Can behavioral interventions be too salient? Evidence from traffic fatality messages

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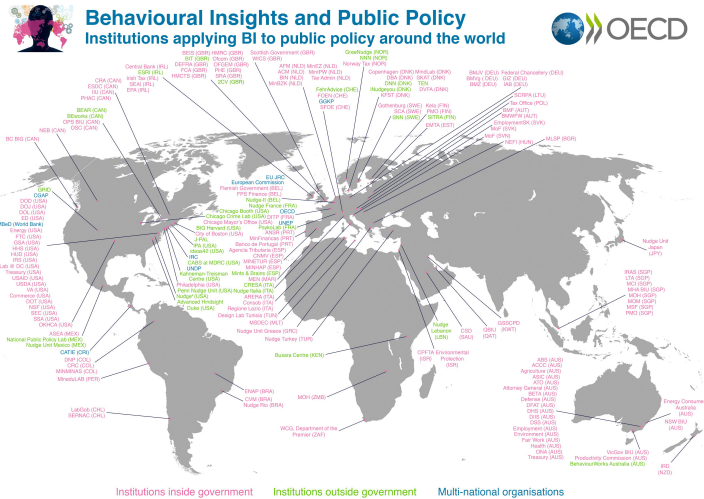
Policy makers increasingly turning to behavioral interventions

Motivation

- Growing interest in behavioral interventions as low-cost and easy to implement method of changing behavior
- Used to address
  - Voter turnout (Gerber and Rogers 2009)
  - Charitable giving (Frey and Myers 2004)
  - Retirement savings (Beshears et al. 2015)
  - Water and energy conservation (Ferraro and Price 2013, Allcott 2011)
  - Hand-washing (Luby et al. 2005)
  - Caloric intake (Bollinger, Leslie, and Sorensen 2011)
  - Risky sexual behavior (Dupas 2011)
  - and more…

Behavioral interventions used by over 150 governments



Guidebooks say behavioral interventions should be

- Salient – “seize people’s attention”
- Timely – implement at a time individuals can take the desired action

(Behavioural Insights Team 2014, OECD 2018)

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Unfortunately, doing so may distract people from a more important task

We show interventions can be too salient, with costly consequences

Main contribution

- Behavioral interventions have cognitive costs, and may crowd out other, more important, considerations—causing the intervention to backfire
- Four lessons for behavioral interventions
  - When designing:
    1. Consider individuals' cognitive loads when interventions will occur
    2. Be careful interventions are not too salient
    3. Build in measurement
  4. When evaluating: full accounting of welfare effects of should consider whether adding to participants' cognitive loads has spillover effects outside the targeted domain

Research setting: Traffic safety campaign

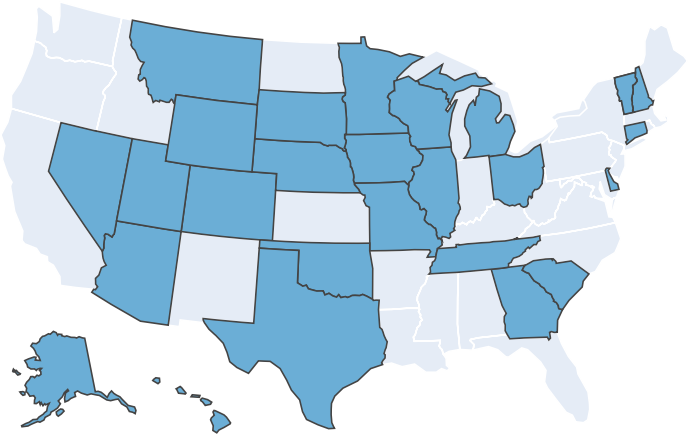
- Traffic fatalities are the leading cause of death of 5–45 year-olds in US and worldwide
- Traffic crashes kill over 39,000 Americans per year

Message intentionally designed to be salient

Official statements on fatality messages

- Ohio: “hope” that these “in your face” safety messages will “motivate motorists to exercise caution behind the wheel”
- Texas: “hope” that a “sobering new message…will help save lives.”

