

RESEARCH ARTICLE SUMMARY

CRIMINAL JUSTICE

Behavioral nudges reduce failure to appear for court

Alissa Fishbane, Aurelie Ouss*, Anuj K. Shah

INTRODUCTION: Each year, millions of people in the United States are required to appear in court for low-level offenses. Many defendants miss their court dates. Criminal justice policy often uses punitive sanctions to deter these failures to appear. For example, when defendants fail to appear, arrest warrants are issued, which draws defendants further into the criminal justice system. These policies presume that defendants pay attention to these penalties and weigh them when deciding whether to appear in court. In this study, we explore a different possibility for why defendants might miss court—simple human error. Although defendants are given all of the relevant information they need, they might be insufficiently aware of this information—it might not be salient enough or defendants might forget it.

RATIONALE: We conducted two large-scale field studies in New York City evaluating interventions to make defendants more aware of court

information. In the first study, we redesigned the summons form that defendants receive for low-level offenses. The old summons form listed court information at the bottom of the form below less important information (e.g., the defendant's physical characteristics and details about the issuing officer), which makes it easy to overlook. The redesigned form moves court information to the top of the ticket, where people are more likely to see it. It also clearly states in bold typeface on the front of the form that missing the assigned court date will lead to a warrant. In the second study, we augmented the redesigned form by sending text messages to highlight critical court information for defendants in the week leading up to their court appearance.

In laboratory experiments, we tested how quickly people could identify, and how well they could remember, court information on the old and new forms. Then, we examined laypeople's and experts' beliefs about whether

failures to appear were intentional and how these beliefs affected their support for nudges to reduce failures to appear.

RESULTS: The redesigned summons form and text messages reduced failures to appear on average by 13 and 21%, respectively. In our laboratory experiments, people who saw the new forms identified court information more quickly (and recalled it more accurately). This suggests that a meaningful proportion of defendants who fail to appear are not intentionally skipping court but are effectively unaware of court.

We estimate that these nudges helped avoid at least 30,000 arrest warrants being issued over 3 years, and they resulted in approximately 20,000 people having their cases fully dismissed instead of having an open warrant. We see suggestive evidence that these nudges were more effective for defendants living in poorer neighborhoods. Additionally, the bulk of warrants avoided are for defendants living in poorer neighborhoods and neighborhoods with higher proportions of Black and Hispanic residents—though this reflects, rather than repairs, existing disparities in how summonses are issued.

However, in our laboratory experiments on people's attitudes, we find that laypeople believe failures to appear for court are more intentional than other failures to act (e.g., missing medical appointments). And although laypeople can be prompted to see how defendants might mistakenly miss court, their default assumption is to see it as intentional. This assumption reduces support for these nudges and increases support for more punitive approaches to reducing failures to appear. Criminal justice experts (e.g., prosecutors and judges), however, do not share this intuition—they are more likely to believe that failures to appear are unintentional and to support these nudges.

CONCLUSION: This work suggests that there is a straightforward explanation for why many defendants miss court—information about their court dates is not sufficiently salient. Although simple nudges can remedy this, policy-makers have been slow to experiment with and adopt them. Instead, criminal justice policy on failures to appear often hews closer to laypeople's intuitions. Widespread adoption of interventions such as these might depend on a shift in the assumptions of why failures to appear happen. Otherwise, these policies risk merely punishing people, not deterring actions. ■

SUMMONS PROCESS



Police officer issues court summons



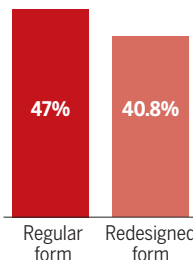
On court date, defendant shows up for hearing

INTERVENTION #1

REDESIGN CITY'S SUMMONS FORM

- Label as court appearance ticket
- Move court date and time near top
- Clearly indicate court location
- Highlight consequences of missing court

Failure-to-appear rates



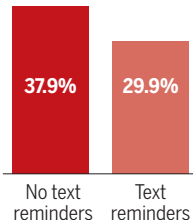
23,000 Warrants avoided

INTERVENTION #2

SEND TEXT REMINDERS IN ADVANCE OF DEFENDANT'S COURT DATE



Failure-to-appear rates



7,800 Warrants avoided



Defendant doesn't show up and court issues arrest warrant

Reducing failures to appear. In two field studies, we made court information more salient by redesigning the court summons form and sending text messages to defendants. We find that these interventions significantly reduced the rate at which defendants missed their court dates for low-level offenses, and fewer arrest warrants were issued as a result.

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RESEARCH ARTICLE

CRIMINAL JUSTICE

Behavioral nudges reduce failure to appear for court

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Each year, millions of Americans fail to appear in court for low-level offenses, and warrants are then issued for their arrest. In two field studies in New York City, we make critical information salient by redesigning the summons form and providing text message reminders. These interventions reduce failures to appear by 13 to 21% and lead to 30,000 fewer arrest warrants over a 3-year period. In laboratory experiments, we find that whereas criminal justice professionals see failures to appear as relatively unintentional, laypeople believe they are more intentional. These lay beliefs reduce support for policies that make court information salient and increase support for punishment. Our findings suggest that criminal justice policies can be made more effective and humane by anticipating human error in unintentional offenses.

More than 10 million people are arrested each year in the United States, and millions more are issued summonses that draw them into the criminal justice system and require court appearances. Most of these arrests and summonses are for low-level offenses (1), and many of these defendants end up missing their court dates. In New York City alone, for example, we calculate that ~40% of defendants (or 100,000 people) missed their court date for low-level offenses in 2015. These failures to appear for court add to the original offense—defendants are held in contempt of court, and an arrest warrant is issued, which is supposed to act as a deterrent. Failures to appear are also common for more serious offenses, such as felonies and misdemeanors. In those contexts, the consequences can be even more costly. Partly to reduce the risk of failures to appear, judges often assign felony and misdemeanor defendants to pretrial detention, which contributes to the scale of incarceration in the United States, where 500,000 people are in jail awaiting their trials each day. Other felony and misdemeanor defendants are asked to post monetary bail, which acts as collateral to incentivize appearance in court. These deterrence policies aim to reduce failures to appear by increasing the penalties associated with them. These policies will be most effective if defendants pay attention to the penalties and make an intentional decision whether to skip court or not on the basis of the costs and benefits of doing so.

In this paper, we explore a different possibility for why defendants might miss court—simple human error. Although defendants are

given all of the relevant information they need (e.g., when and where to appear for court and what the consequences are for missing court), they might be insufficiently aware of this information. This could happen for various reasons: The information might not be salient enough, or defendants might simply forget it as their court date approaches. In other words, many failures to appear may occur not because defendants are intentionally showing contempt of court, but rather because existing policies do not allow enough room for error.

In some ways, this hypothesis is fairly straightforward. Insufficient awareness can explain various other failures to act—for example, failures to save money or pay bills (2, 3), failures to get immunizations (4–6), and even student failures to matriculate in college (7). In criminal justice, raising the awareness of consequences can reduce misconduct (8). However, the simplicity of this hypothesis makes it all the more startling in this context. A single failure to act in other domains might have few direct consequences, and those consequences might be delayed (often by years). By contrast, failures to appear for court have direct, immediate, and severe consequences—conditions that criminology suggests should reduce misconduct (9). It might seem that court dates and the threat of arrest warrants would not be things that people would simply forget or overlook.

If our hypothesis is true, however, then policies that focus only on punishment may be poorly targeted for reducing failures to appear. It might in fact be more cost-effective, and more humane, to make court information salient for defendants.

