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ATTITUDES AND SOCIAL COGNITION

From Variability to Vulnerability: People Exposed to Greater Variability Judge Wrongdoers More Harshly

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Recent decades have seen increased *variability* in diverse domains, such as the climate and asset prices. As more resources are required to cope with greater variability in the outside world, exposure to greater variability can make people feel that society is more vulnerable. This sense of vulnerability, in turn, can lead people to judge and punish wrongdoers more harshly. Studies 1a–2c found that people who were exposed to graphs representing greater variability were more willing to punish wrongdoers, both in domains that were related to the source of variability and those that were unrelated. Studies 3 and 4 found that people who experienced more variable dice rolls were more likely to punish unethical behaviors in hypothetical scenarios and in experimental games, even at a financial cost to themselves. Studies 5a and 5b provided evidence for the underlying mechanism—sense of vulnerability—using correlational designs. Study 6 provided experimental evidence for the underlying mechanism. These findings suggest that increasing variability in diverse domains can have unexpected psychological consequences.

Keywords: moral judgment, punishment, unethical behavior, variability, vulnerability

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Variability refers to changes in quantity over time. Recent decades have seen increased variability in numerous domains. For example, greater variability in temperature and precipitation is a defining feature of the climate change that the world is currently experiencing (Intergovernmental Panel on Climate Change, 2007). The variance in average monthly crude oil prices, which translates into the prices that consumers pay at the gas station, has increased more than sixfold in the most recent decade compared with the previous decade.[1] The coefficient of variation, or risk per unit return, of the U.S. S&P 500 stock index has been gradually increasing over the past 50 years.[2] People experience this variability in their everyday lives (e.g., in weather and oil prices), and are exposed to data representations of this variability (e.g., in weather reports and economic news). The key research question that we ask is whether exposure to variability in the outside world, both observed and experienced, can influence people's behaviors.

The current research is rooted in socioecological psychology, a field that examines the effects of the physical, societal, and interpersonal environment on people's psychological functioning and behavior (Oishi, 2010, 2014). Past work in this area has examined how mean levels of various environmental variables (e.g., weather and climate) influence people's beliefs and behaviors (e.g., Li, Johnson, & Zaval, 2011; Zwebner, Lee, & Goldenberg, 2014). Yet, researchers have rarely explored whether the degree of variability in environmental factors could also influence people's psycholog-

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[1] The variances were computed from January 1995 to December 2004 and from January 2005 to December 2014. The data are available from the U.S. Energy Information Administration. Retrieved from http://www.eia.gov/dnav/pet/pet_pri_dfp1_k_m.htm.

[2] The coefficient of variation was computed by taking the standard deviation of the average monthly price of the S&P 500 index over a 12-month period, and dividing it by the average monthly price over the same period. It was computed over a moving 12-month window from January 1965 to December 2015.

ical functioning (see Van Lange, Rinderu, & Bushman, 2017, for an exception). In the present research, we investigate whether perceived and experienced variance in environmental variables can shape people's behaviors—specifically, their moral judgments and punishments.

Extensive research on compensatory control theory has argued that people prefer a world that is structured (Kay, Laurin, Fitzsimons, & Landau, 2014; Neuberg & Newsom, 1993; Rahinel, Amaral, Clarkson, & Kay, 2016); orderly, predictable, nonrandom (Kay, Moscovitch, & Laurin, 2010; Laurin & Kay, 2017; Tullett, Kay, & Inzlicht, 2015); stable and consistent (Laurin, Gaucher, & Kay, 2013; Proudfoot, Kay, & Mann, 2015); controllable (Kay, Gaucher, Napier, Callan, & Laurin, 2008); and meaningful (Heine, Proulx, & Vohs, 2006; Proulx & Heine, 2006, 2009). Low levels of these desired characteristics motivate people to restore their sense of control and structure by bolstering their beliefs in personal agency, bolstering their beliefs in external sources of agency that can influence their own outcomes, seeking clear and reliable action-outcome contingencies, and seeking clear and consistent interpretations of the environment (Kay, Whitson, Gaucher, & Galinsky, 2009; Landau, Kay, & Whitson, 2015; Laurin & Kay, 2017). For instance, people who experienced a lack of control reported a higher need for structure and were more inclined to perceive illusory patterns even when none existed (Whitson & Galinsky, 2008).

Variability is related to constructs studied in the compensatory control literature in that greater variability can imply a lack of order and greater unpredictability, randomness, and uncertainty, all of which could reduce people's sense of control. However, the present research is the first to examine how mathematical representations of variability (e.g., the standard deviation) in data representations influence people's behavior. We also studied a novel outcome—increased punishment—that has not been examined in the compensatory control literature.

From Variability to Vulnerability

We argue that in many domains, people dislike high degrees of variability because greater variability requires society to devote more resources to cope with a broader range of outcomes. If society does not have the resources to cope with a wider range of outcomes, then exposure to greater variability may lead people to feel that their society is more vulnerable to extreme outcomes. For example, increased variability in temperature or rainfall would likely increase the risk of heatwaves and cold waves, and droughts and floods. Similarly, increased variability in oil prices and stock prices would likely increase people's risk of running out of money and retirement savings. Research has found that climate variability reduces fishing employment (Oremus, 2019). Thus, we argue that exposure to greater variability would make people feel that their society is more vulnerable.

The climate change and sustainability science literatures had operationalized perceived societal vulnerability using two measures—the perceived likelihood of experiencing hazards (i.e., risk perception), and the perceived society's capacity of coping, adapting, and transforming in response to environmental and other stressors (i.e., adaptive capacity; Adger, 1999; Handmer, Dovers, & Downing, 1999; Turner et al., 2003; Smit & Wandel, 2006; Brown & Westaway, 2011; Kahan et al., 2012). People who perceive a higher degree of societal risk in the climate domain are more likely to support climate change policies, such as reducing greenhouse gas emissions and increasing vehicle fuel economy standards (Leiserowitz, 2006; Weber & Stern, 2011). People who believe that their society has a low level of adaptive capacity are less likely to take actions to adapt to climate change proactively (e.g., farmers hesitating to substitute maize with millet during drought; Grothmann & Patt, 2005; Ziervogel, 2004).

Research in life history theory suggests that organisms can respond to the level of variability in their environment with two different strategies, fast and slow (Del Giudice, Gangestad, & Kaplan, 2015; Hurtado & Hill, 1990; Lack, 1968). The fast strategy speeds up individuals' growth and reproduction rates, and correspondingly, decreases their life span; this strategy ensures that individual's genes would be passed on to the next generation as quickly as possible. The slow strategy involves slowing down growth and reproduction rates, and correspondingly, increases the life span; this strategy ensures that individuals are stronger and can survive for a longer time (Bogin, Silva, & Rios, 2007; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Griskevicius, Cantú, & Van Vugt, 2012; Sng, Neuberg, Varnum, & Kenrick, 2017). Researchers have argued that "larger degrees of seasonal variation in climate, call for individuals and groups to adopt a slower life history strategy, a greater focus on the future (vs. present), and a stronger focus on self-control" (Van Lange et al., 2017, p. 19). Thus, higher variability leads to the development of a slower life strategy, which helps the species cope with the greater threat posed by high variability in the outside world.

From Vulnerability to Punishment

If exposure to high variability makes people feel that society is more vulnerable, it might lead people to judge and punish unethical behaviors more harshly. Two arguments support this prediction. The theory of just deserts states that the punishment should be proportionate to how much harm an offender brings (Carlsmith, Darley, & Robinson, 2002; Kant, 1952). If people perceive that society is more vulnerable, they might perceive the same transgression as being more severe in magnitude (Rossi, Waite, Bose, & Berk, 1974) or less acceptable (Finkel, Maloney, Valbuena, & Groscup, 1996; Robinson & Darley, 1995), and therefore, prescribe harsher punishments. The theory of deterrence assumes that potential criminals are rational, and that punishment is effective because it changes the costs-benefit ratio, making the transgression less attractive (Bentham, 1962; Nagin, 1998). If people perceive that society is more vulnerable, they might want to particularly deter future transgressions to avoid compounding the existing vulnerability, and therefore, prescribe harsher punishment.

Research has found that in societies that face a high degree of vulnerability, such as a result of insufficient food supply and or serious threats to health, people prepare for the next season "by adopting a future orientation (e.g., planning) and by exercising self-control (resisting the temptation to consume the harvest directly, a commitment to work hard to optimize the harvest for later [Ainslie, 2013; Baumeister, Park, & Ainsworth, 2013])," and people "place greater value on future-oriented rewards such as perseverance and thrift (Hofstede, 2001)" (Van Lange et al., 2017, p. 7). From the perspective of life history theory, these behaviors reflect a slow strategy. Research has also found that a slow life strategy

can increase individuals' religiosity and strengthens moral institutions in society, which help people restrain their impulses (Gladden, Welch, Figueredo, & Jacobs, 2009). Stronger moral and social rules in the face of vulnerability (Rushton, 1985) might lead to greater punishment for wrongdoers. Thus, high degrees of societal vulnerability can lead society to adopt a slower life strategy, which strengthens moral norms and thus can lead to greater punishment.