Because of its low cost and ease of implementation, 27 states have implemented some form of fatality message since 2012



People are confident fatality messages work

- Rapid adoption by 27 states — with no evaluation
- Illinois: Unanimous support from the Department of Transportation, State Police, and Department of Public Health
- Surveys show drivers believe: (Boyle et al 2014)
  - Fatality message more effective than other public safety messages
  - Fatality messages causes them to drive safer
- "At this time, our [redacted] program is pretty popular and there is belief that it is helping to change the 'safety culture' which in turn will help reduce crashes in the long run."
  – Director, Traffic and Safety, [redacted] Department of Transportation

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Contrary to expectations, we find these messages increase the number of crashes

Texas provides an great setting for studying effect of fatality messages

Why Texas?

- Large state with over 800 digital message signs and 29 million residents
- TxDOT decided to show these fatality messages for only one week each month: the Monday-to-Monday prior to monthly TxDOT board meeting

Fatality messages cause 4.5–8.0% more crashes w/in 10 km of a DMS

Results

- Weeks assigned to treatment have 1.4–2.2% more crashes within 10 km of a DMS than other weeks in same month
- IV estimates: message causes 4.5–8.0% more crashes
- After 5 years of seeing messages, still causing more crashes
- Proposed mechanism: Messages add to drivers' cognitive loads, distracting them and crowding out capacity to drive safely
- No evidence that fatality message leads to safer driving after treatment
- Heterogeneity: Message helps when reported number of fatalities is low and on road segments that are not complex

These findings make three additional contributions

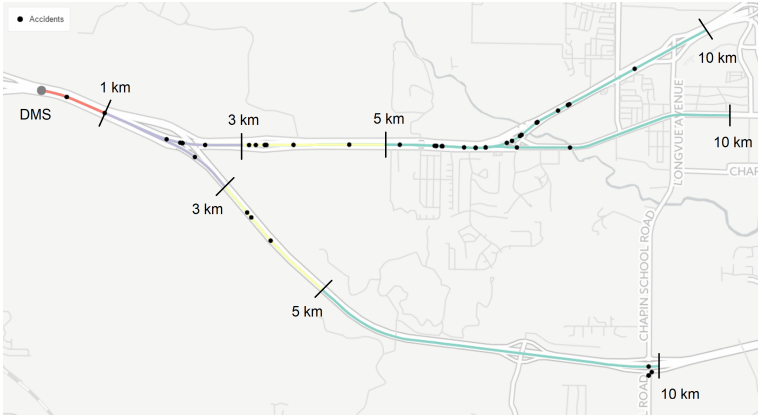
Additional contributions

- Individuals do not necessarily habituate to behavioral interventions
  - Limited evidence, Allcott and Rogers (2014) find individuals habituate after 4 home energy reports, we find no habituation after 5 years
- The effects of behavioral interventions need not persist after treatment stops
  - Most of literature finds effects do not persist, we agree
- Generic risk disclosures can affect individual behavior

Compare outcomes during campaign weeks vs. not, within same segment-year-month-day of week-hour

Research design

- Calculate all highway crashes within a given driving distance following a DMS for each hour of each day



Compare outcomes during campaign weeks vs. not, within same segment-year-month-day of week-hour

Research design

- Calculate all highway crashes within a given driving distance following a DMS for each hour of each day
- Difference-in-differences design
  - First-difference: Difference between crash counts during campaign week (week prior to a TxDOT board meeting) and other weeks within the same segment-year-month-day of week-hour
  - Second-difference: Difference between after safety campaign began (August 2012–December 2017) and before (January 2010–July 2012)
- Control for weather conditions and holidays

Main regression specification is difference-in-differences

$$\begin{aligned}\text{Crashes (\%)}_{s(x),d,h} = &\beta_1 \cdot \text{Board meeting}_{d,h} + \delta \cdot \text{Board meeting}_{d,h} \cdot \text{Post}_d \\ &+ \beta_3 \cdot \text{Trace precipitation}_{s,d,h} + \beta_4 \cdot \text{Trace precipitation}_{s,d,h} \cdot \text{Post}_d \\ &+ \beta_5 \cdot \text{Precipitation}_{s,d,h} + \beta_6 \cdot \text{Precipitation}_{s,d,h} \cdot \text{Post}_d \\ &+ \gamma_{s,m(d),dow(d),h} + \zeta_{holiday} + \epsilon_{s,d,h}\end{aligned}$$

