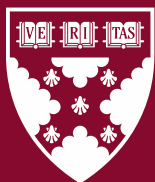


Working Paper 23-036

Public Perception and Autonomous Vehicle Liability

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Public Perception and Autonomous Vehicle Liability

[Authors Anonymized For Review]

ABSTRACT (200 WORDS [MAX: 200 WORDS])

The deployment of autonomous vehicles (AVs) and the accompanying societal and economic benefits will greatly depend on how much liability AV firms will have to carry for accidents involving these vehicles, which in turn impacts their insurability and associated insurance premiums. We investigate whether accidents where the AV was not at-fault could become an unexpected liability risk for AV firms, by exploring public perceptions of AV liability and defectiveness. We find that when such accidents occur, what is salient to consumers is that the human occupant of the AV was not in control. This leads consumers to spontaneously entertain counterfactuals in which the human occupant had more control of the vehicle, and to conclude that in such a case the human would have acted more optimally to prevent or avoid the accident, even if the human did not cause it. Given this inference, consumers conclude that the technology is preventing or impeding the driver from acting in their interests, leading consumers to judge AV firms as more liable than both HDV firms and HDV drivers for the damages. Suggesting potential intervention routes, we find that consumers are more likely to show this response pattern if they do not trust AVs.

Keywords: Autonomous vehicles; moral judgment; insurance; liability; harm

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Every year globally, around 1.25 million people are killed by motor vehicle accidents on our roads and 20 million more are injured. Human error—and the systems that make it easy for these errors to be dangerous (Nader 1965; Welle et al. 2018)—is responsible for 90% of these accidents (Singh 2015).

Fully autonomous vehicles (AVs), which perform the driving task without human intervention or assistance, promise to improve this status quo, both societally and economically. Societally, AVs should react faster, not speed, not get distracted, and not get literally drunk (Koopman and Wagner 2017). They should reduce congestion by driving optimally; free human attention to converse, conduct meetings, drive inebriated, or just sleep; and, because most AVs will use electric or hybrid drivetrains rather than internal combustion engines, they should reduce our carbon footprint on the planet. Economically, AVs should enable shuttle and ride-sharing firms to offer their services 24/7, without worker capacity limits or the costs of employing human drivers.

Yet, as the public starts to encounter and use AVs that function in increasingly broad operating conditions—as is already happening in Austin, Las Vegas, Phoenix and San Francisco (Carlson 2022; Kolodny 2022; Randazzo 2020; Wessling 2022)—accidents are inevitable, increasing the liability risk for AV firms. In the USA, for example, makers of driver assistance technologies (a lower level of automation than fully autonomous vehicles) have already faced a stream of accident-related lawsuits for issues such as defective steering sensors and camera misalignments (Smith 2017a; Smith 2022; Villasenor 2014). Further, Tesla, a vehicle maker using driver assistance technologies in its vehicles, is facing both a class action lawsuit over misleading claims about its self-driving software (Lambert 2022) and a reported Department of

Justice criminal probe into its tech (Spector and Levine 2022). What will be the impact of such events on the development and adoption of fully autonomous vehicles?

Here, we approach this question by exploring how consumers perceive the liability of AV manufacturers in the common scenario where the AV is not at-fault. While not-at-fault accidents are not typically considered liability risks for human drivers or HDV manufacturers, we examine whether such increasingly common accidents for AV firms could become unexpected litigation risks for AV manufacturers. We ask whether the public thinks that the firm which manufactured the not-at-fault vehicle is more liable when the vehicle was an AV than HDV, and whether the AV firm is seen as more liable than a human driver of a not-at-fault HDV. If so, this might pose an existential threat to AV adoption and development and a liability risk for the specific firms who make AVs, for a few reasons. First, the lawsuits from these accidents may be prohibitively expensive for AV firms and their investors, given the costs of settlements, claims administration costs, and legal fees for each claim filed (Morgan 1982). Second, any unanticipated public perception or litigation risks stemming from not-at-fault accidents are heightened by the high frequency of such accidents, with potentially large and unexpected financial impacts on the bearers of risk (e.g., insurers or a self-insured company). Third, because AV firms are more likely to have the means to cover damages than individual human parties, this may make them attractive targets of lawsuits, even if they are viewed as just weakly or partially liable (Smith 2017a). Relatedly, under the law of ‘joint and several liability’ that is active in some states of the US, a party that is only partially responsible for the damages may be required to pay all damages if they are the only party carrying insurance (Wright 1992). Fourth, in anticipation of these lawsuits, bearers of risk may increase insurance premiums, which may lead AV firms to pass on the additional costs to consumers, as via higher ride-sharing prices. Such actions may make AVs

less attractive, reducing their adoption and thereby reducing the expected prevention of accident-related injuries and deaths (Nichols 2013; Villasenor 2014). In some cases, AV firms with more capital may try to avoid this outcome by retaining a substantial portion of the risk rather than paying insurers to cover it, increasing their own risk if a costly lawsuit is brought against them.

Since some firms make not just the hardware but also the software that drives AVs, it should be unsurprising that they will be viewed as more culpable than HDV manufacturers for driver errors *at fault* (Smith 2017a). But a more surprising possibility, and the focus of the present work, is that consumers will hold AV firms as more liable than traditional manufacturers even when their vehicles are *not* at fault, i.e., even when their vehicles are not causally responsible for the accident. We predict that when an accident occurs and the AV is not at fault, what is salient to consumers is that the human user of the technology was *not in control*. This leads consumers to spontaneously entertain counterfactuals in which the human occupant had more control of the technology, and to conclude that in such a case the human would have acted more optimally to prevent or avoid the accident and survive, even if the human did not cause the accident. Given this conclusion, they infer that the technology must be defective or technically immature, and that the firm is therefore partially liable for the damages. We predict that a similar inference is less likely to arise when the not-at-fault vehicle is an HDV, because there is nothing out of the ordinary about such a vehicle. In what follows, we present our conceptual framework, followed by nine studies that test the proposed response pattern and underlying counterfactual thought process. We conclude with theoretical and practical implications.

Conceptual Framework

Product Liability

Broadly, businesses are vulnerable to lawsuits when they are causally connected to defects in their offerings (Loudenback and Goebel 1974; Morgan 1987). In fact, firms may be held liable even if they exercised due care in the production and sale of their offerings and abided by existing regulations, since they are ultimately judged on whether they behaved ‘unreasonably’ by not taking alternative actions to prevent harm. Given this standard, a significant challenge for firms is anticipating all the scenarios in which they could be judged as unreasonable—even potential ‘edge cases’ like a consumer using their product in unlikely ways, e.g., driving a tire at exceedingly high speeds.

While managers and employees cannot avoid liability risks altogether, they can take actions that reduce such risks, such as inspecting their assembly lines, carefully designing and packaging products to minimize and warn against risks, not over-promoting their offerings, partnering with distribution partners to insure products do not reach unintended customers, and delivering constructive after-sales service (Gitlow and Hertz 1983; Manley 1987; Morgan 1988; Morgan Jr 1979). By encouraging these behaviors, product liability achieves its intended outcome of reducing the risk of consumer injuries and compensating consumers when injuries do occur (Morgan and Avrunin 1982). Firms can also limit their exposure to liability through insurance plans; by the same token, however, the greater the liability risk the firm is exposed to, the more insurers will charge them for this coverage.

If a motor vehicle accident occurs, then consumers have the choice to settle through a traditional insurance policy, or to engage in litigation against the vehicle manufacturer¹. For accidents involving regular HDVs, if the accident results from driver error, then it falls under the legal banner of ‘driver negligence’ and that driver (or their insurance) pays the damages. If

¹ <https://www.hg.org/legal-articles/my-car-is-defective-and-caused-an-accident-what-can-i-do-31809>

the accident results from some defect in the vehicle itself, however, then it falls under ‘product liability’, and the manufacturer’s insurance covers the damages instead. Such product liability cases currently make up around 6% of motor-vehicle related claims (Smith 2017b).

Product Liability for Autonomous Vehicles

So, how will liability risks play out when, inevitably, AVs are involved in motor accidents? Since AV firms make the AI-aided software stack responsible for the driving task, if an AV is *at fault* then this ‘driver error’ should now be the firm’s responsibility, falling under the traditional banner of product liability.

In the current research we consider a less intuitive question: how will firm liability be impacted when an AV is involved in an accident where it is *not* at fault? We get at this question by measuring consumer ascriptions of liability in such scenarios, since these ascriptions are pertinent for several reasons. First, consumers will be the plaintiffs in lawsuits against AV firms, which are most likely to go to trial when victims are seriously injured. In these cases, the awards will be economically significant for firms. For instance, for cases involving HDVs, the median plaintiff verdict can range from \$5 million (in the event of victim death) to \$14 million (quadraplegia) (Smith 2017b), and they balloon once we consider class actions, which are lawsuits on behalf of a larger group². Even if only some cases reach a jury, precedent suggests that the results of these trials will set the benchmark for settlements that take place outside of court (Smith 2017b).

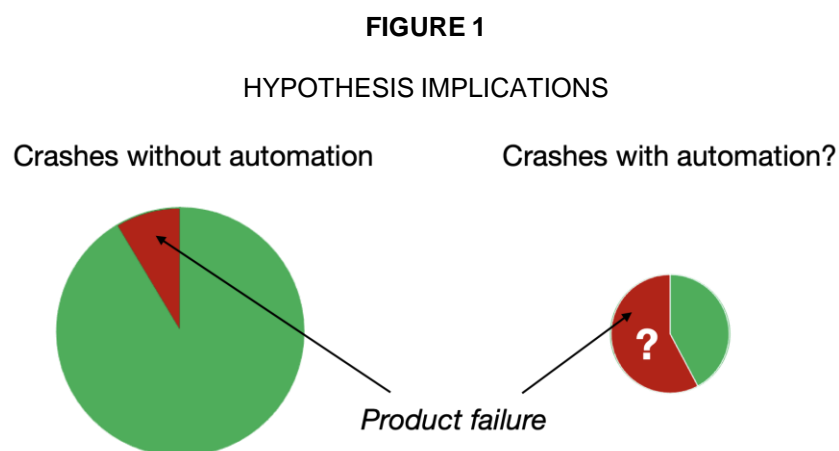
Second, consumers will make up the juries that decide how much to award in these cases. Aspects of juror psychology, such as a juror sympathy for the defendant, may affect product liability awards (Darden et al. 1991).

² https://www.law.cornell.edu/wex/class_action

Third, because AVs are not yet widely deployed, there is a dearth of claims data available (Wells 2022), making it difficult to apply traditional actuarial approaches for risk-assessment (SwissRe 2022). Additionally, since AVs have not yet driven sufficient miles to afford a statistically meaningful safety comparison with HDVs (Kalra and Paddock 2016), manufacturers and insurers must turn to alternative approaches to estimate and explain liability risk.

