Efficient Institutions and Effective Deterrence: On Timing and Uncertainty of Punishment

Johannes Buckenmaier
University of Zurich

Eugen Dimant*
University of Pennsylvania

Ann-Christin Posten
University of Cologne

Ulrich Schmidt
Kiel Institute for the World Economy

Abstract

This paper presents the first controlled economic experiment to study *celerity*, i.e. the effectiveness of swiftness of punishment in reducing illicit behavior. We consider two dimensions: timing of punishment and timing of the resolution of uncertainty regarding the punishment. We find a surprising u-shaped relation between deterrence and the delays of punishment and uncertainty resolution. Institutions that either reveal detection and impose punishment immediately or maintain uncertainty about the state of detection and impose punishment sufficiently late are equally effective at deterring illicit behavior. Our results yield strong implications for the design of institutional policies to mitigate misconduct and reduce recidivism.

Keywords: Deterrence; Institutions; Punishment; Swiftness; Uncertainty
JEL: C91, D02, D81, K42

1 Introduction

Governments all over the world use substantial resources to keep society safe and punish people for criminal acts. Annually, mass incarceration costs amount to approximately $182 billion in the US (Wagner and Rabuy, 2017). Thus, it is hardly surprising that

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[*] E-Mail of corresponding author: edimant@sas.upenn.edu. We would like to thank Dan Ariely, Gary Bolton, Christoph Engel, Catherine Eckel, Simon Gächter, Kyle Hyndman and David Rand for helpful remarks and input. We are also indebted to Gary Charness for comprehensive input on an earlier version of our experimental design. Comments at workshops and conferences, most notably the CESifo Venice Summer Institute 2016, the Norms, Actions Games Workshop at the Institute for Advanced Study, the Morality, Incentives and Unethical Behavior Conference at UCSD, the Max Planck Institute for Economics, the London School of Economics (Behavioral Science Hub), Yale University (Human Cooperation Laboratory), University of Pennsylvania (Solomon Laboratories of Experimental Psychology), and the Institute for the World Economy are greatly appreciated. Generous financial support through the Edmond J. Safra Center for Ethics at Harvard University and the Heinz Sauermann Award by the German Society for Experimental Economic Research (GfeW) is acknowledged.

This version August 21, 2018.

extensive research has been done to understand the determinants of deviant behavior and shed light on alternative deterrence mechanisms. Existing economic literature not only stresses the relevance of institutional environments in shaping prosperity and growth (La Porta et al., 1999; Acemoglu et al., 2005), but also their importance in effectively deterring criminal and immoral behavior in ways that include staff rotations in public administration, whistleblower protection, and changes in punishment regimes (Shleifer and Vishny, 1993; Abbink, 2004; Abbink et al., 2014; Engel et al., 2016; Buckenmaier et al., 2018).

Understanding the mechanisms underlying deterrence of deviant behavior yields important policy implications. Over the past decades, a vast literature on criminal deterrence has focused on the relevance of the certainty and severity of punishment in deterring deviant behavior (see e.g. Becker, 1968; Baker et al., 2004; DeAngelo and Charness, 2012; for a recent review of economic research, see Chalfin and McCrary, 2017, and for a cross-disciplinary discussion of experimental work, see Engel, 2016). However, the swiftness of punishment (often referred to as *celerity*), frequently mentioned alongside certainty and severity (Bailey, 1980; Howe and Brandau, 1988; Yu, 1994; Nagin and Pogarsky, 2001, 2004), has been under-researched in the economics literature. The concept of celerity has its scholarly roots in the writings of Bentham and Beccaria, representing a fundamental component in deterrence theory and has been referred to as the 'neglected middle child of the deterrence family' (Pratt and Turanovic, 2018).

Given the high costs involved in increasing punishment's certainty (e.g. costs for an executive body) or punishment's severity (e.g. incarceration costs), we argue that the timing of punishment as well as the timing at which individuals are informed about the consequences, that is, their delay with respect to the transgression in question, can potentially serve as a powerful tool for deterrence that is often available at a relatively low cost. Classically, celerity referred exclusively to the temporal delay of a potential sanction following a transgression. In this paper, we adopt a wider definition of celerity, using it as a catch-all phrase for the timing of the various facets of a deterrence mechanism (Pratt and Turanovic, 2018). In particular, we distinguish between the delay of punishment and the timing of the resolution of uncertainty regarding the punishment.

The goal of this paper is to experimentally study the role of timing and uncertainty in the context of institutional deterrence mechanisms. In particular, we are interested in how the timing of sanctions (be it conviction or sentencing) and the timing of the resolution of uncertainty surrounding these sanctioning mechanisms affects deterrence. We systematically vary the celerity of a sanction within a new, stylized, experimental paradigm along the following two dimensions: first, we vary the delay between offense and detection/conviction; second, we vary the delay between offense and sanctioning. Our main objective is to shed light on the link between the efficiency of institutions and swift punishment, which is, in our opinion, an important dimension of most deterrence mechanisms that has received surprisingly little attention in previous literature. We argue that celerity could potentially serve as a useful tool for policy makers to design more efficient and/or less expensive institutional deterrence mechanisms. However, delayed punishment is not necessarily less deterrent (due to discounting) if utility from anticipation is taken into account. Additionally, we study the role of the timing of resolution of uncertainty by varying the point in time when the information about whether or not a transgression was detected is revealed to subjects.

More generally, from an aggregate perspective, the speed of justice matters because it facilitates economic development and market efficiency (North, 1991; Djankov et al., 2008; Ponticelli and Alencar, 2016). Recent empirical results evaluating the impact of legal reform to increase judiciary adjudication in Senegal find an increase in procedural efficiency without any adverse effects on quality (Kondylis and Stein, 2018). From an individual perspective, research in psychology and neuroscience argues that timing affects the association formed in one's mind between the deviant act and the ultimate punishment: without proper swiftness, sanctions risk to lose their bite, regardless of how certain or severe they are – a fact prominently argued a long time ago (Watson, 1924).

In reality, the closest we can get to achieving maximal celerity of punishment is by catching deviants in the act and punishing them right away. Exemplary, during the FIFA World Cup 2010 in South Africa, the local government agreed to establish 56 so-called 'World Cup Courts' across the country, assigning 1,500 dedicated personnel including magistrates, prosecutors, and public defenders. This was done to achieve speedy justice, in some cases leading to convictions on the same day.[1] Recently, the concept of celerity has entered the correctional arena through the project HOPE (Hawaii Opportunity Probation with Enforcement) as a new model for probation. "In 2004, First Circuit Judge Steven Alm launched a pilot program to reduce probation violations by drug offenders and others at high risk of recidivism. This high-intensity supervision program, called HOPE Probation [...], is the first and only of its kind in the nation. Probationers in HOPE Probation receive swift, predictable, and immediate sanctions – typically resulting in several days in jail – for each detected violation, such as detected drug use or missed appointments with a probation officer." (Alm, 2014). In a first pilot, the project was found to reduce drug use, crime, and incarceration, and simultaneously save the government approximately $6,000 per participant per year through reduced

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[1] https://www.theguardian.com/football/2010/jun/20/world-cup-2010-fans-marketing-justice-fifa

incarceration (Hawken and Kleiman, 2009).[2]

The existing line of research, both in psychology and criminology, has often relied on studying celerity in the field and has acknowledged mixed findings (for a discussion, see Pratt and Turanovic, 2018). However, as recognized by this stream of literature as well, the common absence of reliable observational data and the ability to account for potentially confounding influences (i.e., perceived or actual certainty or severity of punishment) render the study of celerity methodologically challenging. We follow the recent surge of experimental economists studying related topics, such as corruption or tax evasion (Abbink, 2006), in controlled laboratory environments.

Our experimental analysis is based on a simple cheating game where subjects may cheat in some periods to increase payoffs. After these periods there is an investigation such that cheaters will be detected and fined with a given probability. In different treatments, we vary both the timing of the potential fine as well as the timing of the resolution of uncertainty, i.e. when the participants learn the results of the investigation. We analyze behavior alongside two dimensions: total propensity to cheat and recidivism (cheating conditional on having cheated at least once before). Our results show that delayed resolution of uncertainty has no systematic impact on behavior. With respect to the relation between the delay of punishment and deterrence, we observe an u-shaped relationship where deterrence is lowest for a short delay of punishment and significantly higher for either no delay or a long delay when combined with a late resolution of uncertainty. This result is at odds with discounted expected utility and theories of anticipatory utility, but can be explained by the recent model of Baucells and Bellezza (2016). We conclude that in order to improve deterrence in sanctioning mechanisms, punishment should either be swift or sufficiently delayed and paired with the psychological dread of uncertainty.

