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Moral judgment under uncertainty: A CNI model analysis

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Abstract

Past research suggests that uncertainty reduces our preference for utilitarian over deontological responses in moral dilemmas. The objective of the current research was to disentangle the possible mechanisms through which uncertainty shapes moral-dilemma responses. Using the CNI model of moral decision-making, we examined if uncertainty influences moral-dilemma responses via sensitivity to consequences, sensitivity to moral norms, or general action tendencies. Across four preregistered experiments (N = 1400), sensitivity to consequences was lower when the outcomes in moral dilemmas were uncertain than when they were certain. This effect emerged regardless of whether participants were asked to judge if they would perform the described actions or if they deem the described actions acceptable. The results are consistent with accounts suggesting that uncertain outcomes influence responses in moral dilemmas through discounting of cost-benefit ratios. Implications for public policy and moral decisions in real-world contexts are discussed.

KEYWORDS
CNI model, deontology, moral choices, uncertainty, utilitarianism

1 | INTRODUCTION

With the COVID-19 pandemic came a flurry of conundrums with which governments across the world had to contend. At the onset of the pandemic in early 2020, cruise ships full of tourists experienced outbreaks on board. Questions about the best course of action to take quickly abound: Should countries allow the cruise ships to dock, so that everyone who got infected can receive the medical treatment they would need to maximise their chance to survive? Or should countries prevent the cruise ships from docking and sacrifice the lives of many people on board to minimise potential greater losses on land (Street, 2020)? Then, as governments across the world began administering vaccines for the virus, resistance mounted with each case of unexpected fatality linked to the vaccines. Whereas health professionals and governments emphasised the low risk of fatality, some felt that the few cases of fatality were one too many (Bastian, 2021; McGuirk, 2021).

The conflicting views raised in such real-world dilemmas can be understood through two moral doctrines. For example, the decision to deny cruise ships from docking because the virus may spread and cause the deaths of more people than those few on board is in line with the principle of utilitarianism. A form of consequentialism, utilitarianism considers an action to be moral if it maximises society's welfare while minimising suffering. In contrast, from a deontological perspective, the morality of an action depends on its consistency with universal norms, rules, and duties. In the case of the cruise ships with COVID-19 outbreaks, preventing passengers from disembarking and receiving treatment could be considered immoral because it violates the norm that one should help people whose lives are at risk.

An extensive body of psychological research has investigated the underpinnings of utilitarian and deontological judgments and decisions through moral-dilemma vignettes based on either hypothetical or real-world scenarios (Bartels, 2008; Greene et al., 2001, 2004, 2008). Most moral dilemmas used in this research have been deterministic in that the moral agents are assumed to have complete certainty about the decision outcomes. For example, in the footbridge version of the classic trolley problem, the moral agent is informed that a trolley is hurtling towards five people trapped on a track. The moral agent has the option of pushing a man from a bridge to stop the trolley. In this dilemma, the moral agent is presumed to know with certainty that the trolley would kill the five people on the track if the man is not pushed from the bridge and that the lives of the five people would indeed be saved if the man is pushed from the bridge (Thomson, 1985). However, in real-world

settings, having complete certainty about decision outcomes is the exception rather than the rule. Building on extant research on the influence of uncertainty in moral dilemmas, the current research uses a mathematical modelling approach to investigate the precise mechanisms underlying the relationship between uncertainty and moral-dilemma responses.

1.1 | Uncertainty in moral dilemmas

Armed only with the knowledge that an action has the potential to cause harm despite benevolent intentions, how do we decide what is morally right or wrong? Although scant studies have examined the impact of uncertainty on moral choices, the general consensus in the extant literature is that uncertainty curtails preference for utilitarian over deontological responses (Cherry & Fraedrich, 2002; Kortenkamp & Moore, 2014; Royzman & Baron, 2002; see Shou & Song, 2017 for an alternative interpretation). For example, in a series of experiments examining the relationship between outcome uncertainty and moral-dilemma judgments, Kortenkamp and Moore (2014) found that participants who read dilemmas described with the probabilistic modal verb 'might' were less likely to judge a characteristically utilitarian judgment to be moral and appropriate than those who read the same dilemmas described with the deterministic modal verb 'will'. The precise mechanisms underlying this finding, however, remain unclear because of two shortcomings inherent to the classic moral-dilemma paradigm employed.

First, research using variants of traditional moral dilemmas such as the trolley problem pit utilitarian responses against deontological ones, regarding them as opposing ends of a bipolar continuum. In this approach, rejecting a utilitarian response is assumed to be indicative of an endorsement of a deontological response, and vice versa. This assumption is contestable, given that deontological and utilitarian responses are theorised to have distinct underlying mental processes (see Conway & Gawronski, 2013). Second, in classic moral dilemmas, the benefits associated with an action always outweigh its costs (e.g., kill one to save the lives of five) and the norm violated by the action is always proscriptive in nature (e.g., do not kill). Classic dilemmas thus conflate utilitarian responses with a preference for action (i.e., pushing the man) and deontological responses with a preference for inaction (i.e., not pushing the man; see Crone & Laham, 2017).

These shortcomings of the classic moral-dilemma paradigm render the relationship between uncertainty and moral choices unclear given the different ways in which the findings of prior studies can be interpreted. A review of the extant literature suggests that uncertainty may influence moral choices through three primary routes. First, consistent with Kortenkamp and Moore's (2014) interpretation, past findings that participants judged an action in a traditional dilemma to be less moral under uncertainty may reflect a negative association between uncertainty and utilitarian response tendencies. According to Shafir and Tversky (1992), people have a difficult time thinking through non-moral decision scenarios with multiple possible outcomes. In such circumstances, people may discount the informational value of consequences and therefore weigh consequences less when forming their moral judgments and behavioural intentions (Cherry & Fraedrich, 2002).

The second route through which uncertainty may impact moral choices is through norm adherence. Because deontological responses are assumed to be the bipolar opposite of utilitarian responses in traditional dilemmas, participants in past studies may have judged the action of sacrificing a few to save more as less moral because of their greater adherence to moral norms, rather than being less concerned with the decision's consequences. Research from the social influence literature suggests that people have a basic desire to resolve feelings of uncertainty, and one way of doing so is to rely on social cues and norms to gauge how one should behave (Cialdini & Goldstein, 2004; Deutsch & Gerard, 1955; Smith et al., 2007). Past findings that people are less utilitarian and thus, as a corollary, more deontological under uncertainty could therefore be accounted for by a heightened sensitivity to moral norms, rather than a generalised discounting of consequences.

Lastly, because the classic dilemma paradigm conflates deontological responses with a preference for inaction, past findings that uncertainty promotes deontological responses may be accounted for by differential omission bias tendencies. Omission bias refers to the tendency for people to judge actions with adverse outcomes as worse than omissions with the same outcomes (Baron & Ritov, 1994, 2004; Ritov & Baron, 1995). This tendency has been documented to influence moral judgments, such that harm inflicted through commission is perceived to be more immoral, attributed more to personal responsibility, and judged to be more intentional than harm inflicted through omission (e.g., Cushman et al., 2006; DeScioli et al., 2011; Jamison et al., 2020; Kordes-de Vaal, 1996; see Yeung et al., 2022 for a meta-analytic review). In the context of moral dilemmas, participants in past studies may have exhibited a greater preference for inaction under uncertainty, because the decision to act could potentially lead to greater losses or personal blame than the decision not to act. However, counter to this idea, another line of research suggests that uncertainty may reduce (rather than increase) omission bias tendencies. Specifically, uncertainty may increase one's perceptions that one is less morally responsible for actions with uncertain outcomes; instead of one's actions being the cause of the loss, the chance is the deciding, albeit secondary, factor (Leonhardt et al., 2011). The predictions derived from this line of reasoning would be contrary to extant findings because uncertainty should lead to the increased endorsement of action in the classic dilemma paradigm rather than decreasing it.

In sum, extant theories on judgment and decision-making suggest four potential mechanisms by which uncertainty may influence responses in moral dilemmas: (1) discounting of cost-benefit ratios under uncertainty, (2) enhanced reliance on rules as a means to reduce uncertainty, (3) enhanced concern with potential losses under uncertainty, and (4) reduced feelings of responsibility for potential losses under uncertainty. Whereas the first three mechanisms imply that preference for utilitarian over deontological judgments should be enhanced under uncertainty as found in previous research (e.g., Kortenkamp & Moore, 2014), the fourth mechanism implies the opposite pattern.

