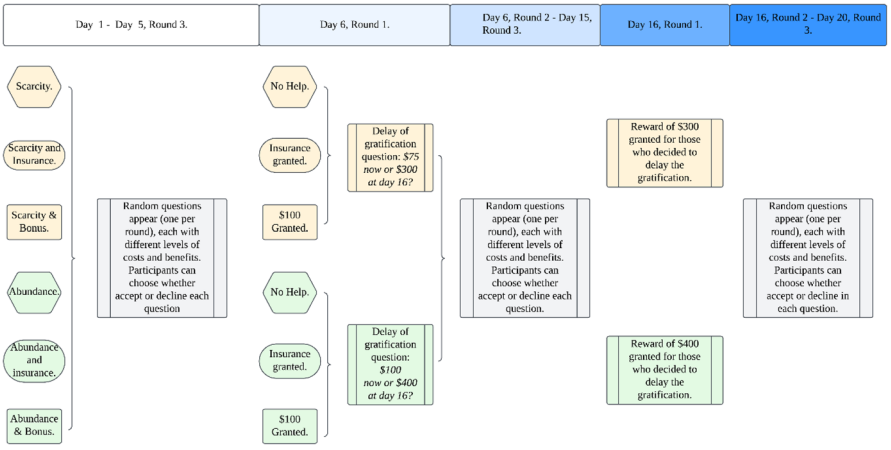

Fig. 2 Experimental design of the game

- *Cost Uncertainty:* Introduced through the unpredictable presentation of options with varying cost levels (low, medium, high), preventing participants from anticipating the type of decision they would face in each round.
- *Environmental Uncertainty:* Implemented through random "token events" that could increase or decrease participants' resources or well-being without their control, simulating the volatility typical of scarcity contexts.

Subsequently, in the first round of day 6, we introduced the manipulation of uncertainty through one of three interventions:

- A $100 bonus, which was especially useful to reduce scarcity for those in the scarcity condition.
- Insurance guaranteeing protection from high-difficulty options and bad token events until day 16 (reducing uncertainty for 45 rounds)
- No aid (control)

The timing of the interventions was deliberately designed to ensure that participants directly experienced their assigned conditions before making the critical delayed gratification decision. This sequence was crucial because both scarcity and uncertainty are psychological states that emerge from accumulated experience rather than from abstract information.

During the first five days, all participants were exposed to uncertainty, as it was impossible to predict the cost of available options or the occurrence of token events. At the same time, participants in the scarcity condition faced the pressure of limited resources and some costly decisions, in contrast to those in the abundance condition. The final design was a 2 (budget) $\times$ 3 (intervention) between-subjects design: scarcity with bonus, scarcity with insurance, scarcity with no aid, abundance with bonus, abundance with insurance, and abundance with no aid (see Fig. 2).

2.2.3 Reward structure and additional tasks

Immediately following the intervention (or lack thereof), at the beginning of day 6, all participants completed a delay of gratification task: To choose between receiving an immediate amount of money for use in the game or waiting until day 16 for a larger amount. In this task, delay of gratification refers to the decision to forgo an immediately usable reward in exchange for a larger but inaccessible payoff, under conditions of uncertainty and potential resource depletion.

To determine the specific amounts to include in the question, we conducted a pilot study testing responses and preferences according to the assigned condition. Based on preliminary results, we set the immediate amount for the scarcity group at $75 and the delayed reward at $300. For those in the abundance group, we set $100 for the immediate and $400 for the delayed reward. We decided to do this because prior research already shown that monetary rewards do not have a fixed psychological value; rather, their impact is shaped by the recipient's existing financial situation and their subjective interpretation of the reward's meaning (Thibault-Landry et al., 2022; Bowen & Kensinger, 2017).

Setting the delay of gratification question immediately after the manipulation was crucial, as it allowed participants to make their decision with full knowledge of their

current resources and level of certainty about future events. For participants who received the bonus, the additional funds were already reflected in their budget when making the decision. For those who received insurance, they were explicitly informed before making their choice that they were protected from high-cost options and negative token events until the end of day 15. This sequential ordering and manipulation ensured that participants' decisions about delayed gratification were directly influenced by their experimental condition and the specific intervention they had received.

Additionally, another pivotal feature of our experimental design was the implementation of meaningful real monetary rewards that directly corresponded to participants' in-game performance. This incentive structure was deliberately designed trying to align participants' in-game decision-making with the type of consequential economic choices they would make in real-world scenarios. All participants received a base compensation of USD $5 for participation, but could earn up to USD $9.50 total depending on their performance and strategic decisions. Specifically, participants who successfully reached day 16 in the game earned an additional USD $2.50, representing a 50% increase in their compensation. Furthermore, for each additional full day survived beyond day 16, participants received an incremental USD $0.25.

This progressive reward structure created genuine stakes for the delay of gratification decision, as choosing the larger delayed reward (rather than the immediate smaller sum) could significantly impact both in-game survival and actual monetary earnings. We incorporated these real-world financial consequences, trying to ensure that participants approached the decisions with psychological conditions like those that characterize actual economic choices under scarcity and uncertainty. This methodology addresses limitations of hypothetical choice paradigms common in decision-making research, where participants may indicate what they believe they: "should" do rather than what they would actually do when facing real financial constraints and opportunities (See Supplementary Materials section for more details).