The paper is organized as follows. Section 2 details our experimental design and procedures. Section 3 discusses theoretical predictions on the relation between celerity and deterrence in our setup. Results are presented in Section 4. The final section discusses our results and derives some conclusions.

2 Relevant Literature

Standard theories produce conflicting results with respect to the role of timing, as studied in our paper, on deterrence. The classic theoretical approach towards the deterrence

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[2] Though its overall effectiveness has been contested and requires more empirical testing (for a recent discussion and critical review of literature, see Doleac, 2018).

of criminal activity (e.g. Becker, 1968) is based on the assumption that potential offenders mainly weigh the expected gains against the expected adverse consequences of an offense. This poses an intertemporal decision problem under uncertainty: the benefits of criminal behavior are usually immediate, whereas any proceeding detection, conviction, and implementation of legal consequences are generally delayed and stochastic. In the standard framework of discounted expected utility, delayed punishment should reduce deterrence due to a discounting effect, whereas the timing of resolution of uncertainty should have no effect on behavior.

However, it has been argued that the uncertainty associated with anticipatory emotions negatively affects intentions (Bee and Madrigal, 2013). Psychological learning theories (Skinner, 1963; Tversky and Kahneman, 1986; Ehrlich, 1996; Hackenberg, 2009) second the argument that the time between a transgression and the punishment as well as the uncertainty that is associated with the punishment are driving forces for effective behavioral changes. If this is indeed the case, then the classical interpretation of celerity as the time between committing an offense and the actual punishment (e.g. fine or imprisonment) should be complemented by the time the uncertainty is resolved, that is, the time of sentencing.

Starting with the seminal paper of Loewenstein (1987), several theories propose that anticipation of future events is an important determinant of intertemporal utility (see e.g., Wu, 1999; Lovallo and Kahneman, 2000; Caplin and Leahy, 2001; Dillenberger, 2010; Strzalecki, 2013; Golman and Loewenstein, 2015). These models are based on the idea that a non-negligible proportion of the overall consequences from future consumption (be it negative or positive) is already consumed in the form of so-called anticipatory utility before actual consumption takes place. As a consequence, resolution of uncertainty may affect deterrence and the effect of delayed punishment may be reverted leading to an increase in deterrence. Recently, Baucells and Bellezza (2016) extended anticipatory utility by a reference point, a utility of recall and a magnitude effect in discounting. Their model allows to derive the optimal duration of anticipation for a given event, which might be interior. In our context, this potentially gives rise to a u-shaped relationship between delay of punishment and deterrence. While there is growing theoretical literature supporting anticipatory utility theory and its implications, there is little empirical work being done and even less experimental investigation.[3]

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[3] Two recent exceptions are Falk and Zimmermann (2016), who experimentally tested the implications of anticipatory utility in the context of information preferences and Kogler et al. (2016), who showed that delayed resolution of a tax audit results in higher tax compliance.

3 Experimental Design

Different theories come to different conclusions regarding the implications of the timing of a sanction on deterrence (see Section 3.4 for details). Clearly this is an important point that has to be taken into consideration for the design of legal institutions. A systematic study of the role of celerity for deterrence poses a serious empirical challenge, because changing the celerity of an enforcement mechanism would most likely impact existing institutional structures on multiple levels. For that reason, isolating the impact of such an intervention is hardly possible in the field. In addition, it is unclear whether an actual or would-be offender is aware of this change or not, making identification almost impossible. Thus, a systematic study of celerity calls for a highly controlled environment that allows for the isolation of the direct effect of institutional changes varying celerity on behavior. Fortunately, the experimental laboratory provides such a controlled environment.

3.1 The Card Game

We use a simple card game, in which subjects have to guess which card was drawn from a deck of cards. The game is played repeatedly by our subjects for a total of 28 rounds. In certain rounds subjects are presented with the option to "cheat." Cheating guarantees them the maximum possible payoff for that round. Our goal was to design a simple task where the option to cheat was auxiliary, that is, we wanted the task to be easy-to-understand, but meaningful regardless of whether or not the option to cheat was presented. Specifically, we wanted to make sure that cheating was not considered part of the game, but a clear violation of said game's rules. In the game, a card that is randomly drawn from a full deck of 32 cards and subjects have to guess which card was drawn. A subject received 10 Experimental Currency Units (ECU) for a correct guess and 4 ECU for an incorrect guess. In some rounds, participants are given the option to cheat. By cheating, participants are allowed to uncover the randomly drawn card before making one's guess, ensuring a correct answer and the maximum payoff of 10 ECU less a possible fine if detected.[4] Participants were informed that each instance of cheating would be followed by an "investigation" that would detect cheating with a fixed probability of 25%. Hence, cheating exposes them to the risk of being caught and fined.

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[4] When subjects decide to cheat, we automatically implement the "right guess" for them. Subjects are informed about this procedure in the instructions. We implement this forced guess to avoid "second thoughts" where a subject cheats, views the drawn card, but chooses a different card.

If caught, the consequences in the form of punishment are two-fold. First, the subject has to pay a fine of 10 ECU. Second, the subject is suspended from the game for one round, is not allowed to make any decision, and cannot earn any ECU. Consequently, cheating yields an expected payoff of about 6.5 ECU in that round, whereas the expected payoff of not cheating is about 4.2 ECU. Furthermore, suspended participants are forced to wait 60 seconds before they are allowed to continue in the next period. We deliberately chose suspension as part of the sanctioning mechanism to increase salience with regard to the timing of sanctions.[5] While one might argue that a delayed fine in a laboratory context where all "actual" payments are realized at the very end of the experiment decreases the result's robustness, such concerns do not apply to the suspension as it is clearly linked to the particular round a subject is suspended.

In order to make the moral dimension of cheating more salient in our laboratory context we introduce a third party, represented by a charity, that incurs a monetary damage as a result of cheating. Specifically, for each experimental session, there is a charity pool of 250 ECU (worth $25) from which 50 ECU is deducted each time a particular subject decides to cheat. At the end of the experiment, one subject is randomly selected. This subject's behavior is implemented towards the charity and the remainder is donated to "Doctors without Borders."

3.2 Treatments

In our experiment, we vary the timing along the following two dimensions: the timing of punishment and the timing of the resolution of uncertainty. Punishment is either immediate, delayed by 2 rounds, or delayed by 4 rounds. In addition, the resolution of uncertainty regarding whether cheating is detected (and hence whether there are sanctions) is either immediate or delayed by two periods. To ensure that later cheating decisions are not affected by unresolved risk, each cheating decision was followed by five rounds without cheating.[6]

All treatments consist of 28 rounds: 4 training rounds followed by 4 blocks of 6 rounds each. In the first 4 rounds participants play the card game without cheating to familiarize themselves with the game and the interface. In the first round of each block,

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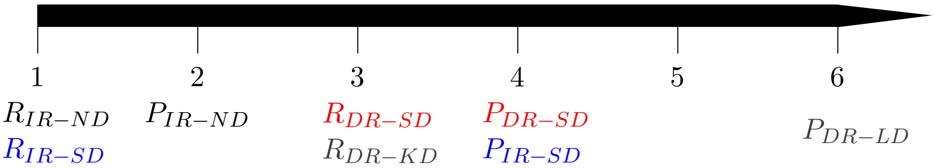
[5] Existing research in psychology indicates that delay typically renders the impact of punishment less effective as the connection between the deviant act and the resulting punishment gets lost. Hence, in order to retain effectiveness, any minuscule delay of punishment must come with a clear verbal/cognitive component. For a discussion, see Pratt and Turanovic (2018).

[6] For each subject, there were exactly four cheating opportunities, that is, in rounds 5, 11, 17, and 23, subjects were given the opportunity to cheat. Subjects were told that, "occasionally," they will be presented with the option to cheat, but they were informed about the exact timing and frequency of the occurrence of this option.

subjects can cheat. In the remaining rounds of a block (rounds 2-6), they play the card game without the option to cheat. Using blocks of 6 rounds allows us to vary both the timing of the resolution of uncertainty, as well as the timing of punishment without an overlap with subsequent cheating decisions.

Table 1: Overview of timing of resolution of uncertainty and punishment in the different treatments.