Finally, the AV industry has not yet adequately articulated a concept of AV defectiveness (Smith 2017a), which will need to cover not just the hardware but also the software responsible for the driving task. Typically, the driving task (and driving error) has been the domain of human drivers and been handled under the legal umbrella of ‘driver negligence’. In the absence of formal definitions of AV defectiveness, public perception biases can have greater impact.

Here, we investigate whether consumers are inclined to hold AV firms more liable than HDV firms for identical accidents not at fault. If so, this outcome has both economic and societal implications. Economically, it suggests that even though the size of the overall ‘pie’ of accidents is expected to be smaller for AVs (figure 1), firms may be responsible for a larger ‘slice’ of that pie than they are currently (Smith 2017b).



NOTE.—Adapted from Smith 2017. Green = driver negligence cases, red = product liability cases.

Societally, if firms must charge higher prices to cover higher anticipated liability costs, as via higher ridesharing prices, this may discourage adoption and ultimately delay the progress of technology and the expected safety benefits of AVs. In the extreme, firms and investors may avoid AVs altogether. Thus, various stakeholders will want to respond with interventions that prevent these outcomes. Here, we explore whether the likelihood of these outcomes ultimately boils down to how consumers simulate counterfactuals involving AVs vs. HDVs in the aftermath of motor vehicle accidents.

Counterfactual Simulation

Consumer judgments are sometimes affected by counterfactuals (Folkes and Lassar 2015; Tsiros and Mittal 2000; Wiggin and Yalch 2015)—psychological simulations of how events could have turned out differently, had an alternative course of action been taken (Kahneman and Tversky 1982). To illustrate, participants in one seminal study read about a protagonist who used to take the same route to work every day, but one day decided to take a different, more scenic route instead (the ‘route’ condition), before tragically being hit and killed by another driver who skipped a traffic light. When the authors asked participants to explain how things could have turned out differently, most cited the change in the protagonist’s daily route, despite the many other causal explanations available. In short, participants tended to think of counterfactuals in which there was no deviation from what normally happened (Kahneman and Tversky 1982).

More broadly, consumers tend to think of counterfactuals when an event deviates from the statistical or social norm (Hitchcock and Knobe 2009; Miller and McFarland 1986; Phillips, Luguri, and Knobe 2015), and when factors of the event can easily be ‘mentally undone’ as in ‘near miss’ scenarios where the more favorable alternative seems to be in close proximity

(Miller, Turnbull, and McFarland 1990; Wiggin and Yalch 2015). There are also individual differences in the propensity to think of counterfactuals (Kasimatis and Wells 2014).

Within consumer psychology, counterfactual simulation has been implicated in a few notable domains, including: post-purchase regret and consumption choices (Roese, Summerville, and Fessel 2007; Strahilevitz, Odean, and Barber 2011; Tsiros and Mittal 2000), as when consumers do not want to repurchase rising stock that they previously sold, in order to avoid the regret of initially selling it (Strahilevitz et al. 2011); responses to product breakdown and brand transgressions (Folkes and Lassar 2015; Wiggin and Yalch 2015), as when a product needs repairs and the warranty expired only recently (Folkes and Lassar 2015); and promotion tactics and consumer responses to them (Krishnamurthy and Sivaraman 2002; Li, Hsee, and O'Brien 2022). In the current work, we explore whether and how counterfactual thinking affects product liability for a new technological product, autonomous vehicles, which involve surrendering control in a high-stakes context to artificial intelligence algorithms.

Attitudes Toward Autonomous Vehicles

Consumers fear fully ceding control to AVs. For instance, discussions of AVs tellingly tend to gravitate toward so-called 'driverless dilemmas', in which an AV will purportedly need to make difficult moral tradeoffs, e.g., whether to crash into a group of elderly pedestrians or swerve into a barrier, thereby killing the passengers it contains. Despite the fact that there are good reasons to dismiss the practical relevance of these ideas (De Freitas et al. 2020; De Freitas et al. 2021; De Freitas and Cikara 2021), social scientists have raised the alarm on such dilemmas (Awad et al. 2018; Bonnefon, Shariff, and Rahwan 2016; Gill 2020; Greene 2016; Novak 2020), and the media has amplified these concerns (Donde 2017; Edmonds 2018; Markoff 2016; Nowak 2018; Shariff, Rahwan, and Bonnefon 2016). Corroborating these

concerns, public surveys find that 74% of Americans feel that fully autonomous vehicles will be unsafe (Giffi et al. 2017), only around half of Americans trust an AV to drive on their behalf (Casley, Jardim, and Quartulli 2014), 59% of Americans would not pay any amount to adopt AV technology, and around the same percentage is afraid of AVs (Bansal and Kockelman 2017).

Here, we explore how these attitudes may affect the counterfactuals that consumers spontaneously generate when they learn about an accident involving an AV, even when the vehicle is not at fault. We expect that when the accident occurs, consumers begin to search for a causal explanation. If the not-at-fault vehicle is an HDV, what is most salient to consumers is that the at-fault vehicle broke the law, so they hardly even consider the role of the not-at-fault vehicle. But when the not-at-fault vehicle is an AV, now what competes for their attention is that the occupant of the AV was not in control of the vehicle. This leads them to entertain a counterfactual in which the occupant *was* in control and had the instinct to survive the accident. Given this simulation, some consumers infer that the occupant would have acted more optimally had he or she been in control of the vehicle—such as by taking an evasive maneuver to avoid the accident or minimize damage³. Given this inference, they conclude that the technology is preventing or impeding the driver from acting in their interests, making the firm judged to be liable for the damages. In short, attitudes toward AVs might affect which counterfactuals come to mind, in turn affecting intuitions about firm liability.

This proposed thought process differs subtly from an alternative view that says AV firms may be viewed as more liable simply because consumers hold AVs to a higher standard than

³ We note that, while AVs are expected to take evasive maneuvers, an active area of engineering is teaching AVs to detect when and how to sometimes violate road rules in the service of more important goals like preventing harm, e.g., veering across a solid road line in order to avoid an oncoming vehicle Censi, Andrea, Konstantin Slutsky, Tichakorn Wongpiromsarn, Dmitry Yershov, Scott Pendleton, James Fu, and Emilio Frazzoli (2019), "Liability, Ethics, and Culture-Aware Behavior Specification Using Rulebooks," *arXiv preprint arXiv:1902.09355*. Optimal behavior in such scenarios is hard to measure, and there are not yet clear metrics available.

H DVs (Smith 2017b). While experts and maybe even lay consumers have this expectation for AVs (De Freitas et al. 2021), for consumers what might be more salient about AVs is their abnormality and threatening presence, thereby inducing the proposed counterfactual thought process. Despite the differences in these possible thought processes, however, they may yield the same ultimate outcome: holding AV firms as more liable than HDV firms and HDV drivers.

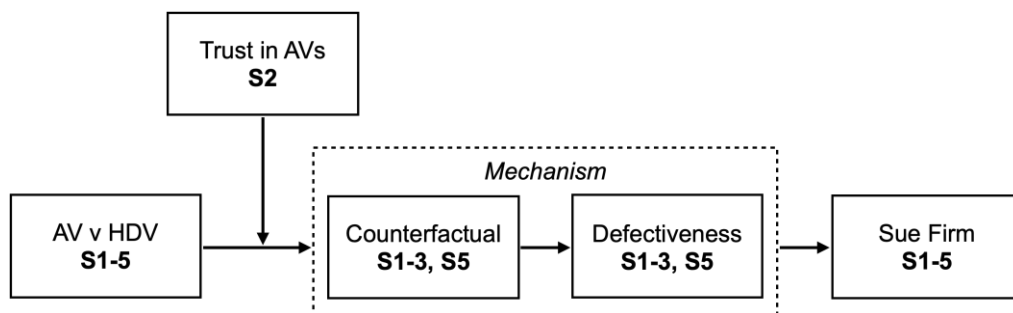
Consumer Trust

By this same logic, we also expect that the more one finds AVs to be an abnormal presence that could interfere with human competence, the more likely one is to think of counterfactuals in which humans are in control of the vehicle instead. In short, we expect that the proposed tendency to generate counterfactuals is moderated by individual levels of trust in AVs (figure 2).

Trust is typically defined as a willingness to become vulnerable with another because one has positive expectations about them (Rousseau et al. 1998, p. 395). While the importance of trust is most obvious in interpersonal settings, where it enables cooperation (Deutsch 1958; Tyler 2003), it has also been implicated in several marketing-relevant relationships, including: collaborations between managers and market researchers (Moorman, Deshpande, and Zaltman 1993; Moorman, Zaltman, and Deshpande 1992), buyer-seller relationships in B2B settings (Doney and Cannon 1997; Schurr and Ozanne 1985), cooperation between a firm and its subsidiaries (Hewett and Bearden 2001), and relationship marketing between firms and consumers (Chaudhuri and Holbrook 2001). For instance, higher brand trust yields higher loyalty, which in turn leads to larger market share and greater tolerance of high prices (Chaudhuri and Holbrook 2001; Delgado-Ballester and Munuera-Alemán 2001; Garbarino and Johnson 1999).

Here, we treat trust as a willingness to make oneself vulnerable to an autonomously behaving product whose operation is outside of one's own control. Vulnerability in this context is clear because using the product is consequential: if the AV does not properly perform its job, then this poses an injury or mortal risk to the passenger(s). In this work, we operationalize trust as individual differences in willingness to trust AVs. While there are several demographic variables that have been linked to willingness to adopt AVs—including youth, level of education, and tech savviness (Haboucha, Ishaq, and Shiftan 2017; Lavieri et al. 2017; Menon et al. 2020)—we focus on trust because we suspect that it is the underlying psychological construct through which all of these variables ultimately impact willingness to adopt AVs. We also focus on trust in an AV's driving competence, as opposed to other aspects of trust like integrity or values (Xie and Peng 2009). We do this because consumers who share their opinions of AVs tend to raise negatives around malfunctions, fear, and loss of control, with 60% of one survey's respondents feeling “very concerned” about “computer system malfunctions causing a crash” (Bloomberg 2016).

FIGURE 2
THEORETICAL FRAMEWORK



NOTE.—Proposed thought process for assessing accidents not at fault, by which vehicle type influences whether consumers consider a counterfactual in which the human occupant had control, which in turn informs inferences of vehicle defectiveness and, ultimately, firm liability for the accident. Individual levels of trust in AVs influence the propensity to engage in these counterfactuals. ‘S’ refers to ‘study’, indicating studies that test each component of the thought process.