After concluding the game, each participant completed an exit survey with exploratory questions about game dynamics. Laboratory assistants instructed participants on all rules and objectives using an integrated tutorial and administered control questions to ensure comprehension.

3 Results

3.1 Primary findings

The data was analysed using R Studio and JASP. We performed a binomial logistic regression to examine the effects of induced scarcity and the type of aid received on participants' decisions to delay gratification. The model presented a Nagelkerke $R^2 = 0.225$, showing that initial budget (scarcity vs. abundance) significantly predicted delayed gratification decisions ($\beta = 1.53$, $SE = 0.29$, $Z = 5.13$, $p < .001$, Odds Ratio $= 4.66$). Participants in the abundance condition were approximately five times more likely to choose delayed gratification compared to those in the scarcity condition, thus supporting hypothesis 2.

The type of aid received also significantly influenced decisions. Compared to receiving no aid, both insurance ($\beta = 0.93$, SE = 0.35, Z = 2.59, $p < .01$, Odds Ratio (OR) = 2.54) and bonus ($\beta = 1.37$, SE = 0.36, Z = 3.80, $p < .001$, OR = 3.94) significantly increased the likelihood of choosing delayed gratification. However, the difference between receiving a bonus versus insurance was not statistically significant ($\beta = 0.43$, SE = 0.36, Z = 1.21, $p = .22$).

3.2 Interaction between resource availability and aid

We tested the interaction between budget condition and aid type to examine whether uncertainty reduction effects were specific to scarcity conditions. The logistic regression model revealed significant interactions between budget and both bonus ($\beta = -2.13$, SE = 0.79, Z = − 2.67, $p = .01$) and insurance ($\beta = -1.90$, SE = 0.80, Z = − 2.37, $p = .05$), indicating that aid effects differed significantly across resource conditions. Conversely, we did not find a significant difference between the insurance and bonus conditions (Table 1).

After using scarcity with no aid as the reference group, participants experiencing scarcity showed dramatically improved delay of gratification when receiving either insurance (OR = 7.69, Z = 3.30, $p < .001$) or bonus (OR = 12.67, Z = 4.15, $p < .001$), supporting our hypothesis 1 (See Table 2). Notably, insurance and bonus effects were statistically equivalent within the scarcity condition, suggesting that uncertainty reduction can be as effective as direct resource provision for improving delay of gratification.

In contrast, participants in abundance conditions demonstrated consistently high delay of gratification across all aid conditions (no aid: OR = 19.00; insurance: OR

Table 1 Complete binomial logistic regression model predicting delay of gratification choice

Predictor	β	SE	Z	*p* value	OR
Main effects					
Budget (abundance vs. scarcity)	1.53	0.29	5.13	< .001	4.66
Aid: insurance vs. no aid	0.93	0.35	2.59	.010	2.54
Aid: bonus vs. no aid	1.37	0.36	3.80	< .001	3.94
Aid: bonus vs. insurance	0.43	0.36	1.21	.224	1.54
Interactions					
Budget × insurance	− 1.90	0.80	− 2.37	.018	0.15
Budget × bonus	− 2.13	0.79	− 2.67	.008	0.12
Model information					
Nagelkerke R^2				.225	
Log-likelihood				− 120.45	
AIC				252.90	
N				230	

Table 2 Simple effects analysis (using Scarcity + No Aid as reference)

Condition	β	SE	Z	*p* value	OR
Abundance + no aid	2.94	0.626	4.71	< .001	19.000
Abundance + bonus	3.35	0.651	5.14	< .001	28.500
Abundance + insurance	3.08	0.648	4.76	< .001	21.850
Scarcity + bonus	2.54	0.611	4.15	< .001	12.667
Scarcity + insurance	2.04	0.619	3.30	< .001	7.690

= 21.85; bonus: OR = 28.50, all $p < .001$ compared to scarcity no-aid), with no meaningful differences between aid types (See Table 2).

As shown in Fig. 3, participants in the abundance condition demonstrated a similar tendency to delay gratification regardless of the type of aid received. In contrast, participants in the scarcity condition showed marked differences based on the type of aid received. Those who received no aid were substantially less likely to delay gratification compared to participants who received either a bonus or insurance (See Fig. 3). These results suggest that when resources are abundant, additional aid has minimal impact on delay of gratification. However, when resources are scarce, receiving either monetary aid (bonus) or uncertainty reduction (insurance) significantly increases willingness to delay gratification.

Additionally, we examined whether delayed gratification choices had consequential effects on game performance by analysing survival rates to Day 16, the point at which delayed rewards would be received. Table 3 presents survival percentages by experimental condition and delayed gratification choice.