Specificity of the Variability–Punishment Link

It is important to distinguish whether any effect of greater variability on increased punishment is restricted to the same domain (e.g., after being exposed to greater variability in rainfall, people would be more likely to punish others who waste more water but not those who steal money), or whether the effects generalize even across seemingly unrelated domains (e.g., after being exposed to greater variability in rainfall, people would be more likely to punish those who steal money). The answer to this question depends on the specificity of the underlying psychological state that is activated through exposures to greater variability.

If exposure to greater variability in one domain only makes people perceive higher vulnerability in that particular domain, then the effects of variability are unlikely to generalize across domains. However, if exposure to greater variability in one domain gives rise to a diffuse sense of vulnerability, then we would expect that greater variability in one domain (e.g., the weather) would lead to harsher moral judgments or increased punishment even in seemingly unrelated domains (e.g., financial crimes). Indeed, people may generalize their conclusions from increased variability in one domain to another domain, and so on. For example, after being exposed to information about high variability in temperature, people might think that there is also likely to be high variability in rainfall, and therefore, high variability in agricultural output, and therefore, high variability in food prices, and therefore, more social unrest. Thus, we predicted that the sense of societal vulnerability activated by exposure to greater variability in the world would often be diffuse, and thereby increase people's willingness to punish norm violators even in domains that are unrelated to the domain of the variability.

Potential Mechanisms

Although we posited that the effects of exposure to greater variability on punishment would run through an increased sense of societal vulnerability, many other mechanisms might also be at play. One candidate is increased anxiety. For example, people who read an article claiming that the world is random (i.e., neither orderly nor comprehensible) felt more anxious (Tullett et al., 2015). Given that people may interpret higher variability as an expression of more randomness, it is possible that exposure to higher variability would make people feel more anxious. This increased anxiety may lead people to assign greater punishment to wrongdoers (Dowler, 2003).

Greater variability in the past implies higher uncertainty and unpredictability in the future. Given people's general need for order and structure (Neuberg & Newsom, 1993; Webster & Kruglanski, 1994), expectations of higher uncertainty and unpredictability in the future might lead people to evaluate individuals who conform to social norms more positively than individuals who fail to conform (Kruglanski & Webster, 1991), and therefore, lead to higher punishment. Thus, the effects of greater variability can run through higher perceived uncertainty and unpredictability.

Greater variability can also lead to a loss of perceived control, both personal and societal, as people might feel that they themselves and their society are helpless pawns in the hands of unpredictable external forces. Research has found that the less people believe in a controlling God, the greater their desire to punish wrongdoers (Laurin, Shariff, Henrich, & Kay, 2012). Given that believing in God provides people a sense of control (Landau et al., 2015), this finding suggests that a lack of perceived control might increase punishment.

Greater variability might threaten people's sense of collective efficacy, as the global nature of the problem might appear too big for a single society to counteract on its own (Bamberg, Rees, & Seebauer, 2015). People might think that prescribing harsher punishments is one way to restore collective efficacy, as harsher punishments would demonstrate that society has the capacity to engage in collective actions that are needed to maintain order. Thus, a lower sense of collective efficacy might explain the relationship between variability and punishment.

Finally, greater variability could also shift people's regulatory focus (Higgins, 1997). In times of high variability, extreme events become more likely (e.g., the greater variability associated with climate change increases the risk of both heat waves and cold snaps; Intergovernmental Panel on Climate Change, 2007). If people realize this point, then they may be more focused on trying to avoid bad outcomes (i.e., having a prevention focus) rather than approaching good outcomes (i.e., having a promotion focus). A higher prevention focus might lead people to punish wrongdoers more, as one of the primary goals of punishment is to deter wrongdoing in the future.

We tested all the above potential mechanisms in these current studies.

Overview of Studies

To gauge the generalizability of our findings, we assessed whether different indicators of variability influence people's punishment decisions. One indicator of variability is the standard deviation or variance of a quantity across time (Dodge, 2006; Pearson, 1894). This indicator is likely salient when people see the levels of a quantity across time represented in the form of a graph or a table. A second indicator is the standard deviation of successive differences (Bloomfield, 2004; von Neumann, Kent, Bellinson, & Hart, 1941). This indicator is likely salient when people experience changing levels of a quantity over time and compare each experience with the previous experience. Taken together, we theorized that the objective variability in weather, prices, and other domains would influence individuals through a subjective sense of variability, which can be shaped both by people's everyday experiences (e.g., large intraday variation in temperature), and by their exposure to data representations of variability (e.g., seeing a graph depicting variation in temperature on the Weather Channel).

We presented participants with data drawn from distributions with the same mean but with higher versus lower variance (Study 1a), gave people the appearance of greater versus lower variability by altering the range of the *y* axis in graphical representations (Studies 1b, 2a–2c, 6), and led people to experience outcomes with

higher versus lower standard deviation of successive differences (Studies 3 and 4). We tested whether these diverse manipulations and measures of perceived variability would have similar effects on individuals' moral judgments and punishment using scenarios (Studies 1a and 1b, 2a–2c, 3, 6), economic games (Study 4), and support for the death penalty (Studies 5a and 5b). We also tested the underlying mechanism—an increased sense of societal vulnerability (Studies 5a and 5b, 6). Studies 2b and 6 were preregistered.

In all studies, only multiple responses from the same IP address were excluded because they could have originated from the same individual(s). No other participants were excluded. All studies were run in a single wave. All experimental conditions and measures are reported. The stimuli and scenarios used in all studies are provided in the online supplemental materials. The data used in this article are currently available at https://osf.io/mu8ew/?view_only=70a07ddf1e2d42eaacb0dbdc0c8ec24f.

Study 1a

Study 1a tested our main hypothesis that exposure to greater variability can lead people to prescribe harsher punishment for unethical behaviors. Inspired by prolonged droughts in the western half of the United States in 2012 and 2013 (Ingram & Malamud-Roam, 2013), Study 1a tested whether compared with people exposed to lower variability in temperature, those exposed to greater variability in temperature would judge and punish more harshly for a person who violated mandatory water restrictions during a drought.

Method

Participants. Because this study was conducted after Studies 2a and 2c, a power analysis based on effect size Cohen's $d = .49$ (the average effect size from Studies 2a and 2c), $\alpha = .05$ (two-tailed), *power* = 80%, indicated that we would need to recruit 67 participants per condition. We decided to recruit 100 participants per condition as that was the minimum sample size in the lab at the time of the study. A survey seeking 200 U.S. residents was posted on Amazon's Mechanical Turk (MTurk). Among the 200 participants who completed the study on MTurk, 20 responses that came from duplicated IP addresses were excluded from further analyses. The final sample consisted of 180 participants (92 women, 88 men; mean age 34.5 years). Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Participants were instructed: "In this study, we are interested in how people acquire information from graphs. We will show you a weather graph and ask you some questions about it." We showed participants a line graph of annual temperature in the US over the past 30 years (from 1985 to 2014). In the greater variability condition, the temperature data was generated from a normal distribution with a mean of 52.9°F and a standard deviation of 5.7°F (see Figure 1). In the lower variability condition, the temperature data were generated from a normal distribution with the same mean but a lower standard deviation of 1.8°*F* (see Figure 2). To ensure that participants attended to the graph, we asked them to indicate the years with the highest and the lowest average temperatures, and to summarize the information conveyed by the graph in their own words: (a) "Which year had the highest average temperature? (Please type as YYYY format)" (open-ended); (b) "Which year had the lowest average temperature? (Please type as YYYY format)" (open-ended); (c) "Please summarize the information conveyed by the graph above in one sentence" (open-ended).

Next, we administered a manipulation check: "How variable do you think was the temperature of the United States over the past 30 years?" (7-point scale ranging from *Not at all* to *Extremely*).

Next, as part of a second task, participants were asked to imagine that they were residents of a small island, which depended entirely on rainfall to supply its water needs. They were informed that owing to a severe drought, the government has imposed mandatory water restrictions, but they witnessed their neighbor watering the lawn and washing the car (see the online supplemen-

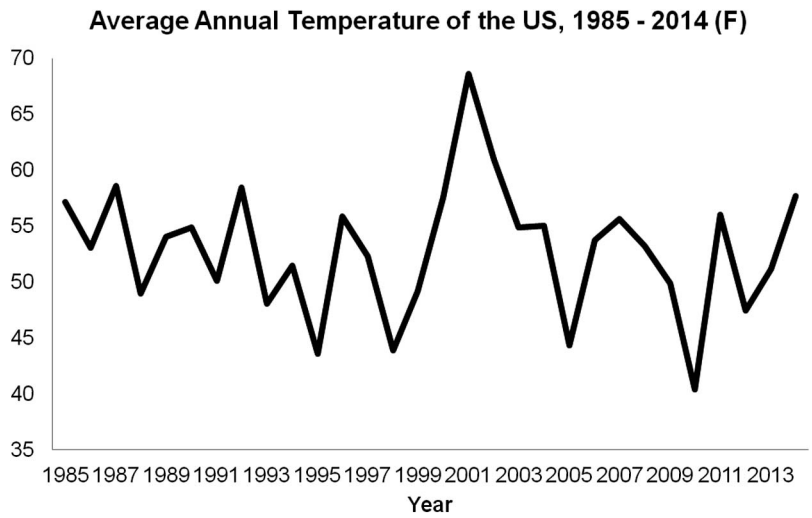

Figure 1. Line graph used in the greater variability condition (Study 1a). See Figure S1 in the online supplemental materials for the color version of this figure.