- Fixed effects for
  - Segment-Month-Day of Week-Hour
  - Each holiday (i.e. "4th of July", "Day after Thanksgiving")
- Cluster standard errors by Geography-Year-Month

Data sources

- Location-specific crash data from TxDOT's Crash Records Information System for 2010–2017
- Board meeting dates from TxDOT website
- Digital Message Sign (DMS) latitudes/longitudes from TxDOT website
- DMS message logs for Houston for 2012–2013
- Web-scraped DMS messages from TxDOT website for all of Texas for 2016–2017
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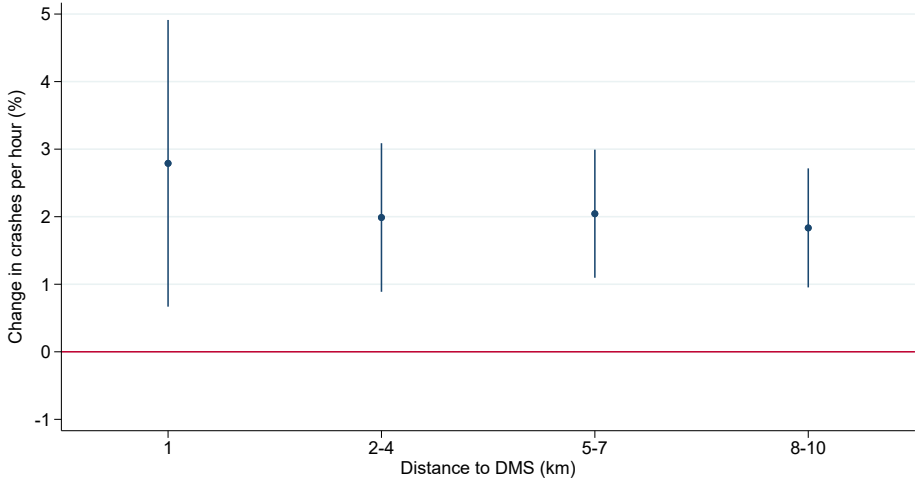
W. Hall searching for the location of a DMS

Campaign weeks are associated with more crashes

Effect of campaign weeks on crashes



We pass two placebo tests

Placebo tests

- Campaign weeks do not cause additional crashes upstream of DMSs ▸ Figure
- "Campaign weeks" do not cause additional crashes in the pre-treatment period
  ▸ Figure

Diff-in-diff shows no effect in pre-period

Effect of week prior to board meeting (campaign week) on traffic crashes

	Crashes per hour (%)		
	3 km	5 km	10 km
Board meeting × post	1.19	1.54**	1.36**
	(0.86)	(0.68)	(0.60)
Board meeting	0.35	-0.25	-0.33
	(0.63)	(0.48)	(0.43)
Observations	62,118,334	62,118,334	62,118,334
Adj R-squared	0.02	0.03	0.08
Rain & interactions	Yes	Yes	Yes
S-Y-M-D-H FE	Yes	Yes	Yes
Holiday FE	Yes	Yes	Yes

Diff-in-diff shows more crashes during campaign week

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Magnitude of the effect is large given size of intervention

What is the magnitude of effect within 10 km of DMS?

- Two-sample IV estimates: showing fatality message increases crash rate 4.5–8.0%
- Comparable to
  - Increasing speed limit 3–9 mph (van Benthem 2015)
  - Decreasing highway troopers 12–24% (DeAngelo and Hansen 2014)
  - Increasing drinking days 5–10% for young adults (Carpenter and Dobkin 2009)

Absolute magnitude of effect is large

Annual effect

- In Texas
  - An additional 2,600 crashes per year (based on conservative estimates)
  - Social cost: $380 million per year
  - Underpowered to detect effect on fatalities, but if assume percentage change is the same:
    - An additional 16 fatalities per year
- In all treated states nationwide
  - Hard to extrapolate out to other states given varying treatment intensities, but if we scale by licensed drivers:
    - An additional 16,000 crashes per year
    - An additional 98 fatalities per year
    - Social cost: $2.3 billion per year

What is the mechanism?