In the scarcity + no aid condition, no participants survived to Day 16 regardless of their choice (0/4 who delayed; 0/38 who took immediate rewards). Notably, 90% of

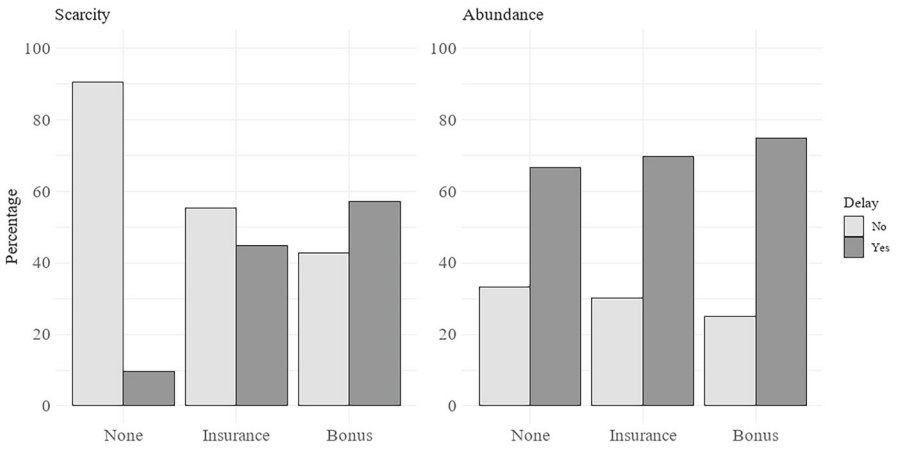

Fig. 3 Percentage of delay of gratification by initial budget and condition (type of aid)

Table 3 Percentage of participants who survived to Day 16

Condition	Delayed choice	Immediate choice
Scarcity + no aid	0% (0/4)	0% (0/38)
Scarcity + insurance	53% (9/17)	19% (4/21)
Scarcity + bonus	66% (16/24)	39% (7/18)
Abundance + no aid	77% (20/26)	77% (10/13)
Abundance + insurance	78% (18/23)	70% (7/10)
Abundance + bonus	83% (24/29)	78% (7/9)

Percentages represent proportion surviving to Day 16. Numbers in parentheses show (survivors/total)

participants in this condition (38/42) chose the immediate reward, which aligned with the structural impossibility of survival: both choices led to identical outcomes.

The pattern changed dramatically when scarcity was coupled with uncertainty reduction or resource provision. Among scarcity + insurance participants, those who chose to delay showed 53% survival (9/17) compared to 19% (4/21) for those who took immediate rewards ($\chi^2 = 4.79$, $p = .029$). Similarly, in the scarcity + bonus condition, 66% of participants who delayed survived (16/24) versus 39% who took immediately (7/18; $\chi^2 = 2.89$, $p = .089$).

3.3 Additional analyses

Additionally, as proposed in our hypotheses 3 and 4, we sought to determine whether individuals in the scarcity condition perceived the delay-of-gratification decision as more difficult and whether it would take them longer to decide. To address these questions, we included a scale from 1 (very difficult) to 5 (very easy) asking participants how difficult they found the decision to defer gratification before receiving aid (or the lack thereof). We also internally tracked the time taken to make the delay of gratification decision. We conducted pairwise comparisons between budget levels for each aid condition. Contrary to our expectations, we found that the time required to make the decision did not differ between participants with low and high budgets in the insurance ($t = 0.61$, $df = 69$, $p = 0.53$), bonus ($t = 1.19$, $df = 76$, $p = 0.23$), or no aid conditions ($t = 1.37$, $df = 79$, $p = 0.17$).

Although we did not find significant differences in decision-making time, a two-way ANOVA revealed a main effect of budget on the perception of difficulty ($F = 7.86$; $p < 0.01$, $\eta p^2 = 0.03$). Participants in the low-budget conditions reported that the decision to delay gratification was more difficult ($M = 2.93$; $SD = 0.93$) than participants with a high budget ($M = 3.27$; $SD = 0.85$), which partially aligns with one of our predictions. Nevertheless, approximately 50% of participants reported that deciding to delay gratification was moderately difficult, regardless of their experimental condition.

4 Discussion

Using a serious game approach, we aimed to establish how uncertainty impacts the delay of gratification when individuals deal with scarcity. The serious game is best interpreted as a controlled sequential decision problem under uncertainty, rather than as a canonical intertemporal choice task designed to estimate pure time preferences. Our findings reveal that uncertainty does not uniformly impair the decision to delay gratification but rather interacts specifically with scarcity conditions. At each decision point, participants faced a trade-off between securing an immediate, certain payoff and continuing to play for a larger but probabilistic future reward.

Participants in the abundance conditions demonstrated similar tendencies to delay gratification regardless of whether they received uncertainty-reducing insurance, suggesting that adequate resources provide a buffer against uncertainty's effects. In contrast, participants experiencing scarcity showed significant improvements in delay of gratification when uncertainty was reduced. This pattern indicates that uncertainty may amplify the negative effects of scarcity on gratification delay and that reducing uncertainty alters the expected value of waiting.

A central finding of our study is that, even though insurance did not provide immediate liquidity, it increased delayed gratification almost as effectively as the monetary bonus among scarcity-exposed participants. This finding requires careful interpretation: while insurance did not provide immediate liquidity, it may have worked as 'functional liquidity' by reducing uncertainty about future resource needs and increasing participants' perceived ability to meet those needs. When participants knew they would not face high costs or negative token events until day 16, their existing resources were perceived as available to deal with future needs. In this sense, reducing uncertainty increased the functional purchasing power of current resources -not by adding money, but by removing the need for large precautionary buffers against unknown future shocks.

Importantly, this mechanism operates differently from nominal liquidity. The bonus increased absolute resources, allowing participants to absorb unexpected costs. Insurance, conversely, eliminated the possibility of such costs, making existing resources sufficient. We consider that both paths (increasing resources or decreasing uncertainty) achieved the same outcome: making delayed gratification feasible and rational.