We find evidence for this from two large-scale field studies conducted in New York City. In the first study, we redesign court summons forms to simplify how information is presented. In the second study, we augment the redesigned form by sending text messages that highlight critical court information for defen-

dants. These interventions reduce failures to appear, on average, by 13 and 21%, respectively, which suggests that a meaningful proportion of defendants who fail to appear are not intentionally skipping court but are effectively unaware of court. In a series of laboratory experiments, we find evidence in support of this hypothesis, as the redesigned summons form improved participants' identification and recall of court information.

However, we also find that laypeople's intuitions about why failures to appear happen might lead them to overlook the value of these interventions. Specifically, laypeople believe that failures to appear are relatively intentional, and this belief leads to lower popular support for interventions like the ones we tested here. When prompted, laypeople can appreciate how human error might play a role in failures to appear, and this increases their support for the interventions we tested. However, laypeople's default intuition is that failures to appear stem from intentional decisions to skip court. Notably, criminal justice experts (e.g., prosecutors and defense attorneys) are more likely to believe that failures to appear are unintentional and are more likely to support these interventions. Nevertheless, current criminal justice policy often aligns more with the intuitions of our samples of laypeople rather than those of experts.

Field studies on nudges for defendants

In our study, we focus on criminal summonses, which are typically issued for the lowest level of criminal offenses, in New York City. Criminal summonses typically result from quality-of-life offenses, such as open containers, disorderly conduct, or park trespassing (see table S1 for more information on summonses and descriptive statistics on summons recipients). In 2015, the most recent year before our study period, 256,488 summonses were issued that required court appearances [though summonses have since declined (10)]. For these offenses, defendants are typically not arrested, taken into custody, detained pretrial, or required to post bail. Instead, they are given a summons form and are required to appear in court 60 to 90 days later, with some flexibility the week before the scheduled court date. However, if they fail to appear in court, a warrant is opened for their arrest, which means that future interactions with the police are more likely to result in an arrest, possibly even after an illegal stop. Failure to appear is also a separate violation that can carry a fine of \$250 and a penalty of up to 15 days in jail. If defendants voluntarily show up to court at a later date, the warrant will often be vacated. However, many defendants may effectively be unaware that they have open warrants. Historically, failure-to-appear rates are ~40% for summonses that require a court appearance.

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A

CRC-3206 (5/12)

Complaint/Information
The People of the State of New York vs.

Name (Last, First, MI)
Street Address
City
State
Zip Code
Apt. No.

ID/License Number
State
Type/Class
Expires (mm/dd/yy)
Sex

Date of Birth (mm/dd/yy)
Hi
Wt
Eyes
Hair
Plate/Reg

Reg State
Expires (mm/dd/yy)
Plate Type
Veh Type
Make
Year
Color

The Person Described Above is Charged as Follows:

Time 24 Hour (hh-mm)
Date of Offense (mm/dd/yy)
County

Place of Occurrence
NY Precinct

In Violation of Section
Subsection
VTL
Admin Code
Penal Law
Park Rules
Other

Title of Offense:

Bronx Criminal Court - 215 E 161st Street, Bronx, NY 10451
Kings Criminal Court - 346 Broadway, New York, NY 10013
Redhook Community Justice Center - 88-94 Visitation Place, Brooklyn, NY 11231
New York Criminal Court - 346 Broadway, New York, NY 10013
Midtown Community Court - 314 W 54th Street, New York, NY 10019
Queens Criminal Court - 120-55 Queens Boulevard, Kew Gardens, NY 11415
Richmond Criminal Court - 67 Targee Street, Staten Island, NY 10304

Defendant stated in my presence (in substance):

I personally observed the commission of the offense charged herein. False statements made herein are punishable as a Class A Misdemeanor pursuant to section 210.45 of the Penal Law. Affirmed under penalty of law.

Complainant's Full Name Printed
Rank/Full Signature of Complainant
Date Affirmed (mm/dd/yy)

Agency
Tax Registry #
Command Code

The person described above is summoned to appear at NYC Criminal Court
Summons Part
County

Date of Appearance (mm/dd/yy)
At 9:30 a.m.

B

CRC-3206 (7/15)

Criminal Court Appearance Ticket

Name (Last, First, MI)
Date of Birth (mm/dd/yy)

Cell Phone Number (where court may contact you)
Home Phone Number (where court may contact you)

Show up to court on:
Court Appearance Date (mm/dd/yy):
at: 9:30 a.m.

Your court appearance location: ☐ Other (specify) _____

☐ Bronx Criminal Court
☐ Kings & New York Criminal Court
☐ Midtown Community Court
☐ Redhook Community Justice Center
☐ Queens Criminal Court
☐ Richmond Criminal Court

****To avoid a warrant for your arrest, you must show up to court.****
At court, you may plead guilty or not guilty.
Please see back for exceptions for Public Consumption of Alcohol and Public Urination offenses.
Court Locations: You must appear at the court location identified above.
Bronx Criminal Court 215 E 161st Street, Bronx, NY 10451
Kings & New York Criminal Court 346 Broadway, New York, NY 10013
Redhook Community Justice Center 88-94 Visitation Place, Brooklyn, NY 11231
Midtown Community Court 314 W 54th Street, New York, NY 10019
Queens Criminal Court 120-55 Queens Boulevard, Kew Gardens, NY 11415
Richmond Criminal Court 26 Central Ave, Staten Island, NY 10301

You are Charged as Follows:

Title of Offense:
Time 24 Hour (hh-mm)
Date of Offense (mm/dd/yy)
County

Place of Occurrence
Precinct

In Violation of Section
Subsection
VTL
Admin Code
Penal Law
Park Rules
Other

For Additional Information and Questions:

Visit the website or call the number below for additional information about your court appearance and translation of this document.
www.mysummons.nyc
OR
Call 646-760-3010

Defendant stated in my presence (in substance):

I personally observed the commission of the offense charged herein. False statements made herein are punishable as a Class A Misdemeanor pursuant to section 210.45 of the Penal Law. Affirmed under penalty of law.

Complainant's Full Name Printed
Rank/Full Signature of Complainant
Date Affirmed (mm/dd/yy)

Agency
Tax Registry #
Command Code

Note - If you do not follow these instructions a warrant may be ordered for your arrest.
To Plead Not Guilty. You must come to court at the place and time shown on the front of this summons.
To Plead Guilty. You must come to court at the place and time shown on the front of this summons. However, if you are charged with **Public Consumption of Alcohol**, or **Public Urination**, you may plead guilty by mail. If you plead guilty by mail you do not have to come to court.
To Plead Guilty by Mail within 10 days of the date this summons was issued (To one of the above two charges only):
* Complete and sign the "Guilty Plea by Mail Form" below.
* Prepare a check or money order payable to NYC Criminal Court for **\$25 for Public Consumption of Alcohol** or **\$50 for Public Urination**.
* Write the summons number on the check or money order.
DO NOT SEND CASH.
* Mail the check or money order with this completed form to:
NYC CRIMINAL COURT
P.O. BOX 555
NEW YORK, N.Y. 10031-0555
The court record of this case will show your guilty plea to an offense that is not a crime under New York law. This guilty plea will be a public record available at the courthouse. Consult with an attorney if you have questions about this.