Hypothesis: Fatality messages add to drivers' cognitive loads, distracting them, and reducing their ability to drive safely

Evidence that fatality messages distract drivers

- Fatality messages do more harm when the reported # of deaths is larger ▸ Figure
- Effect of message very large in January (when displayed number is largest) and is very small in February (when displayed number is smallest) ▸ Figure
- Fatality messages do more harm on more complex road segments ▸ Table
- Fatality messages do more harm when DMSs close together ▸ Table
- Fatality messages increase multi-vehicle crashes, but not single-vehicle crashes ▸ Table

Alternative hypotheses: Are messages are like a vaccine, where they hurt today, but cause people to drive better rest of time?

No evidence messages help in long-run

Evidence fatality messages do not help in the long-run

- The days after the safety campaign ends are not safer than others ▸ figure
- Drivers are not getting used to the messages after 5 years ▸ figure
- Statewide crashes higher during treated weeks ▸ results
- Number of fatalities per vehicle mile traveled have increased 6.2% from 2011 to 2017

Please see the paper for:

- Four additional alternative hypotheses ▸ Details
- Ten robustness tests ▸ Details
- Discussion of external validity ▸ Details

Fatality messages lead to more traffic crashes

Results

- Fatality messages increase traffic crashes
- Heterogeneous effect: Messages help with reported number of fatalities is low and road segment is not complex
- Proposed mechanism: Messages add to drivers' cognitive loads, crowding out capacity to drive safely

This has important implications for the design of behavioral interventions

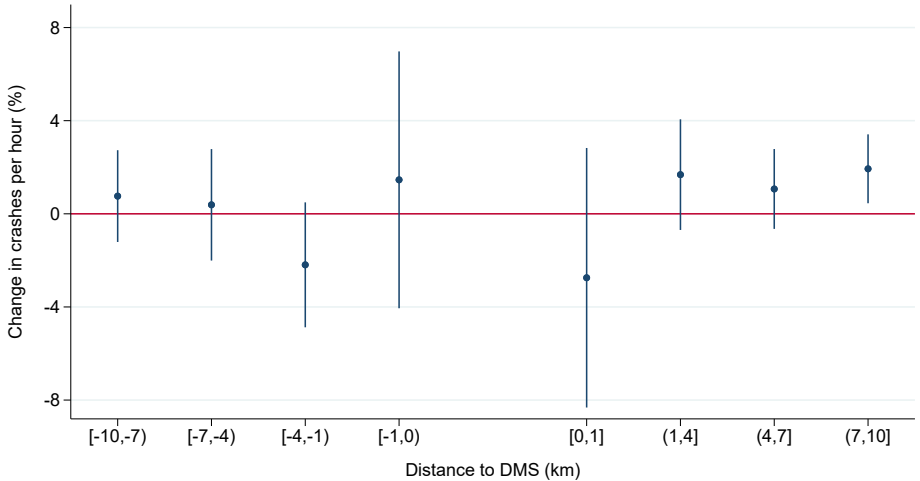
Why matters?

- Shows behavioral interventions have cognitive costs, and may crowd out other, more important, considerations—making things worse
- Lessons for behavioral interventions
  - When designing:
    - Consider individuals' cognitive loads when interventions will occur
    - Be careful interventions are not too salient
    - Build in measurement
  - When evaluating: full accounting of welfare effects of should consider whether adding to participants' cognitive loads has spillover effects outside the targeted domain