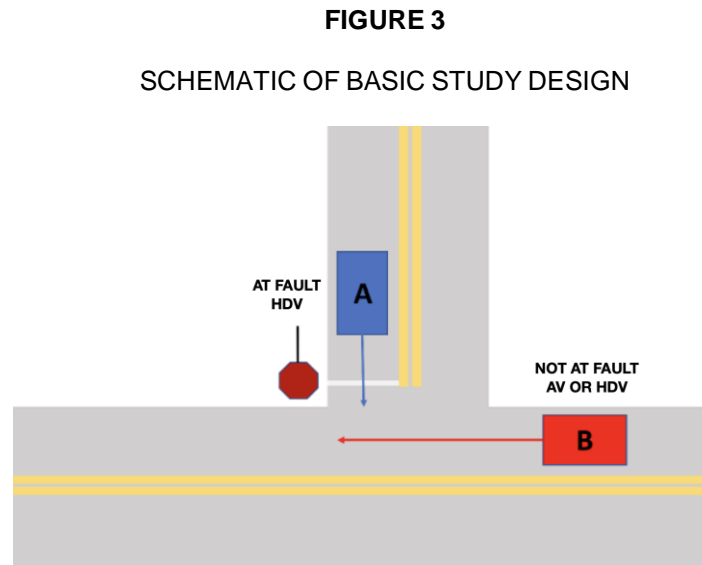
Overview of Studies

We begin by running a pre-study that establishes whether, in fact, AVs are viewed as more abnormal and threatening than HDVs. Thereafter, we proceed by asking whether AV firms are viewed as more liable than HDV firms for accidents not at fault, and whether this response pattern is driven by the proposed counterfactual mechanism (study 1). We then test whether the effect generalizes to other road scenarios in which an AV is not at fault (studies 2-3), and whether the effect of vehicle type on counterfactual simulation is moderated by trust in AVs (study 2). For each of the three scenarios, we run a companion study in which we investigate whether there is also greater willingness to sue the manufacturer of an AV as compared to a *human driver* of an HDV (studies 1b, 2b, 3b).

Next, we test whether it is possible to eliminate the bias against AV (vs. HDV) firms by asking participants to evaluate both conditions (AV vs. HDV not at fault) within the same setting, i.e., by making participants aware of their bias (study 4). Finally, we intervene on counterfactual simulation to test whether this causally increases willingness to sue the AV firm (study 5).

All our studies involve video recreations of an accident, inspired by the fact that such videos will most likely be at the heart of court cases involving AV-related accidents. Firms developing AV technology are already using data recorders in their AVs in order to be able to reconstruct accident scenarios as a means of defending themselves in court and lowering insurance premiums, and in order to study and improve the driving skills of their AVs (AUVSI 2012). Finally, all three of our driving scenarios have the same basic event structure, in which

there is one vehicle at fault and one not at fault. The at-fault vehicle is always human driven, while we vary whether the not-at-fault vehicle is an HDV or AV (figure 3).



Pre-Study

Our theoretical framework assumes, building on previous work, that our proposed counterfactual effect arises because AVs' abnormal presence interferes with human competence. We tested the abnormality assumption in a pre-study that asked consumers whether they perceive current AVs as less familiar, less safe, riskier, and scarier than HDVs.

Method

We recruited 150 participants (U.S. residents only) from Amazon's Mechanical Turk ($M_{age} = 54$, 45% females) who passed two attention checks and completed the survey, in exchange for \$0.25. The university research ethics board approved the materials in all studies, and consent was obtained from all participants. Participants could not participate in more than one study of this project.

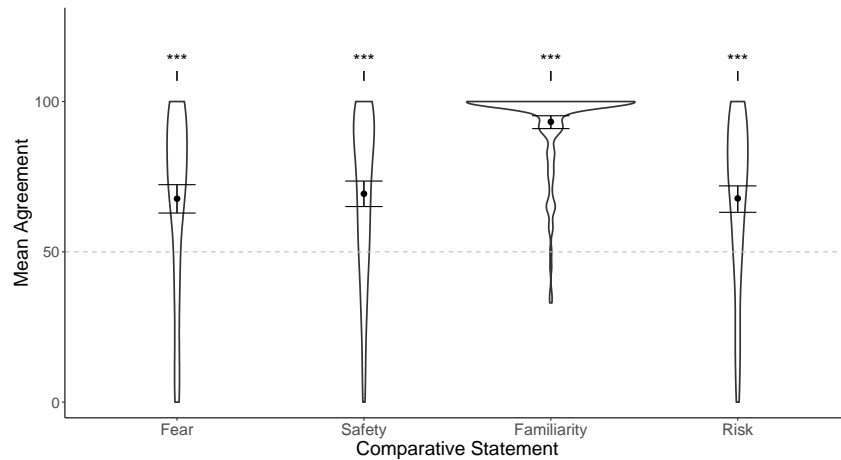
Participants indicated the extent to which they agreed with the following statements (presented in randomized order) on scales anchored from 0 (Completely disagree) to 100 (Completely agree): (1) *Currently, I am more afraid of riding in a self-driving vehicle than in a human-driven vehicle.*; (2) *Currently, I believe that human-driven vehicles are safer than self-driving vehicles.*; (3) *Currently, I am more familiar with human-driven vehicles than self-driving vehicles.*; (4) *Currently, I think it would be more risky to ride in a self-driving vehicle than in a human-driven vehicle.* Surveys, data, and code for all studies are included in the online Github repository for this project: [anonymized].

Results

In line with our theoretical framework, we found that participants agreed with all four statements. Using a one-sample t-test against a theoretical mean of 50 (neither agree nor disagree with the statement), we found that participants were (1) more afraid of riding in AVs than in HDVs ($M = 67.66$, $SD = 29.21$, $t(149) = 7.41$, $p < .001$), (2) believed HDVs are safer than AVs ($M = 69.31$, $SD = 26.67$, $t(149) = 8.86$, $p < .001$), (3), are more familiar with HDVs than with AVs ($M = 93.23$, $SD = 13.40$, $t(149) = 39.52$, $p < .001$), and (4) think it would more risky to ride in an AV than HDV ($M = 67.78$, $SD = 27.03$, $t(149) = 8.06$, $p < .001$) (figure 4).

FIGURE 4

AGREEMENT RATINGS IN PRE-STUDY



NOTE.— Error bars indicate 95% CIs. Statistics reflect results of one-sample t-tests against a theoretical mean of 50. *** $p < .001$.

Discussion

In our pre-study, participants viewed AVs as less familiar, less safe, riskier, and more fear-inducing than HDVs. The study empirically verifies our assumption that, as of 2022 when AVs are not yet widely deployed, AVs are perceived as more abnormal and threatening on several dimensions as compared to HDVs.

Study 1: A Liability Risk For AVs?

Study 1 tests whether the likelihood of suing the manufacturer of a vehicle that is *not at fault* in an accident depends on whether it is human driven or autonomous. Because AVs violate the norm in which a human is in control of the vehicle, we anticipated that in the event of an accident involving an AV, participants are more likely to consider the counterfactual in which a human had been in control and conclude that a human driver might have been able to avoid, or minimize damage from, the accident. Given this counterfactual reasoning, participants should be

more likely to conclude that the AV was defective, thereby increasing their willingness to sue its manufacturer.

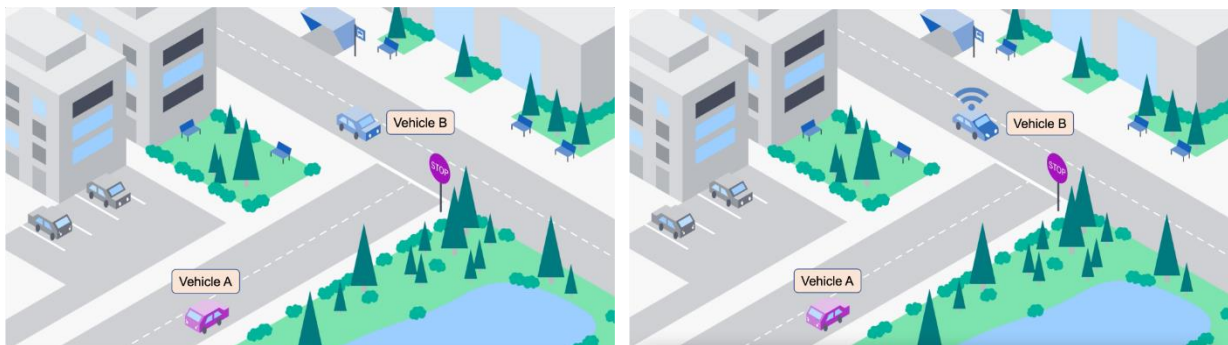
Method

We recruited 298 participants from Amazon's Mechanical Turk who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 45 for failing comprehension checks (described below), leaving 253 ($M_{\text{age}} = 41$, 49% females). Participants were only allowed to participate if they correctly answered two attention checks at the beginning of the survey. Participants were evenly assigned to one of two vehicle type conditions (HDV or AV) and given the following instruction (the bold font was only included in the AV condition), accompanied by figure 5:

*You will watch an animated video of a traffic scenario depicted below. The video shows an intersection in which the driver of Vehicle A runs a stop sign and strikes Vehicle B, seriously injuring its occupant. **Vehicle B is a fully autonomous Robocar, which means that it is driven by a computer algorithm.***

FIGURE 5

INSTRUCTION STILLS FOR HUMAN-DRIVEN (LEFT) AND AUTONOMOUS (RIGHT) CONDITIONS



Readers can view the videos here: <https://www.youtube.com/watch?v=IPRH7NTtF8M> (HDV); <https://youtu.be/fCp1vakYZ3c> (AV). Participants were required to watch the video twice, then indicate the extent to which they agreed with several randomized statements anchored on scales from 0 (Completely disagree) to 100 (Completely agree) and presented in randomized order. Each statement was presented on its own page, accompanied by the relevant AV or HDV still image from figure 5. The dependent variables pertained to the liability of the at-fault and not-at-fault vehicles, although we were chiefly interested in the latter (table 1).

TABLE 1
MEASURES IN STUDY 1

Sue Driver, At Fault (DV)	<i>It would be reasonable to sue the driver of Vehicle A for the serious injuries sustained by the occupant of Vehicle B.</i>
Sue Firm, Not at Fault (DV)	<i>It would be reasonable to sue the manufacturer of Vehicle B for the serious injuries sustained by the occupant of Vehicle B.</i>
Defective, Not at Fault (M)	<i>Vehicle B is defective.</i>
Negligent, Not at Fault (M)	<i>The behavior of Vehicle B was negligent.</i>
Expectations, Not at Fault (M)	<i>Vehicle B should avoid accidents when it is not necessarily at fault.</i>
Capability, Not at Fault (M)	<i>Vehicle B should have been able to avoid this accident.</i>
Counterfactual (M)	<i>[Alex and Sam scenario; see below]</i>

Note: DV=dependent variable, M=mediator, MOD=moderator

Our main, hypothesized mediating variables asked about defectiveness (table 1) and counterfactuals. To measure counterfactual reasoning, we asked how much participants considered a counterfactual scenario in which the human occupant of Vehicle B had more control. To get at this naturally, participants were provided with a dialogue between two speakers, Sam and Alex, who are discussing what transpired in the video (adapted from Phillips et al. 2015). Participants indicated how much they agreed with Sam, who thought it was relevant

to consider the counterfactual scenario in which the occupant of Vehicle B had more control of the vehicle:

Alex: “I wonder how things could have gone differently.”