Guilty Plea by Mail Form
For Public Consumption of Alcohol or Public Urination Only
I hereby plead guilty to the following charge: (Place a mark next to the correct charge.)
Public Consumption of Alcohol [Administrative Code section 10-125 (b)], a violation not a crime as charged on this summons.
* I understand that this violation is punishable by a fine of not more than \$25 or imprisonment of up to five days or both.
* I agree that the sentence imposed will be a \$25 fine.
Public Urination [Administrative Code section 16-118(6)], a violation not a crime as charged on this summons.
* I understand that this violation is punishable by a fine of \$50-\$250 or imprisonment for up to ten days or both.
* I agree that the sentence imposed will be a \$50 fine.
By entering a plea of guilty to this charge I agree to the following:
* I waive arraignment in open court, the right to the assistance of a lawyer, and the right to receive a copy of the accusatory instrument.
* I understand that a plea of guilty to the charge is equivalent to a conviction after a court trial.
* I understand that the court can refuse my guilty plea. If this occurs my payment will be returned and the court will notify me in writing when and where to come to court regarding this summons.
I plead guilty to and admit committing the offense as set forth in this summons.
Signature _____ Date _____
Check or Money Order Payable to NYC Criminal Court Must Be Enclosed.

Fig. 1. Old and redesigned New York City summons forms. (A) Front and back of previous version of the New York City summons form. **(B)** Front and back of the redesigned version of the form.

For our analyses, we rely on administrative data collected by the New York State Office of Court Administration. The data contain defendant gender, date of birth, and address; information about the violation; and court outcomes (see supplementary materials for more details). Our primary sample includes all 323,922 summonses issued in New York City between 1 January 2016 and 14 June 2017.

At the time of our first study, the only way that defendants were notified of their court dates was on the summons ticket they received at the time of the original offense. The entire policy to inform defendants about their court date and deter them from skipping court depended on this form. However, the form's design prioritized information about the original offense rather than information about the defendant's court appearance. For example, it devoted substantial space to describing the defendant (e.g., height, weight, hair color, and the defendant's vehicle) and the violation. The defendant's court date was written at the bottom of the form, below details about the officer issuing the summons form. Only on the back of the form was it mentioned that arrest warrants are issued for those who fail to comply. Given that this information was so easy to overlook, many defendants might have been insufficiently aware of when they were expected to appear in court and what the consequences were for missing court.

We worked with the Mayor's Office of Criminal Justice, New York City Police Department, and the New York State Office of Court Administration to redesign the summons ticket to make relevant information more salient. The new form prominently features the appearance date and court location at the top of the ticket, where people are more likely to see it. It also clearly states in bold typeface on the front of the form that missing the assigned court date will lead to a warrant (see Fig. 1 for old and new forms). If this form reduces failures to appear, that suggests that many defendants might have missed court simply because they were unaware of important information.

We evaluated the effectiveness of this intervention using a regression discontinuity design, which compared failure-to-appear rates for defendants who happened to be among the first to receive a new form given by a particular police officer versus failure-to-appear rates of defendants who were among the last to receive the old form given by that same officer. New forms were gradually rolled out between

March and August of 2016. Police officers only had one pad of summons forms with them. They switched from old forms to new forms when they used up their pad of old forms or when their supervisor handed out pads of new forms. We obtained the identification number of the issuing officer for each form. Every summons form has a serial number, and we can match serial numbers to old or new forms. We construct an officer's switch date by randomly choosing a date between when that officer issues their last old form and their first new form. By construction, before an officer's switch date, all of the forms issued were of the old design; but after the switch date, 97.6% of forms were of the new design, which suggests very good compliance (fig. S1).

Because the introduction of the new forms was staggered, we can also control for seasonality (which is important because types of crimes and failures to appear both vary seasonally) and other time trends. Our main identifying assumption is that there are no observable differences in defendants' characteristics on the basis of whether they received a summons form before or after an officer's switch date. We in fact find no differences in prior summonses or failures to appear, types of offenses, or their predicted failure-to-appear likelihood based on observables, and we observe only a small difference in gender (figs. S2 and S3 and table S2). Because the only notable difference before and after the switch date is the kind of form issued, any difference in failure-to-appear rates for defendants on either side of the switch date can plausibly be attributed to the redesigned form (see supplementary materials for details and robustness checks regarding our identification strategy).

Our main results are presented in Fig. 2 and table S3. Figure 2 presents failure-to-appear

rates for defendants issued forms just before and just after officers' switch dates. Failure-to-appear rates are lower just after the introduction of the new summons forms. To estimate the magnitude of this drop in failure-to-appear rates, we follow the approach of Calonico *et al.* (11, 12), which allows us to obtain consistent estimates when we include covariates. We find that the new forms reduced failures to appear by 6.2 percentage points, or by 13.2% relative to the 47% baseline failure-to-appear rate in the estimation bandwidth ($P < 0.001$). Note that in Fig. 2, the failure-to-appear rate appears to be increasing before the switch date. This is because most officers switched to the new form between May and July, when failure-to-appear rates are highest. We observe this seasonality of failure-to-appear rates in other years, but the drop in failure-to-appear rates after the switch date appears to be the specific result of introducing the redesigned forms (see supplementary materials discussion of robustness checks and fig. S5).

Our second field study provides more direct evidence that failures to appear might stem from defendants' lack of awareness of critical information. In this study, we tested whether failures to appear could be further reduced by texting defendants their court information (date and location) and information about the consequences of missing court. Defendants who received the new summons form could provide their cell phone number to the citing officer, though doing so was not mandatory. All defendants who provided their cell phone number were included in this evaluation.

Approximately 11% of defendants (23,243) provided their phone numbers. There appears to be positive selection in who provided a phone number. For example, the failure-to-appear rate of people who provided a phone

number and were randomized to the control group is 37.9%, relative to 40.8% for defendants who did not provide a phone number ($P < 0.001$). Still, failures to appear were very frequent even among people who provided a phone number (see supplementary materials for a more detailed discussion of and tests for external validity on the basis of this sample).

Defendants were randomly assigned to one of four conditions. The control group received no text messages. In the other groups, summons recipients received three messages: a message 7 days before, a message 3 days before, and a message 1 day before their scheduled court date. We varied the content of the messages to better identify what information is most effective at reducing failures to appear. In the consequences group, defendants received messages that described their court date and location and also told them that a warrant would be opened and they might be arrested if they missed their court date. In the plan-making group, defendants received messages that described their court date and location and also prompted them to make a plan to attend court, including marking their calendars, setting an alarm, and looking up directions (but there was no mention of consequences). In the combination group, defendants received a mix of the messages from the consequences and plan-making groups. Analyses below were preregistered. Defendants who missed court were also randomized to receive different follow-up messages, but these were not part of our primary analyses in our preanalysis plan and are not discussed here.

We can evaluate the effectiveness of these messages in a few ways. First, do any text messages reduce failures to appear? As shown in table S5, relative to a 37.9% failure-to-appear rate in the control group, receiving any text message reduced failures to appear by 8 percentage points, which represents a 21% relative reduction ($P < 0.001$). Second, the differences across treatment groups also provide some evidence for why these messages are effective (Fig. 3 and table S5). The consequences and combination messages were most effective, reducing failures to appear by 8.9 and 9.9 percentage points relative to the control group (23.5 and 26.1% relative reductions; $P < 0.001$ in both cases), respectively. This suggests that a substantial proportion of defendants miss court because they are unaware of the consequences. The plan-making messages, which did not mention the consequences of failure to appear, also significantly reduced failures to appear by 6 percentage points (15.8%; $P < 0.001$). These results build on an earlier smaller-scale study that examined the effectiveness of postcard reminders for defendants in a context where baseline failure-to-appear rates were substantially lower than the current context (13).