Placebo test 1: No effect on crashes upstream

Effect of campaign weeks on crashes for DMS without upstream DMS within 10 km

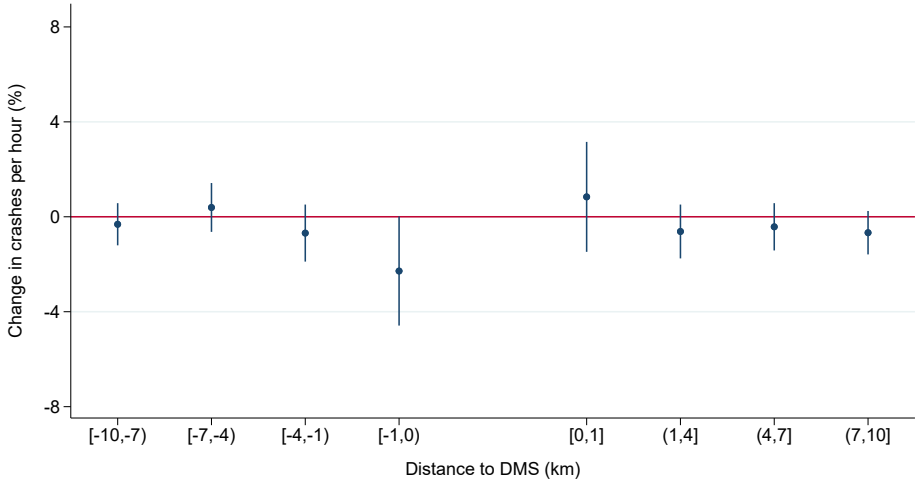
Back



Placebo test 2: No effect on crashes prior to treatment

Effect of campaign weeks on crashes in pre-treatment period

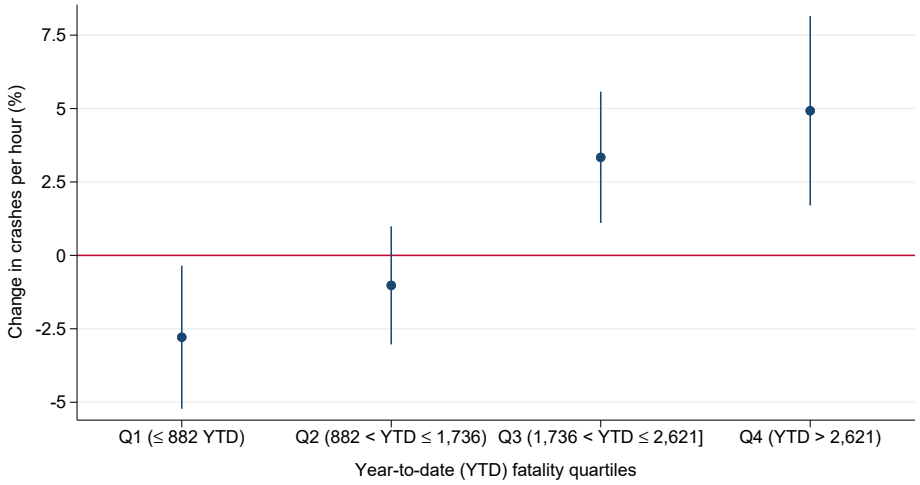
Back



Harm done by messages increasing in reported # of deaths

Effect of fatality messages by death count

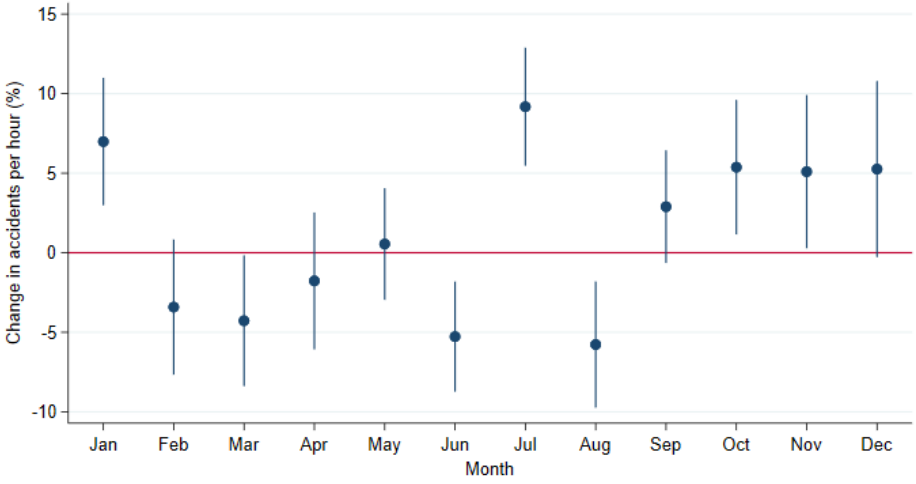
Back



Effect is climbing throughout year

Effect of campaign week by month

Back



Fatality messages increase multi-vehicle crashes, but not single-vehicle crashes

Effect of fatality message by crash type

Back

	Crashes per hour over 10 km (%)	
	Multi-vehicle	Single vehicle
Board meeting × post	1.61***	-0.26
	(0.62)	(1.59)
Board meeting	-0.65	1.75
	(0.44)	(1.13)
Observations	62,118,334	62,118,334
Adj R-squared	0.08	0.01
Rain & interactions	Yes	Yes
S-Y-M-D-H FE	Yes	Yes
Holiday FE	Yes	Yes