Sam: “Well, I really wonder what would’ve happened if the occupant of Vehicle B had more control of the vehicle.”

Alex: “Really? Of all the ways things could have gone differently, that doesn’t seem like the one that’s worth thinking about.”

We also added several potential competing mediators. First, motivated by the literature on moral judgment (Malle, Guglielmo, and Monroe 2014), we probed whether participants viewed the not-at-fault vehicle as negligent (table 1). Second, motivated by theoretical observations that AVs might be viewed as more liable because consumers expect them to be more capable or have more foresight (Smith 2017a), we included a measure assessing this.

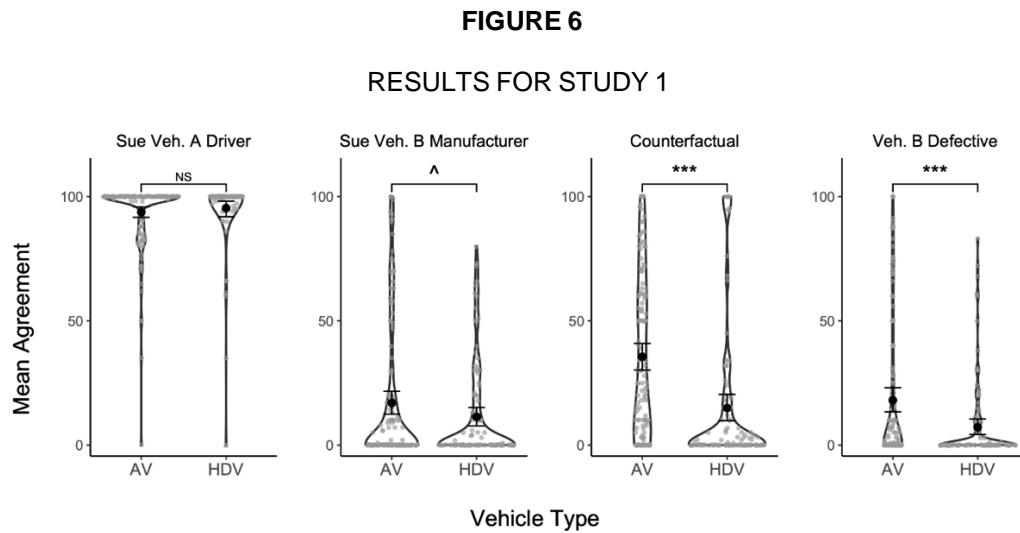
All measures were presented in randomized order. After completing them, participants also answered an exploratory moderator item on whether they expect AVs to be superior to HDVs. Finally, they completed two comprehension checks about what type of vehicle they saw in the scenario (AV or HDV) and which vehicle ran the stop sign (vehicle A or B), followed by standard demographics questions. Participants who failed either of the comprehension checks were excluded from analysis.

Results

We compared each of the measures between AVs and HDVs, finding significant differences for five out of seven measures (figure 6, table 2). Unsurprisingly, the at-fault vehicle (vehicle A in the scenario) was viewed as highly culpable whether it struck an AV or HDV. Crucially, however, the manufacturer of the not-at-fault vehicle (vehicle B in the scenario) was

viewed as marginally more culpable when its vehicle was an AV versus HDV ($M_{AV} = 16.97$, $M_{HDV} = 11.33$, $t(249) = 1.87$, $p = .063$, $d = 0.23$). Given our directional hypothesis, we are also justified in running a one-sided t-test of whether the AV condition elicits significantly higher willingness to sue than the HDV condition; this analysis yielded a statistically significant difference ($t(249) = 1.87$, $p = .031$, $d = 0.23$).

In line with our hypothesized thought process, we also found that participants were more likely to consider the counterfactual (in which a human driver had more control) when the not-at-fault vehicle was an AV than a HDV, and were more likely to conclude that the AV was defective (figure 6; table 2). These results suggest that manufacturers of AVs face a higher liability risk, even in accidents where they are not at fault and where manufacturers of HDVs would be judged more favorably.



NOTE.— Error bars indicate 95% CIs. ^ $p < 0.1$; *** $p < .001$

TABLE 2
STATISTICS FOR STUDY 1

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault (DV)	93.78 (13.71)	95.35 (16.04)	$t(214)=-0.82$	0.11
Sue Firm, Not at Fault (DV)	16.97 (28.11)	11.33 (19.91)	$t(249)=1.87^{\wedge}$	0.23
Defective, Not at Fault (M)	18.03 (28.81)	7.21 (16.32)	$t(232)=3.78^{***}$	0.45
Negligent, Not at Fault (M)	12.50 (24.84)	4.11 (14.87)	$t(238)=3.34^{***}$	0.40
Expectation, Not at Fault (M)	62.59 (31.40)	47.83 (33.98)	$t(225)=3.54^{***}$	0.45
Capability, Not at Fault (M)	31.14 (31.44)	11.53 (18.42)	$t(236)=6.20^{***}$	0.74
Counterfactual (M)	35.55 (32.79)	14.91 (28.78)	$t(247)=5.32^{***}$	0.66
AV superhuman (MOD)	68.29 (26.28)	75.92 (22.88)	$t(247)=-2.46^{*}$	0.31

NOTE.— T-statistics reflect results of independent-samples t-tests. DV=dependent variable, M=mediator, MOD=moderator. $^{\wedge} p < .10$, $^{*} p < .05$, $^{***} p < .001$.

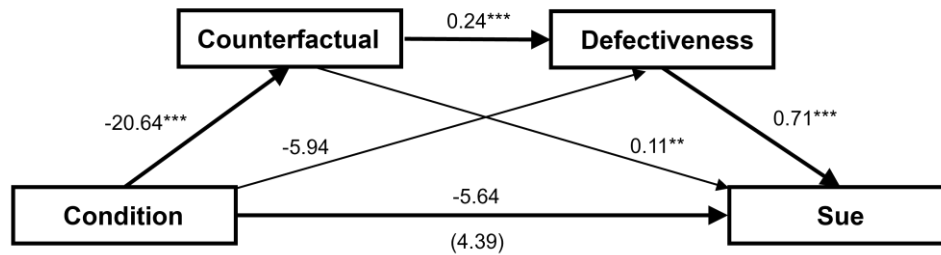
Mediation analysis. To investigate possible mediators of this effect of vehicle type on willingness to sue Vehicle B's manufacturer, we conducted a parallel mediation analysis (PROCESS Model 4; Hayes 2012) with all five potential mediators (defectiveness, negligence, counterfactual, capability to avoid, and avoid when not at fault) as potential mediators. Of the five measures, defectiveness ($b = -6.66$, $SE = 2.24$, 95% CI [-11.44, -2.75]) and counterfactual ($b = -2.07$, $SE = 1.00$, 95% CI [-4.39, -0.51]) selectively mediated the effect.

We then used a serial mediation analysis (PROCESS Model 6; Hayes 2012) to determine whether these two mediators followed the predicted causal order: condition \rightarrow counterfactual \rightarrow defectiveness \rightarrow sue manufacturer. This analysis indicated that the serial mediation was statistically significant ($b = -3.49$, $SE = 1.30$, 95% CI [-6.50, -1.45]; figure 7).

FIGURE 7

SERIAL MEDIATION FOR STUDY 1.

95% CI [-6.50, -1.45]



NOTE.— ** $p < .01$; *** $p < .001$

Discussion

Consumers thought it was more reasonable to sue manufacturers of AVs than HDVs for accidents not at fault. This discrepancy was rooted in a greater tendency to entertain counterfactual scenarios in which humans had more control when the not-at-fault vehicle was an AV than HDV. Given these mental simulations, participants may have concluded that the AV could have done more, hence their judgments that AVs were more defective and their assessments that AV manufacturers were more liable.

Study 1b: AV Firm Vs. Human Driver

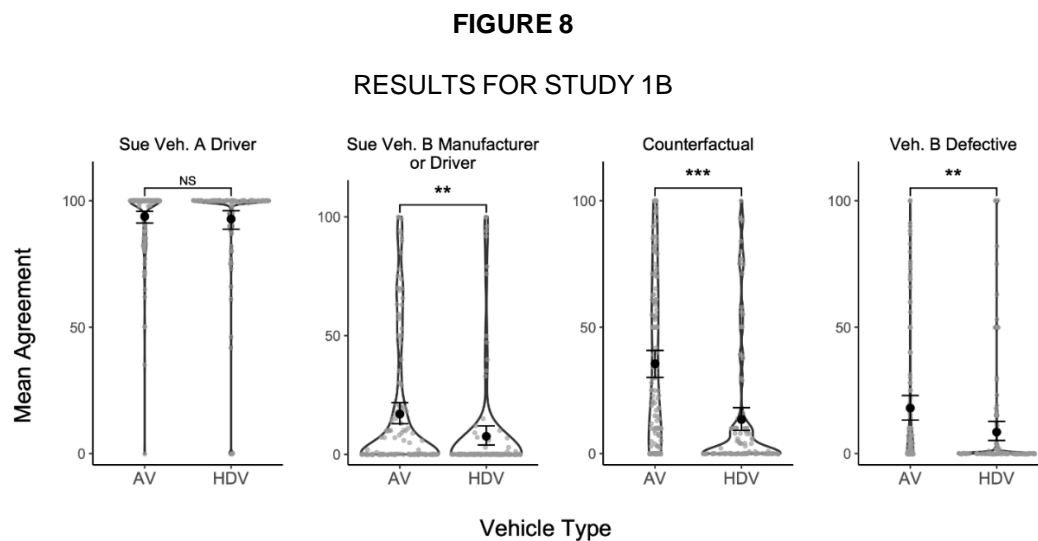
In study 1, participants were asked to judge the liability of the *manufacturer* of Vehicle B in both the AV and HDV conditions. Study 1b tested whether there is also a greater willingness to sue the manufacturer of an AV when compared to a *human driver* of a HDV, who should be viewed as just as agentic as, if not more agentic than, the AV manufacturer. Participants were shown the same video as in study 1.

Method

We recruited 149 participants from Amazon’s Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 28 for failing the same comprehension checks as in study 1, yielding 121 participants ($M_{age} = 40$, 45% females). Unlike study 1, all participants were shown the HDV condition, which we planned to compare to the AV condition of Study 1. Instead of indicating the extent to which they agreed that the HDV’s manufacturer is liable, participants indicated their agreement that the vehicle’s human driver is liable: *It would be reasonable to sue the **driver of Vehicle B** for the serious injuries sustained by the occupant of Vehicle B.* All other aspects of the design were identical to study 1.