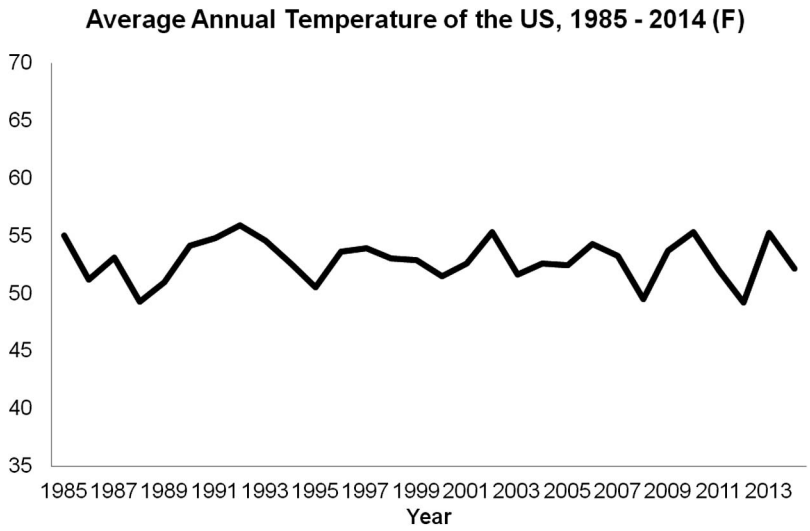

Figure 2. Line graph used in the lower variability condition (Study 1a). See Figure S1 in the online supplemental materials for the color version of this figure.

tal materials for the complete scenario). Participants were then asked three questions: (a) "How likely will you be to call the police and anonymously report your neighbor?"; (b) "How severely do you think your neighbor should be punished?"; and (c) "How bad is it that your neighbor is not following the water use restrictions?" They were asked to respond on a 7-point scale ranging from *Not at all* to *Extremely*, $\alpha = .78$. These items measured both moral judgment and punishment.

Results

The manipulation check confirmed that participants in the greater variability condition rated the temperature as being more variable ($N = 88$, $M = 4.76$, 95% CI [4.51, 5.02], $SD = 1.20$) than those in the lower variability condition ($N = 92$, $M = 3.14$, 95% CI [2.86, 3.42], $SD = 1.36$), $t(178) = 8.47$, $p < .001$, Cohen's $d = 1.26$.

As hypothesized, we found that participants in the greater variability condition were to judge and punish their neighbor more harshly ($N = 88$, $M = 4.59$, 95% CI [4.32, 4.86], $SD = 1.28$) than those in the lower variability condition ($N = 92$, $M = 4.00$, 95% CI [3.73, 4.26], $SD = 1.29$), $t(178) = 3.12$, $p = .002$, Cohen's $d = .46$.

Discussion

Thus, Study 1a provided initial support for our hypothesis that exposure to greater variability in a given domain (i.e., climate) increases people's tendency to judge and punish wrongdoers in the same domain (i.e., those who waste water in a drought, which is also a climate-related phenomenon).

Study 1b

Because variability is a continuous rather than a categorical variable, Study 1a focused on comparing conditions of higher versus lower levels of variability. However, it would be interesting to examine whether the effect observed in Study 1a is driven more by the low variability condition or the high variability condition. Thus, Study 1b included a control condition in which participants did not receive any information about variability in the relevant domain.

Method

Participants. A power analysis based on effect size Cohen's $d = .46$ (from Study 1a), $\alpha = .05$ (two-tailed), *power* = 80%, indicated that we would need to recruit 76 participants per condition. We decided to recruit 100 participants per condition as that was the minimum sample size in the lab at the time of the study. A survey seeking 300 U.S. residents was posted on MTurk. In response, 295 participants completed the study on MTurk. We excluded one response that came from the same IP address. The final sample consisted of 294 participants (150 women, 143 men, 1 of unreported gender; mean age 38.7 years). Participants were randomly assigned to one of the three conditions: the greater variability condition, the lower variability condition, or the control condition with no variability information.

Procedure. Participants were asked to imagine that they were residents of a small fictitious island that depended entirely on rainfall to supply its water needs. In the two variability conditions, participants were shown a graph of the annual rainfall in this island over the last 15 years, which ranged from 27.1 to 33.7 in.; in the control condition, participants were not presented with any graph. In the greater variability condition, the *y* axis of the graph ranged from 27 to 34, which made the variation in rainfall appear relatively large. In the lower variability condition, the scale ranged from 10 to 50, which made the same variation in rainfall appear relatively small.

All participants were informed that the island received lower than average rainfall in the last three years, and therefore, the government has imposed mandatory water restrictions. However, they witnessed their neighbor watering the lawn and washing the car (see the online supplemental materials for the complete scenario). Participants were then asked three questions: (a) "How

likely will you be to call the police and anonymously report your neighbor?"; (b) "How severely do you think your neighbor should be punished?"; and (c) "How bad is it that your neighbor is not following the water use restrictions?" They were asked to respond on a 7-point scale ranging from *Not at all* to *Extremely*, $\alpha = .77$. These items measured both moral judgment and punishment.

Results

We replicated Study 1a's finding that participants in the greater variability condition were to judge and punish the wrongdoer more harshly ($N = 97$, $M = 5.12$, 95% CI [4.91, 5.33], $SD = 1.04$) than those in the lower variability condition ($N = 95$, $M = 4.36$, 95% CI [4.07, 4.65], $SD = 1.43$), $t(190) = 4.21$, $p < .001$, Cohen's $d = .61$. More importantly, participants in the greater variability condition also indicated higher punishment than those in the control condition ($N = 102$, $M = 4.58$, 95% CI [4.30, 4.86], $SD = 1.42$), $t(197) = 3.04$, $p = .003$, Cohen's $d = .43$. There was no significant difference between participants in lower variability condition and the control condition, $t(195) = 1.08$, $p = .28$, Cohen's $d = .15$.

Discussion

Thus, Study 1b provided further support for our hypothesis that exposure to greater variability in a given domain (i.e., rainfall) increases people's tendency to punish wrongdoers in the same domain (i.e., those who waste water in a drought), compared with exposure to lower variability. We also found the lower variability condition did not differ from a control condition in which participants were provided no information about variability in rainfall. However, the greater variability condition increased punishment compared with the control condition. This finding indicates that people's default perception of variability in rainfall corresponds more closely to the lower variability condition than to the greater variability condition.

Study 2a

Studies 1a and 1b tested whether greater variability in one domain leads people to punish wrongdoers in the same domain: weather. The goal of Study 2a was to test whether the same effect occurs in the domain of money. Further, whereas Studies 1a and 1b presented participants with hypothetical data in the variability manipulation, in Study 2a, we presented participants with factual data.

Method

Participants. Because this was the first study that we ran for this project, we did not have an estimate of the effect size to conduct a power analysis. Therefore, we decided on a sample size of 100 per cell, which would give us 80% power to detect a medium effect size, Cohen's $d = .40$, $\alpha = .05$ (two-tailed). A survey seeking 200 U.S. residents was posted on MTurk. In response, 199 participants completed the study on MTurk. Of these, we excluded eight responses that came from duplicated IP addresses. The final sample consisted of 191 participants (109 women, 80 men, 2 of unreported gender; mean age 37.0 years). Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Participants were instructed: "In this study, we are interested in how people extract information from graphs. We will show you a graph about the currency exchange rate for US Dollar to Euro and ask you some questions about it." Participants were presented with a line graph of the actual U.S. dollar to Euro quarterly average exchange rate from 2004 to 2014, which ranged from 0.64 to 0.84. As in Study 1b, we used identical data points across both conditions but varied the scale of the *y* axis across conditions. In the greater variability condition, the scale ranged from 0.60 to 0.85, which made the exchange rate variations appear relatively large. In the lower variability condition, the scale ranged from 0 to 1.40, which made the same exchange rate variations appear relatively small. To ensure that participants attended to the graph, we asked them four questions about the graph, similar to Study 1a: (a) "In which quarter would you get the most Euros in exchange for U.S. Dollars? (Please type as YYYYQQ format)" (open-ended); (b) "In which quarter would you get the least Euros for 1 US$? (Please type as YYYYQQ format)" (open-ended); (c) "If you wanted to use your US Dollars to buy Euros, would you get more Euros if you made the purchase in 2011 Quarter 3 or if you made the purchase in 2012 Quarter 3?" (binary choice); (d) "Please summarize the information you get from the graph in one sentence" (open-ended).