Treatment	Timing of resolution of uncertainty	Timing of punishment
IR-ND	immediate	no delay
IR-SD	immediate	short delay (2 rounds)
DR-SD	delayed (2 rounds)	short delay (2 rounds)
DR-LD	delayed (2 rounds)	long delay (4 rounds)



Note: In the timeline P and R indicate the timing of resolution of uncertainty and timing of punishment for *IR-ND*, *IR-SD*, *DR-SD*, and *DR-LD*, respectively.

Table 1 summarizes the four treatments. In treatment *IR-ND*, we have immediate resolution of uncertainty and no delay of punishment. Subjects receive immediate feedback within the same round about whether cheating was detected and there is no delay in punishment. That is, the fine (if due) is deducted and a potential suspension is implemented immediately for the next period.[7] In treatment *IR-SD*, resolution of uncertainty is again immediate, but now there is a short delay in punishment of two periods; when cheating in period t, the uncertainty will be resolved immediately, but the potential fine and suspension are executed only in period $t + 3$ (as opposed to $t + 1$ in *IR-ND*). We will also refer to *IR-SD* as immediate resolution of uncertainty and short delay of punishment. In treatment *DR-SD*, the investigation into cheating does not conclude immediately, but lasts for two additional periods. Only after that is the participant informed about whether his cheating was detected or not. As in *IR-SD*, there is a short delay of punishment. We hence refer to *DR-SD* as delayed resolution of uncertainty and short delay of punishment. Finally, in treatment *DR-LD*, resolution is again delayed, but now punishment is delayed for four periods rather than two. That is, cheating in period t results in resolution of uncertainty in period $t + 2$, followed by the actual punishment

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[7] Clearly, punishment cannot precede the resolution of uncertainty which determines whether a subject was detected and hence will have to face a punishment.

(if due) in period $t + 5$.

3.3 Experimental Procedures

We conducted 32 experimental sessions at the Decision Science Lab at Harvard University. Participants were recruited vie e-mail invitation from the laboratory's database which contains students as well as non-students. A total of 296 subjects (out of which 46.6% were males) participated in the experiment split between treatments as follows: 66 subjects in *IR-ND*, 85 subjects in *IR-SD*, 69 subjects in *DR-SD* and 76 subjects in *DR-LD*. The experiment was programmed and run using z-Tree (Fischbacher, 2007).[8] Within each session, participants were randomly assigned to a computer booth in which they would participate in the experiment anonymously. The consent forms and instructions for the corresponding treatment were distributed.[9] Upon agreeing to the informed consent page, the participants were given sufficient time to read the instructions carefully. Before the start of the experiment, subjects had to answer a series of comprehension questions in order to check their understanding of the game and its payoff structure. Subjects then played 28 periods after which they were informed of their total earnings via a detailed summary screen. One subject was randomly drawn to determine the charity pool and all participants were informed about the final amount left in the pool to be donated to "Doctors without Borders."[10] At the end of the experiment, subjects completed a questionnaire containing questions on personal characteristics (demographics, education, income, age), risk-attitudes (SOEP), consideration of future consequences (Strathman et al., 1994) and self-control (Tangney et al., 2004).

Sessions lasted approximately 45 minutes excluding the time for payment. A participant's payoff was determined by the sum of his earnings over all 28 rounds. The total payoff in ECU was then converted to dollars at a rate of 10 ECU = \$1. The average payment was \$14.29, which includes a show-up payment of \$2.50.

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[8] It is worth noting that we observed an influx of disproportionately older participants due to a bug in the recruitment software in our first sessions. This was quickly resolved. Participants of 41 years and older represent around 11% of our data set. Unless noted otherwise, our results are robust with respect to this subgroup.

[9] The original instructions are provided in Appendix A.

[10] Prior to the experiment subjects received a short description of the work of "Doctors Without Borders", helping us to enforce a minimal level of common knowledge to increase salience of pro-sociality. A receipt of the amount actually donated was made available to all participants via email.

3.4 Theoretical Predictions: A Benchmark

In this section, we illustrate how deterrence could be affected by our two main treatment variables, the delay of punishment and the timing of resolution of uncertainty, in light of existing theories of intertemporal decision making. There are several prominent economic theories of intertemporal decision making. We will focus on three such theories that are particularly important for our setting with the intent of using their predictions as a benchmark. We consider discounted expected utility theory (DEU), utility from anticipated emotions (UAE), and the anticipation-event-recall model (AER), in that order. At this point we will only argue intuitively how each theory gives rise to its specific predictions and delegate the formal derivation to Appendix A.

Theories of temporal discounting suggest that future costs or benefits receive a lower weight than immediate ones; this weight decreases as one moves further into the future (Frederick et al., 2002). Consider a standard DEU model with discount factor $0 < \delta < 1$ and for simplicity, restrict attention to a single block of six periods involving one cheating opportunity. Note that in this model, the timing of the resolution of uncertainty does not affect utility. Further, note that only the utility generated from cheating differs across treatments and this utility is larger the more the punishment is delayed. Hence, if a potential offender discounts delayed legal consequences, then deterrence decreases the longer the delay. As a consequence, higher celerity (less delay) would increase the efficiency of legal sanctions, which is the classical hypothesis in criminology literature (Nagin and Pogarsky, 2004; Paternoster, 2010). Thus DEU yields the following predictions for our treatments.

Prediction 1 (DEU)**.** According to DEU, the efficacy of deterrence decreases as the delay of punishment increases, independent of the timing of resolution of uncertainty. In particular, the point in time where the uncertainty is resolved has no effect on deterrence.

Empirically, this prediction has to be taken with some caution. Gains are usually discounted with a positive rate, making earlier gains more attractive than delayed ones. Fines are, however, losses and the evidence for discounting of losses is rather mixed. While studies consistently show that losses are discounted less than gains, it is unclear whether the discount rate for losses is positive as for gains, equal to zero, or even negative (Thaler, 1981; Loewenstein, 1987; MacKeigan et al., 1993). Due to this ambiguity, we aim to minimize the effect of discounting in our design, which poses an additional advantage over the field settings in which the role of celerity has been previously studied and has produced mixed findings. All earnings are paid at the end of the experiment without any additional delay.

Second, theories of anticipatory utility incorporate anticipatory feelings such as excitement, fear or dread into classical expected utility theory. DEU fails to take such considerations into account. These theories suggest that one might want to bring forward an unpleasant event to shorten the period of dread (or delay a positive event to enjoy the excitement for a longer period of time). The idea is that future events influence current utility. More precisely, negative future events cause more negative utility today the further away the event is (at least up to a certain point). If this effect outweighs the discounting effect described above, then a further delay increases deterrence due to negative utility from anticipation.

Prediction 2 (UAE)**.** Under UAE, for a fixed timing of resolution of uncertainty, deterrence is increasing in the delay of punishment if the effect of anticipation is sufficiently high.

Anticipated emotions in Loewenstein's model refer to future consumption under certainty. Caplin and Leahy (2001) extend this model by allowing for uncertainty and point toward the importance of anticipatory feelings prior to the resolution of uncertainty. Anticipatory emotions, such as anxiety, are often predicated on an uncertain future and, thus, are mainly relevant prior to the resolution of uncertainty. As a consequence, the point in time at which uncertainty is resolved matters. For example, Kreps and Porteus (1978) and Kocher et al. (2014) show that preferences over temporal lotteries also depend on the point in time when the uncertainty is resolved. That is, agents can show a preference for earlier or delayed resolution of uncertainty. Caplin and Leahy (2001) argue that anxiety experienced one period before the resolution of uncertainty should depend on both, the detection probability and the severity of the punishment. Typically, this anxiety, if large enough, leads to a preference for early resolution of uncertainty for negative outcomes. That is, if the effect of anxiety experienced just before the resolution of uncertainty is large enough, a decision-maker discounting future events will prefer to resolve this uncertainty as late as possible to minimize the impact of anxiety.

Prediction 3 (UAE)**.** If anxiety prior to the resolution of uncertainty is large enough, then under UAE, delayed resolution of uncertainty increases deterrence holding the delay of punishment fixed.

A delay of the resolution of uncertainty cannot be accomplished without a delay in punishment, as punishment cannot precede its resolution. Given that the effect of anticipation and anxiety are large enough, the combined effect of delayed resolution and delayed punishment can be grasped by comparing for example *DR-SD* to *IR-ND*.