Fatality messages do more harm on more complex road segments

Effect of fatality message on crashes: segment characteristics

▸ Back

	Crashes per hour over 10 km (%)			
	Centerline km (1)	Lane km (2)	VKT (3)	DMS proximity (4)
Board meeting × measure × post	2.26***	2.80***	3.05***	0.60**
	(0.85)	(0.98)	(0.94)	(0.27)
Board meeting × post	1.36**	1.05	1.03	1.36**
	(0.60)	(0.68)	(0.69)	(0.60)
Board meeting × measure	0.25	0.38	0.13	0.05
	(0.55)	(0.71)	(0.67)	(0.20)
Board meeting	-0.33	-0.03	-0.02	-0.33
	(0.43)	(0.55)	(0.55)	(0.43)
Observations	62,118,334	54,017,004	54,017,004	62,048,221
Adj R-squared	0.08	0.08	0.08	0.08
Rain & interactions	Yes	Yes	Yes	Yes
S-Y-M-D-H FE	Yes	Yes	Yes	Yes
Holiday FE	Yes	Yes	Yes	Yes

Fatality messages do more harm when DMSs close together

Effect of fatality message on crashes: segment characteristics

▸ Back

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Adj R-squared	0.08	0.08	0.08	0.08
Rain & interactions	Yes	Yes	Yes	Yes
S-Y-M-D-H FE	Yes	Yes	Yes	Yes
Holiday FE	Yes	Yes	Yes	Yes

Summary statistics

	Pre-treatment period				Treatment period				
		Board meeting				Board meeting			
	All	No	Yes	Difference	All	No	Yes	Difference	DiD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No precipitation	0.932	0.928	0.946	0.018***	0.917	0.920	0.906	-0.014***	-0.031***
	[0.251]	[0.258]	[0.226]	(0.003)	[0.276]	[0.271]	[0.292]	(0.003)	(0.004)
Trace precipitation	0.027	0.028	0.024	-0.005***	0.040	0.039	0.044	0.005***	0.010***
	[0.163]	[0.166]	[0.152]	(0.001)	[0.197]	[0.194]	[0.206]	(0.001)	(0.002)
Precipitation	0.041	0.044	0.031	-0.013***	0.043	0.041	0.050	0.009***	0.022***
	[0.197]	[0.204]	[0.172]	(0.002)	[0.202]	[0.197]	[0.217]	(0.002)	(0.003)
Crashes 3 km (10^{-3})	4.215	4.214	4.218	0.004	7.198	7.165	7.309	0.144***	0.140**
	[66.525]	[66.489]	[66.647]	(0.039)	[87.089]	[86.901]	[87.725]	(0.037)	(0.053)
Crashes 5 km (10^{-3})	9.901	9.918	9.846	-0.071	16.753	16.684	16.990	0.306***	0.378***
	[102.600]	[102.646]	[102.441]	(0.070)	[134.297]	[134.011]	[135.265]	(0.070)	(0.099)
Crashes 10 km (10^{-3})	35.047	35.110	34.835	-0.275	59.003	58.775	59.778	1.003***	1.278***
	[196.577]	[196.729]	[196.058]	(0.222)	[260.823]	[260.208]	[262.904]	(0.221)	(0.313)
Observations	20,047,441	15,488,085	4,559,356	20,047,441	42,070,893	32,510,953	9,559,940	42,070,893	62,118,334