The performance of participants in the scarcity without aid condition was consistent with previous research that demonstrated that scarcity is negatively correlated with delay gratification, likely due to the depletion of cognitive resources (Carvalho et al., 2016; Mani et al., 2013) and, in some cases, the mediating effect of self-control (Yu et al., 2023). In our study, however, an alternative explanation is that the most contextually "rational" decision at the moment of choice was to take the immediate reward. Given the scarcity and the inability to predict the difficulty and costs of the rest of the decisions, opting for the immediate reward appeared to be a reasonable strategy to sustain themselves until the end of the game. Supporting this interpretation, we observed that when participants had experienced the same scarcity and uncertainty but received a bonus or a guarantee that they would not face high-cost options, most of them opted to delay gratification. This interpretation aligns with recent work on liquidity constraints in contexts of scarcity (Cassidy, 2019; Dean & Sautmann, 2021). For

instance, Cassidy (2019) demonstrates that apparent present bias often reflects rational responses to liquidity constraints rather than stable preference parameters. Our findings may extend this logic: uncertainty constrains liquidity by forcing individuals to hold precautionary reserves. When uncertainty is reduced, reserves become available.

We align with the idea that, in our study, decisions to delay or not delay gratification were mostly driven by thoughtful considerations influenced by the particular conditions that each participant faced in the game. To complement this approach, our survival analysis reveals that delayed gratification choices may reflect rational assessments of environmental conditions. In scarcity + no aid, 90% of participants chose immediate rewards, although none of them reached day 16. However, when uncertainty was reduced or resources were provided, participants who chose to delay showed significantly higher survival (53%–66%) compared to those who took immediate rewards (19%–39%). This demonstrates that delaying became objectively advantageous only when environmental conditions made reaching Day 16 feasible. On the other hand, in abundance conditions, survival rates were uniformly high (70%–83%) regardless of delayed gratification choice or aid type. This suggests that adequate resources create a buffer, making both uncertainty reduction and additional resources functionally redundant.

The apparent failure to delay gratification in many contexts may stem from a deliberated and coherent decision-making process that extends beyond systems of rules, intuitions, and habits (Bulley & Schacter, 2020; McGuire & Kable, 2013). When in a context of high uncertainty, limiting persistence (knowing when to give up) is an element that can be seen as appropriate, and even adaptive for gaining some benefit instead of ending up empty-handed (Dasgupta & Maskin, 2005; Fawcett et al., 2012).

Our findings are also close to previous works that have shown how persistence is not beneficial in all circumstances (McGuire & Kable, 2013). For instance, Wooten (2024) explored how low-income Black men transitioning to adulthood fell into "effort traps," where striving too hard to escape poverty became counterproductive. He found that societal pressures and misleading lessons about hard work led them to overcommit, resulting in exhaustion and failure. Participants' experiences of poverty and scarcity intensified their desires to escape from disadvantage, leading them to overcommit to immediate opportunities for advancement, even when these were unsustainable. In other words, working to meet immediate financial or survival needs was non-negotiable, which constrained their ability to pursue long-term goals. These findings challenge the notion that grit and perseverance are universally positive, showing that in contexts of severe inequality, these traits can contribute to burnout and systemic reproduction of disadvantage.

Furthermore, some laboratory evidence suggests the expectation of obtaining something in the future decreases if the waiting time is too long (Lampert et al., 2018; 2023). This phenomenon is related to the concept of temporal expectations (MacGuire & Kable, 2013), where it is considered coherent not to continue waiting or insisting on something if the time that passes causes the reward to lose value or be perceived as less attractive. When the moment of receiving the reward is uncertain, the value of persistence fundamentally depends on the nature of the decision-makers' prior temporal beliefs.

Although the uncertainty of our participants was not precisely temporal, but rather related to costs and the environment, this logic could be extended to our findings. The basic idea behind it is that when the conditions in the game seemed unfavourable to individuals, they valued the reward less since it was perceived as more distant or unlikely. The expectation of obtaining a greater reward later decreased, which implies that adaptive behaviour does not require maximizing one's level of persistence but calibrating it appropriately to the environment (McGuire & Kable, 2012, 2015).

Additionally, due to the experimental design, it is possible that those participants who had to continue experiencing scarcity and uncertainty when deciding to delay gratification perceived the game's dynamics as an unreliable and unstable environment. Specifically, due to the lack of guarantees that the remaining questions on the way to that reward would involve low costs or that no token events would occur. This possibility also relates to the theoretical implications derived from re-examinations of the classic marshmallow task by Mischel and colleagues (Mischel et al., 1972; Shoda et al., 1990). In newer versions of this classic experiment, the experimenters noticed that children's waiting times seemed to be modulated by a rational decision-making process considering the reliability of the environment (Kidd et al., 2013; Moffett et al., 2020). The results showed that children in the reliable condition chose to wait much longer than those in the unreliable condition, suggesting that children's waiting times might reflect reasoned beliefs about the stability of the world, and consequently, whether the wait would bring results.

Another interesting finding was that participants who started in scarcity perceived the decision to delay gratification as slightly more difficult compared to those who started in abundance, although nearly half of the entire sample perceived the difficulty as moderate. In addition to this, contrary to one of our hypotheses, the time it took to make this decision showed no differences between the groups with decreased uncertainty. The relationship between perceived difficulty and decision time is not necessarily straightforward nor linear. Rather, it follows an inverse U-shaped pattern that also considers factors such as the importance of the decision (Haans et al., 2016; Starcke & Brand, 2016). Both very simple and very complex decisions tend to be made quickly, while moderately complex decisions often take longer (Gonçalves, 2024; Mazzotta et al., 1995). All this suggests a process of greater deliberation and analysis of possibilities, which is precisely what we believe happened with most of the participants in this study.