The combination of Prediction 2 and 3 leads to an increase in deterrence when the delay of both punishment and resolution is increased. Summarizing, UAE predicts a positive effect of delayed punishment on cheating, in contrast to DEU. Additionally, delayed resolution of uncertainty may matter under UAE, potentially further increasing deterrence.

Recently, Baucells and Bellezza (2016) proposed a new theory of intertemporal decision making. They extend the existing models of anticipatory utility by a reference point that adjusts. It does so during the anticipation phase by altering a utility of recall in the periods succeeding the consumption and changing the magnitude effect in discounting. According to this theory, it is possible that the utility maximizing timing of an unpleasant event is somewhere in the middle of the time horizon, i.e. fines in earlier or later periods hurt more and should, therefore, lead to higher deterrence. While both DEU and UAE predict a monotonic effect as a result of an increase in the delay of punishment, this theory allows for the possibility that deterrence is highest for an intermediate delay. Intuitively, DEU suggests that potential offenders would prefer to delay their punishments to the indefinite future, whereas UAE implies to get ones punishment over with as quickly as possible. In contrast, the AER model accounts for the possibility that there is a positive but finite duration of anticipation that makes a negative future event the least dreadful. This is possible if there is a large enough magnitude effect in discounting, that is, the smaller the magnitude of the event, the smaller the discount factor. In this case, some anticipation has the positive effect of lowering discount rates for recall. Anticipation reduces the magnitude of the event, since there is more time to adapt one's reference point, which in turn decreases the impact of the negative outcome.

Prediction 4 (AER)**.** If there is a strong enough magnitude effect in discounting, then AER is compatible with an u-shaped relation between delay of punishment and deterrence, in particular it allows for a non-monotonic relationship.

4 Results

Here, we present our results using parametric and non-parametric comparisons,[11] as well as various regression models to analyze differences in cheating behavior. Please note that not only the number of cheating opportunities (4) were the same in all treatments, but

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[11] We follow Moffatt (2015) and employ the bootstrap two-sample t-test method (hereafter BSM) with 9999 replications to analyze mean differences of average return behavior. This has the advantage that we can retain the rich cardinal information in the data without making any assumptions about the distribution. Unless noted otherwise, the use of non-parametric Mann-Whitney-U (hereafter MWU) tests yields results that are in line with our bootstrap approach.

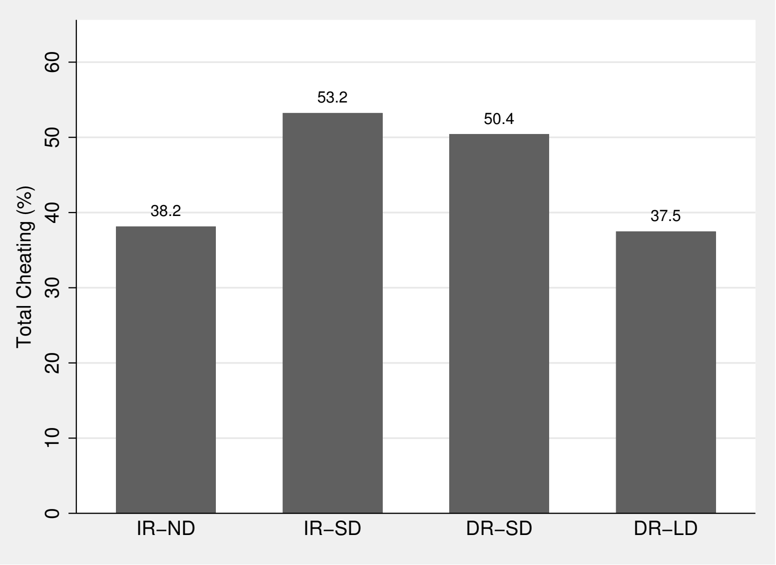

Figure 1: Total Cheating. Percentage of individual cheating attempts relative to the maximum of possible cheating attempts.

also their timing holding the position within the block constant (in the first round of each block). Hence, any difference in behavior can only result from our systematic variation in the timing of punishment and the timing of resolution of uncertainty.

First, we look at the mean differences in total cheating across all treatments. Total cheating is defined as the total number of individual cheating incidences across all rounds. We calculate the percentage as the ratio of actual individual cheating decisions to the maximum possible number of cheating opportunities (4). We present the a graphical illustration in Figure 1 and regression results in Table 2. Results illustrate an interesting inverted U-shape relationship: compared to the IR-SD case (immediate resolution, punishment inflicted with a short delay), cheating is significantly lower in both IR-ND (BSM, 53.2% vs. 38.2%, $p = 0.03$) as well as DR-LD (BSM, 53.2% vs. 37.5%, $p = 0.02$). This result alone indicates that the most deterrent form of punishment is either swift or sufficiently delayed when coupled with a long period of unresolved uncertainty.[12] In comparing our results to the benchmark predictions presented in Section 3.4, we observe only partial alignment with both discounted expected utility theory and utility from anticipated emotions. In turn, our results are more in line with the the anticipation-event-recall model. We discuss the implications in greater detail in the next

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[12] Compared to DR-SD, cheating is marginally lower in both IR-ND (BSM, 50.4% vs. 38.2%, $p = 0.09$) as well as DR-LD (BSM, 50.4% vs. 37.5%, $p = 0.07$). There is no significant difference between IR-SD and DR-SD.

Table 2: Propensity to cheating Using Random Effects Logit Regression

Cheat	model 1		model 2	
IR-ND	0.2964^{**}	(0.1711)	0.5497^{***}	(0.1246)
DR-SD	0.9669	(0.5779)	0.8021	(0.1736)
DR-LD	0.3284^{**}	(0.1821)	0.5397^{***}	(0.1183)
Male	5.7757^{***}	(2.5301)	1.9773^{***}	(0.3259)
Age	0.9400^{***}	(0.0173)	0.9815^{**}	(0.0075)
Round	0.8346^{**}	(0.0656)	0.9685	(0.0762)
GuessCorrect	0.7616	(0.1872)	0.9151	(0.0920)
L.Cheat			8.4476^{***}	(1.9811)
L.Punishment			1.6634^{*}	(0.4461)
Observations	1184		888	

Note: Odds ratios reported. Standard errors in parentheses are clustered at the individual level. $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$. The reference category is IR-SD. Age reflects the participants' age in years. Lagged variables for cheating and punishment are dummies indicating whether an individual cheated or was punished for cheating in the previous round, respectively.

section.

In order to check for robustness, we run a series of regressions to analyze the behavioral motivations that result in cheating and the total amount of cheating that took place. Treating decisions across rounds in panel data fashion, our dependent variable in Table 2 is a dummy variable indicating the decision to cheat in each block.To this end, we use *IR-SD* with a short delay of punishment and no delayed resolution of uncertainty as our reference category. The extended form regressions (column 2) include a battery of relevant covariates (gender, age, number of correct card guesses, experience with punishment from past cheating, previous cheating decision, round dummy).[13]

We capitalize on the panel structure of our data by performing a random effects Logit regression (coefficients represent odds ratios). Our analysis in Table 2 suggests that, relative to a short delay of punishment *IR-SD*, both swifter punishment (IR-ND) as well as more delayed punishment *DR-LD* renders individual cheating decisions significantly less likely. The introduction of delayed uncertainty resolution holding the timing of punishment constant *DR-SD* itself does not significantly affect cheating behavior. A direct comparison of our treatments mirrors this finding, indicating that higher deterrence can be achieved by either implementing swift punishment (*IR-ND*) or through

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[13] We also have measures for risk aversion, awareness of future consequences, self-control, and a participant's previous participation in economic experiments. None of these controls show up significantly and also do not change the significance levels of any of our variables of interest. Hence, we drop them from the regression table in the interest of brevity, but results are available upon request.

the combination of delayed uncertainty resolution and significantly delayed punishment (*DR-LD*). Post-estimation tests yield a marginally significant difference between *DR-SD* and *DR-LD* ($p = 0.058$), and no significant difference between the coefficients of *IR-ND* and *DR-LD* ($p = 0.88$), suggesting that the effectiveness of deterrence is comparable in both cases. All of these results corroborate our previously obtained non-parametric comparisons.