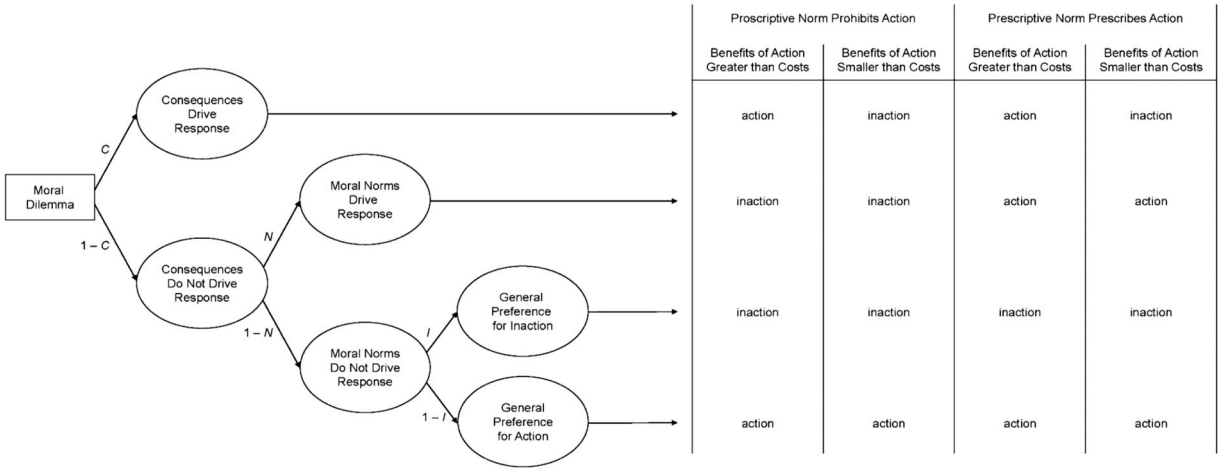

FIGURE 1 CNI model of moral decision-making predicting action versus inaction responses in moral dilemmas with proscriptive and prescriptive norms, and consequences wherein the benefits of action are either greater or smaller than the costs of action. Reproduced from Gawronski et al. (2017). Reprinted with permission from the American Psychological Association.

1.2 | The CNI model

One tool that can be used to disentangle the four potential ways by which uncertainty may influence moral-dilemma responses is the CNI model of moral decision-making (Gawronski et al., 2017). The CNI model is a multinomial model that was developed to disentangle sensitivity to consequences (*C*), sensitivity to moral norms (*N*), and general preference for inaction versus action (*I*) in responses to moral dilemmas. Research using the CNI model has provided nuanced insights into the determinants and correlates of these three factors, including cognitive resources (Gawronski et al., 2017), incidental emotions (Gawronski et al., 2018), social power (Gawronski & Brannon, 2020), basic personality traits (Kroneisen & Heck, 2020; Luke & Gawronski, 2022), political ideology (Luke & Gawronski, 2021a), psychopathy (Luke et al., 2022; Luke & Gawronski, 2021b), and dishonest behaviour (Ng et al., 2022).

The CNI model quantifies the three factors underlying moral-dilemma judgments using responses to matching sets of moral dilemmas that differ in two ways: (1) cost-benefit ratios (i.e., benefits associated with action are greater or smaller than costs) and (2) type of moral norm (i.e., proscriptive or prescriptive). As depicted in Figure 1, each of the three factors is captured by a parameter characterised by a unique pattern of responding across the four dilemma variants. The CNI model's *C* parameter captures the extent to which participants' responses to moral dilemmas are sensitive to consequences such that they (1) prefer to act in dilemmas when the benefits associated with action outweigh their costs and (2) prefer not to act when the costs outweigh the benefits (first row in Figure 1). The *C* parameter reflects the difference between these two specific cases. Although the *C* parameter could be argued to reflect the general norm *always maximise the benefits* (Hennig & Hütter, 2020), the response pattern captured by the *C* parameter is distinct from the one captured by the CNI model's *N* parameter on sensitivity to moral norms, which reflects the extent to which participants (1) support action when the action is prescribed by a prescriptive norm and (2) support inaction when the action is prohibited by a proscriptive norm (second row in Figure 1). Instead of presuming that the response pattern captured by the *N* parameter is driven by conscious, explicit thoughts about specific moral norms, the parameter simply captures the difference in responses between cases wherein the action either causes or prevents proximal harm. Lastly, the CNI model's *I* parameter captures the extent to which participants' responses reflect a general preference for inaction versus action such that they generally prefer not to act (vs. to act) regardless of cost-benefit ratios and type of moral norm (third and fourth rows in Figure 1). Although the response pattern captured by the *I* parameter may be argued to reflect the general norm *first, do no harm* (Baron & Goodwin, 2020, 2021), this response pattern is again distinct from the one captured by the *N* parameter. Whereas the *N* parameter captures discrepancies between moral dilemmas wherein the focal action either causes or prevents proximal harm, the *I* parameter captures general preferences for inaction (vs. action) regardless of whether the focal action causes or prevents proximal harm and regardless of cost-benefit ratios. Adherence to the general norm *first, do no harm* would be reflected in a general preference for inaction regardless of the moral-dilemma variant. The CNI model disentangles sensitivity to consequences, sensitivity to moral norms, and general preference for inaction versus action in responses to moral dilemmas by quantifying these three distinct response patterns.

1.3 | The present research

In conjunction with the CNI model as a methodological tool, extant theories of how uncertainty may influence moral-dilemma responses lead to unique predictions about the effects of uncertainty on the three model parameters. First, if uncertainty influences moral-dilemma responses via discounting of cost-benefit ratios, uncertainty should reduce sensitivity to consequences on the *C* parameter. Second, if uncertainty influences moral-dilemma responses via enhanced

reliance on rules as a means to reduce uncertainty, uncertainty should increase sensitivity to moral norms on the *N* parameter. Third, if uncertainty influences moral-dilemma responses via enhanced concerns about potential losses, uncertainty should increase general preference for inaction versus action on the *I* parameter. Finally, if uncertainty influences moral-dilemma responses via reduced feelings of responsibility for potential losses, uncertainty should decrease the general preference for inaction versus action on the *I* parameter.

The purpose of the present research was to test these competing predictions. To this end, we conducted four experimental studies using the CNI model of moral decision-making to disentangle the possible effects of uncertainty on moral-dilemma responses via (1) sensitivity to consequences, (2) sensitivity to moral norms, and (3) general preference for inaction versus action. Levels of certainty were experimentally manipulated via language that was either deterministic (i.e., 'will') or probabilistic (i.e., 'might') in nature (see Kortenkamp & Moore, 2014). All four studies were preregistered prior to data collection. Study 1 sought to establish if uncertainty shapes moral-dilemma responses through sensitivity to consequences, sensitivity to moral norms, or general preference for inaction versus action. Studies 2 and 3 were conducted to replicate the effects identified in the first study and further explore factors underlying the identified effects. Study 4 was conducted to examine whether the results obtained for action choices in Studies 1–3 generalise to judgments of moral acceptability. We report all data, all measures, and all data exclusions. The materials, data, and analysis codes for the four studies can be accessed at https://osf.io/hdq3x/.

The studies were approved by the Institutional Review Board of the University of Texas at Austin .

2 | STUDY 1

The first study aimed to establish if uncertainty shapes moral-dilemma responses through sensitivity to consequences, sensitivity to moral norms, or general preference for inaction versus action. To disentangle the possible alternatives, we used four types of moral dilemmas that differed on two levels: (1) whether the dilemmas involved a prescriptive or proscriptive norm, and (2) whether the benefits associated with the action were greater or smaller than the costs. Using the CNI model of moral decision-making (Gawronski et al., 2017), we quantified sensitivity to consequences, sensitivity to moral norms, and general preference for inaction versus action.

Regarding the possible routes through which uncertainty may impact moral-dilemma responses, we tested the following hypotheses. First, if uncertainty influences moral-dilemma responses by leading people to discount the importance of consequences, uncertainty should reduce sensitivity to consequences on the CNI model's *C* parameter (Hypothesis 1).[1] Second, if uncertainty influences moral-dilemma responses via enhanced reliance on rules as a means to reduce uncertainty, uncertainty should increase sensitivity to moral norms on the CNI model's *N* parameter (Hypothesis 2). Third, if uncertainty influences moral-dilemma responses via enhanced concerns about potential losses, uncertainty should increase general preference for inaction on the CNI model's *I* parameter (Hypothesis 3a). Finally, if uncertainty influences moral-dilemma responses via reduced feelings of responsibility for potential losses, uncertainty should decrease general preference for inaction on the CNI model's *I* parameter (Hypothesis 3b).

The design, procedures, and data analytic plan were preregistered prior to data collection at https://osf.io/2ptw3. For conceptual clarity, we refer to certainty at the stimulus level as *outcome certainty* (i.e., referring to whether the descriptions of outcomes in the dilemmas use deterministic vs. probabilistic language) and self-reported certainty at the psychological level as *subjective certainty* (i.e., referring to participants' subjective level of psychological certainty).