Next, we asked a manipulation check question: "How variable do you think the exchange rates for U.S. Dollar to Euro were throughout the past ten years?" (7-point scale ranging from *Not at all* to *Extremely*).

Next, participants were presented with four scenarios in which people engaged in unethical behaviors such as cheating, committing tax fraud, stealing money, and appropriating others' belongings (Sharma, Mazar, Alter, & Ariely, 2014; see the online supplemental materials for complete scenarios). For each scenario, participants were asked, "How seriously do you think that [the person] should be punished as a result of his behavior?" They were asked to respond on a 7-point scale ranging from *Not at all punished* to *Extremely seriously punished* ($\alpha = .75$). These items measured punishment.

Results

The manipulation check indicated that participants in the greater variability condition rated the exchange rates as being more variable ($N = 93$, $M = 5.11$, 95% CI [4.84, 5.38], $SD = 1.31$) than those in the lower variability condition ($N = 96$, $M = 3.51$, 95% CI [3.24, 3.78], $SD = 1.31$), $t(187) = 8.35$, $p < .001$, Cohen's $d = 1.22$.[3]

Participants in the greater variability condition indicated that the unethical behaviors should be punished more harshly ($N = 94$, $M = 5.46$, 95% CI [5.28, 5.64], $SD = .87$) than those in the lower variability condition ($N = 97$, $M = 4.84$, 95% CI [4.64, 5.04], $SD = .99$), $t(189) = 4.59$, $p < .001$, Cohen's $d = .66$.

Discussion

Study 2a found that exposure to greater variability in one domain (i.e., currency exchange rates) increased people's tendency

[3] Two participants did not answer the manipulation check question.

to punish wrongdoers in a similar domain (i.e., those who overcharged, stole, or committed tax fraud).

Study 2b

To assess the robustness of our findings, we conducted a preregistered exact replication of Study 2a.

Method

The procedure for this study was preregistered at https://osf.io/3jbe2.

Participants. As preregistered, a survey seeking 400 U.S. residents was posted on MTurk. In response, 382 participants completed the study on MTurk. Of these, we excluded eight responses that came from the same IP address. The final sample consisted of 374 participants (205 women, 167 men, 2 of unreported gender; mean age 34.0 years). Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. The procedure for this study was identical to that of Study 2a.

Results

As per the preregistered analysis plan, we found that greater variability lead to higher punishment, $B = 0.20$, 95% CI [0.01, 0.39], $SE = 0.10$, $t(372) = 2.06$, $p = .040$. Specifically, participants in the greater variability condition recommended more punishment ($N = 179$, $M = 5.40$, 95% CI [5.27, 5.53], $SD = .89$) than those in the lower variability condition ($N = 195$, $M = 5.20$, 95% CI [5.06, 5.34], $SD = .98$), $t(372) = 2.06$, $p = .02$ (one-tailed), Cohen's $d = .21$.

Discussion

Study 2b provided an exact, preregistered replication of Study 2a, providing additional evidence for the robustness of our effect.

Study 2c

To further assess the replicability of our findings, we conducted a conceptual replication of Study 2a using the annual temperature of the United States (rather than the U.S. dollar–Euro exchange rate) to manipulate perceived variability and using a different set of scenarios to measure moral judgment and punishment. Further, in Studies 1a–2b, the sources of variability and the domains of the unethical behavior were related. In the current study, we tested the effect in unrelated domains.

Method

Participants. A power analysis based on effect size Cohen's $d = .66$ (from Study 2a[4]), $\alpha = .05$ (two-tailed), *power* = 80%, indicated that we would need to recruit 38 participants per condition. We decided to recruit 100 participants per condition as that was the minimum sample size in the lab at the time of the study. A survey seeking 200 U.S. residents was posted on MTurk. In response, 200 participants who completed the study on MTurk. Of these, we excluded six responses that came from duplicated IP addresses. The final sample consisted of 194 participants (115 women, 79 men; mean age 37.6 years). Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Participants were instructed: "In this part of the study, we are interested in how people acquire information from graphics. We will show you a weather graph and ask you some questions about it." They were presented with a line graph of the actual average annual temperature in the United States over 20 years (from 1994 to 2013), which ranged from 51.8°F to 55.3°F. We used identical data points across both conditions but varied the scale of the *y* axis across conditions. In the greater variability condition, the scale ranged from 51.5°F to 55.5°F, which made the temperature variations appear relatively large. In the lower variability condition, the scale ranged from 40°F to 65°F, which made the same temperature variations appear quite small (see Figure S4 in the online supplemental materials). To ensure that participants attended to the graph, participants were asked three questions about the presented graph: (a) "Which year had the highest average temperature? (Please type as YYYY format)" (open-ended); (b) "Which year had the lowest average temperature? (Please type as YYYY format)" (open-ended); (c) "Please summarize the main information you get from this graph in one sentence" (open-ended).

We also administered a manipulation check question: "How variable do you think the weather is in the United States?" (7-point scale ranging from *Not at all* to *Extremely*).

Participants were then presented with five scenarios in which people engaged in unethical behaviors (i.e., a candidate cheating in an interview, a firm producing cheap but toxic fertilizers, a company tricking customers, a doctor prescribing an easier but less optimal treatment to patients, and a broker hiring an inspector with a conflict of interest; adapted from Kouchaki & Desai, 2015; Gino, Norton, & Ariely, 2010; and Gino, Shu, & Bazerman, 2010; see the online supplemental materials for complete scenarios). For each scenario, participants were asked three questions: (a) "How bad was [the person's] action?"; (b) "How unethical was [the person's] action?"; and (c) "How much should [the person] be punished for this action?" They were asked to respond on a 7-point scale ranging from *Not at all* to *Extremely*, $\alpha = .86$ across all items and scenarios. These items measured both moral judgment and punishment.

Results

The manipulation check indicated that participants in the greater variability condition rated the weather as being more variable ($N = 96$, $M = 4.55$, 95% CI [4.24, 4.86], $SD = 1.52$) than those in the lower variability condition ($N = 98$, $M = 2.76$, 95% CI [2.52, 2.99], $SD = 1.15$), $t(192) = 9.30$, $p < .001$, Cohen's $d = 1.34$.

An independent-samples *t* test revealed that people who were exposed to greater variability judged and punished unethical behaviors more harshly ($N = 96$, $M = 4.86$, 95% CI [4.68, 5.04], $SD = .88$) than those exposed to lower variability ($N = 98$, $M =$

[4] Studies 1a, 1b, and 2b were conducted after Study 2c, and thus Studies 1a, 1b, and 2b's effect sizes were not taken into account when we conducted the power analysis for Study 2c.

4.55, 95% CI [4.34, 4.76], $SD = 1.07$), $t(192) = 2.19$, $p = .030$, Cohen's $d = .31$.

Discussion

Study 2c replicated the findings of Studies 2a and 2b using different stimuli to manipulate perceived variability and using new measures to assess people's tendency to punish wrongdoers. We found that exposure to high variability in the climate domain influenced people's judgment and punishment for unethical behaviors in domains that were completely unrelated to the climate. The findings suggest that the effects of exposure to high variability can be diffuse and generalize to other domains.

Study 3

Studies 1a manipulated perceived variability by manipulating the standard deviation of a quantity across conditions, and Studies 1b–2c did so by manipulating the scale of the *y* axis. The goal of Study 3 was to test whether we can conceptually replicate the findings while manipulating another indicator of variability—the standard deviation of successive differences. We did so by presenting participants with sequences of dice rolls in which were either relatively large or relatively small differences between successive rolls. We tested whether experiencing a greater standard deviation of successive differences in the dice rolling game would lead people to punish others more in a subsequent task.

External Pretest of Dice Rolling Manipulation

Participants. A survey seeking 200 U.S. residents was posted on MTurk. The final sample consisted of 197 participants (98 women, 98 men, one nonbinary; mean age 36.2 years), all from unique IP addresses. Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Participants were instructed: "In this study, we want to see how well people can predict the outcome of dice rolls. The computer will roll a regular six-sided dice for a total of 10 times. Before each roll, please guess which number the dice will land (1, 2, 3, 4, 5, or 6)." All participants were asked to play 10 trials of a dice rolling game on the computer. Each dice roll was equally unpredictable—the dice could land on any one of its six sides. Unbeknownst to participants, we manipulated the perceived variability of the realized dice rolls by altering the standard deviation of successive deviations (*SDSD*). In the lower variability condition, subsequent dice rolls were close to previous rolls (i.e., 1, 2, 1, 2, 3, 4, 6, 5, 5, 6; $SDSD = 0.96$), whereas in the greater variability condition, subsequent dice rolls were far away from previous roll (i.e., 1, 6, 2, 5, 1, 5, 3, 6, 2, 4; $SDSD = 3.56$). The actual dice rolls were identical across condition—they were just arranged differently to manipulate the *SDSD*. To increase participants' engagement with the task, in each trial, participants were asked to predict the number that the next dice roll would land on: "Which number do you think the dice will land on Roll [the round number]?" The computer then depicted the outcome of the dice roll based on participants' experimental condition, along with feedback about whether the participant's guess was correct ("Correct!" or "Incorrect!"). In each trial, we further presented a graph depicting the outcomes of the current and all previous rolls (see Figure S4 in the online supplemental materials).