The results also suggest that cheating behavior increases with both past round's cheating behavior and having been caught and punished for cheating. This finding indicates that individuals try to make up for incurred losses by increasing the frequency of cheating and taking larger risks, thus being more risk-seeking in losses. It is worth noting that we observe substantial gender heterogeneity indicating that males cheat significantly more than females, although we do not observe this effect to differ across treatments (interactions between treatment and gender not reflected in the table but available upon request). Additionally, a participant's age is inversely and significantly correlated with one's probability to cheat.[14] This indicates that potential wealth effects cannot explain cheating behavior. All this suggests that swifter punishment or delayed punishment in combination with delayed resolution of uncertainty significantly increases the deterrence of deviant behavior. The delay of uncertainty alone remains ineffective.

We conclude that both very efficient (no delays of punishment) and very inefficient (long delays of punishment in combination with long uncertainty about the status of discovery) punishment institutions are equally effective in deterring deviant behavior.

What is more, one could also plausibly assume the presence of learning effects. A large body of existing literature suggests that the learning effects that emerge through experience are shaped by the timing of rewards and punishments. Due to this, they affect subsequent behavior (cf. Camp et al., 1967; Parke and Deur, 1972). This is of particular importance in the punishment context, because such learning effects would directly speak to the occurrence of recidivism among former felons. Following this logic, the experience of uncertainty and punishment following transgressive behavior could lead to differences in subsequent transgressions. We refer to this as *recidivism.* Recidivism is defined as the propensity to cheat conditional on at least one previous transgression (which can occur at the beginning of any of the first three blocks). The idea behind this measure is to understand whether experiencing the drain of uncertainty of punishment following the first cheating decision will affect the individual's subsequent propensity to cheat. Our results do not indicate that any such learning effect exists. In fact,

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[14] Importantly, the amount of correct guesses in non-cheating rounds, which are the driving force behind potential wealth accumulation in our setting, has no significant predictive power for cheating.

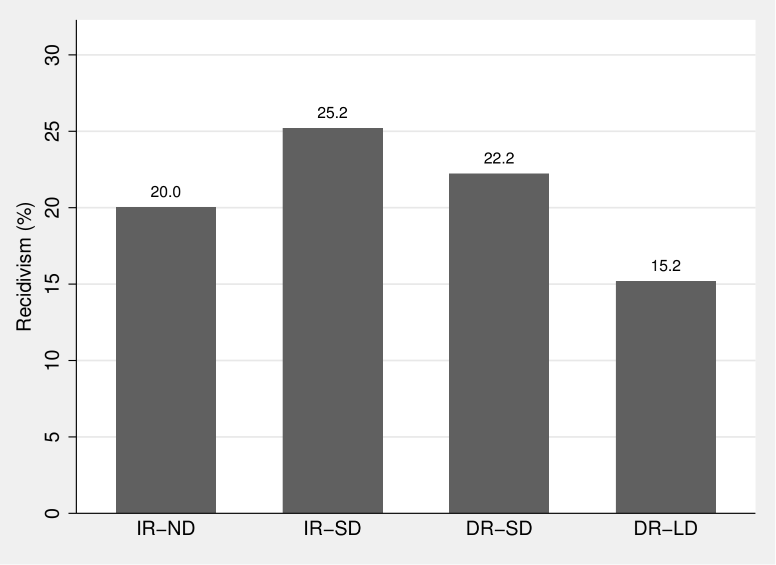

Figure 2: Recidivism. Percentage of individual cheating attempts relative to the maximum of possible cheating attempts following their first cheating decision.

cheating behavior following the experience of uncertainty and punishment is congruent to our previous findings on unconditional cheating behavior. We present a graphical illustration in Figure 2.

In order to shed light on this mechanism, we employ the same estimation approach as previously, but now restrict our sample to observations where participants have cheated at least once before. Our dependent variable of interest continues to be the propensity to cheat in any given period. Through these regressions, reported in Table 3, we look to analyze the propensity to recidivate and continue to cheat.

Our results for recidivism are consistent with our previous findings, suggesting that the recidivism of individuals is lowest when punishment is either immediate or late when paired with uncertainty. The delay of uncertainty alone is ineffective. We again find an inverted u-shape relationship; when combining the long delay of punishment with uncertainty of resolution, cheating rates return to levels similar to those found when immediate punishment is paired with no uncertainty resolution (*IR-ND*). In support of this, post estimation tests show that the drop in cheating rates in *DR-LD* is even marginally significant compared to cheating in *DR-SD* ($p = 0.078$). In contrast to total cheating behavior, we do not observe gender heterogeneity for recidivism rates, except in *DR-SD*, where males are significantly more likely to recidivate (interaction not shown in the table). Age continues to be inversely related to cheating propensity.

Table 3: Propensity to Recidivate Using Random Effects Logit Regression

Cheat	model 1		model 2	
IR-ND	0.3025^{**}	(0.1612)	0.2053^{**}	(0.1476)
DR-SD	0.5752	(0.3104)	0.4845	(0.3488)
DR-LD	0.2001^{***}	(0.1165)	0.1100^{***}	(0.0906)
Male	2.0156^{*}	(0.8525)	2.5307	(1.4561)
Age	0.9609^{**}	(0.0188)	0.9477^{*}	(0.0266)
Round	0.8604	(0.1248)	0.6218^{**}	(0.1337)
GuessCorrect	0.5212^{**}	(0.1332)	0.4312^{**}	(0.1527)
L.Cheat			0.2017^{***}	(0.1153)
L.Punishment			3.6193^{***}	(1.6273)
Observations	493		493	

Note: Odds ratios reported. Standard errors in parentheses are clustered at the individual level. * $p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The reference category is IR-SD. Age reflects the participants' age in years. Lagged variables for cheating and punishment are dummies indicating whether an individual cheated or was punished for cheating in the previous round, respectively.

We observe a particularly interesting finding for the lagged cheating and lagged punishment variables. The results suggest that following one's previous decision to cheat, subsequent cheating decisions become less likely, *unless* previous cheating was accompanied with punishment. Then, participants are substantially more likely to recidivate, which suggests recidivism is driven by one's desire to make up for previous losses.

In summary, we can conclude that the same institutional settings that are capable of reducing recidivism are also the ones deterring deviant behavior in the first place. Our results demonstrate that swift or sufficiently delayed punishment, where the latter is accompanied by an extensive dread of uncertainty regarding one's detection, reduces future criminal behavior.

5 Discussion and Conclusion

We investigate along two dimensions how timing can impact the effectiveness of sanctions. We use a controlled laboratory experiment designed to study the effect of delayed punishment and delayed resolution of uncertainty on deterrence. Our experimental findings show that the timing of resolution of uncertainty has no effect on deterrence. For the delay of punishment, we observe the following inverted u-shape relationship: deterrence is highest for no delay or a large delay of punishment and lowest for a short delay of punishment.

The observed inverted u-shape is at odds with both discounted expected utility theory and anticipatory utility theory. According to the first theory, deterrence should decrease monotonically with the delay of punishment. According to the second, there should also be a monotonic relation between deterrence and delay which would be the inverse of that in the previous case if the effect of anticipation is sufficiently high. In the anticipation-event-recall model (Baucells and Bellezza, 2016), it is possible that the utility maximizing timing of an unpleasant event is somewhere in the middle of the time horizon. That is, fines in earlier or later periods hurt more and should, therefore, lead to higher deterrence. While our experiment was not designed to test this theory explicitly, it is the only theory which is compatible with the findings of our experiment.

It is important to note that the effects of the treatments on the total cheating behavior can be obtained by two different, possibly simultaneously operating processes. First, the variations in the experimental treatments could have affected anticipatory reasoning in the participants about how a possible punishment would impact them. If the impact is anticipated to be severe, this could lead to no or delayed cheating. Second, learning processes may have affected cheaters (who (at least once) underwent the respective treatments) differently by experiencing the (non)waiting for a resolution of uncertainty and the potential execution of an immediate or delayed punishment. This may have influenced their likelihood to cheat again in the future. Inspecting the results for recidivism (i.e. future cheating upon having cheated before) shows that they closely mirror the results of the total cheating behavior. Even if some experience for the treatments to become effective would be needed, basic learning theories (e.g. Azrin, 1956; Banks and Vogel-Sprott, 1965) are at odds with the inverted u-shaped relation between deterrence and delay of punishment which is also observed for recidivism. Arguably, the highly effective deterrence of deviant behavior in *DR-LD* could be interpreted in one of the following two ways: one, only an extensive delay of punishment, and not the existence of uncertainty resolution, is responsible for the decrease in cheating; two, it is the combination of both the extensive delay in punishment and the existence of uncertainty that imposes additional dread and, thus, the interaction of both is driving the strength of deterrence. Our regression analysis and theoretical foundation suggests that it is most likely the former. We consider this as a promising venue for future research.