4.1 Implications

The implications of our research extend beyond the laboratory setting and pose significant practical and theoretical value, particularly in the realm of economic decision-making. Uncertainty is an unavoidable part of life, and it must be integrated into models explaining economic phenomena such as delaying gratification. Reducing uncertainty leads to substantial changes in how individuals approach economic decisions. Whether in personal financial decision-making or large-scale public policies, understanding how uncertainty influences choices can lead to more effective, targeted solutions. If we aim to foster better decision-making under scarcity, reducing

uncertainty may have an impact on people's ability to wait for rewards, particularly in situations requiring long-term planning and delayed gratification.

Moreover, our findings carry significant implications for social interventions aimed at supporting individuals in scarce conditions. The amount of uncertainty perceived by people living in scarcity is different from that of those in abundance. This distinction is crucial because it shows that scarcity is not merely about the lack of resources, but also about the psychological impact of uncertainty. Addressing uncertainty, such as providing contingency insurance or guarantees rather than just increasing the amount of money may help people achieve their long-term goals. Interestingly, our results suggest that whether you offer more money (bonus) or provide some level of guarantee about the future (insurance), the impact on delaying gratification is similar, at least for decisions in a lab context. However, in real-life contexts, it is important to consider that insurance may prove to be a sustainable option, as it mitigates the risk of individuals mismanaging their funds.

Finally, future studies could benefit from using this type of serious game that closely mirrors real-life decision-making dynamics, particularly in areas such as personal finance, health, or policy-making. These types of games provide a unique opportunity to study decision-making in more naturalistic contexts, offering insights that go beyond the constraints of traditional experimental setups.

4.2 Limitations

While participants made decisions under conditions of scarcity and uncertainty, the dynamics of the game cannot fully replicate the complexities and emotions involved in actual economic decisions. Real-world decisions are influenced by a variety of contextual and emotional factors that cannot be entirely modelled in an experimental setting (Lempert et al., 2018). For example, within the context of the game, people could not gain any more money than the amount they started with. If people had different opportunities to gain money, the game would better reflect real life. Therefore, while our findings offer valuable insights, we must be cautious when extending the results to real-world situations outside the laboratory.

A different but closely related limitation regarding the ability of the game to mimic real-life conditions was that the variables we measured were focused on economic and well-being conditions, but there are other kinds of scarcity and uncertainty that we left out. For example, the time consumed within each decision, or specifying more precisely well-being in properties such as happiness, health, peace, or satisfaction. Moreover, if there is a relationship between uncertainty and previous experiences of injustice or the perception of injustice, such as racial, sexual or gender factors, the game does not capture the uncertainty that could come from them.

Moreover, although we conceptually distinguish between different types of uncertainty, our experimental manipulation simultaneously combined multiple dimensions, namely, environmental and cost uncertainty. Future research should examine the independent effects of each type of uncertainty to determine which are most critical in contexts of scarcity. Our focus on uncertainty limits generalizability to situations where probabilities are unknown or incalculable, as opposed to contexts involving

risk, where probabilities are known, but outcomes remain uncertain. Future research should explore how varying levels of probabilistic information interact with scarcity to influence intertemporal decision-making.

Another significant limitation of our study lies in the individual variables that were not considered but are likely crucial in economic decision-making. Factors such as self-control, risk aversion, or even a tendency toward impulsive decisions are individual traits that influence how people respond to situations of uncertainty and scarcity. While our study focused on the perception of uncertainty and its impact on the delay of gratification, it did not address how these individual characteristics affect decisions in similar contexts. Including these variables in future research could provide a more comprehensive understanding of the factors that shape economic behaviour and improve the accuracy of predictive models related to decision-making under uncertainty.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11238-026-10141-8.

Acknowledgements We gratefully acknowledge the *Self-Control in Context* project team for their valuable intellectual and logistical support throughout the development of this study. Special thanks to Dr. Renato Zambrano, coordinator of the Psychology Laboratory at Universidad Cooperativa de Colombia and laboratory assistants Wendy García, Litzy Pérez, Esteban Rincon and Brenda Solís. Finally, we extend our sincere appreciation to Pablo Castaño, Senior Developer, whose technical expertise and ongoing support were instrumental to the implementation of the experimental platform.

Author contributions Juan P. Arroyave: Writing—review & editing, Writing—original draft, Supervision, Conceptualization, Software, Resources, Methodology, Formal analysis. Alonso Molina: Writing—review, Supervision, Methodology, Conceptualization. Miguel Rotter: Writing—review, Supervision, Methodology, Conceptualization. Gino Carmona-Diaz: Writing—review & editing, Software, Resources, Methodology, Formal analysis.

Funding This project was funded by the John Templeton Foundation under Grant #62622, *Self-Control in Context*. The funders had no involvement in the study design, data collection, analysis, interpretation, or manuscript preparation.

Data availability Both the pre-registration and the dataset are available at the following repository: https://data.mendeley.com/datasets/xyrbbx3ws8/1.