Fatality messages replace “other” messages and time blank

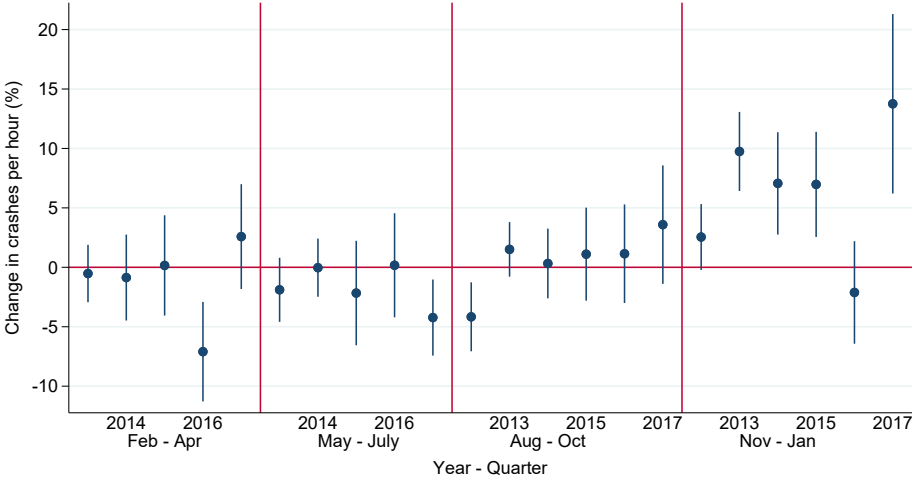
DMS messages summary statistics

▸ Back

	Treatment period			
		Board meeting		
	All	No	Yes	Difference
	(1)	(2)	(3)	(4)
Fatality message minutes	5.2	1.2	19.3	18.2***
	[16.7]	[8.2]	[27.5]	(0.02)
Non-safety message minutes	36.4	38.8	28.1	-10.7***
	[28.8]	[28.2]	[29.3]	(0.02)
Travel time minutes	12.2	12.4	11.3	-1.1***
	[23.4]	[23.6]	[22.7]	(0.01)
Blank minutes	18.4	20.1	12.6	-7.5***
	[27.2]	[27.9]	[24.0]	(0.02)
Amber alert minutes	2.9	2.9	3.0	0.1***
	[12.6]	[12.5]	[12.7]	(0.01)
Observations	15,108,198	11,716,999	3,391,199	15,108,198

Drivers not getting used to messages after 5 years

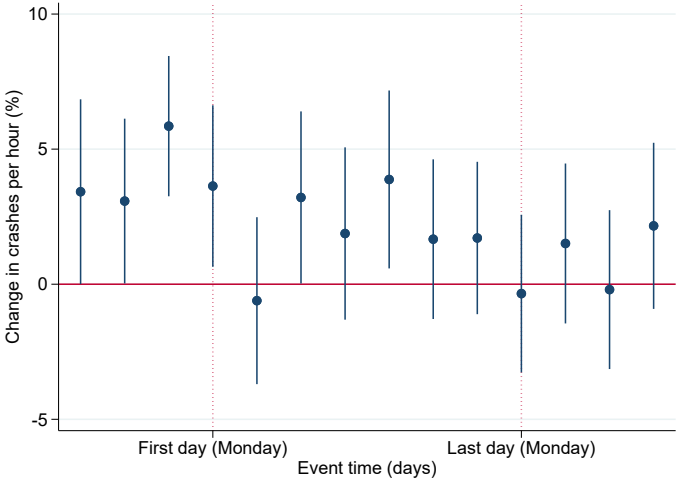
Effect of fatality messages by year-quarter



Drivers don't drive better first few days after treatment ends

Effect of fatality messages by event day

Back



Drivers don't drive better elsewhere on treated days

Statewide effect of fatality messages

	(1) Total	(2) On highway	(3) Off highway
Board meeting × post	1.98**	2.77**	1.16
	(0.96)	(1.19)	(0.95)
Board meeting	-1.61**	-2.39***	-0.79
	(0.72)	(0.89)	(0.75)
Observations	70,127	70,127	70,127
Adj R-squared	0.87	0.82	0.84
Y-M-D-H FE	Yes	Yes	Yes
Holiday FE	Yes	Yes	Yes