2.1 | Method

2.1.1 | Design and participants

The study used a two-group between-subjects design with participants randomly assigned to either a high outcome-certainty or low outcome-certainty condition. A sensitivity power analysis was conducted using G*Power 3.1. A sample of $N = 300$ ($n = 150$ per condition) provides 80% power for the detection of a difference of $d = 0.32$ between two independent means with an alpha level of .05 (two-tailed). We thus aimed to have 150 participants per condition. Based on prior studies conducted by our lab, we expected approximately 10% of the sample would fail an attention check that screens for inattentive participants. Thus, to achieve our desired sample size, we oversampled and recruited 330 participants. All participants were recruited via Prolific Academic, a crowdsourcing platform providing access to demographically diverse samples for online research (Peer et al., 2017). To be eligible for participation in the studies, participants had to (1) be aged 18 years or older, (2) be fluent in English, (3) have an approval rating of over 95% on Prolific, (4) have the United Kingdom as their registered home country, (5) have completed at least 100 studies on Prolific, and (6) have not participated in a prior study from our lab that used the moral dilemmas included in the present research. Participants were compensated $4.00 for their time.

Of the 330 participants who completed the study, 57 failed the attention check (17.3%), thus resulting in a final sample of 273 participants ($n = 135$ in the high outcome-certainty condition; $n = 138$ in the low outcome-certainty condition). The final sample's demographic

[1] The preregistrations for Studies 1–3 included an additional hypothesis, suggesting that uncertainty might increase sensitivity to consequences on the CNI model's *C* parameter. The hypothesis was based on research by Shou and Song (2017), who demonstrated that participants' perceived outcome probabilities predicted their moral-dilemma responses, such that they avoided choices perceived to have high likelihoods of resulting in negative outcomes. In hindsight, we deem it unclear if the tendency to perceive negative outcomes as being more probable than positive ones coupled with an avoidance of negative outcomes under uncertainty would lead to an increase, decrease, or null effect on the CNI model's *C* parameter under uncertainty. We therefore do not discuss this hypothesis any further in the current article.

breakdown is as follows: 190 female, 82 male, 1 other; M_{age} = 40.66, SD_{age} = 11.69; 91.6% identified as being ethnically White, 1.1% as Hispanic, Latino, or Spanish origin, 2.6% as Black, 3.7% as Asian, 0.4% as Middle Eastern or North African, and 1.5% as other ethnicities.

2.1.2 | Procedure and measures

After consenting to participate in the study, participants were randomly assigned to a high outcome-certainty or low outcome-certainty condition. In both conditions, participants completed a battery of moral dilemmas adapted from Körner et al. (2020), which were presented in a fixed random order. The dilemma battery consisted of nine basic real-world scenarios, each of which had four variants that differed in terms of (1) whether the benefits associated with the action were greater or less than the costs and (2) whether the focal norm was prescriptive or proscriptive. All participants thus completed a total of 36 moral dilemmas. Only 9 out of the original 12 basic scenarios (i.e., 36 out of 48 dilemmas) from Körner et al. (2020) were used in the current study, because (1) not all scenarios could be modified to include probabilistic outcome descriptions and (2) one dilemma set (i.e., *abduction dilemma*) was found in prior research to have low construct validity (Gawronski et al., 2020). Following the procedure by Kortenkamp and Moore (2014), participants in the high outcome-certainty and low outcome-certainty conditions read the 36 moral dilemmas described with the modal verbs 'will' and 'might', respectively. In both conditions, participants indicated whether they would perform the described action using a binary *'yes'/ 'no'* answer choice. An example of a modified moral dilemma used in the current study is presented in Table 1.

Following each dilemma, participants responded to a single-item measure of subjective certainty by indicating how certain they were that the different options presented in the moral-dilemma scenario would lead to the described outcomes ('*Based on the descriptions in the scenario, how certain are you that the different options in this scenario will lead to the described outcomes?*'). Responses were measured with 7-point rating scales ranging from 1 ('*very uncertain*') to 7 ('*very certain*'). After completing all 36 moral dilemmas and 36 subjective certainty items, participants answered demographic questions on their gender, age, and ethnicity. Lastly, they completed a reading-intensive instructional attention check (Oppenheimer et al., 2009). The instructions for the attention check were as follows:

> *To facilitate our research on decision-making we are interested in learning a little more about you, the decision-maker. Psychological research using text-based materials requires that study participants read the materials and do not skip over longer pieces of text. We are therefore interested in whether you actually take the time to read the directions; if not, then some of our manipulations that rely on changes in the instructions will be ineffective. To demonstrate that you have read the instructions, please ignore the question below and all of the response options. Instead, simply continue on to the next page without answering the question. Thank you very much.*

Following the instructions, participants were presented with the question 'Of following destinations, which one would be your first choice for a vacation if you had a free all-inclusive round trip after the Covid-19 pandemic? (Check all that apply)' and the available response options Australia, Brazil, China, Egypt, France, Germany, India, Japan, New Zealand, Mexico, Russia, South Africa, Spain, Sweden, and the United States. Because the instructions directed participants to not select any options but instead skip ahead to the next screen, those who checked one or more of the 15 response options were considered to have failed the attention check.

2.1.3 | Data aggregation and analysis

For each dilemma, the decision to act (*yes*) was coded as '1′ and the decision to not act (*no*) was coded as '0′. The number of times participants chose to act across each of the four dilemma variants was summed, such that higher scores reflect a greater preference for action versus inaction on a given dilemma variant. This procedure resulted in four action indices (i.e., one per dilemma variant). To obtain the four indices of inaction responses, the indices of action responses were subtracted from 9. With a total of nine scenarios for each dilemma variant, aggregate scores could range from 0 to 9.

Moral-dilemma responses were analysed using three preregistered approaches. First, to permit comparisons with past research, we tested effects of outcome certainty on the sum of action responses to the dilemma variant wherein the benefits associated with the action outweighed the costs to overall well-being and the norm that would be violated by the action is proscriptive in nature. Following the interpretational practice in the traditional moral-dilemma paradigm, higher scores on this dilemma variant can be interpreted as reflecting a greater preference for utilitarian over deontological choices. For the sake of simplicity, we refer to this index as *traditional dilemma score*. Differences in traditional dilemma scores across conditions were analysed using an independent sample *t*-test.

Next, we estimated the three CNI model parameters and tested effects of outcome certainty using both group-level and individual-level analyses. The CNI model provides four non-redundant equations to estimate numerical values for the *C*, *N*, and *I* parameters based on the empirically observed probabilities of *action* (*yes*) versus *inaction* (*no*) responses on the four dilemma variants (Figure 1). The four equations include the three model parameters as unknowns and the empirically observed probabilities of *action* versus *inaction* responses on the four dilemma variants as known numerical values. Using maximum likelihood statistics, multinomial modelling generates parameter estimates for the three unknowns that minimise the difference between the empirically observed probabilities of *action* versus *inaction* responses on the four dilemma variants and the probabilities of *action* versus *inaction* responses predicted by the model equations using the identified parameter estimates.

To estimate group-level model parameters, the eight action/inaction response indices were aggregated by condition, resulting in four action indices and four inaction indices per condition. The CNI model was then

TABLE 1 Example of a moral dilemma involving either a proscriptive or prescriptive norm where the benefits associated with action are either greater or smaller than the costs of action. Dilemmas adapted from Körner et al. (2020) with slight modifications for the manipulation of outcome certainty.

	Proscriptive norm prohibits action		Prescriptive norm prescribes action	
Condition	Benefits of action greater than costs	Benefits of action smaller than costs	Benefits of action greater than costs	Benefits of action smaller than costs
High outcome certainty	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. The patients all need organ transplants or they will die. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he will not live for much longer. You could remove the patient's ventilator, which will cause him to die. You could then take his organs for the five accident victims, which will save their lives.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. These patients all need organ transplants or they will have health problems for the rest of their lives. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he will not live for much longer. You could remove the patient's ventilator, which will cause him to die. You could then take his organs for the five accident victims, which will prevent them from having health problems.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. These patients all need organ transplants or they will have health problems for the rest of their lives. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he will not live for much longer. Suddenly, the patient's blood-oxygen level drops, and he will die if he does not receive a ventilator. If the patient dies, you could take his organs for the five accident victims, which will prevent them from having health problems. You could give the patient a ventilator, which will save him from dying.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. The patients all need organ transplants or they will die. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he will not live for much longer. Suddenly, the patient's blood-oxygen level drops, and he will die if he does not receive a ventilator. If the patient dies, you could take his organs for the five accident victims, which will save their lives. You could give the patient a ventilator, which will save him from dying.
Low outcome certainty	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. The patients all need organ transplants or they might die. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he might not live for much longer. You could remove the patient's ventilator, which might cause him to die. If he dies, you could take his organs for the five accident victims, which might save their lives.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. These patients all need organ transplants or they might have health problems for the rest of their lives. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he might not live for much longer. You could remove the patient's ventilator, which might cause him to die. If he dies, you could take his organs for the five accident victims, which might prevent them from having health problems.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. These patients all need organ transplants or they might have health problems for the rest of their lives. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he might not live for much longer. Suddenly, the patient's blood-oxygen level drops, and he might die if he does not receive a ventilator. If the patient dies, you could take his organs for the five accident victims, which might prevent them from having health problems. You could give the patient a ventilator, which might save him from dying.	You are a surgeon in a small hospital. One day, your hospital receives five badly hurt patients from a car accident. The patients all need organ transplants or they might die. You have no spare organs, but there is a patient who has been in intensive care for several weeks. His condition is worsening and he might not live for much longer. Suddenly, the patient's blood-oxygen level drops, and he might die if he does not receive a ventilator. If the patient dies, you could take his organs for the five accident victims, which might save their lives. You could give the patient a ventilator, which might save him from dying.
Moral action question	Would you remove the patient's ventilator in this case?	Would you remove the patient's ventilator in this case?	Would you give the patient a ventilator in this case?	Would you give the patient a ventilator in this case?
Moral acceptability question	Is it acceptable in this case to remove the patient's ventilator?	Is it acceptable in this case to remove the patient's ventilator?	Is it acceptable in this case to give the patient a ventilator?	Is it acceptable in this case to give the patient a ventilator?