Our findings yield important insights for optimally designing sanctioning schemes in legal systems. Existing deterrence literature has almost exclusively focused on the role of severity and certainty of legal consequences in deterring proscribed actions. Our study shows that celerity, the timing of sanctions through sentencing, may also be a crucial component of an effective legal system. Our results imply that punishment should either follow the criminal act quickly or be sufficiently delayed if deterrence is to be maximized. As immediate punishment may be relatively costly, an optimally delayed punishment could be the most efficient solution.

Our study provides a first step into analyzing the effects of deterrence in a sanctioning system. In order to make conclusions for an optimal policy in the real world, future research needs to tackle several limitations of our study. In particular, it seems necessary to study celerity when the delay of punishment extends to the real payout of subjects. Also, the optimal delay may be very sensitive to the type of punishment, e.g. the optimal delay may be rather different for monetary fines than for imprisonment. Despite these limitations, we think that our study highlights the role of celerity in designing optimal sanctioning systems and points to fruitful avenues for future research.

Appendix A Theoretical predictions

In this appendix, we provide further details regarding the derivation of the behavioral implications outlined in Section 3.4. We present the formal derivation of those predictions for discounted expected utility theory (DEU), utility from anticipated emotions (UAE), and the anticipation-event-recall model (AER), in that order.

In the standard discounted expected utility (DEU) model, optimal decisions do not depend on the timing of resolution of uncertainty. In the DEU model, a delay of punishment should decrease deterrence. The utility of not cheating (NC) is identical in all treatments and is given by

$$\text{DEU}(NC) = \frac{31}{32}4 + \frac{1}{32}10 \tag{1}$$

where we assume for convenience a linear utility function.[15] We restrict attention to a single block consisting of 6 periods, where cheating was possible in the first round of that block. Further, we only consider the utility generated from the decision about cheating in the first period of such a block in all our analyses. The remaining utility components within a block are identical across treatments. In all treatments, detected cheaters are fined 10 ECU plus one round of suspension for a total expected fine of $F = 10 + \text{DEU}(NC)$, but the time at which the punishment occurs varies across treatments. In the baseline treatment, detected cheaters are punished directly in the next period. For a discount factor $\delta < 1$, the utility of cheating (C) amounts to

$$\text{DEU}(C, \text{IR-ND}) = 10 - \frac{1}{4}\delta F \tag{2}$$

as cheating is not possible in the next period. Compared to the baseline treatment, punishment is delayed by two further periods in *IR-SD*. The same is true for *DR-SD*. As the timing of resolution of uncertainty is immaterial under DEU, we get

$$\text{DEU}(C, \text{IR-SD}) = \text{DEU}(C, \text{DR-SD}) = 10 - \frac{1}{4}\delta^3 F. \tag{3}$$

Finally, we have

$$\text{DEU}(C, \text{DR-LD}) = 10 - \frac{1}{4}\delta^5 F. \tag{4}$$

as punishment is delayed by a total of four periods in *DR-LD*.

Since $\text{DEU}(C, \text{IR-ND}) < \text{DEU}(C, \text{IR-SD}) = \text{DEU}(C, \text{DR-SD}) < \text{DEU}(C, \text{DR-LD})$

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[15] While risk aversion modeled by a concave utility function certainly influences the decision between cheating and not cheating, it does not imply differences between treatments.

where the utility of not cheating is independent of the treatments, we get the following prediction:

Proposition 1. *Under DEU, increasing the delay of punishment decreases deterrence for a fixed timing of resolution of uncertainty.*

As a consequence, DEU predicts more violations in *IR-SD* compared to *IR-ND* and more violations in *DR-LD* compared to *DR-SD*. Since the timing of resolution of uncertainty does not affect behavior, following DEU violations in Treatments *IR-SD* and *DR-SD* are identical.

Proposition 2. *Under DEU, the timing of resolution of uncertainty does not affect behavior, implying that violations in Treatments IR-SD and DR-SD are identical.*

Proposition 3. *Since under DEU the timing of resolution of uncertainty does not change deterrence and increasing the delay of punishment decreases deterrence, we will have more violations in DR-SD than in IR-ND and more violations in DR-LD than in IR-SD.*

Following Loewenstein (1987), negative future outcomes can cause immediate disutility through negative anticipatory emotions such as fear, dread, or anxiety. DEU fails to take this into consideration. Suppose you were cheating in the baseline treatment. Then, you dread in the first period that you will be fined in the next one, i.e. you dread a loss of $F = 10 + \mathrm{DEU}(NC)$. For a discount rate γ which measures the degree to which current utility is influenced by anticipated emotions from consumption in the next period, the utility of cheating is given by

$$\mathrm{UAE}(C, \text{IR-ND}) = 10 - \frac{1}{4}(\delta + \gamma)F \tag{5}$$

where UAE denotes utility with anticipated emotions. We now consider *IR-SD* where there is a short delay of punishment by two periods. Note that the utility from anticipation is discounted with discount factor δ. While the discounting effect in (3) increases utility compared to *IR-ND*, anticipation leads to decreasing utility as dread is now experienced in more than one period. More specifically, we get

$$\mathrm{UAE}(C, \text{IR-SD}) = 10 - \frac{1}{4}\delta^3 F - \frac{1}{4}(\gamma^3 + \delta\gamma^2 + \delta^2\gamma)F \tag{6}$$

Comparing (5) and (6), it may well be that the utility of cheating is lower in *IR-SD* than in *IR-ND* if γ is sufficiently high. Since the utility of not cheating is identical across treatments, we get the opposite of Proposition 1.

Proposition 4. *If the effect of anticipation is sufficiently high, delaying punishment increases deterrence leading to less violations in IR-SD compared to IR-ND and in DR-LD compared to DR-SD.*

Anticipated emotions in the model of Loewenstein (1987) refers to future consumption under certainty. In Treatments *DR-SD* and *DR-LD*, resolution of uncertainty is delayed which may alter anticipatory emotions. While in *IR-SD* a detected cheater may feel dread in periods 1-3 due to anticipating the punishment in period 4, in *DR-SD* a cheater may experience the anxiety of being detected in the later investigation. Following Caplin and Leahy (2001), the anxiety experienced one period before resolution should depend on the probability of being detected and the size of the fine. As all these parameters are identical in Treatments *DR-SD* and *DR-LD*, we simply use the term A to denote the anxiety of a cheater one period before resolution. We now introduce a third discount rate α, such that anxiety experienced t periods before resolution is given by $\alpha^t A$. This yields the following utility of cheating in *DR-SD*:

$$\text{UAE}(C, \text{DR-SD}) = 10 - \frac{1}{4}\delta^3 F - (\alpha + \delta\alpha^2)A - \frac{1}{4}\delta^2\gamma F \tag{7}$$

Typically, it is observed that people prefer early resolution of uncertainty for negative outcomes. In our model this is the case if

$$(\alpha^2 + \delta\alpha)A > \frac{1}{4}(\gamma^3 + \delta\gamma^2)F \tag{8}$$

and leads to the following hypothesis:

Proposition 5. *Delayed resolution of uncertainty increases deterrence leading to less violations in DR-SD compared to IR-SD.*

Obviously, if the resolution of uncertainty should be delayed in order to increase deterrence, punishment has to be delayed as it cannot precede the resolution of uncertainty. The combined effect of delayed resolution and delayed punishment can be grasped by comparing *DR-SD* to *IR-ND*. If both delaying punishment according to Proposition 4 and delaying resolution according to Proposition 5 increases deterrence, our UAE implies the following:

Proposition 6. *If delaying punishment increases deterrence due to dread and delayed resolution also increases deterrence due to anxiety, then the combined effect of delaying punishment and resolution results in less cheating and, therefore, less violations in DR-SD compared to IR-ND.*

Let us finally consider the utility of cheating in *DR-LD*. Here we get

$$\text{UAE}(C, \text{DR-LD}) = 10 - \frac{1}{4}\delta^5 F - \frac{1}{4}(\gamma^3 + \delta\gamma^2 + \delta^2\gamma^3 + \delta^3\gamma^2 + \delta^4\gamma)F \tag{9}$$

The cheater experiences anxiety prior to the resolution of uncertainty as in *DR-SD*, but there is also an extended period where he may experience dread due to delayed punishment. The second component is similar to the dread experienced in *IR-SD*, additionally discounted as the experience starts two periods later. Assuming (8), a comparison of (9) and (6), reveals that the utility of cheating in *DR-LD* will be smaller than that of cheating in *IR-SD* under the conditions of Proposition 4. This leads to the following result:

Proposition 7. *If* (8) *holds and the effect of anticipation is sufficiently high* (γ *is large enough), then delayed resolution combined with delaying punishment results in less cheating leading to less violations in DR-LD compared to IR-SD and less violations in DR-LD compared to IR-ND.*

Finally, we consider a version of the anticipation-event-recall (AER) model of Baucells and Bellezza (2016) in discrete time according to which total utility of negative future events consists of three components: utility of anticipation (U_A), event utility (U_E), and utility from recall (U_R). In what follows, we show that the AER model admits an interior solution in our setting, in the sense that the decision-maker prefers some delay of punishment, but not too much. This gives rise to an u-shaped relationship between delay of punishment and deterrence.