Results

Participants thought it was more reasonable to sue the AV manufacturer than the human driver of Vehicle B ($M_{AV\ Firm} = 16.97$, $M_{HDV\ driver} = 7.57$, $t(261) = 3.02$, $p = .003$, $d = 0.37$; figure 8; table 3). They were also more likely to consider a counterfactual in which a human driver had more control when the not-at-fault vehicle was an AV than an HDV, and they were more likely to conclude that the AV was defective (figure 8; table 3).



NOTE.— Error bars indicate 95% CIs. ** $p < .01$; *** $p < .001$

TABLE 3

STATISTICS FOR STUDY 1B

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault	93.78 (13.71)	92.78 (19.87)	$t(208)=0.47$	0.06
Sue Firm/Driver, Not at Fault	16.97 (28.11)	7.57 (22.53)	$t(261)=3.02^{**}$	0.37
Defective, Not at Fault	18.03 (28.81)	8.53 (21.40)	$t(258)=3.07^{**}$	0.37
Counterfactual	35.55 (32.79)	13.47 (25.60)	$t(260)=6.14^{***}$	0.74

NOTE.— T-statistics reflect results of independent-samples t-tests. $^{**} p < .01$, $^{***} p < .001$.

Discussion

We found that AV manufacturers are not just held more liable than HDV manufacturers for accidents not at fault, but are also held more liable than human drivers of not-at-fault HDVs. Thus, AVs are ultimately held to higher standards than all comparable not-at-fault parties.

Study 2: Four-Way Intersection

Study 2 tested whether the tendency to sue manufacturers of AVs more than HDVs for collisions not at fault generalizes to a new scenario involving a four-way intersection. We also investigated whether the greater tendency to consider counterfactuals for AVs is moderated by the degree to which consumers trust AVs.

Method

We recruited 300 participants from Amazon's Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 49 for failing the same comprehension questions as Study 1, leaving 251 participants ($M_{age} = 40$, 50% females). The design was identical to study 1, except participants in the two conditions were given the following instructions (bold font was only included in the AV condition), accompanied by figure 9:

*You will watch an animated video of a traffic scenario, depicted below. The video shows a four-way intersection in which the driver of Vehicle A runs a stop sign and strikes Vehicle B, seriously injuring its occupant. **Vehicle B is a fully autonomous Robocar, which means that it is driven by a computer algorithm.***

FIGURE 9

INSTRUCTION STILLS FOR HUMAN-DRIVEN (LEFT) AND AUTONOMOUS (RIGHT) CONDITIONS

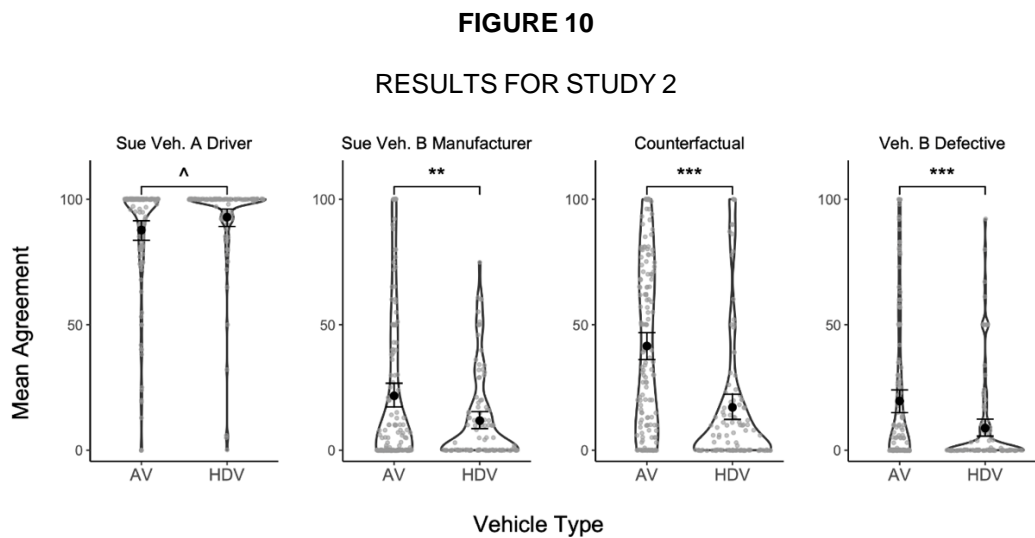


Readers can view the videos here: <https://youtu.be/3UQ1GkjTZk0> (HDV); <https://youtu.be/J9zzSe-VHiM> (AV). Participants watched the assigned video twice. After completing the same measures and checks as study 1, participants rated how much they trusted AVs. To this end, we utilized five statements from an existing psychological scale originally developed to measure trust between managers and researchers (Moorman et al. 1992), adapting it to refer to AVs. We found the original scale fitting for the AV context, because it assessed managers' beliefs in researchers' *competence*, while in this study we intended to measure trust in the technology's competence. In the current study, participants indicated the extent to which they agreed with the following statements on a scale anchored from 0 (Completely disagree) to 100 (Completely agree), presented in randomized order: (1) *I would be willing to let an AV make important driving decisions without my involvement.*; (2) *If I was unable to monitor my driving*

activities, I would be willing to trust an AV to get the job done right.; (3) I trust an AV to do things I can't do myself.; (4) I trust an AV to do things my vehicle can't do itself.; (5) I generally do not trust an AV.

Results

In line with hypothesis 1, participants thought it was more reasonable to sue the not-at fault vehicle’s manufacturer if it was an AV than HDV ($M_{AV} = 21.69$ $M_{HDV} = 11.80$, $t(237) = 3.21$, $p = .002$, $d = 0.40$; figure 10, table 4). Again, this result suggests that manufacturers of AVs face a higher liability risk for accidents where their vehicles are not at fault. We also found that participants were more likely to consider a counterfactual in which a human driver had more control when the not-at-fault vehicle was an AV than HDV, and that they were more likely to conclude that the AV was defective (figure 10; table 4).



NOTE.— Error bars indicate 95% Cis. ^ $p < 0.1$; ** $p < .01$; *** $p < .001$

TABLE 4

STATISTICS FOR STUDY 2

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault	87.75 (23.07)	92.88 (18.41)	$t(247)=-1.96^{\wedge}$	0.24
Sue Firm, Not at Fault	21.69 (30.76)	11.80 (17.71)	$t(237)=3.21^{**}$	0.40
Defective, Not at Fault	19.62 (28.92)	8.83 (18.48)	$t(245)=3.60^{***}$	0.43
Counterfactual	41.53 (34.01)	17.09 (27.40)	$t(247)=6.30^{***}$	0.78

NOTE.— T-statistics reflect results of independent-samples t-tests. $^{\wedge} p < .10$ $^{**} p < .01$, $^{***} p < .001$.

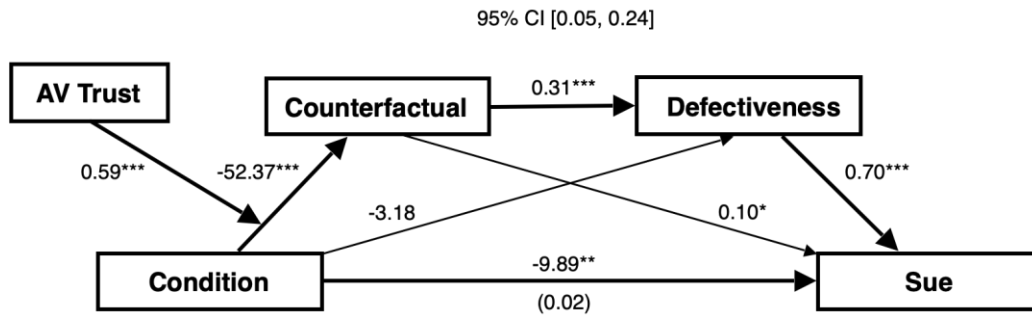
Mediation analysis. Next, we conducted a moderated serial mediation analysis (PROCESS Model 83; Hayes 2012), testing for the same serial model as study 1, but with the path between vehicle condition and counterfactual moderated by trust in AVs. There was high agreement among our measures of AV trust ($\alpha = 0.94$), so we averaged them to form a single measure of AV trust.

Firstly, the analysis again indicated that the serial mediation was significant ($b = -5.34$, $SE = 1.66$, 95% CI [-9.18, -2.64]). Secondly, we found that the index of moderated mediation was significant ($b = 0.13$, $SE = 0.05$, 95% CI [0.05, 0.24]; figure 11). In line with our predictions, the less that participants trusted AVs, the more likely they were to entertain the counterfactual (figure 12).

To test the extent to which this moderation effect was specific to the condition → counterfactual path, we also tested moderated mediation of the other paths in the serial mediation model. We found that trust in autonomous vehicles did not moderate the path from counterfactuals to defectiveness (PROCESS Model 91; $b = 0.03$, $SE = 0.04$, 95% CI [-0.04, 0.11]), or from defectiveness to suing Vehicle B's manufacturer (PROCESS model 87; $b = 0.00$, $SE = 0.02$, 95% CI [-0.05, 0.04]).

FIGURE 11

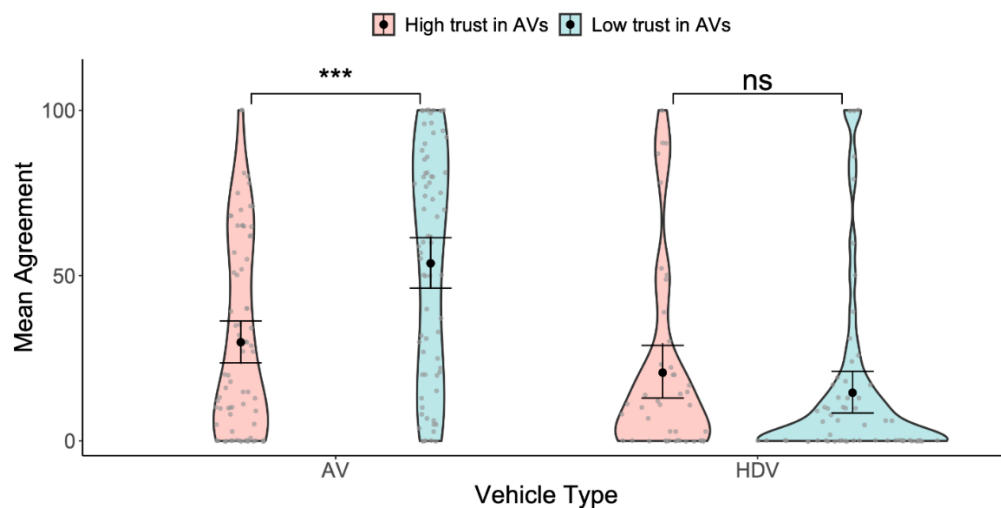
MODERATED SERIAL MEDIATION FOR STUDY 2



NOTE.— * $p < .05$; ** $p < .01$; *** $p < .001$

FIGURE 12

THE AFFECT OF TRUST IN AVS ON AGREEMENT WITH THE COUNTERFACTUAL



NOTE.—High Trust > 50 average on trust scale; Low Trust ≤ 50 . Error bars indicate 95% CIs. *** $p < .001$

Discussion

In line with hypotheses 1 and 2, we successfully replicated the tendency to hold firms more liable for not-at-fault accidents involving an AV versus HDV. This effect was again explained by counterfactual reasoning leading to ascriptions of defectiveness and, ultimately,

higher liability. Additionally, we found that the degree to which consumers generated counterfactual simulations more so for AVs than HDVs was moderated by their trust in AVs.