fit to these aggregated moral-dilemma indices to estimate the *C*, *N*, and *I* parameters for each condition (see Gawronski et al., 2017). With two experimental conditions, the model had a total of eight free categories (i.e., four types of dilemmas for each of the two conditions) and six parameters (i.e., three parameters estimated for each of the two conditions), resulting in two degrees of freedom. To test the study's hypotheses, the initial model estimating group-level parameters across conditions was designated as the baseline model. To test differences between groups on a given parameter, a new model was estimated constraining estimates for that specific parameter to be equal across groups. The fit of the new model was then compared against the fit of the baseline model. If constraining a given parameter to be equal across conditions leads to a significant reduction in model fit, the parameter can be said to be significantly different across conditions (see Gawronski et al., 2017). This procedure was followed for all three model parameters.

An alternative to testing differences across experimental conditions by aggregating data at the group-level (see Gawronski et al., 2017) is to fit the model to the data of each individual participant (see Körner et al., 2020) and then test differences across experimental conditions based on the individual-level estimates of the three parameters. A disadvantage of the group-level approach is that it can lead to false positives, because it does not account for variation at the individual level. Conversely, a disadvantage of the individual-level approach is that parameter estimates are based on small numbers of observations, which makes them unreliable and susceptible to false negatives. To gain greater confidence in the reliability of the obtained results, we preregistered both data analytic approaches, stating that we would interpret effects only if they replicate across the two approaches.

To estimate the individual-level model parameters, the eight action/inaction response indices were aggregated within each participant. The CNI model was then fit to the aggregated moral-dilemma indices for each individual participant, resulting in estimations of unique CNI model parameters for each participant (see Körner et al., 2020). The model for each participant had a total of four free categories and three parameters, resulting in one degree of freedom. To test the study's hypotheses, independent samples *t*-tests were conducted to determine whether individual estimates for each model parameter differed between the two conditions.

The freeware multiTree was used to conduct the modelling analyses (Moshagen, 2010). Group-level analyses were conducted with the template files provided by Gawronski et al. (2017) at https://osf.io/m82k7/; individual-difference analyses were conducted with the template files provided by Körner et al. (2020) at https://osf.io/ndf4w/. Following Gawronski et al. (2017), we used a fixed estimation algorithm with random start values, two replications, and a maximum of 90,000 iterations. More details on the modelling analyses can be found in Gawronski et al. (2017). Following our preregistered exclusion criteria, data from participants who did not complete the study until the end, failed the attention check, or showed the same response on all dilemmas were excluded from analyses.

2.2 | Results

Means and 95% confidence intervals for the manipulation-check measure, four moral dilemma action (vs. inaction) indices, and CNI model parameters are presented in Table 2.

2.2.1 | Manipulation check

An index of overall subjective certainty was generated by calculating the mean score across all 36 subjective certainty items (Cronbach's $\alpha = .95$). Higher scores on this index reflect greater perceived certainty about the described outcomes. Subjective certainty scores were subjected to an independent samples *t*-test to determine if the manipulation of outcome certainty through language had shaped subjective perceptions of certainty. Consistent with the experimental manipulation's intended effect, participants in the low outcome-certainty condition ($M = 4.65$, $SD = 0.88$) tended to report having less subjective certainty of the dilemma decision outcomes than those in the high outcome-certainty condition ($M = 4.82$, $SD = 0.81$). However, this difference was only marginal, $t(271) = -1.71$, $p = .089$, $d = 0.206$.

2.2.2 | Traditional analysis

To permit comparisons to past research, moral-dilemma responses were first analysed using the traditional approach. Towards this end, the sum of action responses to the proscriptive dilemmas wherein the benefits associated with action outweighed the costs was subjected to an independent samples *t*-test. Consistent with prior research (Kortenkamp & Moore, 2014), participants in the low outcome-certainty condition ($M = 2.92$, $SD = 1.77$) tended to show a weaker preference for action over inaction on this dilemma type than those in the high outcome-certainty condition ($M = 3.32$, $SD = 2.06$). However, this difference was only marginal, $t(262.87) = -1.71$, $p = .088$, $d = 0.207$.

2.2.3 | CNI model group-level analysis

The CNI model fit the data well, $G^2(2) = 5.45$, $p = .066$, $w = 0.024$. Constraining the model such that the *C* parameter for the high outcome-certainty condition was equal to the *C* parameter for the low outcome-certainty condition led to a statistically significant reduction in model fit, $\Delta G^2(1) = 27.19$, $p < .001$, $d = 0.630$, indicating that sensitivity to consequences was significantly weaker for participants in the low outcome-certainty condition than for participants in the high outcome-certainty condition. Constraining the model such that the *I* parameter was equal across the two experimental conditions led to a statistically significant reduction in model fit as well, $\Delta G^2(1) = 4.83$, $p = .028$, $d = 0.266$, indicating that participants in the low outcome-certainty condition had a weaker general preference for inaction than

TABLE 2 Means and 95% confidence intervals of the manipulation check, moral dilemma action (vs. inaction) indices, and CNI model parameters as a function of outcome certainty (High vs. Low), Study 1.

	High outcome certainty ($n = 135$)		Low outcome certainty ($n = 138$)	
	M	95% CI	*M*	95% CI
Manipulation check				
Subjective certainty	4.82	[4.68, 4.96]	4.65	[4.50, 4.80]
Moral dilemma indices				
Proscriptive norm prohibits action				
Benefits of action > costs	3.32	[2.97, 3.67]	2.92	[2.62, 3.22]
Benefits of action < costs	0.94	[0.75, 1.13]	1.12	[0.91, 1.34]
Prescriptive norm prescribes action				
Benefits of action > costs	7.47	[7.28, 7.67]	7.40	[7.19, 7.61]
Benefits of action < costs	4.59	[4.28, 4.89]	5.58	[5.31, 5.85]
CNI model parameters (group)				
C parameter	0.29	[0.27, 0.31]	0.20	[0.18, 0.22]
N parameter	0.61	[0.57, 0.64]	0.62	[0.59, 0.65]
I parameter	0.65	[0.61, 0.69]	0.59	[0.55, 0.63]
CNI model parameters (individual)				
C parameter	0.29	[0.26, 0.32]	0.20	[0.18, 0.22]
N parameter	0.60	[0.55, 0.65]	0.63	[0.58, 0.67]
I parameter	0.70	[0.65, 0.75]	0.65	[0.60, 0.70]

Note: Moral dilemma indices scores can range from 0 to 9.

those in the high outcome-certainty condition. There was no significant effect of the outcome-certainty manipulation on the *N* parameter, $\Delta G^2(1) = 0.37$, $p = .545$, $d = 0.073$.

2.2.4 | CNI model individual-level analysis

Consistent with the group-level analysis, a significant difference on the *C* parameter emerged, such that participants in the low outcome-certainty condition were significantly less sensitive to consequences than those in the high outcome-certainty condition, $t(251.05), = -4.68$, $p < .001$, $d = 0.566$. Also consistent with the group-level analysis, the *N* parameter did not significantly differ across experimental conditions, $t(271) = 0.94$, $p = .348$, $d = 0.114$. Inconsistent with the group-level analysis, there was no significant effect of outcome certainty on the *I* parameter using the individual-level approach, $t(271) = -1.23$, $p = .220$, $d = 0.149$.

2.2.5 | Exploratory analysis

To further investigate relations between subjective certainty and moral-dilemma responses, we examined the correlations between the individual-level CNI parameters and participants' mean subjective certainty scores. The analysis yielded only one significant correlation (Table 3). Specifically, the *N* parameter showed a significant negative correlation with subjective certainty, such that the less certain participants felt about the outcomes, the more sensitive they were to moral norms. Different from the experimental effect of outcome certainty on the *C* parameter, subjective certainty scores were not significantly correlated with the *C* parameter.

2.3 | Discussion

Both the group-level and individual-level analyses revealed a significant difference in the *C* parameter across conditions, suggesting that outcome uncertainty shaped moral-dilemma responses through sensitivity to consequences. Specifically, outcome uncertainty seemed to reduce preference for utilitarian over deontological choices such that whether the benefits associated with the action were smaller or greater than the costs did not matter as much when the dilemmas were described with probabilistic language than when they were described with deterministic language. Even though the experimental effect on sensitivity to moral norms was not statistically significant, the significant negative correlation between the *N* parameter and subjective certainty suggests that uncertainty may still influence moral choices via sensitivity to moral norms. Omission bias tendencies in moral-dilemma responses, on the other hand, do not seem to be reliably associated with uncertainty, given the null findings in the preregistered individual-level CNI model analysis and the exploratory correlational analyses. While the study's findings provide initial insights into the impact of

TABLE 3 Correlations between individual-level CNI model parameters and mean subjective certainty (Study 1).