After playing the dice rolling game, participants were asked to rate their perceived variability, "How much did the numbers that the dice rolled change from roll to roll?" and predictability, "How well can you predict the number that the dice would roll next?" on a 7-point scale ranging from *Not at all* to *Extremely*.

Results. Participants in the greater variability condition perceived the dice rolls as being more variable ($N = 99$, $M = 5.20$, 95% CI [4.97, 5.43], $SD = 1.14$) than those in the lower variability condition ($N = 98$, $M = 4.23$, 95% CI [3.99, 4.48], $SD = 1.23$), $t(195) = 5.73$, $p < .001$, Cohen's $d = .82$. However, participants perceived the predictability of dice rolls to be similar in the greater variability condition ($N = 99$, $M = 1.81$, 95% CI [1.59, 2.03], $SD = 1.11$) and the lower variability condition ($N = 98$, $M = 1.91$, 95% CI [1.63, 2.18], $SD = 1.38$), $t(195) = 0.56$, $p = .58$, Cohen's $d = .08$. Participants' actual accuracy in the dice prediction task was also similar in the greater variability condition ($N = 99$, $M = 1.77$, 95% CI [1.51, 2.02], $SD = 1.28$) and the lower variability condition ($N = 98$, $M = 1.96$, 95% CI [1.70, 2.22], $SD = 1.30$), $t(195) = 1.04$, $p = .30$, Cohen's $d = .15$.

Main Experiment

Participants. A power analysis based on effect size Cohen's $d = .49$ (the average effect size from Studies 2a and 2c), $\alpha = .05$ (two-tailed), *power* = 80%, indicated that we would need to recruit 67 participants per cell. We decided to recruit 100 participants per condition from two major universities in Singapore as that was the minimum sample size in the lab at the time of the study. In response to a study with 200-participant openings, 191 students participated (99 women, 92 men; mean age 21.8 years). No participants were excluded from the analysis. Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Upon arrival, participants were asked to play the dice rolling game used in the pretest. We did not administer the manipulation check in the main study. Thereafter, participants were asked to read three unethical behaviors adapted from past literature (Gino et al., 2010; Sharma et al., 2014), including Scenario 3 used in our Study 2c, and Scenarios 3 and 4 used in our Study 1a (i.e., a doctor prescribing less optimal treatment to patients, a person stealing money, and a person appropriating others' belongings; see the online supplemental materials for complete scenarios).

Participants were then asked to respond to four questions as a measure of their punitive attitudes: (a) "How bad was [the person's] action?" (b) "How unethical was [the person's] action?" (c) "How much should [the person] be punished for this action?" and (d) "How much threat do you think behaviors like these poses to society?" on a 7-point scale ranging from *Not at all* to *Extremely*; $\alpha = .92$ across all scenarios. These items measured both moral judgment and punishment.

Results

As hypothesized, participants in the greater variability condition judged and punished the unethical behaviors more harshly ($N = 95$, $M = 5.71$, 95% CI [5.55, 5.86], $SD = .77$) than those in the lower variability condition ($N = 96$, $M = 5.33$, 95% CI [5.13, 5.54], $SD = 1.00$), $t(189) = 2.88$, $p = .004$, Cohen's $d = .42$.

Discussion

Study 3 conceptually replicated the findings of Studies 1a–2c using a new manipulation of perceived variability that altered the standard deviation of successive differences in a dice rolling game. Further, Study 3 replicated the findings using a task in which people experienced high versus low variability in addition to being presented with data representations of variability.

Study 4

Studies 1a to 3 documented that exposure to greater variability makes people more willing to punish others in scenarios. Study 4 had three goals. First, we tested whether merely experienced variability, without any accompanying graphs, would be sufficient to make people more punitive. Second, we tested whether exposure to greater variability would increase people's punishment behavior, not just punishment judgments, even when punishing others imposed a monetary cost on oneself (Fehr & Gachter, 2000). Third, we tested another alternative hypothesis: Greater variability leads people to engage in more action in general, and because punishing people was the only possible action in previous experiments, those in the greater variability condition appeared to be more punitive. We tested this alternative account by assessing whether greater variability only increases the extent to which people punish bad behaviors, which is predicted by our theorizing, but not the extent to which people reward good behaviors.

Past research has suggested that consistent with the widespread evidence for negativity dominance (Rozin & Royzman, 2001), punishment is a more intuitive and more effective strategy than reward to promote social cooperation (Balliet, Mulder, & Van Lange, 2011; Mulder, 2008; Sefton, Shupp, & Walker, 2007). For example, in a public goods game, participants used sanctions more than rewards to encourage other group members to cooperate; and that the degree to which participants undercontributed was correlated with the magnitude of the sanction that they received but uncorrelated with the magnitude of the rewards that they received (Sefton et al., 2007). Similarly, a meta-analysis found that the effect of punishments on social cooperation ($d = 0.70$) is larger than that of rewards ($d = 0.51$; Balliet et al., 2011). Given that punishment for wrongdoing is more effective in terms of deterring future bad behavior than rewards for good deeds, we hypothesized that exposure to greater variability would not increase the reward for good behavior.

Method

Participants. A power analysis based on effect size Cohen's $d = .42$ (from Study 3, which used the same manipulation), $\alpha = .05$ (two-tailed), *power* = 80%, indicated that we would need to recruit 90 participants per condition. We recruited 200 per cell as that was the minimum sample size in the lab at the time of the study. A survey seeking 400 U.S. residents was posted on MTurk. Among the 391 participants who completed the study on MTurk, six responses that came from duplicated IP addresses were excluded from further analyses. The final sample consisted of 385 participants (223 women, 162 men; mean age 33.7 years). The study used a 2 (variability: greater vs. lower) × 2 (response type: punish self-serving behavior vs. reward altruistic behavior) mixed design, with variability manipulated as a between-participants factor and punish versus reward trials manipulated as a within-participant factor. Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. We used the same dice-rolling manipulation in Study 3 but with two changes: participants did not receive the feedback about whether they had accurately predicted the outcome of each dice roll; and the realized dice rolls were not depicted in a graph—participants simply experienced dice rolls with higher versus lower standard deviation of successive differences. We modified the predeterministic dice rolls outcomes so that participants would experience the same beginning and end outcomes in both conditions. In the lower variability condition, subsequent dice rolls were close to previous rolls (i.e., 6, 5, 5, 6, 4, 3, 2, 1, 2, 1; $SDSD = 0.96$), whereas in the greater variability condition, subsequent dice rolls were far away from previous rolls (i.e., 6, 2, 5, 1, 5, 3, 6, 2, 4, 1; $SDSD = 3.27$).

Thereafter, participants were then asked to play a three-person strategic game with three roles: the Decider, the Receiver, and the Judge (adapted from Peysakhovich, Nowak, & Rand, 2014; Strang et al., 2017). The rules of the game were: (a) The Decider received 10 bonus points and decided whether to keep all 10 points for themselves and give 0 points to the Receiver (i.e., acted in a self-serving manner), or to give 5 points to the Receiver and keep 5 points for themselves (i.e., acted altruistically). (b) The Receiver has no choice but to accept what the Decider gives them. (c) The Judge received 20 bonus points and was informed about the Decider's decision. (d) If the Decider acted in a self-serving manner, the Judge could choose whether or not to give up 5 of their points to punish the Decider, who would receive a deduction of 10 points to end up with nothing. (e) If the Decider acted altruistically, the Judge could choose whether or not to give up 5 of their points to reward the Decider, who would receive 10 additional points to end up with a total of 15 points.

Participants were informed that they would receive their cumulative points in the form of a bonus, with 10 points being equivalent to one cent. Unbeknownst to them, all participants were assigned to the role of a Judge. They played 10 rounds in which the Decider acted self-servingly, and 10 rounds in which the Decider acted altruistically. The order of these 20 rounds was randomized. The number of times that the Judge chose to punish or reward the Decider was our behavioral dependent measure.

Results

Given that the dependent measure was a count variable, we analyzed it using a Poisson regression. We first analyzed the 10 trials in which the Decider acted in a self-serving manner. As predicted, participants in the greater variability condition ($N = 195$, $M = 5.86$, 95% CI [5.30, 6.41], $SD = 3.93$) punished the Decider's self-serving decisions more than those in the lower variability condition ($N = 190$, $M = 5.27$, 95% CI [4.68, 5.87], $SD = 4.15$), $B = .10$, 95% CI [.02, .19], $SE = .04$, *incidence rate ratio* = 1.10, $z = 2.42$, $p = .015$. Another Poisson regression on the 10 altruistic trials revealed that the Judge did not reward the Decider's altruistic decisions more in the greater variability condition ($N = 195$, $M = 7.17$, 95% CI [6.65, 7.68], $SD = 3.66$) compared with the lower variability condition ($N = 190$, $M =$

6.83, 95% CI [6.29, 7.37], $SD = 3.79$), $B = .05$, 95% CI [−.03, .12], $SE = .04$, *incidence rate ratio* = 1.05, $z = 1.25$, $p = .21$.