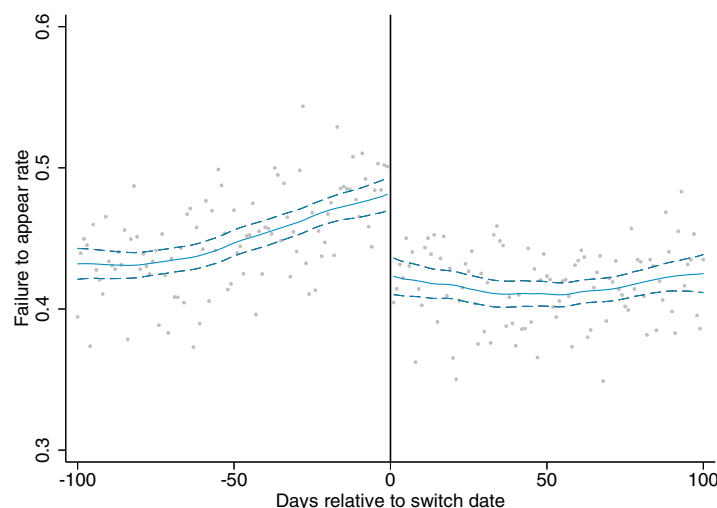
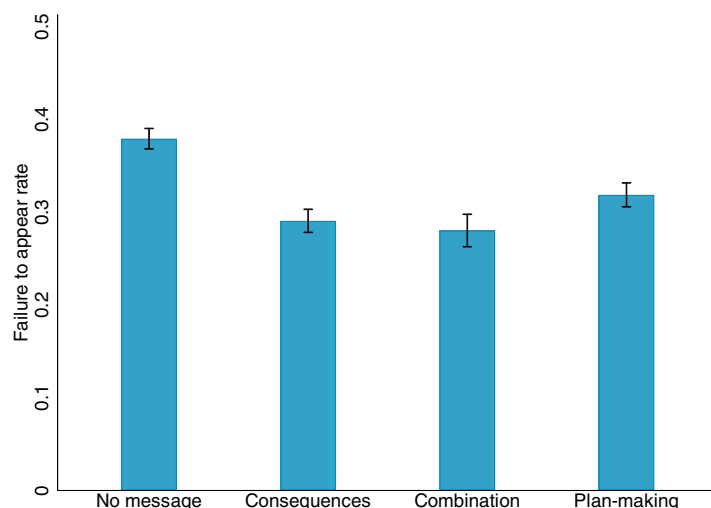


Fig. 2. Scatterplot of daily averages of failure-to-appear rate relative to the switch date from old to new forms. Solid lines are local-polynomial regression lines, and dashed lines represent the 95% confidence intervals.

Fig. 3. Failure-to-appear rate by text message treatment arm. Errors bars represent 95% confidence intervals.



The fact that these reminders are effective suggests that a meaningful proportion of defendants missed court because they lacked the most basic information about their scheduled appearance. It is possible that the plan-making component of the messages might have helped defendants show up to court, but even the simple consequences message—which just contained information about their court appearance—reduced failures to appear.

Laboratory experiments on mechanisms and punitive attitudes

It is possible that our interventions were effective for other reasons besides just making defendants more aware of court information. For example, perhaps defendants were already aware of the information—they noticed it and remembered it—but our interventions led them to believe punishment for failure to appear was more likely. Below, we find stronger evidence for the awareness hypothesis in two laboratory experiments. We then explore whether people might underappreciate how insufficient awareness can lead to failures to appear and whether they might overlook the value of the nudges we tested.

In our first two laboratory experiments, we tested whether the redesigned forms increased awareness of court information (see Materials and methods and the supplementary materials for further details on all laboratory experiments). In the first laboratory experiment, 232 participants from Amazon Mechanical Turk (MTurk) first read background information about failures to appear in New York City. Participants were then shown a summons form and asked to identify three pieces of information on the form: the defendant's court date and time, the defendant's court location, and the defendant's alleged offense. Participants were randomly assigned to see either the old form or new form, and they clicked on the parts of the form that contained the information. The

new form simply moves court information to the top but leaves the position of information about the alleged offense unchanged. We recorded how long (in milliseconds) it took participants to identify each piece of information. We expected that people would be faster to identify court information in the new form (because this information was prioritized at the top of the form) but would not be any faster to identify information about the alleged offense (because its position was unchanged).

Participants who saw the new form identified the court date and time more quickly ($\text{Mean}_{\log(\text{reaction time})} = 4.46$; $\text{SD} = 0.46$) than participants who saw the old form ($M_{\log(\text{RT})} = 4.72$; $\text{SD} = 0.37$), per a t test with unequal variances [$t(229.17) = 4.86$; $P < 0.001$]. This was also true for identifying the court location (new form: $M_{\log(\text{RT})} = 4.59$; $\text{SD} = 0.40$ versus old form: $M_{\log(\text{RT})} = 4.70$; $\text{SD} = 0.35$) [$t(230) = 2.37$; $P = 0.02$]. Participants who saw the old and new forms did not significantly differ in how quickly they identified the alleged offense [$t(230) = 0.39$; $P = 0.69$]. Thus, it is clear that people more easily identify information at the top of the form, and moving court information there makes it more accessible.

Laboratory experiment 2 extends these results by testing whether the new form actually improves recall of court information. We recruited 725 New York City residents on MTurk. Participants were told to imagine receiving a summons form for disorderly conduct. They were then randomized to see either the old summons form or the new summons form. They completed a brief filler task (to create a gap before subsequent questions) and then responded to several questions. Of primary interest were the questions where they were asked to recall the penalty for failure to appear, the court date, and the court location.

First, we found that participants who saw the new forms were more likely to correctly recall their court date (new form, 38%; old form,

19%; $P < 0.001$) and court location (new form, 46%; old form, 26%; $P < 0.001$). Moreover, we found that participants who saw the new forms were more likely to correctly recall that the penalty for failure to appear was a warrant (new form, 52%; old form, 41%; $P = 0.003$; see table S7). The results are similar with and without covariates, including whether a person had received a summons in the past.

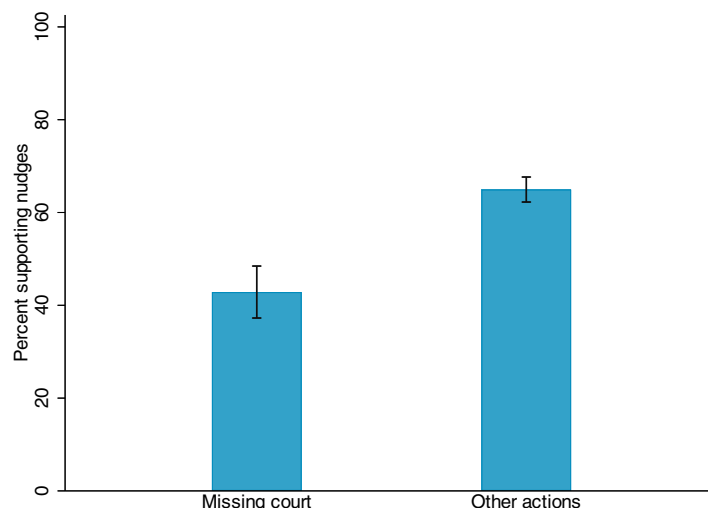
It is worth noting that, in some ways, this experiment makes it fairly easy to remember the court information. Participants were asked about the information shortly after seeing it. Nevertheless, recall rates are lower for the old forms. This suggests that defendants who received the old form might have been unaware of court information simply because it was not communicated effectively. Participants also rated the forms on other dimensions, such as whether they made participants feel angry or confused and whether participants felt the tickets were fair or reasonable. We do not see any reliable differences in ratings across these dimensions. The main difference appears to be that the new form made it easier to find information about court and the consequences of missing court (table S8).