	C parameter	*N* parameter	*I* parameter	α	Inter-item correlation
C parameter	1			.45	.34
N parameter	−0.14*	1		.46	.30
I parameter	−0.07	0.29***	1	.23	.13
Mean subjective certainty	0.03	−0.19**	−0.08	.95	.34

Note: To obtain the internal consistency estimates, we split participants' responses to the moral dilemmas into two test-halves (odd-numbered and even-numbered dilemmas) and estimated two sets of CNI parameter scores.
*$p < .05$.
**$p < .01$.
***$p < .001$.

outcome uncertainty on sensitivity to consequences, the analyses only yielded a marginal effect of the experimental manipulation on a measure of subjective certainty and no significant correlation between subjective certainty and sensitivity to consequences.

One potential explanation for the latter findings is that the study was underpowered for the detection of a significant effect. However, such an explanation conflicts with the findings that (1) our experimental manipulation of outcome certainty showed a substantial effect on the *C* parameter ($d = 0.630$ in the group-level analysis; $d = 0.566$ in the individual-level analysis), (2) the measure of subjective certainty showed higher reliability than the *C* parameter (Cronbach's $\alpha = .95$ vs. .45, respectively; see Table 3), and (3) the correlation between subjective certainty and the *C* parameter was close to zero ($r = .03$, $p = .58$; see Table 3). If anything, the effect of a given manipulation on a proximal mediator (here: subjective certainty) should be stronger, not weaker, than the effect of that manipulation on a distal criterion (here: sensitivity to consequences), especially if the mediator is measured with higher reliability than the criterion. A proposed mediator should also be systematically related to the criterion. Otherwise, one could not conclude that the proximal mediator explains differences in the distal outcome. In view of these considerations, low statistical power seems psychometrically unlikely to account for the current pattern of results. Instead, it seems more likely that a psychological state other than subjective certainty mediated the experimental effect on moral-dilemma judgments. The objective of Study 2 was to shed light on this issue through the inclusion of a new manipulation check assessing subjective likelihood rather than subjective certainty.

3 | STUDY 2

Study 2 sought to replicate the effects found in Study 1 and clarify if the manipulation check used had been inadequate in capturing the between-group differences in psychological certainty. To do so, Study 2 used the same sampling criteria, materials, and analyses as Study 1, the only difference being the phrasing of the manipulation-check item. The design, procedures, and data analytic plan were preregistered prior to data collection at https://osf.io/qnkst.

3.1 | Method

3.1.1 | Design and participants

The study used the same between-subjects design with participants being randomly assigned to either a high outcome-certainty or low outcome-certainty condition. Following the sample-size rationale in Study 1, we recruited a total of 330 participants. Of these participants, 61 failed the attention check (18.5%), which left us with a final sample of 269 participants ($n = 131$ in the high outcome-certainty condition, $n = 138$ in the low outcome-certainty condition). Based on the effect sizes obtained in Study 1, this sample provides a power of 99.9% in replicating the observed effect on the *C* parameter in the group-level analysis and a power of 99.6% in replicating the observed effect on the *C* parameter in the individual-level analysis (two-tailed). The final sample's demographic breakdown is as follows: 168 female, 97 male, 4 other; $M_{age} = 40.23$, $SD_{age} = 15.14$; 86.2% identified as being ethnically White, 0.4% as Hispanic, Latino, or Spanish origin, 3.3% as Black, 10.0% as Asian, 0.7% as Middle Eastern or North African and 1.9% as other ethnicities.

3.1.2 | Procedure and measures

Study 2's procedure was identical to that of Study 1, the only difference being the manipulation-check item used. Specifically, the manipulation-check item in Study 2 measured subjective likelihood instead of subjective certainty. Whereas the former refers solely to expected probabilities for outcomes, the latter involves a central role of decision confidence. Although the two aspects of uncertainty may seem similar, they are not identical because people may differ in their subjective confidence about the same perceived probability. The manipulation-check item measuring subjective likelihood, which was repeated following each dilemma, asked: *How likely do you think it is that the two options (yes vs. no) will result in the respective outcomes described in the scenario?* Participants responded using a 7-point scale, with 1 denoting '*not at all likely*', 4 denoting '*moderately likely*', and 7 denoting '*very likely*'.

TABLE 4 Means and 95% confidence intervals of the manipulation check, moral dilemma action (vs. inaction) indices, and CNI model parameters as a function of outcome certainty (High vs. Low), Study 2.

	High outcome certainty ($n = 131$)		Low outcome certainty ($n = 138$)	
	M	95% CI	*M*	95% CI
Manipulation check				
Subjective likelihood	4.71	[4.54, 4.88]	4.61	[4.47, 4.75]
Moral dilemma indices				
Proscriptive norm prohibits action				
Benefits of action > costs	3.59	[3.25, 3.93]	2.90	[2.63, 3.17]
Benefits of action < costs	1.12	[0.86, 1.38]	1.09	[0.87, 1.31]
Prescriptive norm prescribes action				
Benefits of action > costs	7.18	[6.93, 7.43]	7.23	[7.00, 7.47]
Benefits of action < costs	4.56	[4.26, 4.87]	5.24	[4.97, 5.51]
CNI model parameters (group)				
C parameter	.28	[0.26, 0.31]	.21	[0.19, 0.23]
N parameter	.54	[0.51, 0.58]	.60	[0.57, 0.63]
I parameter	.63	[0.59, 0.66]	.63	[0.59, 0.66]
CNI model parameters (individual)				
C parameter	.29	[0.26, 0.32]	.21	[0.19, 0.24]
N parameter	.56	[0.51, 0.62]	.61	[0.56, 0.65]
I parameter	.71	[0.66, 0.76]	.69	[0.64, 0.74]

Note: Moral dilemma indices scores can range from 0 to 9.

3.1.3 | Data aggregation and analysis

The identical sets of analyses and data exclusion criteria were preregistered for Study 2.

3.2 | Results

Means and 95% confidence intervals for the manipulation-check measure, four moral dilemma action (vs. inaction) indices, and CNI model parameters are presented in Table 4.

3.2.1 | Manipulation check

To verify the effectiveness of our manipulation, subjective likelihood ratings were aggregated by calculating the mean score of all 36 items (Cronbach's $\alpha = .96$). Subjective likelihood scores were then subjected to an independent samples *t*-test. Even though participants in the low outcome-certainty condition ($M = 4.61$, $SD = 0.82$) perceived the described dilemma outcomes to have a lower probability of occurring compared to those in the high outcome-certainty condition ($M = 4.71$, $SD = 0.98$), the difference was not statistically significant, $t(269) = -0.92$, $p = .358$, $d = 0.112$.

3.2.2 | Traditional analysis

Consistent with Study 1 and prior research (Kortenkamp & Moore, 2014), participants in the high outcome-certainty condition ($M = 3.59$, $SD = 1.98$) showed a stronger preference for action over inaction on the traditional dilemma score than those in the low outcome-certainty condition ($M = 2.90$, $SD = 1.60$). Unlike the marginal effect in Study 1, the experimental effect was statistically significant in Study 2, $t(249.61) = -3.13$, $p = .002$, $d = 0.383$.

3.2.3 | CNI model group-level analysis

The CNI model fit the data well, $G^2(2) = 1.15$, $p = .563$, $w = 0.012$. Consistent with Study 1, constraining the model such that the *C* parameter was equivalent across the two conditions led to a statistically significant reduction in model fit, $\Delta G^2(1) = 16.67$, $p < .001$, $d = 0.498$, indicating that participants in the low outcome-certainty condition showed a weaker sensitivity to consequences than participants in the high outcome-certainty condition. Inconsistent with Study 1, a significant effect emerged for the *N* parameter, such that participants in the low outcome-certainty condition showed a stronger sensitivity to moral norms than those in the high outcome-certainty condition, $\Delta G^2(1) = 5.13$, $p = .023$, $d = 0.276$. No significant difference on the *I*

TABLE 5 Correlations between individual-level CNI model parameters and mean subjective likelihood (Study 2).

	C parameter	*N* parameter	*I* parameter	α	Inter-item correlation
C parameter	1			.47	.35
N parameter	−0.06	1		.46	.30
I parameter	0.05	0.35***	1	.23	.13
Mean subjective likelihood	0.08	−0.06	−0.10	.96	.40

Note: To obtain the internal consistency estimates, we split participants' responses to the moral dilemmas into two test-halves (odd-numbered and even-numbered dilemmas) and estimated two sets of CNI parameter scores.
*$p < .05$.
**$p < .01$.
***$p < .001$.

parameter was detected between the two conditions, $\Delta G^2(1) < 0.01$, $p = .950$, $d = 0.007$.