Discussion

Study 4 demonstrated that experiencing greater variability in a dice rolling game makes people more willing to behaviorally punish others who acted in a self-serving manner even at a financial cost to themselves. Further, experienced variability without any graphical representations of variability is sufficient to make people more punitive. Finally, we found that greater variability makes people punish unethical behaviors more but does not make them reward altruistic behaviors more. Thus, greater variability does not increase people's general tendency to take action, but specifically their tendency to punish bad behaviors.

Study 5a

Studies 1a-4 consistently demonstrated that exposure to greater variability makes people more likely to punish unethical behaviors. Study 5a tested a number of potential underlying mechanisms, including a heightened sense of societal vulnerability, increased anxiety, greater feelings of uncertainty and unpredictability, lower sense of personal and collective control, increased desire for control, and more prevention focus. Further, whereas all previous studies manipulated participants' perceptions of variability, in this study, we measured participants' perceptions of variability.

Method

Participants. A survey seeking 200 U.S. residents was posted on MTurk. Of the 200 participants who completed the study on MTurk, we excluded two responses that came from duplicated IP addresses. The final sample consisted of 198 participants (106 women, 92 men; mean age 36.1 years).

Procedure. Participants were instructed: "In this task, we are interested in how you perceive the things in your life and in the world. Please answer the following questions carefully." Participants were then asked to complete a series of scales (see the online supplemental materials for all of the items used to measure each construct).

Participants asked to respond to a three-item measure of perceived variability (e.g., "How variable are most things in the world?"; $\alpha = .89$); a six-item measure of societal vulnerability (e.g., "Our society faces threat from many sources these days;" $\alpha = .91$); a two-item measure of general anxiety (i.e., "How anxious do you feel in your life in general?," "How worried do you feel in your life in general?"; $\alpha = .93$); a single-item measure of uncertainty ("How uncertain do you feel your life is in general?"); a single-item measure of predictability ("How predictable do you feel your life is in general?"); a three-item measure of perceived personal control (e.g., "Generally speaking, I feel I am in control of my life"; $\alpha = .90$; adapted from Fontaine, Manstead, & Wagner, 1993); a three-item measure of perceived collective control (e.g., "Through joint actions, we could contribute to our society"; $\alpha = .90$; adapted from Bamberg et al., 2015); a four-item measure of support for the death penalty scale (e.g., "In general, do you approve or disapprove of the death penalty?"; $\alpha = .90$; adapted from Tam, Au, & Leung, 2008); a four-item measure of desire for control (e.g., "Generally speaking, I plan my daily schedule clearly, such as when to work and when to rest"; $\alpha = .75$); a six-item measure of promotion focus (e.g., "Compared with most people, I am typically unable to get what I want out of life."; $\alpha = .63$); and a five-item measure of prevention focus ("I often got on my parents' nerves when I was growing up."; $\alpha = .84$; Higgins et al., 2001).

All measures were assessed on 7-point scales. See the online supplemental materials for response scale labels.

Results

Table 1 presents the descriptive statistics of all variables, along with their intercorrelations. As hypothesized, the greater variability participants perceived in the world, the more they thought that society was vulnerable ($p < .001$), and the more they supported for the death penalty ($p = .026$). We next tested whether there is an indirect effect of higher perceived variability on punishment through perceived vulnerability using the SPSS PROCESS macro (Hayes, 2013, Model 4) with 5,000 bootstrapped samples. We found a significant indirect effect ($B = 0.15$, 95% CI [.07, .27], $SE = 0.05$).

Table 1
Descriptive Statistics for All Variables Included in Study 5a

Variable	*M*	*SD*	α	1	2	3	4	5	6	7	8	9	10
1. World variability	5.08	1.22	0.89										
2. Societal vulnerability	4.67	1.22	0.91	0.31***									
3. Anxiety	3.60	1.74	0.93	0.31***	0.29***								
4. Uncertainty	3.70	1.84	—	0.26***	0.30***	0.84***							
5. Predictability	3.48	1.48	—	0.004	−0.09	−0.12	−0.16*						
6. Personal control	4.80	1.28	0.90	−0.10	−0.08	−0.55***	−0.54***	0.35***					
7. Collective control	5.59	0.97	0.90	0.21**	−0.02	−0.13	−0.12	0.05	0.42***				
8. Death penalty support	4.57	1.66	0.90	0.16*	0.38***	0.03	0.03	0.08	0.22**	0.03			
9. Desire for control	5.35	0.96	0.75	0.22**	0.16*	−0.13	−0.16*	0.07	0.38***	0.44***	0.32***		
10. Promotion focus	4.62	0.95	0.63	0.02	−0.07	−0.48***	−0.45***	−0.004	0.56***	0.31***	0.07	0.35***	
11. Prevention focus	3.98	1.35	0.84	−0.16*	−0.17*	−0.33***	−0.27***	0.12	0.13	0.008	0.04	0.10	0.18*

Note. Pairwise correlations among constructs (Study 5a). See the online supplemental materials for all of the items used to measure each construct.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Perceived variability was uncorrelated with predictability ($p = .95$), personal control ($p = .16$), and promotion focus ($p = .81$). Higher perceived variability was associated with higher anxiety ($p < .001$), uncertainty ($p < .001$), collective control ($p = .003$), desire for control ($p = .002$), and less prevention focus ($p = .021$). Of these, anxiety, uncertainty, collective control, and prevention focus were uncorrelated with support for the death penalty ($ps > .60$), so they cannot mediate the effect of perceived variability on punishment. However, desire for control was correlated with support for the death penalty ($p < .001$).

A parallel mediation analysis using the PROCESS macro (Hayes, 2013, Model 4) revealed that desire for control also mediated the effect of higher variability on support for the death penalty ($B = 0.09$, 95% CI [.02, .19], $SE = 0.04$). Next, we conducted a test of competing mediation analysis using the PROCESS macro (Hayes, 2013, Model 6), and found that both perceived societal vulnerability and desire for control serve as mediators; perceived societal vulnerability explained of a larger ratio of the indirect effect (65%) than desire for control (33%). See the online supplemental materials for additional analyses.

Discussion

Study 5a provided initial support for the underlying mechanism. The more variability participants perceived, the more they thought that society was vulnerable, and therefore, the more they supported the death penalty. We also found that the more variability participants perceived, the greater their desire for control and thus the more they supported the death penalty; however, perceived vulnerability explained twice as much of the variance in the variability–punishment link than desire for control. A number of related constructs (i.e., anxiety, uncertainty, predictability, personal control, collective control, and regulatory focus) did not serve as mediators.

Study 5b

The goal of Study 5b was to replicate the mediating role of perceived societal vulnerability found in Study 5a by measuring both individual vulnerability and societal vulnerability using the scales that we had created, and a scale measuring societal vulnerability taken from the literature—the belief in a dangerous world scale (Altemeyer, 1988).

Method

Participants. A survey seeking 200 U.S. residents was posted on MTurk. Of the 194 participants who completed the study on MTurk, we excluded five responses that came from duplicated IP addresses. The final sample consisted of 189 participants (101 women, 86 men, two unreported; mean age 38.1 years).

Procedure. Similar to Study 5a, this was a correlational study in which participants completed a number of measures (see the online supplemental materials for all of the items used to measure each construct). Participants were first asked to respond to a three-item measure of perceived variability used in Study 5a ($\alpha = .88$), and a four-item measure of support for the death penalty used in Study 5a ($\alpha = .84$). Next, they were asked to complete three measures of vulnerability in a random order: the 12-item belief in a dangerous world scale (e.g., "If our society keeps degenerating the way it has been lately, it's liable to collapse like a rotten log and everything will be chaos"; $\alpha = .92$; Altemeyer, 1988), a three-item measure of societal vulnerability (e.g., "Our society faces threat from many sources these days"; $\alpha = .80$), and a three-item measure of personal vulnerability (e.g., "I face threat from many sources these days"; $\alpha = .91$). Finally, as in Study 5a, participants completed three-item measures of perceived personal control ($\alpha = .91$) and perceived collective control ($\alpha = .87$).

All measures were assessed on 7-point scales. See the online supplemental materials for response scale labels.

Results

Table 2 presents the descriptive statistics of all variables, along with their intercorrelations. We found that the greater variability participants perceived in the world, the higher their perception of societal vulnerability, measured by both our newly created scale ($p < .001$) and the belief in a dangerous world scale ($p = .017$), and the more they supported the death penalty ($p = .008$). However, participants' perception of variability in the world was not associated with their sense of personal vulnerability ($p = .35$). Perceived societal vulnerability, measured both using the societal vulnerability scale ($p < .001$) and the belief in a dangerous world scale ($p < .001$), predicted participants' support for the death penalty. As in Study 5a, higher perceived variability was uncorrelated with personal control ($p = .52$) but was associated with higher collective control ($p = .010$), However, collective control was uncorrelated with support for the death penalty ($p = .80$).