Given how straightforward these interventions are, why might they have only recently (and not yet widely) been implemented? In our remaining laboratory experiments, we consider whether people's mental models of criminal justice might lead them to underestimate the effectiveness of interventions like these.

In laboratory experiment 3, participants ($N = 301$, MTurk sample) read five scenarios about people failing to take a required action: failing to appear for court, failing to pay an overdue bill, failing to show up for a doctor's appointment, failing to turn in paperwork for an educational program, and failing to complete a vehicle emissions test. These scenarios were selected to provide a cross section of different policy domains—criminal justice, personal finance, health, education, and environmental decisions—and because most are situations where reminders have proven effective. To limit differences across domains, participants were told that the following details applied to each scenario: the person was required to take an action in 60 days, the person did not want to take the action, there was a penalty for failing to act, and ultimately the person did not take the required action. For each scenario, participants rated how likely they thought it was that the person missed their appointment because they did not pay enough attention to the scheduled date or because they simply forgot. They also rated how likely it was that the person deliberately and intentionally decided to skip their appointment. Finally, participants were asked what they thought should be done to make sure that other people show up for their appointments, and they chose

Fig. 4. Participants' support for using nudges to reduce failures to appear in court and failures to complete other actions (from laboratory experiment 3).

Errors bars represent 95% confidence intervals.



one of three options: increase the penalty for failing to show up, send reminders to people about their appointments, or make sure that appointment dates are easy to notice on any paperwork. All scenarios were presented in a random order for each participant.

Relative to most other actions, participants rated failures to appear for court as less likely to be a result of forgetting ($M_{\text{court}} = 3.86$, $SD = 2.06$; $M_{\text{other actions}} = 4.24$, $SD = 1.45$; paired t test, $t(300) = 3.79$, $P < 0.001$) and more likely to be intentional ($M_{\text{court}} = 5.17$, $SD = 1.75$; $M_{\text{other actions}} = 4.82$, $SD = 1.29$; paired t test, $t(300) = 3.92$, $P < 0.001$). Next, we analyzed whether participants supported either of the nudges (sending reminders and making appointment information easy to notice) over stiffer penalties. Relative to all other actions, participants were least supportive of nudges to reduce failures to appear ($M_{\text{court}} = 43\%$, $SD = 50$; $M_{\text{other actions}} = 65\%$, $SD = 34$; paired t test, $t(300) = 8.13$, $P < 0.001$), as shown in Fig. 4 (see figs. S6 and S7 for breakdown by each action). It appears that people generally ascribe greater intentionality to failures to appear, and these intuitions may inform why people believe stiffer penalties are more effective than nudges for reducing failures to appear.

We explore this link further in laboratory experiment 4. Participants ($N = 304$, MTurk sample) read background information on summonses and failure-to-appear rates in New York City. Our main dependent variable was what participants thought should be done to reduce the failure-to-appear rate: increase the penalty for failing to show up, send reminders to people about their court dates, or make sure that court dates are easy to notice on the summonses. Participants were randomly assigned to one of three conditions. In the control condition, participants made their policy choice immediately after reading the background information. In the intentional condition, after

reading the background information, participants wrote down one reason why someone might purposely skip their court appearance, and then they made their policy choice. In the mistake condition, participants wrote down one reason why someone might accidentally miss their court appearance, and then they made their policy choice.

We find two notable results. First, participants' policy recommendations did not significantly differ between the control (63% supported nudges; i.e., reminders or making court dates easy to notice) and intentional (61%) conditions [$\chi^2(1, N = 304) = 0.09$; $P = 0.76$], which suggests that participants' default assumptions are that failures to appear are intentional. Second, 82% of participants supported nudges in the mistake condition, significantly more than in both the control [$\chi^2(1, N = 304) = 9.08$; $P = 0.003$] and the intentional conditions [$\chi^2(1, N = 304) = 10.53$; $P = 0.001$], which suggests that their attitudes are malleable, as shown in Fig. 5. Our participants are generally supportive of using nudges instead of stiffer punishments, and this is in line with previous work that has shown that people tend to hold favorable views of nudges (14, 15). Support for nudges in this experiment is also higher than what we found in laboratory experiment 3, perhaps because more background information (e.g., the baseline failure-to-appear rate) was provided to participants. Nevertheless, our data suggest that people's default assumption is that failures to appear are intentional, and this weakens support for nudges.

In laboratory experiment 5, we tested whether experts shared laypeople's intuitions. We recruited, through email listservs, a sample of criminal justice professionals (e.g., judges, prosecutors, and defense attorneys; for full recruitment details, demographics, and discussion of attrition, see supplementary materials). In total, 145 experts completed the full

study. The most common professions in our sample were prosecutor (58%) and defense attorney (17%).

There were two parts to the study. The first part was a direct replication of laboratory experiment 4. Experts' responses did not significantly vary across conditions ($P > 0.3$ in all conditions), but we found that the vast majority of experts (89% across conditions) favored using nudges over stiffer penalties, showing significantly greater support than that observed in our sample of laypeople [$\chi^2(1, N = 449) = 21.56$; $P < 0.001$].

In the second part of the study, participants were shown pictures of both the old and new form (they were not labeled as such), and they indicated whether they thought recipients of the old or new forms would be more likely to remember their court information and show up for their court appearance. A clear majority of experts thought that recipients of the new form would be more likely to remember their court date (86%) and court location (68%) and show up to court (69%). For comparison, we asked a sample of 301 MTurk participants these same questions. As shown in Fig. 5, experts thought that the new form would be more effective than laypeople, who showed no clear preference for the new form (court date, 49%; court location, 50%; show up to court, 47%; $P < 0.001$ in all cases).

It is possible that our sample of experts was particularly reform-minded relative to other experts. However, these results might suggest a notable tension. These experts seemed to view failures to appear as less intentional than laypeople, and they showed greater support for nudges to reduce failures to appear. This was true regardless of experts' jobs within the criminal justice system. Nevertheless, criminal justice policy on failures to appear seems to hew closer to laypeople's intuitions. It is common to try to deter failures to appear through the threat of punishment but rarer to use nudges to prevent them. These studies suggest that increasing the adoption of these nudges may depend partly on shifting policymakers' mental models of why offenses like failures to appear happen.

Effects across socioeconomic status and race

Failing to account for human error in the context of criminal justice policy has profound consequences, and these consequences are often borne by the poor and people of color, who are disproportionately affected by the criminal justice system. In exploratory analyses, we find some evidence of this disproportionate involvement in the context of failures to appear as well. We do not have reliable, individual-level data on summons recipients' wealth or race. However, we have data on home addresses, which we can match to census tract data. We can then use census