Study 2B: AV Firm Vs. Human Driver

Study 2b again tested whether there is also a greater willingness to sue the manufacturer of an AV compared to a *human driver* of an HDV.

Method

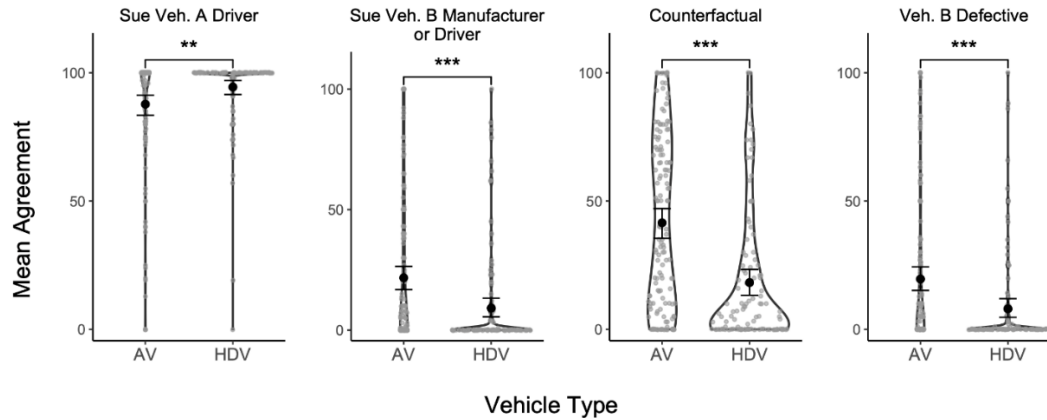
We recruited 154 participants from Amazon's Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 44 for failing the same comprehension checks as studies 1-2, yielding 110 participants ($M_{\text{age}} = 39$, 41% females). The study design was identical to study 1b, except that participants saw the same video as in study 2.

Results

Participants thought it was more reasonable to sue the AV manufacturer than the HDV driver of Vehicle B ($M_{\text{AV Firm}} = 21.69$, $M_{\text{HDV driver}} = 9.09$, $t(251) = 3.88$, $p < .001$, $d = 0.47$; figure 13; table 5). They were also more likely to consider a counterfactual in which a human driver had more control when the not-at-fault vehicle was an AV than an HDV, and they were more likely to conclude that the AV was defective (figure 13; table 5).

FIGURE 13

RESULTS FOR STUDY 2B



NOTE.— Error bars indicate 95% CIs. ** $p < .01$; *** $p < .001$

TABLE 5

STATISTICS FOR STUDY 2B

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault	87.75 (23.07)	94.44 (14.82)	$t(247)=-2.81^{**}$	0.34
Sue Firm/Driver, Not at Fault	21.69 (30.76)	9.09 (21.08)	$t(251)=3.88^{***}$	0.47
Defective, Not at Fault	19.62 (28.92)	8.01 (19.28)	$t(249)=3.84^{***}$	0.46
Counterfactual	41.53 (34.01)	18.24 (26.22)	$t(253)=6.18^{***}$	0.75

NOTE.— T-statistics reflect results of independent-samples t-tests. ** $p < .01$, *** $p < .001$.

Discussion

We again found that AV manufacturers were viewed as more liable for collisions not at fault than human drivers of not-at-fault HDVs, showing that in practice AV firms are held to higher standards in general.

Study 3: Left Turn On Two-Way Street

Study 3 tested whether the tendency to sue manufacturers of AVs more than HDVs for collisions not at fault generalizes to yet another scenario, involving a left turn on a two-way

street. We also explored whether the effect of perceived vehicle defectiveness on perceived firm liability is moderated by individual differences in willingness to punish others.

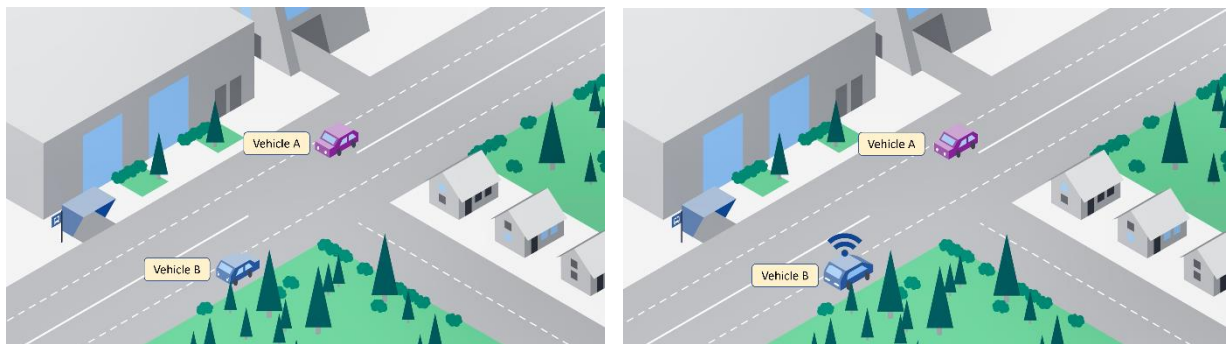
Method

We recruited 301 participants from Amazon's Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 30 for failing similar comprehension checks as studies 1-2 (described below), yielding 271 participants ($M_{\text{age}} = 48$, 50% females). The design was identical to studies 1–2, except participants in the two conditions were given the following instructions (bold font was only included in the AV condition) accompanied by figure 14:

*You will watch an animated video of a traffic scenario, depicted below. The video depicts a two-way street in which the driver of Vehicle A makes a left turn and strikes Vehicle B, seriously injuring its occupant. **Vehicle B is a fully autonomous Robocar, which means that it is driven by a computer algorithm.***

FIGURE 14

INSTRUCTION STILLS FOR HUMAN-DRIVEN (LEFT) AND AUTONOMOUS (RIGHT) CONDITIONS



Readers can view the videos here: <https://youtu.be/EcyuBvOMBeo> (HDV); <https://youtu.be/4ggZQJDJcMo> (AV). Participants watched the assigned video twice. After

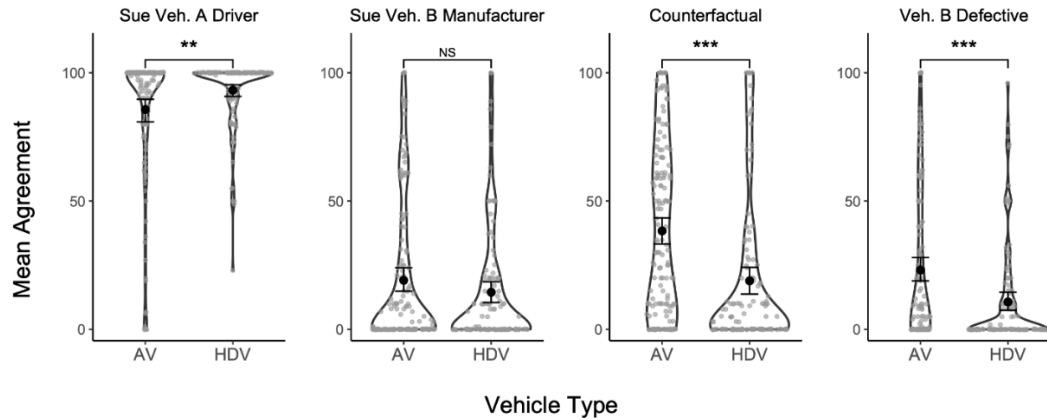
completing the same main measures and checks as in studies 1 and 2, participants were asked to answer two comprehension checks about what type of vehicle they saw in the scenario (AV or HDV) and which vehicle made a left turn (vehicle A or B). They also indicated how much they agreed with several statements pertaining to their inclination to punish others. We utilized sixteen statements from an existing psychological scale on attitudes toward punishment (Moorman et al. 1992). Finally, they answered the demographics items.

Results

In line with the results of studies 1-2, we found that participants were numerically more willing to sue the manufacturer of a not-at-fault AV than HDV ($M_{AV} = 19.13$, $M_{HDV} = 14.46$, $t(269) = 1.50$, $p = .136$, $d = 0.18$; figure 15; table 6). Given our directional hypothesis, we are also justified in running a one-sided t-test of whether the AV condition elicits significantly higher willingness to sue than the HDV condition; this analysis yielded a marginally significant difference ($t(269) = 1.50$, $p = .068$, $d = 0.18$).

The other results also replicated studies 1-2 (table 6), except that this time participants were also more willing to sue the driver of vehicle A when the vehicle crashed into an HDV versus an AV. Perhaps when the not-at-fault vehicle was human-driven, it was more salient to consumers that a human was harmed.

FIGURE 15
RESULTS FOR STUDY 3



NOTE.— Error bars indicate 95% CIs. $^{\wedge}p < 0.1$; $*p < .05$; $**p < .01$; $***p < .001$

TABLE 6
STATISTICS FOR STUDY 3

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault	85.65 (26.20)	93.23 (13.52)	$t(234)=-3.08^{**}$	0.35
Sue Firm, Not at Fault	19.13 (28.20)	14.46 (23.21)	$t(269)=1.50$	0.18
Defective, Not at Fault	23.13 (30.39)	10.70 (19.73)	$t(259)=4.06^{***}$	0.47
Counterfactual	38.36 (33.14)	18.93 (29.02)	$t(266)=5.14^{***}$	0.62

NOTE.— T-statistics reflect results of independent-samples t-tests. $**p < .01$, $***p < .001$.

Mediation analysis. Since there was high agreement among our measures of inclination to punish ($\alpha = 0.91$), we averaged them to form a single measure of inclination to punish. We conducted a moderated serial mediation analysis, testing for the same serial model as in study 1, but with the path between vehicle defectiveness and firm liability moderated by attitudes towards punishment.

Again, we found that the serial mediation was significant ($b = -4.42$, $SE = 1.35$, 95% CI $[-7.47, -2.17]$). However, the index of moderated mediation was not significant (PROCESS model 87; $b = -0.01$, $SE = 0.02$, 95% CI $[-0.05, 0.04]$). We also explored moderated mediation of the other paths in the serial mediation model. Attitudes towards punishment did not moderate the

path from counterfactuals to defectiveness (PROCESS model 91; $b = -0.05$, $SE = 0.04$, 95% CI [-0.12, 0.02]), or from video condition to defectiveness (PROCESS Model 83; $b = -0.01$, $SE = 0.05$, 95% CI [-0.11, 0.08]).