3.2.4 | CNI model individual-level analysis

The individual-level analysis yielded a significant effect on the *C* parameter, such that participants in the low outcome-certainty condition were significantly less sensitive to consequences than those in the high outcome-certainty condition, $t(267), = -4.07$, $p < .001$, $d = 0.495$. The experimental manipulation had no significant effect on the *N* parameter, $t(255.49) = 1.26$, $p = .207$, $d = 0.154$, and the *I* parameter, $t(267) = -0.39$, $p = .700$, $d = 0.064$.

3.2.5 | Exploratory analysis

Expanding on the exploratory analyses in Study 1, we also examined the correlations between the *C*, *N*, and *I* parameters that were aggregated at the individual-level and mean subjective likelihood scores. None of the three CNI model parameters significantly correlated with mean subjective likelihood (Table 5).

3.3 | Discussion

The experimental effect of outcome uncertainty on sensitivity to consequences replicated in Study 2, such that those in the low outcome-certainty condition were less sensitive to consequences than those in the high outcome-certainty condition. Yet, this effect did not seem to be driven by subjective likelihood, given the non-significance of the between-group difference in the manipulation check. When phrased as subjective likelihood, the manipulation-check measure was also not associated with sensitivity to moral norms, unlike the significant association between subjective certainty and sensitivity to moral norms in Study 1. Collectively, the findings of Studies 1 and 2 suggest that (1) outcome uncertainty reduces sensitivity to consequences; (2) subjective uncertainty, but not low subjective likelihood, is associated with stronger sensitivity to moral norms; and (3) neither ratings of subjective certainty nor ratings of subjective likelihood capture the psychological state that mediates the effect of outcome uncertainty on sensitivity to consequences. The purpose of Study 3 was to further address the issue raised in the third point. To this end, Study 3 introduced a new manipulation check assessing affective feelings of general state uncertainty.

4 | STUDY 3

The two goals of Study 3 were to (1) replicate the experimental effect on sensitivity to consequences found in the prior two studies and (2) examine if affective feelings of general state uncertainty better account for this effect than subjective certainty and subjective likelihood. The design, procedures and data analytic plan were preregistered prior to data collection at https://osf.io/gmbhy.

4.1 | Method

4.1.1 | Design and participants

Study 3 adopted the same between-subjects design as the previous two studies. The sample-size rationale was identical to Study 1. Of the 330 participants who completed the study, 60 failed the attention check (18.2%), leaving us with a final sample of 270 participants ($n = 141$ in the high outcome-certainty condition, $n = 129$ in the low outcome-certainty condition). Based on the smallest effect sizes obtained in the previous two studies, this sample provides a power of 98.4% in replicating the observed effect on the *C* parameter in the group-level analysis and a power of 98.2% in replicating the observed effect on the *C* parameter in the individual-level analysis (two-tailed). The final sample's demographic breakdown is as follows: 179 female, 86 male, 3 other and 2 preferred not to answer; $M_{age} = 34.97$, $SD_{age} = 11.17$; 82.2% identified as being ethnically White, 1.5% as Hispanic, Latino, or Spanish origin, 3.0% as Black, 11.9% as Asian, 0.4% as American Indian or Alaska Native, 1.5% as Middle Eastern or North African and 1.5% as other ethnicities.

4.1.2 | Procedure and measures

The procedure of Study 3 was identical to that of Study 1, the only difference being the inclusion of an additional manipulation-check measure. Study 3 thus included two manipulation-checks. The first was the same measure of subjective certainty used in Study 1, wherein participants completed the subjective certainty item after each of the 36 dilemmas. The second manipulation check included in Study 3 was a measure of general state uncertainty, which participants completed after responding to the entire battery of moral dilemmas. The instructions for the general state uncertainty measure were as follows: '*This next section consists of a number of words that describe feelings and emotions. Please read each item and indicate to what extent you are feeling this way right now*'. The general state uncertainty measure comprised six items presented in the following fixed random order: '*uncertain*', '*confident*', '*unsure*', '*certain*', '*unconfident*', and '*sure*'. Participants responded using a 5-point scale ranging from 1 ('*not at all*') to 5 ('*extremely*').

4.1.3 | Data aggregation and analysis

The same manipulation-check analysis, traditional analysis, CNI model group-level aggregate analysis and CNI model individual-level aggregate analysis were preregistered for Study 3. To assess the reliability of the significant negative correlation between the individual-level *N* parameter estimate and subjective certainty that we found in the exploratory analyses of Study 1, we preregistered additional correlational analyses testing associations between subjective certainty and the three individual-level *C*, *N*, and *I* parameter estimates. The same data exclusion criteria were used for the third study. For the additional manipulation-check measure, the items 'sure', 'confident', and 'certain' were reverse-coded such that higher scores reflect greater general state uncertainty. Participants' responses to the six general state uncertainty items were then summed and subjected to an independent samples *t*-test with condition as the predictor variable.

4.2 | Results

Means and 95% confidence intervals for the manipulation-check measures, four moral dilemma action (vs. inaction) indices, and CNI model parameters are presented in Table 6.

4.2.1 | Manipulation check

No significant difference in general state uncertainty (Cronbach's $\alpha = .88$) was found between the two conditions, $t(268) = -0.22$, $p = .827$, $d = 0.027$. Consistent with Study 1, a marginal difference was found for subjective certainty (Cronbach's $\alpha = .96$), such that participants in the low outcome-certainty condition ($M = 4.50$, $SD = 1.01$) tended to be less certain of the dilemma decision outcomes than those in the high outcome-certainty condition ($M = 4.71$, $SD = 0.83$), $t(268) = -1.79$, $p = .074$, $d = 0.218$.

4.2.2 | Traditional analysis

Consistent with Studies 1 and 2 as well as prior research (Kortenkamp & Moore, 2014), participants in the high outcome-certainty condition ($M = 3.63$, $SD = 1.94$) were more likely to endorse action over inaction on traditional dilemmas than those in the low outcome-certainty condition ($M = 2.90$, $SD = 1.84$), $t(268) = -3.17$, $p = .002$, $d = 0.385$.

4.2.3 | CNI model group-level analysis

Unlike the previous two studies, the CNI model did not fit the data well for the group-level analysis, $G^2(2) = 9.12$, $p = .010$, $w = 0.031$. However, because the effect size of the obtained discrepancy between predicted and observed data fell below Cohen's (1988) benchmark for a small effect ($w = 0.1$), we proceeded to test the hypotheses using the group-level analytical method. As in Studies 1 and 2, constraining the model such that the *C* parameter was equivalent across the two conditions again led to a statistically significant reduction in model fit, $\Delta G^2(1) = 21.86$, $p < .001$, $d = 0.568$, indicating that participants in the low outcome-certainty condition showed weaker sensitivity to consequences than participants in the high outcome-certainty condition. No significant group difference was detected for the *N* parameter, $\Delta G^2(1) = 2.15$, $p = .143$, $d = 0.177$, and the *I* parameter, $\Delta G^2(1) = 3.27$, $p = .070$, $d = 0.219$.

4.2.4 | CNI model individual-level analysis

Consistent with the prior studies, the individual-level analysis yielded a significant effect on the *C* parameter, $t(268), = -4.24$, $p < .001$, $d = 0.515$, indicating that participants in the low outcome-certainty condition were significantly less sensitive to consequences than those in the high outcome-certainty condition. The independent samples *t*-tests did not yield statistically significant differences on the *N* parameter, $t(266.01) = .611$, $p = .542$, $d = 0.074$, and the *I* parameter, $t(264.88) = 1.68$, $p = .094$, $d = 0.202$.

4.2.5 | Correlational analysis

Consistent with Study 1, a significant negative correlation was found between the individual-level *N* parameter estimate and mean subjective certainty (Table 7). In other words, the less certain the outcomes were perceived to be, the more sensitive participants were to moral norms. Individual-level estimates for the *C* and the *I* parameters were not significantly correlated with subjective certainty. General state uncertainty was not significantly correlated with any of the three parameters.

TABLE 6 Means and 95% confidence intervals of the manipulation check, moral dilemma action (vs. inaction) indices, and CNI model parameters as a function of outcome certainty (High vs. Low), Study 3.

	High outcome certainty ($n = 141$)		Low outcome certainty ($n = 129$)	
	M	95% CI	*M*	95% CI
Manipulation checks				
Subjective certainty	4.71	[4.57, 4.84]	4.50	[4.33, 4.68]
State uncertainty	18.69	[17.91, 19.48]	18.56	[17.59, 19.53]
Moral dilemma indices				
Proscriptive norm prohibits action				
Benefits of action > costs	3.63	[3.31, 3.95]	2.90	[2.58, 3.22]
Benefits of action < costs	1.29	[1.04, 1.54]	1.14	[0.92, 1.36]
Prescriptive norm prescribes action				
Benefits of action > costs	7.46	[7.25, 7.67]	7.22	[7.01, 7.43]
Benefits of action < costs	4.52	[4.23, 4.80]	5.17	[4.89, 5.45]
CNI model parameters (group)				
C parameter	0.29	[0.27, 0.32]	0.21	[0.19, 0.23]
N parameter	0.55	[0.52, 0.59]	0.59	[0.55, 0.62]
I parameter	0.58	[0.54, 0.62]	0.63	[0.59, 0.66]
CNI model parameters (individual)				
C parameter	0.29	[0.27, 0.32]	0.21	[0.18, 0.24]
N parameter	0.57	[0.52, 0.62]	0.59	[0.54, 0.63]
I parameter	0.64	[0.59, 0.70]	0.70	[0.66, 0.75]

Note: Moral dilemma indices scores can range from 0 to 9.