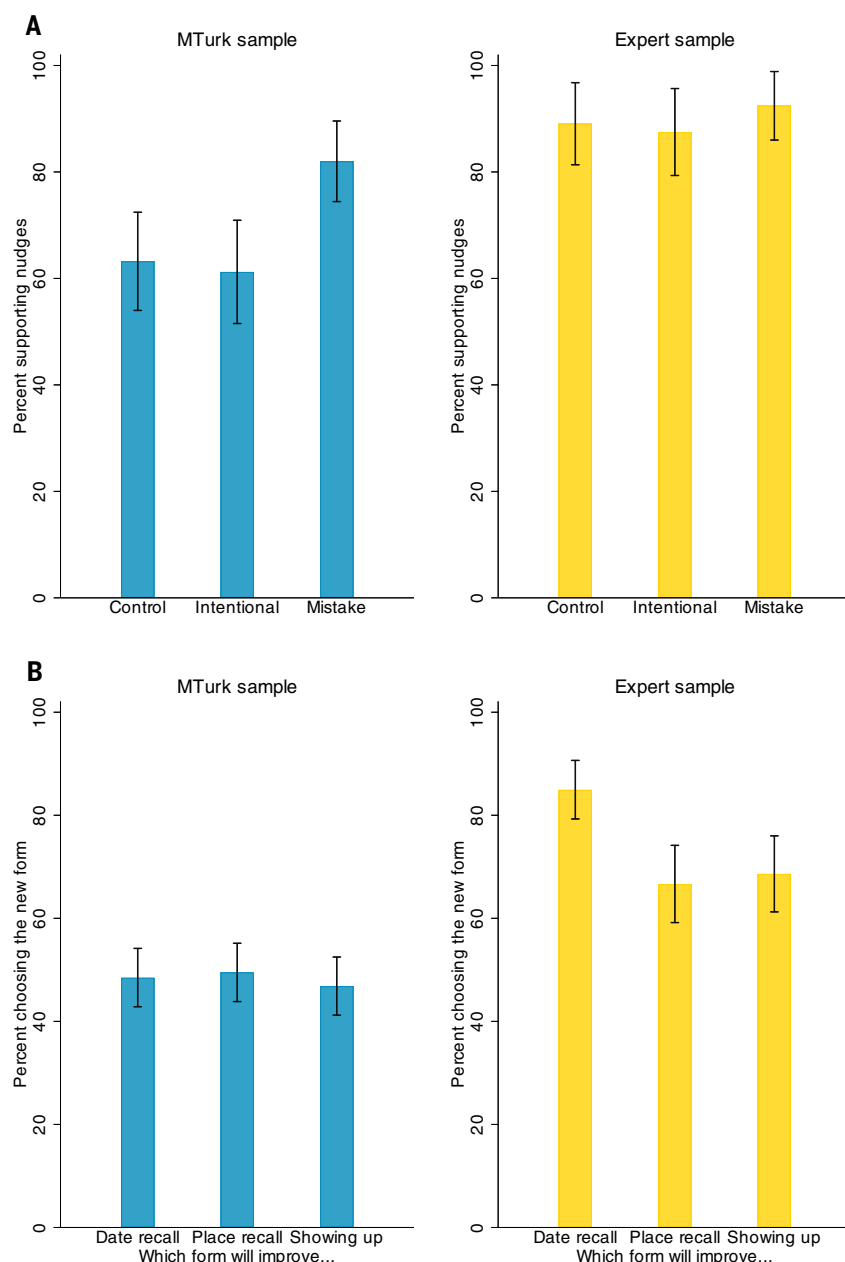


Fig. 5. Laypeople's and experts' beliefs about failures to appear and effectiveness of the redesigned summons forms. (A) Laypeople's (left) and criminal justice experts' (right) support for nudges to reduce failures to appear based on whether they thought about these failures as intentional or as a result of forgetting or were in the control condition. (B) Laypeople's (left) and criminal justice experts' (right) judgments of whether the redesigned summons form would improve recall of court information and the rate at which defendants showed up for court (from laboratory experiments 4 and 5). Error bars represent 95% confidence intervals.

tract-level data on poverty and racial composition as a proxy for defendants' wealth and race.

First, we ask whether the effectiveness of our interventions varied on the basis of the wealth and racial composition of defendants' neighborhoods (fig. S8 and tables S10 to S13). We see some suggestive evidence that the interventions were more effective for poorer defendants. Dividing our sample of summons recipients by quintiles, the treatment effect for

the text messaging intervention is 12.5 percentage points (27%) for defendants living in the bottom quintile of neighborhood wealth, which is significantly greater than the average of 6.4 percentage points (19%) for defendants living in other quintiles [treatment by poorest quintile interaction: $\beta = -0.058$, standard error (SE) = 0.017, $P = 0.001$]. The effectiveness of the form redesign does not significantly vary by wealth, although the results trend in the

same direction. The form redesign reduced failures to appear by 8 percentage points (15%) for defendants living in the bottom quintile of neighborhood wealth compared with a reduction of 5.7 percentage points (13%) for defendants living in other neighborhoods. These results are mixed, but it may be helpful to think about them in the context of recent work, which has suggested that poorer individuals must often cope with greater demands on their cognitive bandwidth (16–18). If poorer individuals are already dealing with greater cognitive demands, then our findings hint at the possibility that interventions such as those evaluated here might be particularly important for poorer defendants.

We do not find that the effectiveness of our interventions depends on the racial composition of defendants' neighborhoods. However, defendants who live in neighborhoods with a higher proportion of Black or Hispanic residents were less likely to give their phone numbers to officers. We cannot identify why this is, but it could reflect different policing practices (e.g., if officers do not ask for phone numbers as often in these neighborhoods) or mistrust between police and people of color (who may be reluctant to provide their phone numbers). If text message reminders are an effective way to reduce failures to appear (and thereby reduce open warrants), greater effort is needed to ensure that this intervention can benefit all communities.

Of course, nudges such as these are not sufficient to address larger, structural disparities in the criminal justice system. These dynamics are apparent when we examine whether wealth and racial composition of a neighborhood predicts the number of summonses issued (Fig. 6). We divided New York City census tracts into percentiles, where higher percentiles correspond to a greater proportion of residents living below the poverty line or a greater proportion of Black and Hispanic residents. We then regressed the number of summonses issued (per 1000 residents) on percentile. We find that more summonses are issued in poorer neighborhoods ($\beta = 0.29$, SE = 0.01, $P < 0.001$) and in neighborhoods with more Black and Hispanic residents ($\beta = 0.35$, SE = 0.01, $P < 0.001$). To put these differences in context, more than half of all summonses issued are in the poorest 30% of census tracts (where >18% of residents live below the poverty line). Similarly, more than half of all summonses issued are in the 32% of census tracts with the highest proportion of Black and Hispanic residents (where >80% of residents are Black or Hispanic). These differences in summonses issued are accompanied by failure-to-appear rates that are higher for defendants living in poorer neighborhoods (poorest quintile among summonses recipients: 53%, versus wealthiest quintile: 37%) and neighborhoods

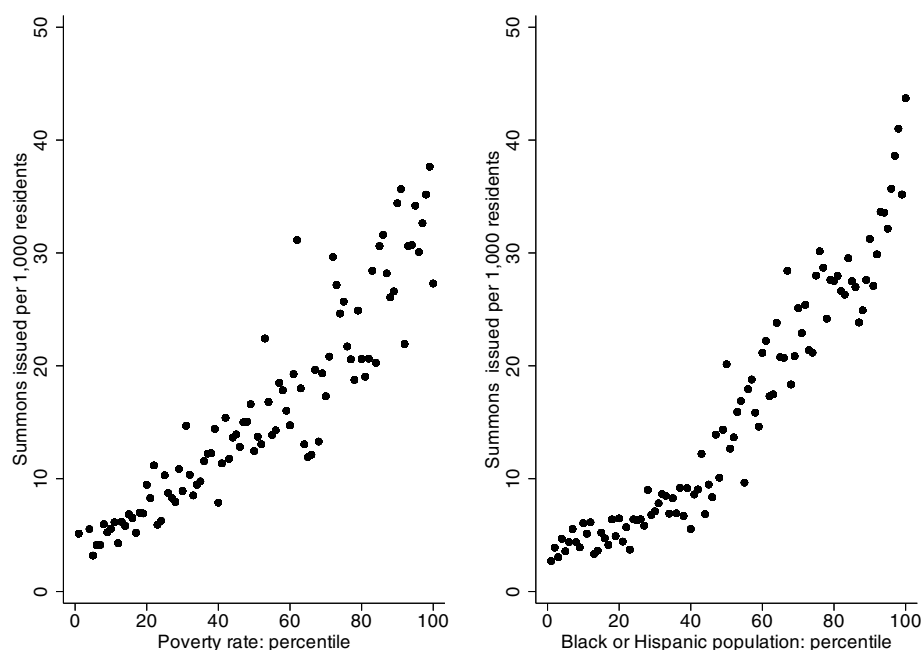


Fig. 6. Summonses, wealth, and race. Summonses issued by wealth (left) and racial composition (right) of census tracts. Census tracts are divided into percentiles, where higher percentiles correspond to a greater proportion of residents living below the poverty line or a greater proportion of Black and Hispanic residents.