Declarations

Conflict of interest The authors declare that there are no commercial or financial relationships that could be construed as a potential conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process During the preparation of this work the authors used CLAUDE in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the published article.

References

Bailey, P., Pritchard, G., & Kernohan, H. (2015). Gamification in market research: Increasing enjoyment, participant engagement and richness of data, but what of data validity? *International Journal of Market Research, 57*(1), 17–28. https://doi.org/10.2501/IJMR-2015-003

Banerjee, A. V., & Duflo, E. (2011). Poor economics: A radical rethinking of the way to fight global poverty. PublicAffairs

Banerjee, A. V., & Duflo, E. (2011). Poor economics: A radical rethinking of the wayto fight global poverty. *Population and Development Review, 37*(4), 796–797. https://doi.org/10.1111/j.1728-4457.2011.00462.x

Barr, M. S. (2012). No slack: The financial lives of low-income Americans. Brookings Institution Press.

Bartos, V., Bauer, M., Chytilová, J., & Levely, I. (2018). Effects of poverty on impatience: Preferences or inattention? CERGE-EI Working Paper Series No. 623. https://ssrn.com/abstract=3247690 or https://doi.org/10.2139/ssrn.3247690

Blank, R. M., & Barr, M. S. (Eds.). (2009). Insufficient funds: Savings, assets, credit, and banking among low-income households. Russell Sage Foundation.

Botelho, C., Fernandes, C., Campos, C., Seixas, C., Pasion, R., Garcez, H., Barbosa, F., et al. (2023). Uncertainty deconstructed: Conceptual analysis andstate-of-the-art-review of the ERP correlates of risk and ambiguity indecision-making. *Cognitive, Affective and Behavioral Neuroscience*. https://doi.org/10.3758/s13415-023-01101-8

Bowen, H. J., & Kensinger, E. A. (2017). Cash or credit? Compensation in psychology studies: Motivation matters. *Collabra: Psychology, 3*(1), Article 12. https://doi.org/10.1525/collabra.77

Braveman, P. A., Cubbin, C., Egerter, S., Williams, D. R., & Pamuk, E. (2010). Socioeconomic disparities in health in the United States: What the patterns tell us. *American Journal of Public Health, 100*(Suppl 1(Suppl 1)), S186–S196. https://doi.org/10.2105/AJPH.2009.166082

Bulley, A., & Schacter, D. L. (2020). Deliberating trade-offs with the future. *Nature Human Behaviour, 4*(3), 238–247. https://doi.org/10.1038/s41562-020-0834-9

Carvalho, L. S., Meier, S., & Wang, S. W. (2016). Poverty and economic decision-making: Evidence from changes in financial resources at payday. *American Economic Review, 106*(2), 260–284. https://doi.org/10.1257/aer.20140481

Cassidy, Rachel. "Are the poor so present-biased?." Unpublished Working Paper. (2019)

Chateauneuf, A., Eichberger, J., & Grant, S. (2007). Choice under uncertainty with the best and worst in mind: Neo-additive capacities. *Journal of Economic Theory, 137*(1), 538–567.

Chew, S. H., & Sagi, J. S. (2008). Small worlds: Modeling attitudes toward sources of uncertainty. *Journal of Economic Theory, 139*(1), 1–24.

Choi, S., Fisman, R., Gale, D., & Kariv, S. (2007). Consistency and heterogeneity of individual behavior under uncertainty. *American Economic Review, 97*(5), 1921–1938.

Dalton, P. S., Nhung, N., & Rüschenpöhler, J. (2020). Worries of the poor: The impact of financial burden on the risk attitudes of micro-entrepreneurs. *Journal of Economic Psychology, 79*, Article Article 102198. https://doi.org/10.1016/j.joep.2019.102198

Dasgupta, P., & Maskin, E. (2005). Uncertainty and hyperbolic discounting. *American Economic Review, 95*(4), 1290–1299. https://doi.org/10.1257/0002828054825637

Dean, M., & Sautmann, A. (2021). Credit constraints and the measurement of timepreferences. *Review of Economics and Statistics, 103*(1), 119–135.

de Almeida, F., Scott, I. J., Soro, J. C., Fernandes, D., Amaral, A. R., Catarino, M. L., Arêde, A., & Ferreira, M. B. (2024). Financial scarcity and cognitive performance: A meta-analysis. *Journal of Economic Psychology, 101*, Article 102702. https://doi.org/10.1016/j.joep.2024.102702

de Bruijn, E.-J., & Antonides, G. (2021). Poverty and economic decision making: A review of scarcity theory. *Theory and Decision*. https://doi.org/10.1007/s11238-021-09802-7. Advance online publication.

Deck, C., & Jahedi, S. (2015). The effect of cognitive load on economic decision making: A survey and new experiments. *European Economic Review, 78*, 97–119. https://doi.org/10.1016/j.euroecorev.2015.05.004

Duggan, J. E., Gillingham, R., & Greenlees, J. S. (2007). Mortality and lifetime income: evidence from US social security records (Working paper No. 7/15). International Monetary Fund. Retrieved from: https://www.imf.org/~/media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2007/_wp0715.ashx.