TABLE 7 Correlations between individual-level CNI model parameters, mean subjective certainty, and mean state uncertainty (Study 3).

	C parameter	*N* parameter	*I* parameter	Mean subjective certainty	α	Inter-item correlation
C parameter	1				.51	.39
N parameter	−0.01	1			.38	.24
I parameter	0.12	0.33***	1		.34	.21
Mean subjective certainty	0.03	−0.17**	−0.10	1	.96	.38
Mean state uncertainty	−0.03	0.02	0.10	−0.34***	0.89	0.56

Note: To obtain the internal consistency estimates, we split participants' responses to the moral dilemmas into two test-halves (odd-numbered and even-numbered dilemmas) and estimated two sets of CNI parameter scores.
*$p < .05$.
**$p < .01$.
***$p < .001$.

4.3 | Discussion

The results of Study 3 replicate the findings of Studies 1 and 2, in that both the group-level and individual-level analyses revealed a significant effect of outcome certainty on sensitivity to consequences. The negative correlation between the *N* parameter and subjective certainty obtained in Study 1 was also replicated, indicating that participants were more sensitive to moral norms when they perceived the outcomes of the moral dilemmas to be less certain. General state uncertainty did not seem to function as a potential avenue through which the experimental manipulation had influenced sensitivity to consequences, as neither the experimental effect on general state uncertainty nor the association between general state uncertainty and the *C* parameter were statistically significant.

5 | STUDY 4

Participants in the first three studies were asked if they would perform the described actions. Expanding on evidence that hypothetical action choices differ from judgments about whether the described actions are morally acceptable (e.g., Tassy et al., 2013), Study 4 investigated

whether the effect on outcome certainty on moral-dilemma judgments is modulated by judgment type (i.e., action vs. acceptability). To this end, Study 4 included a manipulation of judgment type in addition to the manipulation of outcome certainty. Based on the findings of Studies 1–3, we hypothesised that participants in the low-certainty condition would show a significantly weaker sensitivity to consequences on the *C* parameter compared to those in the high-certainty condition (Hypothesis 1a), and we expected this effect to replicate regardless of whether the moral-dilemma question pertains to action choices (Hypothesis 1b) or the acceptability of actions (Hypothesis 1c). We also expected to replicate the negative association between subjective certainty and sensitivity to moral norms (Hypothesis 2a) and investigated whether this association emerges regardless of whether the moral-dilemma question pertains to action choices (Hypothesis 2b) or the acceptability of actions (Hypothesis 2c). Consistent with prior findings indicating that people are more sensitive to moral norms when judging the acceptability of actions than when they make action choices (Gawronski et al., 2017; Körner et al., 2020), we further hypothesised that participants in the acceptability condition would show a significantly stronger sensitivity to moral norms on the *N* parameter than those in the action condition (Hypothesis 3). Finally, consistent with prior findings indicating that people show a stronger general preference for inaction when they make action choices than when they judge the acceptability of actions (Gawronski et al., 2017; Körner et al., 2020), we hypothesised that participants in the action condition would show a significantly stronger general preference for inaction on the *I* parameter compared with those in the acceptability condition (Hypothesis 4). The design, procedures, and data analytic plan were preregistered prior to data collection at https://osf.io/wtg5x.

5.1 | Method

5.1.1 | Design and participants

The study used a between-subjects design with participants randomly assigned to one of four conditions that varied in terms of (1) outcome certainty (high vs. low) and (2) question frame (action vs. acceptability). We aimed to have a sample of $N = 600$ ($n = 150$ per condition), which provides 80% power for the detection of a small effect of $f = .11$ in a 2 (Outcome Certainty: low vs. high) × 2 (Question Frame: action vs. acceptability) ANOVA with an alpha level of .05 (two-tailed). Based onthe previous studies, we expected approximately 15% of the sample would fail the attention checks. Thus, to achieve our desired sample size, we oversampled and recruited 720 participants ($n = 180$ per condition). Data collection ended once 720 participants were approved for compensation. Study 4 used the same recruitment and data exclusion criteria as the previous three studies. Unlike the previous studies, we excluded the data of participants who failed any of two attention checks included in Study 4. Participants who failed both attention checks were not approved for compensation and were replaced with new participants. Participants in Study 4 were compensated $5.00.

We received 750 complete submissions, three of which were duplicate submissions from participants who had restarted the study and 26 of which had failed both attention checks and were thus replaced with new participants. One participant completed the study but did not request compensation. The total number of accepted, complete submissions was thus 721. Of this sample of 721 participants, 47 failed only the new attention check included in Study 4 (6.5%) and 86 failed only the second attention check included in all studies (11.9%), resulting in a total of 133 (18.4%) participants who were excluded from data analysis. The final sample was thus $N = 588$ participants ($n = 144$ in the high outcome-certainty and action condition; $n = 150$ in the high outcome-certainty and acceptability condition; $n = 153$ in the low outcome-certainty and action condition; $n = 141$ in the low outcome-certainty and acceptability condition). The final sample's demographic breakdown is as follows: 392 female, 186 male, 4 other, and 6 preferred not to answer; $M_{age} = 40.69$, $SD_{age} = 13.57$; 88.4% identified as being ethnically White, 0.5% as Hispanic, Latino or Spanish origin, 1.7% as Black, 7.8% as Asian, 0% as American Indian or Alaska Native, 0.9% as Middle Eastern or North African, and 2.4% as other ethnicities.

5.1.2 | Procedure and measures

The procedure of Study 4 was largely identical to that of Study 1 with two exceptions. First, besides being randomly assigned to either a low or high outcome-certainty condition, participants in Study 4 were also randomly assigned to either an action or acceptability condition. As per the previous three studies, participants in the action condition were presented with the moral dilemmas and their accompanying action question (i.e., *Would you do X in this case?*). Participants assigned to the acceptability condition read the moral dilemmas with a question on acceptability (i.e., *Is it acceptable in this case to do X?).* Second, based on concerns about potential data quality issues, Study 4 included (1) a compliance item asking participants at the beginning if they commit to providing thoughtful answers to the study questions and (2) two attention checks instead of one. The additional attention check included in Study 4 was disguised as a moral-dilemma vignette and was placed in the middle of the dilemma set. The vignette contained instructions asking participants to ignore the moral-dilemma question on that page and instead skip ahead. Participants who answered the question accompanying this dilemma were thus considered to have failed the attention check.

5.1.3 | Data aggregation and analysis

Participants' responses were aggregated in the same manner as the prior studies. We preregistered two 2 (Outcome Certainty: high vs. low) × 2 (Question Frame: action vs. acceptability) ANOVAs with (1) mean subjective certainty and (2) the traditional-dilemma score as the dependent variables. In addition, we preregistered group-level and individual-level CNI model analyses to test our focal hypotheses.

For the group-level analyses, we preregistered that we would aggregate the eight action/inaction response indices across participants within each of the four conditions. The CNI model would then be fitted to these aggregated moral-dilemma indices to estimate the *C*, *N*, and *I* parameters for each condition. With four experimental conditions, the model has a total of 16 free categories (i.e., four types of dilemmas for each of the four conditions) and 12 parameters (i.e., three parameters estimated for each of the four conditions), resulting in four degrees of freedom. To test Hypotheses 1, 3, and 4, we preregistered that we would constrain estimates for a given parameter to be equal across specific conditions, and then compare the new model fit against the fit of the baseline model. To test Hypothesis 1a, we preregistered that we would constrain estimates for the *C* parameter to be equal across certainty groups within both the action condition and acceptability condition, respectively (i.e., comparing the baseline model to a model where we constrain the action condition's $C_{\text{high certainty}} = C_{\text{low certainty}}$ and the acceptability condition's $C_{\text{high certainty}} = C_{\text{low certainty}}$). To test Hypothesis 1b, we preregistered that we would constrain estimates for the *C* parameter to be equal across certainty groups within the action condition (i.e., the action condition's $C_{\text{high certainty}} = C_{\text{low certainty}}$). To test Hypothesis 1c, we preregistered that we would constrain estimates for the *C* parameter to be equal across certainty groups within the acceptability condition (i.e., the acceptability condition's $C_{\text{high certainty}} = C_{\text{low certainty}}$). To test Hypothesis 3, we preregistered that we would constrain estimates for the *N* parameter to be equal across framing groups within the low-certainty condition and within the high-certainty condition, respectively. To test Hypothesis 4, we preregistered that we would constrain estimates for the *I* parameter to be equal across framing groups within the low-certainty condition and within the high-certainty condition, respectively.