with the highest proportion of Black and Hispanic residents (highest Black and Hispanic population quintile: 53%, versus lowest Black and Hispanic population quintile: 34%), which compounds the negative consequences of summonses on poor and minority citizens.

Given that summonses (and failures to appear) are disproportionately concentrated in neighborhoods that are poorer and have a higher proportion of Black and Hispanic residents, the benefits (i.e., reductions in failures to appear and open warrants) of implementing interventions such as ours may also be concentrated in these neighborhoods regardless of whether their effectiveness varies on the bases of wealth and race.

Discussion

This work suggests that there is a straightforward explanation for why many defendants miss court—information about their court dates is not sufficiently salient. However, policies have failed to fully account for this. Instead, these policies are often targeted toward reducing failures to appear as if they occur through intention rather than error.

By anticipating how human error can lead to failures to appear, our interventions have clear benefits for both defendants and the court system. We estimate that the form redesign and text message interventions have helped avoid at least 30,000 warrants being issued between August 2016 and September 2019 (see supplementary materials for detailed calculations). Moreover, ~66% of summonses

recipients see their case conditionally or unconditionally dismissed when they show up to court (19). This means that our interventions likely resulted in ~20,000 people having their cases fully dismissed instead of having an open warrant. It is also worth noting that the design of New York City's old summons form was not unique, as other major cities' forms have similar designs (for an example, see fig. S9). The benefits we see here are therefore likely to generalize to other cities as well.

Warrants can negatively affect many dimensions of people's lives, even if they do not result in an arrest. Sociologists have noted how warrants can have an effect of marking people, or designating their involvement in the criminal justice system, which both creates hassles for them and increases the chances of later escalation in criminal justice involvement (20). Ethnographic research has shown that people with open warrants often avoid places where they fear they could be identified and arrested. They may be less likely to go to hospitals for medical treatment or to show up to regular jobs, and they may frequently change their housing (21). They are also less likely to call the police to report crimes (even when they are the victims), and they are less likely to use social services and government assistance available to them, such as food stamps or job training programs (22). Open warrants can also be public record, which could negatively affect job prospects, housing, and a range of other outcomes for defendants. Though it is difficult to quantify these negative effects, it is clear

that by reducing warrants, these interventions can have cascading benefits.

Failures to appear are also costly to the criminal justice system itself. Court personnel time is wasted when defendants miss court, and efforts are diverted in issuing warrants. Each warrant costs approximately \$21 in judge and staff time (23), which translates into a savings of more than \$600,000 in court personnel time alone from these interventions. We can also estimate that each arrest would cost \$454 in police and court personnel time [based on (24); see supplementary materials for detailed calculations]. From our data, we cannot estimate how often warrants for summons failures to appear lead to arrests in New York City. However, a recent study in St. Louis found that in 2017, ~1% of all residents were arrested for similar warrants (25). Of course, the proportion of defendants who are arrested for these warrants is necessarily higher than the proportion of residents, but if even 1% of defendants in our sample were arrested for failure to appear, then our interventions would have saved approximately \$140,000 from August 2016 to September 2019. Additionally, these interventions are cheap. The redesigned form has exactly the same marginal cost as the old form, and sending every summons recipient three text messages would cost New York City about \$4500 a year, making the two interventions we described here incredibly cost-effective. Due in part to these studies, all summons recipients in New York City now receive the new form and text message reminders if they provide a phone number.

These insights on the importance of insufficient awareness can likely mitigate a host of related problems in the criminal justice system. Most directly, the national failure-to-appear rate for felonies is 17 to 22% (26, 27). If insufficient awareness is partly responsible for defendants missing court for more serious offenses, there would be even greater benefits from addressing it. Even within our sample of summons recipients, we find the same treatment effects across offenses of varying severity (table S9), which suggests the possibility that insufficient awareness matters even for more serious offenses. Interventions such as the ones described here might help reduce the need for pretrial detention, as they might mitigate concerns that defendants will miss court. In fact, New York City has since expanded the use of text message reminders as a tool for reducing pretrial detention (28). Moreover, in 2016, 29% of state and federal prisoners were detained for violating some conditions of probation or parole, and it is possible that insufficient awareness might explain some of these violations (29).

More generally, our results highlight a blind spot in traditional criminal justice policies. These policies are built on an assumption that people intentionally weigh the costs and benefits

of a potential offense (30). Policies therefore often focus on deterring crime with various sanctions or punishments. Deterrence policies can only be effective when people consider the consequences of committing an offense, but this may not always happen (37). For example, bail is often used to reduce failures to appear. This system creates clear consequences for failures to appear—forfeiture of money. However, monetary bail does not appear to reduce failures to appear (32). In 2017, New York City reclassified many low-level offenses to be eligible for civil summonses (for which failures to appear do not result in warrants); yet failure-to-appear rates for these offenses did not substantially increase when the threat of warrants was removed (33). The fact that these material consequences have no effect on failures to appear suggests that many defendants are not engaged in a careful calculus of whether to skip court. Our work here goes a bit further than earlier work that has shown how this calculus might not be sensitive to punishment severity (9). Our results suggest that there may be times when such a calculus is essentially impossible because defendants are unaware of the information that would prompt (and influence) such calculation.

However, policy-makers have been slow to experiment with and adopt behavioral interventions such as these. Perhaps this is because of the criminal justice policy’s implicit assumption that failures to appear are intentional. Our laboratory experiments show that many laypeople share this assumption, and people are less supportive of these interventions when they assume that defendants intentionally skip court. It is more encouraging

that our sample of experts have different intuitions—they see how failures to appear can be unintentional, and they see a role for these interventions. However, some policies seem more closely aligned with the intuitions of our sample of nonexperts. Prior research has shown that criminal justice policies in the United States may be more aligned with popular sentiment (and perhaps more punitive) because the criminal justice system relies less on experts who are insulated from public opinion, and more on elected officials (34, 35).

Thus, widespread adoption of interventions such as these might depend on a shift in the assumptions of why failures to appear happen. Deterrence-based policies cannot be effective if people are unaware of the very information necessary for deterrence. This work suggests that making people aware of critical information may be an important addition to deterrence policies. Otherwise, these policies risk merely punishing people and not deterring actions.