Table 2
Descriptive Statistics for All Variables Included in Study 5b

Variable	*M*	*SD*	α	1	2	3	4	5	6
1. World variability	5.18	1.06	0.88						
2. Death penalty support	4.64	1.52	0.84	0.19**					
3. Societal vulnerability	4.81	1.27	0.80	0.34***	0.33***				
4. Dangerous world belief	4.10	1.21	0.92	0.17*	0.36***	0.68***			
5. Personal vulnerability	3.21	1.52	0.91	0.07	0.21**	0.44***	0.36***		
6. Personal control	5.19	1.16	0.91	0.05	0.04	0.03	−0.08	−0.24***	
7. Collective control	5.76	0.90	0.87	0.19**	−0.02	−0.03	−0.19**	−0.23**	0.29***

Note. Pairwise correlations among constructs (Study 5b). See the online supplemental materials for all of the items used to measure each construct.
* $p < .05$. ** $p < .01$. *** $p < .001$.

We next tested whether there is an indirect effect of higher perceived variability on punishment through perceived vulnerability using the SPSS PROCESS macro (Hayes, 2013, Model 4) with 5,000 bootstrapped samples, and found a significant indirect effect using the scale that we had created ($B = 0.14$, 95% CI [.07, .26], $SE = 0.05$) and a significant indirect effect using the belief in a dangerous world ($B = 0.08$, 95% CI [.01, .17], $SE = 0.04$).

Discussion

Study 5b provided further support for the underlying mechanism using multiple measures of perceived vulnerability, including the belief in a dangerous world scale (Altemeyer, 1988). Once again, the relationship between participants' sense of variability in the world and greater support for punishment was mediated by higher perceived societal vulnerability. Participants' perceptions of personal control and collective control did not explain the variability–punishment link.

Study 6

Whereas Studies 5a and 5b provided correlational evidence for the mediating effect of perceived vulnerability, the goal of Study 6 was to test the mediating role experimentally by manipulating perceived variability. We also measured two constructs derived from the climate change literature—perceived risk and adaptive capacity to cope with adversity—as additional potential mechanisms.

Method

The procedure for this study was preregistered at https://osf.io/259ta/?view_only=64fcd57edd6f4f43b82701ada59d98d5.

Participants. As preregistered, a survey seeking 200 U.S. residents was posted on MTurk. Of the 193 participants who completed the study on MTurk, we excluded one response that came from duplicated IP addresses. The final sample consisted of 192 participants (108 women, 84 men; mean age 35.8 years). Participants were randomly assigned to either the greater variability condition or the lower variability condition.

Procedure. Participants were instructed: "Please read the following scenario carefully and answer some questions about it." The experimental manipulation was identical to that used in Study 1b. After reading the scenario, participants were asked to respond to the manipulation check question "How variable do you think the annual rainfall is in Caledonia?" using a 7-point scale ranging from *Not at all* to *Extremely*. We then administered a three-item measure of perceived vulnerability: (a) "How vulnerable do you think this island is to bad weather?"; (b) "How vulnerable do you think this island is given its climate pattern?"; and (c) "How vulnerable do you think this island is to potential changes in climate?" ($\alpha = .81$). Participants were asked to respond on a 7-point scale ranging from *Not at all* to *Extremely*.

The scenario and items used to measure the dependent measure were identical to that used in Study 1b ($\alpha = .80$). These items measured both moral judgment and punishment. Finally, participants were asked to respond on to a three-item risk perception scale (e.g., "How much at risk is this island of facing a long-term water shortage?"; adapted from Leiserowitz, 2006; Kahan et al., 2012; $\alpha = .89$) and a three-item adaptive capacity scale (e.g., "This island has enough resources to adapt to a long-term shortage of water"; adapted from Brown & Westaway, 2011; $\alpha = .79$) from climate change literature (see the online supplemental materials for all the scale items). Participants were asked to respond on a 7-point scale ranging from *Not at all* to *Extremely*.

Results

As per the preregistered analysis plan, we found perceived societal vulnerability mediated the effect of the variability manipulation on punishment ($B = 0.24$, $SE = 0.10$, Sobel test $z = 2.49$, $p = .013$). Specifically, participants in the greater variability condition perceived the rainfall in the island as more variable ($N = 101$, $M = 5.13$, 95% CI [4.89, 5.37], $SD = 1.22$) than those in the lower variability condition ($N = 91$, $M = 3.36$, 95% CI [3.06 3.66], $SD = 1.43$; $t(190) = 9.21$, $p < .001$, Cohen's $d = 1.33$). Importantly, participants in the greater variability condition prescribed higher punishment ($N = 101$, $M = 4.65$, 95% CI [4.38, 4.92], $SD = 1.35$) than those in the lower variability condition ($N = 91$, $M = 4.25$, 95% CI [3.97, 4.53], $SD = 1.36$; $t(190) = 2.05$, $p = .021$ (one-tailed because we preregistered a directional hypothesis), Cohen's $d = .30$). Participants in the greater variability condition also rated their island being more vulnerable ($N = 101$, $M = 5.39$, 95% CI [5.20, 5.58], $SD = 0.97$) than those in the lower variability condition ($N = 91$, $M = 4.99$, 95% CI [4.76, 5.22], $SD = 1.10$; $t(190) = 2.66$, $p = .004$ (one-tailed because we preregistered a directional hypothesis), Cohen's $d = .38$). The more vulnerability participants perceived, the more punishment they assigned, $r = .48$, $p < .001$.

Participants in the greater variability condition perceived higher risk ($N = 101$, $M = 5.57$, 95% CI [5.35, 5.80], $SD = 1.13$) than those in the lower variability condition ($N = 91$, $M = 5.21$, 95% CI [4.96, 5.46], $SD = 1.20$; $t(190) = 2.17$, $p = .032$, Cohen's $d = .31$). The more risk participants perceived, the more punishment they assigned, $r = .60$, $p < .001$. However, participants in the greater variability condition perceived similar levels of adaptive capacity ($N = 101$, $M = 3.57$, 95% CI [3.31, 3.83], $SD = 1.31$) as those in the lower variability condition ($N = 91$, $M = 3.65$, 95% CI [3.38, 3.92], $SD = 1.29$; $t(190) = 0.45$, $p = .65$, Cohen's $d = .06$).

Next, we used the SPSS PROCESS macro to examine the competing indirect effects with 5000 bootstrapped samples (Hayes, 2013, Model 6). We used the variability condition as the independent variable (low variability = 0, high variability = 1), both perceived societal vulnerability and risk perception as potential mediators, and punishment as the dependent variable. We found that perceived societal vulnerability mediated the effect of the variability manipulation on punishment ($B = 0.12$, 95% CI [.04, .26], $SE = 0.06$), but risk perception did not ($B = 0.08$, 95% CI [−.08, .25], $SE = 0.08$).

Discussion

Study 6 provided experimental support for the mediating effect of perceived societal vulnerability. Participants exposed to higher variability in rainfall perceived that the society would be more vulnerable to extreme weather events, and therefore, were more willing to punish someone who wasted water. However, perceived

risk did not mediate the variability—punishment link, although this might have occurred because we measured perceived risk after punishment, but perceived societal vulnerability before punishment.

We also conducted two additional experiments to test the variability—vulnerability—punishment link using the experimental causal chain design (Spencer, Zanna, & Fong, 2005): Supplemental Experiment 1a manipulated variability and measured perceived vulnerability, whereas Supplemental Experiment 1b manipulated perceived vulnerability and measured support for the death penalty (see the online supplemental materials for details).

General Discussion

Ten studies (including two preregistered studies) provided evidence for a psychological consequence of exposure to greater variability—greater punishment. Studies 1a and 1b found that participants exposed to a graph depicting greater weather variability (i.e., the average annual temperature in the United States and the rainfall in a hypothetical island), compared with those who were exposed to lower variability or no variability information, subsequently judged and punished a neighbor who wasted water despite imposed water restrictions more harshly. Studies 2a, 2b, and 2c found that participants who were exposed to graphs depicting greater variability in temperature and in currency exchange rates judged and punished individuals who committed unethical acts more harshly. Studies 3 and 4 manipulated experienced variability by presenting participants with successive dice rolls with a higher standard deviation of successive differences. Those exposed to greater variability judged and punished wrongdoers more harshly in scenarios, and punished those who acted in a self-serving manner more harshly in experimental games, even at a cost to themselves. However, greater variability did not increase the rate with which people rewarded altruistic behaviors. Finally, Studies 5a and 5b identified the underlying mechanism, and Study 6 experimentally tested the underlying mechanism—people who perceived or were exposed to greater variability believed that society was more vulnerable, which explained why they judged and punished wrongdoers more harshly. Study 5a also identified a desire for control as a parallel mechanism, such that people perceiving a greater degree of variability had a greater desire for control, which explained why they were more willing to punish wrongdoers.

Importantly, we found conceptually parallel results in studies conducted in the United States and Singapore, providing initial suggestions that the current findings are likely to be generalizable at least across some cultures.