Drivers don't drive better elsewhere on treated days

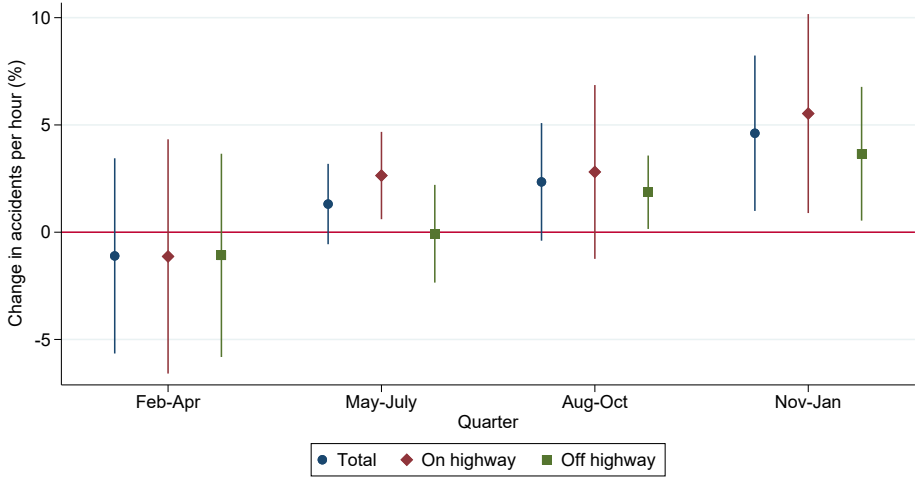
Statewide effect of fatality messages

	(1) Total	(2) On highway	(3) Off highway
Board meeting × post	1.98**	2.77**	1.16
	(0.96)	(1.19)	(0.95)
Board meeting	-1.61**	-2.39***	-0.79
	(0.72)	(0.89)	(0.75)
Observations	70,127	70,127	70,127
Adj R-squared	0.87	0.82	0.84
Y-M-D-H FE	Yes	Yes	Yes
Holiday FE	Yes	Yes	Yes

Statewide effect follows same pattern of climbing throughout year

Statewide effect of fatality messages by quarter

Back



Results are robust

Robustness tests ‣ Back

- Clustering by segment-year-month reduces the standard error in half
- Controlling for rain more flexibility does not affect our results
- Not controlling at all for rain doubles our estimated treatment effect
- Not controlling for holidays increases our estimate 0.1 percentage point
- Alternate outcome measures give larger estimates
  - Indicator variable for whether there is a crash
  - Log crashes + 1
- Limiting sample to those DMSs we know exist at each point in time increases our estimate 0.2 percentage points

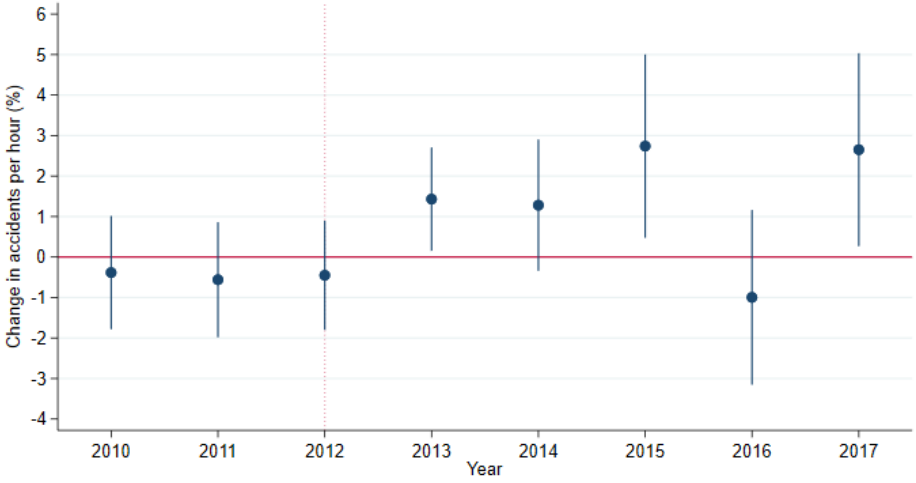
There are three threats to external validity

External validity Back

- Most of the damage is done the first few days the message is displayed, so the effects may be more benign in places where it is shown all of the time
- Fatality messages only hurt when the displayed fatality count is large and Texas leads the nation in traffic fatalities. Is it the relative or absolute number that matters for distracting drivers?
- We estimate the effect of being assigned to show a fatality message relative to the status quo usage. States differ in their status quo usage, and so the treatment effect will vary.

Drivers are not getting used to the fatality message

Effect of campaign weeks on crashes by year



We rule out four other alternative hypotheses

Additional alternative hypotheses

- Is it that showing any message is distracting? No.
- Do some people drive more safely, increasing the variance in speeds, resulting in more crashes? Probably not.
- Is there a Peltzman (1975) effect? Probably not.
- Do the messages communicate that driving is safer than drivers' believed, leading them to rationally drive more recklessly. No.