Materials and methods

Form redesign details

We made four key changes to the summons form. First, the old summons form’s heading read: “Complaint/Information.” On the new form, we changed the heading to read: “Criminal Court Appearance Ticket,” to emphasize that the recipient was required to appear in court. Second, the old summons form listed the court date at the bottom. On the new form, we moved this information closer to the top of the form to make it easier to notice. Third, the old summons form required officers to write out the court’s location (again near the bottom of the form), which would have been easy to

overlook amid all of the other text on the form. On the new form, we moved this to the top, and we made it easier for officers to clearly indicate the court location. Fourth, the old summons form only noted on the back of the form that arrest warrants are issued for failures to appear. The new form included this information in bold font on the front of the form, highlighted in orange.

Message content for text message reminders

The exact wording of the text message reminders across our three treatment arms is provided in Table 1.

Laboratory experiment 1

We recruited participants from Amazon Mechanical Turk (MTurk): 232 participants completed this study. The background information on summonses included the types of offenses for which summonses are issued and the requirement to appear in court 60 to 90 days later. On the screen containing the summons form, there was a text box that reminded participants of the three pieces of information participants were searching for. When participants clicked on the corresponding information in the form, it was removed from the text box. Because reaction times are typically skewed, we analyzed the logarithm of the time it took participants to find each piece of information.

Laboratory experiment 2

We recruited 725 New York City residents from MTurk. Participants differed in many ways from the defendants in our evaluation (see table S6 for characteristics). Most notably,

Table 1. Text messages sent in the week leading up to defendants’ court dates by treatment.			
Treatment	7 days prior	3 days prior	1 day prior
Consequences	Helpful reminder: go to court Mon Jun 03 9:30AM. We’ll text to help you remember. Show up to avoid an arrest warrant. Reply STOP to end texts. www.mysummons.nyc	Remember, you have court on Mon Jun 03 at 346 Broadway Manhattan. Tickets could be dismissed or end in a fine (60 days to pay). Missing can lead to your arrest.	At court tomorrow at 9:30AM a public defender will help you through the process. Resolve your summons (ID#####) to avoid an arrest warrant.
	Helpful reminder: go to court on Mon Jun 03 9:30AM. Mark the date on your calendar and set an alarm on your phone. Reply STOP to end messages. www.mysummons.nyc	You have court on Mon Jun 03 at 346 Broadway Manhattan. What time should you leave to get there by 9:30AM? Any other arrangements to make? Write out your plan.	You have court tomorrow for summons ID#####. Did you look up directions to 346 Broadway Manhattan? Know how you’re getting there? Please arrive by 9:30AM.
Combination	Helpful reminder: go to court Mon Jun 03 9:30AM. We’ll text to help you remember. Show up to avoid an arrest warrant. Reply STOP to end texts. www.mysummons.nyc	You have court on Mon Jun 03 at 346 Broadway Manhattan. What time should you leave to get there by 9:30AM? Any other arrangements to make? Write out your plan.	Remember, you have court tomorrow at 9:30AM. Tickets could be dismissed or end in a fine (60 days to pay). Missing court for ##### can lead to your arrest.

only 4% of the MTurk respondents said they had ever received a court summons, and the sample is 60% female compared with 12% for summons recipients. However, these differences should not interact with the simple recall task in the experiment.

Participants first read a vignette in which they imagined they were involved in an altercation and received a court summons for disorderly conduct. Participants then saw their summons form, with placeholder information written into most fields. Participants were randomly assigned to see either an old or new summons form. Critically, they were informed that their court date would take place on 1 November 2017 (2 months after the incident described above) at Kings Criminal Court (346 Broadway, New York, NY 10013).

Participants then indicated the extent to which the form made them feel angry or confused (scale: strongly disagree to strongly agree). They then completed a word search as a filler task before answering questions about the forms. Next, they responded to multiple choice questions in which they were asked to recall the court date and court location listed on the form. They then indicated how likely they thought each of several outcomes would be if they missed their court date (scale: highly unlikely to highly likely): (i) The ticket would be dismissed. (ii) They would be fined. (iii) A warrant would be issued for their arrest. (iv) Nothing would happen. (v) They would get something in the mail. Finally, they responded to two multiple choice questions asking them what they were being charged with and how they could get more information.

Laboratory experiment 3

We recruited 301 U.S. residents from MTurk. Participants read five scenarios about people failing to take a required action: failing to appear for court, failing to pay an overdue bill, failing to show up for a doctor's appointment, failing to turn in paperwork for an educational program, and failing to complete a vehicle emissions test.

There are many ways in which a court appearance differs from, say, a doctor's appointment. Presumably, few people want to go to court, whereas people willingly make doctors' appointments. There are also stiff penalties for failing to appear for court, less so for other failures. And the hassles involved in attending a court appearance might be greater than the hassles involved in other actions. We attempted to control for all of these differences in our scenarios. Scenarios followed a similar template. Participants imagined that a person was required to take an action in 60 days. They were told that this person does not want to take the action, but will face a penalty for failing to do so. Participants then read that the person did not take the required action.

They then answered questions about why they thought the person failed to take action and what they think should be done to make sure that other people take the required action.

Laboratory experiment 4

We recruited 304 U.S. residents from MTurk. All participants read the same background information about summonses in New York City as in laboratory experiment 1, with additional text explaining that arrest warrants are issued for missing court (and defendants are warned about this), along with the base rate of failures to appear.

Participants were randomly assigned to one of three conditions. In the intentional condition, after reading the background information, participants responded to this question: "What is one reason why people might purposely skip their court appearance?" In the mistake condition, participants responded to this question: "What is one reason why people might accidentally miss their court appearance?" In the control condition, participants were not prompted to write anything. All participants then answered the following question: "What do you think should be done to make sure that other people show up for their court date?" Response options were: "Increase the penalty for failing to show up." "Send reminders to people about their court dates." "Make sure that court dates are easy to notice on the tickets/summonses forms issued."

Laboratory experiment 5

We recruited criminal justice experts to participate between 29 June 2020 and 10 July 2020 from several professional listservs. We received 145 complete responses (with an additional 49 partial responses). Our analyses only focus on complete responses.

After the first two parts of the experiment (described above), participants then completed several demographics questions, mostly related to their profession: what state or territory they worked in, their current role, the number of years they have been in that role, the kind of court they work in (if applicable), and how many defendants they observe failing to appear for court (if applicable). They were also asked their gender and ethnicity. Among people who completed the survey, 84 were prosecutors, 26 were defense attorneys, 7 were police officers, 7 were judges, and 21 had another profession related to criminal justice.

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Data and materials and availability: Preregistration details, all analysis code, data from the laboratory experiments, and anonymized data allowing researchers to reproduce results from the field experiments are available on OSF (<https://osf.io/mb6x7/>).

SUPPLEMENTARY MATERIALS

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Supplementary Materials and Methods

Supplementary Text

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MDAR Reproducibility Checklist

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Behavioral nudges reduce failure to appear for court

Alissa Fishbane, Aurelie Ouss and Anuj K. Shah

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"Nudges" and criminal justice

Criminal justice policy in the United States focuses on increasing negative consequences to deter undesired behavior. However, defendants often appear relatively insensitive to these changes in the severity of consequences. Fishbane *et al.* considered a different policy lever: improving the communication of information necessary to adhere to desired behavior (see the Perspective by Kohler-Hausmann). They found that redesigning a criminal summons form to highlight critical information and providing text message reminders increased the likelihood that defendants would show up to their appointed court date, thus eliminating a substantial percentage of arrest warrants for failing to appear in court. In follow-up experiments, the authors found that laypeople, but not experts, believe that such failures to appear are relatively intentional, and this belief reduces their support for interventions aimed at increasing awareness rather than punishment. These findings have implications for policies aimed at improving criminal justice outcomes.

Science, this issue p. eabb6591; see also p. 658

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