Fawcett, T. W., McNamara, J. M., & Houston, A. I. (2012). When is it adaptive to be patient? A general framework for evaluating delayed rewards. *Behavioural Processes, 89*(2), 128–136. https://doi.org/10.1016/j.beproc.2011.08.015

Freese, M., & Bekebrede, G. (2025). Game research by design in project management and beyond. *Project Leadership and Society, 6*, Article 100174. https://doi.org/10.1016/j.plas.2024.100174

Göllner, L. M., Ballhausen, N., Kliegel, M., & Forstmeier, S. (2018). Delay of gratification, delay discounting and their associations with age, episodic future thinking, and future time perspective. *Frontiers in Psychology, 8*, Article 2304. https://doi.org/10.3389/fpsyg.2017.02304

Gonçalves, Duarte. (2024). Speed, Accuracy, and Complexity. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4762650

González-Jiménez, V. H. (2024). Poverty and uncertainty attitudes. Tinbergen Institute Discussion Paper No. TI 2024–058/I.

Griskevicius, V., Tybur, J. M., Delton, A. W., & Robertson, T. E. (2011). The influence of mortality and socioeconomic status on risk and delayed rewards: A life history theory approach. *Journal of Personality and Social Psychology, 100*(6), 1015–1026. https://doi.org/10.1037/a0022403

Haans, R. F. J., Pieters, C., & He, Z.-L. (2016). Thinking about U: Theorizing and testing U- and inverted U-shaped relationships in strategy research. *Strategic Management Journal, 37*(7), 1174–1195. https://doi.org/10.1002/smj.2399

Haushofer, J., & Fehr, E. (2014). About the psychology of poverty. *Science, 344*, 862–867. https://doi.org/10.1126/science.1232491

Hilbert, L. P., Noordewier, M. K., & van Dijk, W. W. (2022). Financial scarcity increases discounting of gains and losses: Experimental evidence from a household task. *Journal of Economic Psychology, 92*, 102546.

Keren, G., & Roelofsma, P. (1995). Immediacy and certainty in intertemporal choice. *Organizational Behavior and Human Decision Processes, 63*(3), 287–297. https://doi.org/10.1006/obhd.1995.1073

Kidd, C., Palmeri, H., & Aslin, R. N. (2013). Rational snacking: Young children'sdecision-making on the marshmallow task is moderated by beliefs aboutenvironmental reliability. *Cognition, 126*(1), 109–114. https://doi.org/10.1016/j.cognition.2012.08.004

Kim, J., Sorhaindo, B., & Garman, E. T. (2006). Relationship between financial stress and workplace absenteeism of credit counseling clients. *Journal of Family and Economic Issues, 27*(3), 458–478. https://doi.org/10.1007/s10834-006-9024-9

Knight, F. H. (1921). *Risk, uncertainty and profit*. Houghton Mifflin.

Lachman, M. E., & Weaver, S. L. (1998). The sense of control as a moderator of social class differences in health and well-being. *Journal of Personality and Social Psychology, 74*(3), 763–773. https://doi.org/10.1037/0022-3514.74.3.763

Lempert, K. M., Carballeira, C., Sehgal, S., & Kable, J. W. (2023). Pupillometric evidence for a temporal expectations-based account of persistence under temporal uncertainty. *Cognitive, Affective, & Behavioral Neuroscience, 23*(3), 705–717. https://doi.org/10.3758/s13415-023-01100-9

Lempert, K. M., Johnson, E., & Phelps, E. A. (2016). Emotional arousal predicts intertemporal choice. *Emotion, 16*(5), 647–656. https://doi.org/10.1037/emo0000168

Lempert, K. M., McGuire, J. T., Hazeltine, D. B., Phelps, E. A., & Kable, J. W. (2018). The effects of acute stress on the calibration of persistence. *Neurobiology of Stress, 8*, Article 100147. https://doi.org/10.1016/j.ynstr.2017.11.001

Lewis, O. (1966). The culture of poverty. *Scientific American, 215*(4), 19–25.

Li, C. (2017). Are the poor worse at dealing with ambiguity? *Journal of Risk and Uncertainty, 54*(3), 239–268. https://doi.org/10.1007/s11166-017-9262-2

Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational Behavior and Human Decision Processes, 69*(2), 149–163. https://doi.org/10.1006/obhd.1997.2679

Looyestyn, J., Kernot, J., Boshoff, K., Ryan, J., Edney, S., & Maher, C. (2017). Does gamification increase engagement with online programs? A systematic review. *PLoS ONE, 12*(3), Article e0173403. https://doi.org/10.1371/journal.pone.0173403

Luhmann, C. C., Ishida, K., & Hajcak, G. (2011). Intolerance of uncertainty and decisions about delayed, probabilistic rewards. *Behavior Therapy, 42*(3), 378–386. https://doi.org/10.1016/j.beth.2010.09.002

Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. *Science, 341*(6149), 976–980. https://doi.org/10.1126/science.1238041

Mazzotta, M. J., & Opaluch, J. J. (1995). Decision making when choices are complex: A test of Heiner's hypothesis. *Land Economics, 71*(4), 500–515. https://doi.org/10.2307/3146714

McGuire, J. T., & Kable, J. W. (2012). Decision makers calibrate behavioral persistence on the basis of time-interval experience. *Cognition, 124*(2), 216–226. https://doi.org/10.1016/j.cognition.2012.03.016

McGuire, J. T., & Kable, J. W. (2013). Rational temporal predictions can underlie apparent failures to delay gratification. *Psychological Review, 120*(2), 395–410. https://doi.org/10.1037/a0031910

McGuire, J. T., & Kable, J. W. (2015). Medial prefrontal cortical activity reflects dynamic re-evaluation during voluntary persistence. *Nature Neuroscience, 18*(5), 760–766. https://doi.org/10.1038/nn.3994

Mendel, D. (2005). Double jeopardy: Why the poor pay more. The Annie E. Casey Foundation.