Theoretical Implications

Past research has examined how mean levels of various environmental variables (e.g., the temperature) influence people's psychological functioning and behaviors (Oishi, 2010). The current research suggests that people are not only sensitive to variation in means but also to variations in the standard deviation—merely presenting people with graphs or experiences of varying standard deviations (whether actual or perceived) influenced people's behaviors, including consequential behaviors involving monetary payoffs. Thus, the current research indicates that the scope of socioecological psychology can be expanded to examine the effects of variance in environmental variables, not just the means. Overall, the present research suggests that changes in variability in the environment may have long-term psychological and behavioral consequences at the population-level.

This research contributes to the threat compensation literature by identifying higher standard deviation (either in data representations or in experienced outcomes) as a factor that induces a sense of societal vulnerability. Past research in this area has examined the effect of related constructs, such as predictability versus randomness, which are supposed to run through variations in perceived control (Landau et al., 2015). The current research found that exposure to greater variability influences people's punishment decisions even after controlling for perceived control, uncertainty, predictability, and anxiety. Further, the current research contributes to the threat compensation literature by identifying increased punishment as a means for people to reduce their perceived societal threat. Specifically, because punishing wrongdoers can serve as a deterrent for undesirable behaviors in the future, greater punishment can help reduce future threats, and therefore, people's perceived societal vulnerability.

Implications for Psychological Research on Climate Change

The current research has implications for how scientists could communicate findings about climate change to the general population. Climate change involves both changes in the mean (e.g., global warming) along with increased variability (e.g., more frequent extremely hot and extremely cold temperatures). However, lay people often have a hard time understanding how overall warmer temperatures and more extreme cold events cooccur, and often use examples of extreme cold events to discount the idea of global warming (Li et al., 2011). However, our studies suggest that lay people can grasp changes in variability from graphs even when the mean is held constant, and respond in meaningful ways to changes in variability. However, in our studies, the mean was held constant. Future research can test whether people can simultaneously grasp changes in mean and changes in variability from graphs, and thus appreciate that climate change involves both global warming and increased variability. If so, then climate researchers can use such graphs to communicate the pattern of climate change to lay people. Additionally, predictions about the future of the climate typically involve ranges of possible outcomes in the future. In the current research, we just presented participants with means of a value in past years (or quarters) without providing the range within a given year (or quarter). Depicting ranges in graphs would provide another source of variability, and it is not clear whether this source of variability would have an additive effect or an interactive effect with the variability in the mean. Future research is needed to address this question.

In the current studies, we exposed people to high versus low variability without specifying the source of the variability. However, in communications about climate change, people are often presented with information about the likely causes of the variability, including natural causes and human-made causes. Future research can assess whether attributing variability to different types of causes influences people's psychological reactions.

In addition to making people feel that society is more vulnerable, high variability also increases the chance that either society or a natural system might cross a tipping point (Carroll, 1978; Nuttall, 2012). For example, once the glacier reaches a tipping point of reverse sloping (i.e., deepens toward the ice sheet interior), the process would be irreversible and lead to a massive 1.64-feet rise in sea levels in their projections (Robel, Seroussi, & Roe, 2019). Future research investigating combining exposure to high levels of variability with information about tipping points would be particularly effective in making people realize the scale of the vulnerability that society faces, and thus motivate them to engage in environmental action.

Limitations and Future Directions

In the current research, we examined people's reactions to either data representations indicating different degrees of variability in weather and asset prices, or to experienced levels of variability in the context of a game. An important question that arises is whether naturally experienced variability would have similar effects on people's punitive judgments. Field studies could test whether people are harsher toward wrongdoers on days with greater intraday variability in the temperature, or whether traders are more punitive toward others on days with greater intraday variability in stock prices, commodity prices, or currency exchange rates. Future lab experiments can also manipulate variability in several domains (e.g., temperature, background noise, lighting) to test whether participants placed in more variable conditions are indeed harsher when judging others.

The current research ruled in one mechanism for why exposure to greater variability makes people more punitive—a heightened sense of societal vulnerability. However, we also found support for multiple other mechanisms, including a heightened desire for control and greater perceived risk, indicating that this relationship runs through multiple mechanisms. Although we tested for additional mechanisms (e.g., perceived uncertainty and unpredictability, anxiety, perceived personal and collective control, prevention focus) that were not supported in the present studies, it is possible that these mechanisms would operate in other contexts. For example, anxiety and sense of vulnerability are closely related, but anxiety is an emotion whereas sense of vulnerability is a cognitive appraisal (e.g., "I feel unsafe"). The findings indicate that the effect of variability on punishment runs primarily through a cognitive rather than an emotional pathway. However, it is possible that exposure to greater variability might induce nonconscious negative arousal (cf. Proulx & Heine, 2008), which is not fully captured by self-reported measures of anxiety. Further research could examine contexts in which exposure to variability induces significantly higher anxiety or negative arousal, and the outcomes that these affective states predict.

Study 5a did not find a relationship between participants' prevention focus and their support for the death penalty, which seems inconsistent with previous work which found that prevention-focused individuals are more sensitive to negative outcomes, and therefore, punish norm violators to a greater extent (Pfattheicher & Keller, 2013). For the dependent measure included in our Study 5a—death penalty for severe crimes (e.g., first-degree murder)—perhaps nearly all participants perceived the behavior as similarly bad and serious irrespective of their prevention focus, and this is why we failed to find a relationship between prevention focus and punishment in Study 5a. Future work can explore the relationship between variability, prevention focus, and punishment in a wider range of contexts varying in their severity.

We found that people's perceived personal control was not associated with their perceived variability, perceived societal vulnerability, or punishment, but people's desire for control was positively correlated with perceived variability, perceived societal vulnerability, and punishment. This finding suggests that variability in the outside world might increase people's desire for control without reducing their perceived current level of control. Further, desire for control did mediate the relationship between perceived variability and punishment.

Future research can also consider factors that moderate people's reactions to different degrees of variability. For example, because greater variability may indicate lower predictability, people with a higher need for personal structure or order (Thompson, Naccarato, Parker, & Moskowitz, 2001) may be particularly susceptible to changes in variability. Similarly, people with greater uncertainty aversion (Vieider et al., 2015) or need for closure (Webster & Kruglanski, 1994) may also be more susceptible to changes in variability.

Future research can consider the consequences of variability other than the one identified in the current research. Although we focused on judgments of others' unethical behaviors in the current research, it would be interesting to examine whether exposure to different degrees of variability influences people's own unethical behaviors. One possibility is that because exposure to information conveying greater variability makes people judge unethical behaviors more harshly, they would be more likely to refrain from engaging in unethical behaviors themselves. Yet another possibility is that because exposure to information conveying greater variability makes people feel more vulnerable, they may be more willing to engage in unethical behaviors as a means to increase their personal resources to protect against the vulnerability.

Future research can also examine decision-making outcomes of variability. For example, on one hand, higher variability in the environment might reduce risk-taking because people want to compensate for the increased uncertainty that is not in their control by reducing the amount of uncertainty that is actually in their control. On the other hand, it is also possible that higher variability might increase risk-taking because it primes ideas of greater uncertainty and unpredictability, which is a component of high-risk options. Further, people might think that if they select high-risk options and obtain positive results, then they would be able to compensate for the negative outcomes brought on by higher variability. Future research can examine these possibilities.

The present research focused on a negative consequence of exposure to high variability—a greater sense of societal vulnerability. However, more variability need not always lead to higher vulnerability. For example, in situations in which the mean of a quantity is at an undesirable point close to the floor or the ceiling (e.g., consistently low rainfall across successive years, consistently high temperatures over the entire year), evidence that there is low variability in that quantity might lead to despair, as people might think that there is no way out of the current bad situation, that the situation is likely to persist in the future. However, evidence that there is high variability in that quantity might give people hope that things are likely to change in the future. Future research can

examine this question. Similarly, it is possible that greater variability may have a number of positive consequences, particularly in the context of climate change and sustainability. For example, exposure to greater variability may make people more generous in helping victims of natural disasters because they may realize that the high variability in climate conditions is causing great vulnerability to society. Similarly, exposure to greater variability may lead people to conserve natural resources, such as water, if they believe that greater variability in climate may put them in additional risks in the future.

Whereas the current research focused on variability, researchers in the social realm have examined the variability in social behaviors in a given situation, that is, cultural tightness-looseness (Gelfand et al., 2011). It is likely that these two constructs could be related in a bidirectional manner. In tighter cultures, a lower range of behaviors is acceptable in any given social situation, so people may be used to experiencing lower levels of variability in behaviors and therefore be more sensitive to greater variability. On the other hand, it is possible that under greater variability, people may prefer tight cultures more than loose cultures because tight cultures can help compensate for greater variability in the nonsocial domain with lower variability in the social domain. Future research can then examine a possible bidirectional relationship between variability and cultural tightness.

Variability represents an important yet understudied aspect of socioecological psychology (Oishi, 2010, 2014; Uskul, Kitayama, & Nisbett, 2008), a field that links environmental factors with psychological processes. The current research presents the first step in identifying how this increased variability could influence people psychologically.

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