Discussion

In line with hypotheses 1 and 2, we successfully replicated the greater tendency to think that AV manufacturers deserve to be sued for collisions not at fault when their vehicles are AVs vs. HDVs. This effect was again explained by counterfactual reasoning leading to ascriptions of defectiveness, which in turn affected perceived firm liability. Additionally, we did not find evidence that the relationship between counterfactual reasoning and judgments of defectiveness was moderated by attitudes towards punishment.

Study 3b: AV Firm Vs. Human Driver

Study 3b again tested whether there is also greater willingness to sue the manufacturer of an AV compared to a *human driver* of an HDV.

Method

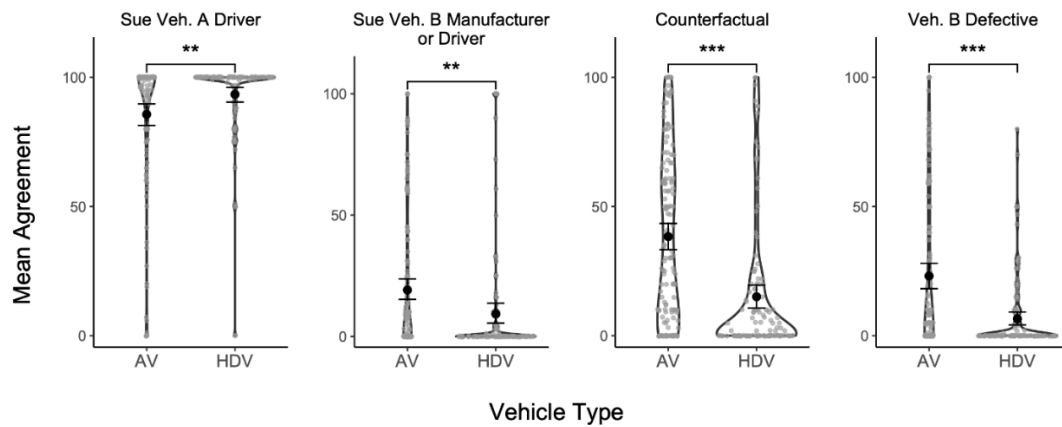
We recruited 152 participants from Amazon's Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 35 for failing the same comprehension checks as studies 1-3, yielding 117 participants ($M_{age} = 43$, 44% females). The study design was identical to studies 1b and 2b, except that participants saw the same video as in study 3.

Results

Participants thought it was more reasonable to sue the AV manufacturer than human driver of Vehicle B ($M_{AV\ Firm} = 19.13$, $M_{HDV\ driver} = 9.24$, $t(264) = 3.11$, $p = .002$, $d = 0.38$ s; figure 16; table 7). They were also more likely to consider a counterfactual in which a human driver had more control when the not-at-fault vehicle was an AV than an HDV, and more likely to conclude that the AV was defective (figure 16; table 7).

FIGURE 16

RESULTS FOR STUDY 3B



NOTE.— Error bars indicate 95% CIs. ** $p < .01$; *** $p < .001$

TABLE 7

STATISTICS FOR STUDY 2B

Measure	AV Mean	HDV Mean	T-Value	Cohen's D
Sue Driver, At Fault	85.65 (26.20)	93.39 (16.26)	$t(255)=-2.97^{**}$	0.35
Sue Firm/Driver, Not at Fault	19.13 (28.20)	9.24 (23.82)	$t(264)=3.11^{**}$	0.38
Defective, Not at Fault	23.13 (30.39)	6.58 (14.26)	$t(224)=5.90^{***}$	0.67
Counterfactual	38.36 (33.14)	15.10 (26.03)	$t(266)=6.43^{***}$	0.77

NOTE.— T-statistics reflect results of independent-samples t-tests. ** $p < .01$, *** $p < .001$.

Discussion

Once again, in a new scenario, firms manufacturing not-at-fault AVs were viewed as more liable than human drivers of not-at-fault HDVs, indicating higher effective standards for AV firms in general.

Study 4: Does Awareness-Raising Reduce The Effect?

In studies 1-3, participants were exposed to only one type of vehicle, either AV or HDV. Study 4 tests whether the tendency to blame firms of AVs more than HDVs continues to hold when participants judge both types of vehicles in a within-subjects design.

Method

We recruited 311 participants from Amazon's Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$1.00. We excluded 69 for failing the same comprehension checks as in studies 1–2, yielding 242 participants ($M_{age} = 39$, 43% females). The study employed a 2 (vehicle type: AV vs. HDV) x 2 (condition order: AV first vs. HDV first) mixed design, with vehicle type shown within-subjects and condition order shown between-subjects. Participants were given the following instructions:

In this study, you will evaluate blame and negligence in a traffic accident scenario. You will watch videos depicting two scenarios. These scenarios will involve human-driven and automated vehicles.

Most aspects of the design were as in study 1, except that participants completed both the AV and HDV conditions. They were assigned to either the HDV or AV condition first, with the order counterbalanced between-subjects. Participants completed all measures from the first condition (except for the item about superhuman abilities of AVs, which was removed), followed by the same comprehension checks from studies 1-3. They were then given the following instructions:

*Part 2: You will now answer questions about this same traffic scenario, but now **Vehicle B** will be a different type of vehicle.*

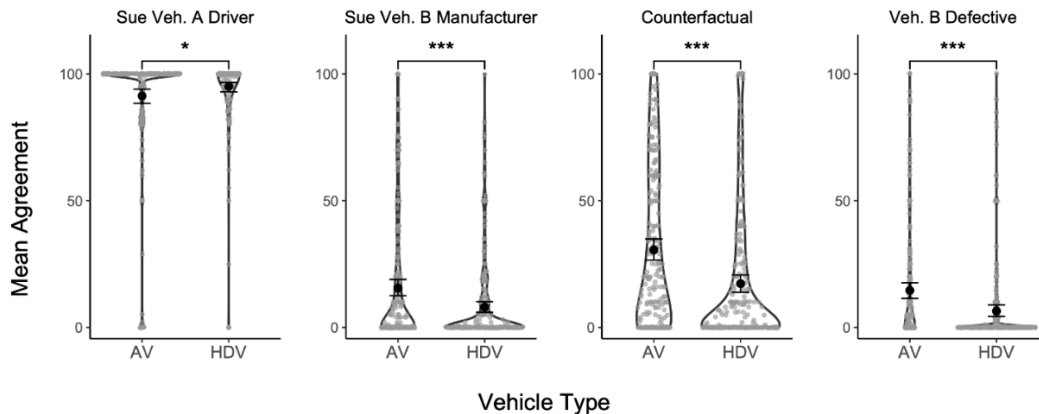
After they completed the second condition, they answered the same set of questions and comprehension checks as in part 1. Finally, they answered four exploratory measures on their familiarity with AV accident prevention algorithms, the insurance industry, the motor insurance industry, and product liability claims, in addition to the demographic items from studies 1-3.

Results

To measure the effect of vehicle type on firm liability while controlling for the order in which the conditions were presented, this time we ran linear regressions with vehicle type as a fixed effect and condition order as a random intercept. For willingness to sue the not-at-fault vehicle manufacturer, we found a significant effect in the predicted direction ($M_{AV} = 15.54$, $M_{HDV} = 8.00$, $b = -7.53$, $p < .001$; figure 17, table 8). We also replicated the results for the counterfactual and defective measures. In short, the main effects found in studies 1-3 held in a within-subjects design.

FIGURE 17

RESULTS FOR STUDY 4



NOTE.— Error bars indicate 95% CIs. * $p < .05$; *** $p < .001$

TABLE 8
STATISTICS FOR STUDY 4

Measure	AV Mean	HDV Mean	Beta Value
Sue Driver, At Fault	91.31 (22.33)	95.04 (15.35)	3.73*
Sue Firm, Not at Fault	15.54 (25.28)	8.00 (16.84)	-7.53***
Defective, Not at Fault	14.62 (24.32)	6.46 (16.96)	-8.16***
Counterfactual	30.61 (32.06)	17.31 (27.14)	-13.29***

NOTE.— Beta coefficients reflect results from mixed effects linear regressions, with vehicle type as a fixed effect and condition order as a random intercept. * $p < .05$, *** $p < .001$.

Mediation analysis. We then ran a serial mediation analysis (PROCESS Model 6; Hayes 2012) to determine whether the results followed the predicted causal order found in studies 1-3: condition → counterfactual → defectiveness → sue manufacturer. The serial mediation was again significant ($b = -1.93$, $SE = 0.63$, 95% CI [-3.35, -0.92]).

Discussion

Participants continued to exhibit a tendency to view firms as more liable for AVs than HDVs in accidents not at fault, even when participants were made aware of their response pattern via a within-subjects design.

Study 5: Causally Intervening on Counterfactuals

Thus far, our claims about the psychological process underlying the bias against AV firms rests on mediation models that are ultimately correlational in nature. In the current study, we manipulated counterfactual thinking and tested whether this causally affects assessments of firm culpability.

Method

We recruited 299 participants from Amazon’s Mechanical Turk, who passed attention checks and completed the survey, in exchange for \$0.50. We excluded 18 for failing the same comprehension checks as studies 1–2 as well as response checks (described below), yielding 280 participants ($M_{\text{age}} = 44$, 56% females). Participants were first given the same instructions as in study 2, except that we additionally specified in the AV condition that “The human occupant of Vehicle B cannot control the vehicle at all”, to further ensure that participants understood the human occupant of the AV could not have intervened during the accident. All participants saw only the version of the four-way intersection crash from study 2, in which the not at fault vehicle is an AV. After showing the video, we administered a counterfactual manipulation in which we induced participants to think of the counterfactual, without telling them what to conclude:

*Please think about how things could have gone differently if, instead of being a passenger of the Autonomous Vehicle B, the human occupant of Vehicle B had been driving a **regular human-driven** vehicle instead. That is, imagine how things could have turned out differently if the human occupant had had **full control** over Vehicle B.*

In the textbox below, please describe how things could have gone differently, starting the sentence with “If the human occupant of Vehicle B had been driving a regular vehicle instead, then...”

We then provided a textbox for participants to type their answers. The rest of the survey was as in study 2.