We focus on the disutility derived from being fined following a cheating decision, $F = 10 + \text{DEU}(NC)$. Depending on the treatment this negative event takes place at $t_e \in \{1, 3, 5\}$. Effective utility results from the difference between conceptual consumption c_t and a reference point r_t, which gradually adapts to c_t for t approaches the time of the negative consumption event t_e. For the sake of tractability we assume that conceptual consumption is constant, that is, $c_t = F$ for $t = 0, \ldots, t_e$. Further, assume that for $t \leq t_e$ the reference point is given by $r_t = \alpha F \frac{t}{t_e}$ such that $r_0 = 0$ and $r_{t_e} = \alpha F$, whereas it stays constant thereafter, i.e. $r_t = \alpha F$ for $t = t_e + 1, \ldots \bar{t}$ where $\bar{t} = 5$. Note that α determines the speed of adaptation. Finally, instant utility depends on the psychological time distance τ_t defined as calendar time multiplied by a discount rate. Let ρ_0 be a base discount rate and define the discount rates for anticipation and recall, respectively, as follows:

$$\rho_a = \frac{\rho_0}{|F|^\mu}$$

$$\rho_r = \frac{\rho_0}{|(1-\alpha)F|^{\mu}},$$

where μ is the parameter of magnitude effect ($\mu = 0$ eliminates the magnitude effect), which captures the idea that larger amounts are discounted less than smaller amounts. Psychological time distance to and from the event is then given by

$$\tau_t = \begin{cases} \rho_a(t_e - t) & t = 0, \dots t_e \\ \rho_r(t - \bar{t}) & t = t_e + 1, \dots, \bar{t} \end{cases}$$

Given t_e instant utility is given by

$$u(t) = \delta^{\tau_t}(F - r_t) = -\mathbb{1}_{t \le t_e} \delta^{\frac{\rho_0}{|F|^{\mu}}(t_e - t)}(F - r_t) - \mathbb{1}_{t > t_e} \delta^{\frac{\rho_0}{|(1-\alpha)F|^{\mu}}(t - t_e)}(F - r_t).$$

Note that $u(t_e) = -(1-\alpha)F$. We are now in a position to derive the total disutility of punishment for treatment IR-ND. Since $t_e = 1$ we have

$$\mathrm{AER}(F, \text{IR-ND}) = -(1-\alpha)F - (1 + \delta + \delta^2 + \delta^3 + \delta^4)\delta^{\frac{\rho_0}{|(1-\alpha)F|^{\mu}}}(1-\alpha)F$$

For both treatments *IR-SD* and *DR-SD* negative consumption takes place in period $t_e = 3$. Hence, assuming that delayed resolution of uncertainty has no effect we have $\mathrm{AER}(C, \text{IR-SD}) = \mathrm{AER}(C, \text{DR-SD})$ and both are given by

$$-\delta^{\frac{\rho_0}{|F|^{\mu}}3}F - \delta^{\frac{\rho_0}{|F|^{\mu}}2}(1 - \frac{1}{3}\alpha)F - \delta^{\frac{\rho_0}{|F|^{\mu}}}(1 - \frac{2}{3}\alpha)F - (1-\alpha)F - (\delta + \delta^2)\delta^{\frac{\rho_0}{|(1-\alpha)F|^{\mu}}}(1-\alpha)F.$$

A comparison of those two expressions shows that $\mathrm{AER}(F, \text{IR-ND}) < \mathrm{AER}(F, \text{IR-SD})$ if and only if

$$\delta^{\frac{\rho_0}{|F|^{\mu}}3}F + \delta^{\frac{\rho_0}{|F|^{\mu}}2}(1 - \frac{1}{3}\alpha)F + \delta^{\frac{\rho_0}{|F|^{\mu}}}(1 - \frac{2}{3}\alpha)F < \delta^{\frac{\rho_0}{|F|^{\mu}}}F + \delta^{\frac{\rho_0}{|(1-\alpha)F|^{\mu}}3}(1-\alpha)F + \delta^{\frac{\rho_0}{|(1-\alpha)F|^{\mu}}4}(1-\alpha)F.$$

This inequality is possible if μ is large enough, i.e. it holds for the parameters $\alpha = 0.01$, $\delta = 0.9$, $\rho_0 = 0.02$, $\mu = 10$, and F is scaled down by a factor of 0.16. Thus for this parametrization the AER model would predict less violations in IR-ND compared to IR-SD.

Finally, consider treatment *DR-LD* where punishment happens in period $t_e = 5$. Here $\mathrm{AER}(F, \text{DR-LD})$ is given by

$$-\delta^{\frac{\rho_0}{|F|^\mu}5}F-\delta^{\frac{\rho_0}{|F|^\mu}4}(1-\frac{1}{5}\alpha)F-\delta^{\frac{\rho_0}{|F|^\mu}3}(1-\frac{2}{5}\alpha)F-\delta^{\frac{\rho_0}{|F|^\mu}2}(1-\frac{3}{5}\alpha)F-\delta^{\frac{\rho_0}{|F|^\mu}1}(1-\frac{4}{5}\alpha)F-(1-\alpha)F$$

$$\text{AER}(F,\text{DR-LD}) = -(\delta^5+\delta^4+\delta^3+\delta^2+\delta-\alpha(\frac{1}{5}\delta^4+\frac{2}{5}\delta^3+\frac{3}{5}\delta^2+\frac{4}{5}\delta))\delta^{\frac{\rho_0}{|F|^\mu}}F-(1-\alpha)F$$

Comparing the expressions for treatment *DR-SD* and *DR-LD* we obtain $\text{AER}(F,\text{DR-LD}) < \text{AER}(F,\text{DR-SD})$ if and only if

$$\begin{aligned}&\delta^{\frac{\rho_0}{|F|^\mu}3}F+\delta^{\frac{\rho_0}{|F|^\mu}2}(1-\frac{1}{3}\alpha)F+\delta^{\frac{\rho_0}{|F|^\mu}}(1-\frac{2}{3}\alpha)F+(\delta+\delta^2)\delta^{\frac{\rho_0}{|(1-\alpha)F|^\mu}}(1-\alpha)F\\ >\ &\delta^{\frac{\rho_0}{|F|^\mu}5}F+\delta^{\frac{\rho_0}{|F|^\mu}4}(1-\frac{1}{5}\alpha)F+\delta^{\frac{\rho_0}{|F|^\mu}3}(1-\frac{2}{5}\alpha)F+\delta^{\frac{\rho_0}{|F|^\mu}2}(1-\frac{3}{5}\alpha)F+\delta^{\frac{\rho_0}{|F|^\mu}1}(1-\frac{4}{5}\alpha)F\end{aligned}$$

It can be verified that this inequality holds as well for the parametrization above. Thus, for this parametrization, the AER model also predicts less violations in DR-LD compared to IR-SD and DR-SD. Our calculation exercise shows that for the AER model subjects may perceive an intermediate delay in punishment the least deterrent, that is, $\text{AER}(F,\text{IR-ND}) < \text{AER}(F,\text{IR-SD})$ and $\text{AER}(F,\text{DR-LD}) < \text{AER}(F,\text{DR-SD})$ may hold simultaneously. Thus the AER model can account for an u-shaped relation between delay of punishment and deterrence.