Michaelson, L., de la Vega, A., Chatham, C. H., & Munakata, Y. (2013). Delaying gratification depends on social trust. *Frontiers in Psychology, 4*, Article 355. https://doi.org/10.3389/fpsyg.2013.00355

Milkman, K. L. (2012). Unsure what the future will bring? You may overindulge: Uncertainty increases the appeal of wants over shoulds. *Organizational Behavior and Human Decision Processes, 119*(2), 163–176.

Mischel, W., Ebbesen, E. B., & Raskoff Zeiss, A. (1972). Cognitive and attentionalmechanisms in delay of gratification. *Journal of Personality and SocialPsychology, 21*(2), 204–218. https://doi.org/10.1037/h0032198

Mode, N. A., Evans, M. K., & Zonderman, A. B. (2016). Race, neighborhood economic status, income inequality and mortality. *PLoS ONE, 11*(5), Article e0154535. https://doi.org/10.1371/journal.pone.0154535

Moffett, L., Flannagan, C., & Shah, P. (2020). The influence of environmentalreliability in the marshmallow task: An extension study. *Journal ofExperimental Child Psychology, 194*, Article 104821. https://doi.org/10.1016/j.jecp.2020.104821

Morton, J. M. (2017). Reasoning under scarcity. *Australasian Journal of Philosophy, 95*(3), 543–559. https://doi.org/10.1080/00048402.2016.1236139

Morton, J. M. (2022). Resisting pessimism traps: The limits of believing in oneself. *Philosophy and Phenomenological Research, 104*(3), 728–746. https://doi.org/10.1111/phpr.12818

Mullainathan, S., & Shafir, E. (2013). *Scarcity: Why having too little means so much.* Times Books/Henry Holt and Co.

Platt, M., & Huettel, S. (2008). Risky business: The neuroeconomics of decision making under uncertainty. *Nature Neuroscience, 11*, 398–403. https://doi.org/10.1038/nn2062

Schilbach, F., Schofield, H., & Mullainathan, S. (2016). The psychological lives of the poor. *American Economic Review, 106*(5), 435–440.

Shah, A. K., Mullainathan, S., & Shafir, E. (2012). Some consequences of having too little. *Science, 338*(6107), 682–685. https://doi.org/10.1126/science.1222426

Shah, A. K., Mullainathan, S., & Shafir, E. (2019). An exercise in self-replication: Replicating Shah, Mullainathan, and Shafir (2012). *Journal of Economic Psychology, 75*, 102127.

Sharma, D. K., & Ranjan, S. (2021). Behavioral Finance for Financial Acumen. In G. Singh, H. Singh Dhanny, V. Garg, & S. Sharma (Eds.), *Financial Intelligence in Human Resources Management: New Directions and Applications for Industry 4.0* (Chapter 7). Apple Academic Press. https://doi.org/10.1201/9781003083870-7

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive andself-regulatory competencies from preschool delay of gratification: Identifyingdiagnostic conditions. *Developmental Psychology, 26*(6), 978–986. https://doi.org/10.1037/0012-1649.26.6.978

Singh, G. K., & Siahpush, M. (2006). Widening socioeconomic inequalities in US life expectancy, 1980–2000. *International Journal of Epidemiology, 35*(4), 969–979. https://doi.org/10.1093/ije/dyl083

Sniazhko, S. (2019). Uncertainty in decision-making: A review of the international business literature. *Cogent Business & Management, 6*(1), Article 1650692. https://doi.org/10.1080/23311975.2019.1650692

Starcke, K., & Brand, M. (2016). Effects of stress on decisions under uncertainty: A meta-analysis. *Psychological Bulletin, 142*(9), 909–933. https://doi.org/10.1037/BUL0000060

Stevens, J. R. (2017). Intertemporal choice and delayed gratification. In J. Call, G. M. Burghardt, I. M. Pepperberg, C. T. Snowdon, & T. Zentall (Eds.), *APA handbook of comparative psychology: Perception, learning, and cognition* (pp 35–552). American Psychological Association. https://doi.org/10.1037/0000012-024

Thibault Landry, A., Papachristopoulos, K., Gradito Dubord, M. A., & Forest, J. (2022). Here's some money, your work's so worthy? A brief report on the validation of the functional meaning of cash rewards scale. *Frontiers in Psychology, 13*, Article 821501. https://doi.org/10.3389/fpsyg.2022.821501

Wang, L., Zheng, J., Huang, S., & Sun, H. (2015). P300 and decision making under risk and ambiguity. *Computational Intelligence and Neuroscience*, *2015*, 108417. https://doi.org/10.1155/2015/108417

Wooten, T. (2024). Effort traps: Socially structured striving and the reproduction of disadvantage. *The American Journal of Sociology, 130*(2), 344–383.

Yu, L., Gao, J., Kong, Y., & Huang, L. (2023). Impact of perceived scarcity on delay of gratification: meditation effects of self-efficacy and self-control. Current psychology (New Brunswick, N.J.), 1–9. Advance online publication. https://doi.org/10.1007/s12144-023-04455-x