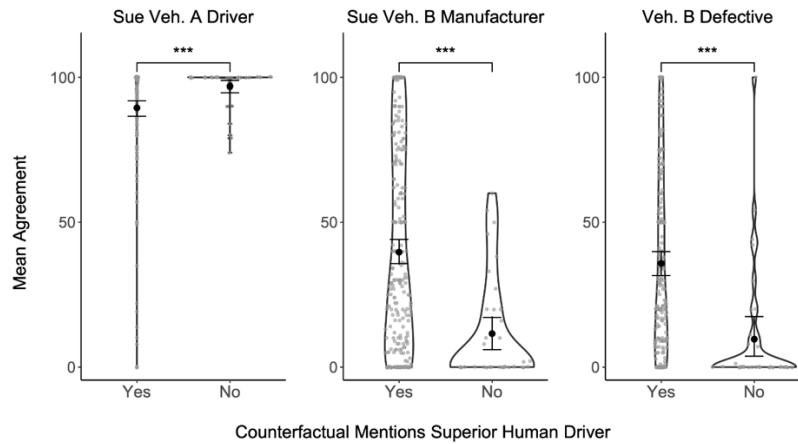
Results

We coded whether participants' responses expressed that a human would have behaved more optimally or that the outcome would not have changed from what transpired in the original video. 86.8% of participants spontaneously indicated that they thought a human driver would have acted more optimally, 12.8% thought nothing would change, and one person (making up less than a percent) was unsure; we excluded this participant from subsequent analyses, as well as three participants whose responses suggested that they misunderstood the question. These results support our interpretation in studies 1-4 that the reason participants were more inclined to conclude that the AV was defective is that they believed a human driver could have done more to avoid the accident.

Next, we compared perceived AV firm liability based on what kinds of counterfactual explanations participants generated. Participants believed it was much more reasonable to sue the AV firm if they thought a human driver would have acted more optimally than if they thought nothing would have changed ($M_{human-superior} = 39.67$, $M_{human-same} = 11.56$, $t(79) = 7.58$, $p < .001$, $d = 0.86$; figure 18), and we found a similar result for judgments of defectiveness ($M_{human-superior} = 35.78$, $M_{human-same} = 9.64$, $t(62) = 6.48$, $p < .001$, $d = 0.86$). Interestingly, participants who thought a not-at-fault human driver would have acted more optimally were also less likely to say that the driver of the *at-fault* vehicle deserved to be sued ($M_{human-superior} = 89.48$, $M_{human-same} = 96.94$, $t(154) = -4.23$, $p < .001$, $d = 0.38$), suggesting that the more they thought the not-at-fault AV was defective, the less they blamed the at-fault human driver.

FIGURE 18

RESULTS FOR STUDY 5

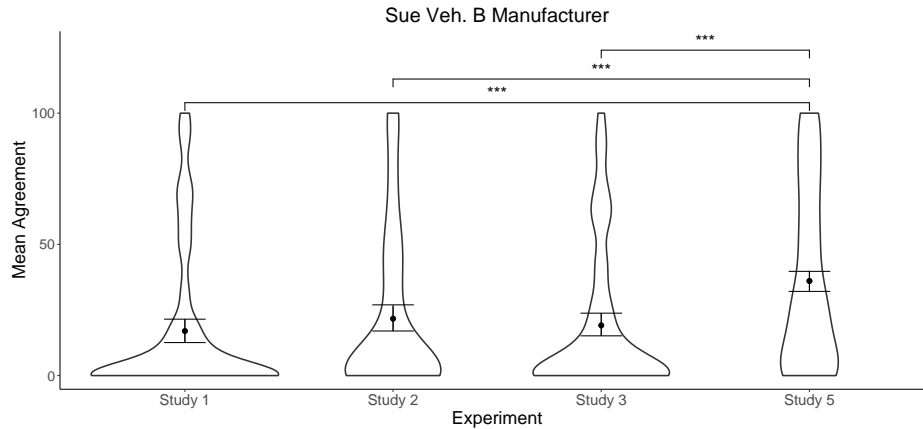


NOTE.— Error bars indicate 95% CIs. *** $p < .001$

Mediation analysis. We conducted a mediation analysis (PROCESS Model 4; Hayes 2012) to determine whether judgments followed the predicted causal order: type of counterfactual → defectiveness → sue manufacturer, and found that the mediation was significant ($b = -21.39$, $SE = 3.59$, 95% CI $[-28.08, -13.94]$).

Comparing study 5 to studies 1-3. To assess the magnitude of our causal intervention, we also compared the current results to those in the AV of condition of studies 1-3. We found that participants in the current experiment who were prompted to think of counterfactuals judged that it was much more reasonable to sue the AV firm's manufacturer than participants in studies 1-3, who were given no such prompt: study 1 ($M_{\text{Study5}} = 36.06$, $M_{\text{Study1}} = 16.97$, $t(336) = 6.15$, $p < .001$, $d = 0.60$; figure 19), study 2 ($M_{\text{Study5}} = 36.06$, $M_{\text{Study2}} = 21.69$, $t(317) = 4.41$, $p < .001$, $d = 0.44$; figure 19), and study 3 ($M_{\text{Study5}} = 36.06$, $M_{\text{Study3}} = 19.13$, $t(358) = 5.53$, $p < .001$).

FIGURE 19



NOTE.— Error bars indicate 95% CIs. *** $p < .001$

Discussion

We found that inducing counterfactual simulations in which the human occupant had more control of the vehicle led participants to spontaneously conclude that a human driver would have acted more optimally, that the vehicle was defective, and that the firm was more liable. The results provide causal evidence for the proposed counterfactual thought process underlying the response pattern found in studies 1-5.

General Discussion

Across seven studies, we found that vehicle manufacturers are more likely to be viewed as liable when their vehicles are autonomous (AVs) than human driven (HDVs), even in accidents where their AVs are not at fault. This response pattern was driven by a tendency to imagine counterfactual scenarios in which a human had more control over the AV. Based on such simulations, participants spontaneously concluded that a human would have done more to avoid the accident or minimize its damage, leading them to conclude that the AV must have had some defect and that, hence, an AV firm was more liable than a HDV firm. The tendency to

imagine this counterfactual was moderated by individual levels of trust in AVs—the less participants trusted AVs, the more they entertained the counterfactual. Similarly, the AV firm was also seen as more liable than the human driver of the HDV, showing that in practice they were held to a higher standard than all comparable parties.

Theoretical Implications

Our research has four main theoretical implications. First, we contribute to work on counterfactual reasoning in consumer psychology, by revealing that new technology affects which counterfactuals come to mind in event-based scenarios, and that this influences inferences about product defects and firm liability.

Second, we contribute to the literature on consumer concerns about accidents involving AVs. While previous research has focused on hypothetical moral dilemmas in which AVs are forced to make a choice between two harmful outcomes (Awad et al. 2018; Bonnefon et al. 2016; Gill 2020), the current work suggests economic and social risks arising from how consumers think about the exceedingly more prevalent scenario in which AVs are involved in accidents not at fault.

Third, we contribute to work on consumer trust by exploring its role in the liability assigned to manufacturers. While previous work has investigated the role of trust in interpersonal marketing relationships (Doney and Cannon 1997; Hewett and Bearden 2001; Moorman et al. 1993; Moorman et al. 1992; Schurr and Ozanne 1985) and brand loyalty (Aaker, Garbinsky, and Vohs 2012; Chaudhuri and Holbrook 2001; Mal, Davies, and Diers-Lawson 2018), we show how it could influence the adoption of a new technology that requires surrendering control to autonomously behaving algorithms.

Fourth, we contribute to literature on moral judgment in consumption. Most studies of moral judgment find that consumers blame the *agent/perpetrator* of a harm (Folkes 1984). In contrast, here, we unveil a case in which the *patient* is blamed instead. The closest related work is on victim blaming, the tendency to blame the victims of harmful interactions (Reich, Campbell, and Madrigal 2020; Ryan 1976; Xu, Bolton, and Winterich 2021). Yet in the current case we find not just a general patient-blaming tendency, but a tendency to blame patients more so when they have salient features that affect counterfactual simulation.

Practical Implications

Our results carry implications for all stakeholders in the AV industry. If AV firms face unreasonable liability risks rooted in how consumers view their vehicles, then different stakeholders may need to proactively respond: insurers, by charging premiums that adequately reflect this risk; AV firms, by increasing the prices of their related services; and governments, by creating incentives that make AVs more economically attractive to consumers.

All stakeholders may also want to normalize AVs in the minds of consumers. A possible silver lining is that once AVs are rolled out and become ubiquitous in large cities, the feeling that they are abnormal should be reduced. At the same time, it is yet unclear what kinds of exposure to AVs will have this effect, and how long it will take to reach an equilibrium in which AVs seem as normal as HDVs. Similarly, deployments could be delayed if consumers are exposed to news that confirms their current mistrust—as in various recent reports that the technology has been over-hyped (Chafkin 2022; Isidore, McFarland, and Valdes-Dapena 2022) and public campaigns against the technology (Vynck 2022)—even if accidents are rarer for AVs than HDVs. This dynamic will continue to play out in the early days of adoption, with potential long-term consequences for whether the technology is widely adopted.

Limitations and Future Directions

Our findings raise several open questions for future work on psychological mechanisms, generalization of the effects, and potential interventions.

On psychological mechanisms, one question is whether the same thought process at play here affects not just views about firm liability but also brand image, with effects on purchase intent. Future investigations can also probe whether other psychological processes contribute to the liability response patterns found here. One possibility is that consumers employ a generalization heuristic, assuming that an error with one AV also implicates all other AVs from the firm or even all AVs in general, resulting in a larger total risk of harm (as in so-called "algorithmic transference" effects; Longoni, Cian, and Kyung 2022). If such an inference is at play, it would be in addition to the counterfactual mechanism uncovered here, which was causally implicated in the response pattern.

On generalization, future studies can expand upon the liability and insurance risks for firms by surveying other relevant stakeholders, such as underwriters and lawyers. It can also measure how consumers apportion liability across various stakeholders in the value chain, such as vehicle manufacturers, software providers, and bus operators. Global studies can test whether the current effects are limited to the litigious U.S. context or generalize to other geographics where AVs are being actively developed or deployed, like Europe and Asia, where we predict consumers will show the present response pattern so long as they view AVs as an abnormal presence that potentially interferes with human competence.

On interventions, future work can investigate how exposure to AVs, both by passengers of AVs but also by other drivers and pedestrians, affects the phenomena uncovered here. The question is whether exposure can serve to normalize AVs, thereby mitigating the bias found here,

or whether negative public perceptions will be too persistent and a possible stopper for AV firms. Another approach may be to target consumer trust, by communicating that AVs do not only follow the literal rules of the road, but also take deliberate steps to evade accidents when they are not at fault. On this note, the current work studied the effect of trust in the AV's *competence*, given that competence is of primary concern for new technological products. But future work could also investigate whether other types of trust pertaining to the AV *firm* (rather than to the AV itself) influence liability, including trust based on the firm's benevolence (the extent to which the firm seems to want to do good to the trustor, regardless of profit incentive), and integrity (the extent to which the firm adheres to principles that the trustor thinks are reasonable) (Mayer, Davis, and Schoorman 1995; Sirdeshmukh, Singh, and Sabol 2002; Xie and Peng 2009).

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