Appendix B Instructions

General Instructions

Welcome to the Lab! You are about to participate in an experiment on decision-making. During the experiment you can earn money. The amount of money you will earn depends on your decisions during the session. The session consists of 28 rounds. Your earnings are determined by the sum of your earnings in each round. During the experiment all amounts will be presented in ECU (Experimental Currency Unit). At the end of the experiment all the ECU you have earned will be converted to Dollars as follows:

$$10 \text{ ECU} = 1\$$$

At the end of the experiment your total earnings, which is the amount you have earned during the session (converted to Dollars), will be privately paid to you in cash.

Additionally, there is a separate charity fund for each participant, which initially contains 250 ECU. Your decisions during the experiment will affect the final amount of ECU in your charity fund. At the end of this session, one participant will be randomly chosen and the final amount of ECU that remain in that participant's charity fund will be donated to Doctors Without Borders (for more information on the work and the mission of Doctors Without Borders please find enclosed the summary taken from their website). Therefore, if you are selected your decisions throughout the experiment would directly affect the amount of money that is actually donated. A copy of the receipt of the donations can be made available upon demand.

If there is something you do not understand or if you have any questions, now or at some point during the experiment, please raise your hand and remain seated. One of our colleagues will come to you and answer your question.

It is important that you read all instructions and explanations on the screen carefully before making your decision.

For the purpose of the experiment it is important that you do not talk or communicate in other ways with the other participants. Please turn off your cell phone and all other electronic devices.

After the actual experiment concludes, we will ask you to fill out a questionnaire. Please fill out the questionnaire carefully and truthfully. The whole experiment is completely anonymous and your answers cannot be traced back to you personally. Therefore, it is important that you fill out the questionnaire carefully even if you have already answered a similar questionnaire in another experiment in the past.

Round Type: A

You are currently not under investigation.

Your Total Payoff: 0

Figure B.1

On the next pages you will receive further information regarding the experiment and your decisions.

Experiment Instructions

In this experiment you have to make a series of decisions over 28 rounds. In each round the computer will draw a single card from a deck of cards. The deck contains the 32 cards shown in Figure B.1 below. Each card is drawn with the same probability.

There are two different types of rounds, type A and type B. This means any of the 28 rounds is either of type A or type B. For each round the round type is indicated on the computer screen at the top left corner. We detail the course of events for each type of round below.

Type A

In rounds of type A you have to play the “guessing game” where you have to guess which card was randomly drawn by selecting the corresponding card from the 32 cards shown on your screen (see Figure B.1 above). For a correct guess, that is if the card you have chosen is the exact same card drawn by the computer in suit and number, you will receive a payout of 10 ECU. For an incorrect guess, that is the computer has drawn a card different from the one you have chosen, you will receive a payout of 4 ECU.

Example:

1. Suppose your guess is “King Of Hearts,” i.e. you have chosen “King Of Hearts” on the screen in Figure B.1, and the card actually drawn by the computer is “King Of Hearts”. This means you guessed correctly and 10 ECU is added to your account.
2. Suppose your guess is “King Of Hearts” and the card actually drawn by the computer is “Queen Of Spades.” This means you guessed incorrectly and 4 ECU is added to your account.
3. Suppose your guess is “King of Hearts” and the card actually drawn by the computer is “King of Clubs.” This means you guess incorrectly and 4 ECU is added to your account.

Type B

In rounds of type B, you first have to decide whether you want to follow the rules of the guessing game or cheat in the guessing game. If you choose to cheat, the computer will guess the right card for you. In other words:

- If you decide to follow the rules, you can make your guess just as in rounds of type A with the same possible payouts, i.e. if you guess correctly you receive 10 ECU and if you guess incorrectly you receive 4 ECU.
- If you decide to cheat, you do not have to guess which card was drawn, but the computer will automatically choose the right card for you. This means when you choose to cheat you will always “guess” correctly and win 10 ECU. However, when you cheat, an amount of 50 ECU will be subtracted from the charity pool, i.e. every time you cheat the amount of money that will be donated to “Doctors Without Borders” is reduced by 50 ECU. This reduction in the charity fund will become a reality in the case that your decisions are randomly chosen to determine the ending amount in the charity fund at the conclusion of the experiment.

Any instance of cheating will be investigated. Cheating is detected with a probability of 25%. This means that one out of four times you will be detected. The investigation is completed in the same round. When the investigation is completed, you are informed whether your cheating was detected or not.

If your cheating was detected, you will be suspended for one round and you have to pay a fine of 10 ECU. When suspended you can neither cheat nor guess and will not earn any ECU in that round. Moreover, the fine of 10 ECU will be deducted from your account in the round you are suspended. Your suspension will be implemented in the first round after the investigation is completed and your cheating is detected (see the timeline in Figure B.2 below). This does not affect any other round except the round of your suspension.

There are no more than five type B rounds.

Examples:

Situation 1: Suppose we are in round 7 and this is a round of type A.

There are two possible payouts for this round, which depend on your guess:

1. You guessed correctly (your guess and the computers draw coincide). You earn 10 ECU in round 7.
2. You guessed incorrectly (your guess and the computers draw do not coincide). You earn 4 ECU in round 7.

Situation 2: Suppose we are in round 7 and this is a round of type B.

There are four possible payouts for this round, which depend on whether you cheat, are detected upon investigation, and, in case you did not cheat also on your guess:

1. You did not cheat and guessed correctly. You earn 10 ECU in round 7. There are no other consequences.
2. You did not cheat and guessed incorrectly. You earn 4 ECU in round 7. There are no other consequences.
3. You cheated and 10 ECU are added to your account in round 7. The investigation reveals in round 7 that you were not detected and do not face any further consequences.

   Because you cheated an amount of 50 ECU will be deducted from the charity pool if your decisions are chosen to determine the charity fund.

4. You cheated and 10 ECU are added to your account in round 7. The investigation reveals in round 7 that you were detected. You will be suspended for round 8, further you have to pay a fine of 10 ECU which will deducted from your account during your suspension in round 8. This means in round 8 you cannot make any decision, but the fine of 10 ECU will be deducted from your account.

   Because you cheated an amount of 50 ECU will be deducted from the charity pool if your decisions are chosen to determine the charity fund.

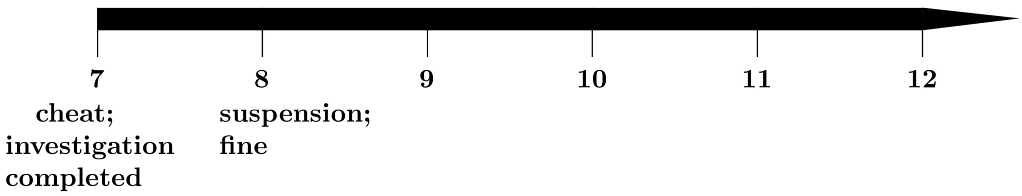

Figure B.2

Summary

We now summarize the course of action for a single round:

1. If you are suspended for this round a pop-up screen will inform you that you are not allowed to make any decisions in this period. Please wait for the next round to proceed.
2. In rounds of type A you have to play the guessing game (see Figure B.1).
3. In rounds of type B you have to decide whether you want to cheat or follow the rules. If you cheat the computer selects the right card for you. If you do not cheat you play the guessing game as in rounds of type A.
4. After you have made your decisions the outcome screen appears where you are informed of the outcome of this round and your payoff. If an investigation is completed you are informed about the outcome and consequences.
5. If you were detected for cheating, your punishment consists of a) losing the 10 ECU you won by engaging in elicit behavior, b) you have to pause for the next round (60 seconds waiting time), and c) you forgo the potential income of the round in which you are paused.

Comprehension Questions

Please answer the following comprehension questions. If you have any questions, please raise your hand and remain seated. Somebody will come to you and answer your question.

QUESTION 1: In rounds of type A, you have the option to cheat.
(Please circle the right answer.)

right	wrong

QUESTION 2: In rounds of type B, you have the option to cheat.
(Please circle the right answer.)

right	wrong

QUESTION 3: How many ECU are added to your account if you cheat in that round?

QUESTION 4: What is the probability that you are detected after you cheated?

QUESTION 4: What is your payout if you guess correctly/incorrectly in the guessing game?

QUESTION 5: Suppose you cheated in round 7. In which round is the investigation completed and you are informed whether you have been detected or not?
(Please circle the right answer.)

round 7	round 8

QUESTION 6: Suppose you cheated in round 7 and the completed investigation has revealed that you have been detected. In which round are you suspended and is the fine deducted from your account?
(Please circle the right answer.)

round 7	round 8

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