To assess potential interactions between outcome certainty and question frame, we preregistered that we would first test the effect of outcome certainty within the action condition by constraining estimates for a given parameter to be equal across outcome-certainty conditions within the action condition and comparing the fit of the constrained model against the fit of the baseline model. Next, we tested the effect of outcome certainty within the acceptability condition by constraining estimates for a given parameter to be equal across outcome-certainty conditions within the acceptability condition and compared the fit of the constrained model against the fit of the baseline model. We then calculated the difference between the ΔG^2 value obtained for the effect of outcome certainty within the action condition and the ΔG^2 value obtained for the effect of outcome certainty within the acceptability condition, which provides the ΔG^2 value for the difference in the effect of outcome certainty across question-frame conditions.

Consistent with the prior three studies, we also analysed the individual-level CNI model parameters to test the robustness of the obtained results across data analytic approaches. To this end, we preregistered that we would conduct 2 (Outcome Certainty: low vs. high) × 2 (Question Frame: action vs. acceptability) ANOVAs to determine whether individual-level estimates for each model parameter differed across outcome-certainty conditions and if question framing moderated the effects of outcome certainty. Follow-up independent samples *t*-tests were conducted to test effects of outcome certainty within the action condition and the acceptability condition, respectively. Hypothesis 1a would be confirmed by a significant main effect of outcome certainty on the *C* parameter, with higher *C* scores in the high-certainty condition compared to the low-certainty condition. Hypothesis 1b would be confirmed by a significant effect of outcome certainty on the *C* parameter within the action condition, with higher *C* scores in the high-certainty condition compared to the low-certainty condition. Hypothesis 1c would be confirmed by a significant effect of outcome certainty on the *C* parameter within the acceptability condition, with higher *C* scores in the high-certainty condition compared to the low-certainty condition. Hypothesis 3 would be confirmed by a significant main effect of question frame on the *N* parameter, with higher *N* scores in the acceptability condition compared to the action condition. Hypothesis 4 would be confirmed by a significant main effect of question frame on the *I* parameter, with higher *I* scores in the action condition compared to the acceptability condition.

To test Hypotheses 2a–2c, we examined the correlations between individual-level *N* parameter scores and subjective certainty across question-framing conditions (Hypothesis 2a), within the action condition (Hypothesis 2b), and within the acceptability condition (Hypothesis 2c). Each hypothesis would be confirmed by a significant negative correlation between subjective certainty and *N* parameter scores.

5.2 | Results

Means and 95% confidence intervals for the manipulation check measures, four moral dilemma action (vs. inaction) indices, and CNI model parameters are presented in Table 8.

5.2.1 | Manipulation check

Unlike Studies 1 and 3, which found only a marginal effect of outcome certainty on subjective certainty, the 2 (Outcome Certainty: low vs. high) × 2 (Question Frame: action vs. acceptability) ANOVA revealed a significant main effect of outcome certainty on subjective certainty (Cronbach's $\alpha = .96$), $F(1, 584) = 7.70$, $p = .006$, $\eta_p^2 = 0.013$, indicating that participants in the low outcome-certainty condition ($M = 4.58$, $SD = 0.97$) were less certain of the dilemma decision outcomes than those in the high outcome-certainty condition ($M = 4.79$, $SD = 0.91$). Follow-up independent samples *t*-tests suggest that the difference in subjective certainty emerged between the low and high outcome-certainty conditions only in the acceptability condition, $t(289) = -2.68$, $p = .008$, $d = 0.314$, but not in the action condition, $t(295) = -1.29$, $p = .197$, $d = 0.150$. There was, however, no main effect of question frame and the interaction between question frame and outcome certainty did not reach statistical significance ($Fs \leq .79$, $ps > .374$).

TABLE 8 Means and 95% confidence intervals of the manipulation check, moral dilemma action (vs. inaction) indices, and CNI model parameters as a function of question frame (Action vs. Acceptability) and outcome certainty (High vs. Low), Study 4.

	Action ($n = 297$)				Acceptability ($n = 291$)			
	High outcome certainty ($n = 144$)		Low outcome certainty ($n = 153$)		High outcome certainty ($n = 150$)		Low outcome certainty ($n = 141$)	
	M	95% CI	*M*	95% CI	*M*	95% CI	*M*	95% CI
Manipulation check								
Subjective certainty	4.74	[4.59, 4.90]	4.60	[4.43, 4.76]	4.84	[4.69, 4.99]	4.56	[4.41, 4.71]
Moral dilemma indices								
Proscriptive norm prohibits action								
Benefits of action > costs	3.41	[3.01, 3.73]	2.69	[2.43, 2.95]	3.43	[3.11, 3.76]	2.94	[2.65, 3.23]
Benefits of action < costs	0.91	[0.71, 1.11]	0.98	[0.79, 1.17]	0.89	[0.72, 1.06]	1.16	[0.97, 1.36]
Prescriptive norm prescribes action								
Benefits of action > costs	7.33	[7.11, 7.54]	7.43	[7.23, 7.64]	7.75	[7.58, 7.92]	7.55	[7.37, 7.73]
Benefits of action < costs	4.60	[4.33, 4.88]	5.35	[5.10, 5.59]	5.25	[4.96, 5.53]	5.82	[5.56, 6.08]
CNI model parameters (group)								
C parameter	0.29	[0.27, 0.31]	0.21	[0.19, 0.23]	0.28	[0.26, 0.30]	0.20	[0.17, 0.22]
N parameter	0.59	[0.56, 0.62]	0.64	[0.61, 0.67]	0.67	[0.64, 0.70]	0.64	[0.61, 0.67]
I parameter	0.66	[0.62, 0.70]	0.64	[0.60, 0.68]	0.58	[0.54, 0.63]	0.55	[0.51, 0.59]
CNI model parameters (individual)								
C parameter	0.29	[0.26, 0.32]	0.21	[0.19, 0.23]	0.28	[0.25, 0.30]	0.20	[0.18, 0.22]
N parameter	0.60	[0.55, 0.65]	0.65	[0.61, 0.70]	0.65	[0.60, 0.70]	0.65	[0.60, 0.69]
I parameter	0.70	[0.65, 0.76]	0.68	[0.63, 0.73]	0.65	[0.59, 0.70]	0.58	[0.54, 0.63]

Note: Moral dilemma indices scores can range from 0 to 9.

5.2.2 | Traditional analysis

Consistent with the previous three studies as well as prior research (Kortenkamp & Moore, 2014), there was a significant main effect of outcome certainty on endorsements of action over inaction in the traditional dilemmas, $F(1, 584) = 15.81$, $p < .001$, $\eta_p^2 = 0.026$. Specifically, participants in the high outcome-certainty condition ($M = 3.42$, $SD = 1.98$) were more likely to endorse action over inaction on traditional dilemmas than those in the low outcome-certainty condition ($M = 2.81$, $SD = 1.69$). Independent samples *t*-tests further revealed that the difference in endorsements of action over inaction in the traditional dilemmas between the low and high outcome-certainty conditions emerged for both acceptability judgments, $t(287.32) = -2.22$, $p = .027$, $d = 0.259$, and action judgments, $t(279.50) = -3.43$, $p < .001$, $d = 0.399$. There was no main effect of question frame and question frame did not qualify the main effect of outcome certainty (*F*s < .82, *p*s > .367).

5.2.3 | CNI model group-level analysis

The CNI model fit the data well, $G^2(4) = 4.59$, $p = .332$, $w = 0.015$. Confirming Hypothesis 1a, participants in the low outcome-certainty condition showed weaker sensitivity to consequences than participants in the high outcome-certainty condition, $\Delta G^2(2) = 51.81$, $p < .001$, $w = 0.049$. Confirming Hypotheses 1b and 1c, this difference emerged for both action judgments, $\Delta G^2(1) = 24.23$, $p < .001$, $d = 0.572$, and acceptability judgments, $\Delta G^2(1) = 27.59$, $p < .001$, $d = 0.615$. Question frame did not significantly qualify the effect of outcome certainty, $\Delta G^2(1) = 3.36$, $p = .067$, $w = 0.013$. Sensitivity to consequences did not significantly differ across question-frame conditions, $\Delta G^2(2) = 0.94$, $p = .624$, $w = 0.001$.

For sensitivity to moral norms, constraining the *N* parameter to be equivalent across certainty conditions within the moral action condition and within the moral acceptability condition significantly worsened the model fit, $\Delta G^2(2) = 6.32$, $p = .043$, $w = 0.017$, indicating that participants in the low outcome-certainty condition showed a stronger sensitivity to moral norms than participants in the high outcome-certainty condition. The difference between the ΔG^2 values obtained for the effect of outcome certainty across the moral action and moral acceptability conditions suggested that question frame did not qualify the effect of outcome certainty, $\Delta G^2(1) = 2.30$, $p = .129$, $w = 0.010$. Confirming Hypothesis 3, sensitivity to moral norms was stronger for acceptability judgments than action judgments, $\Delta G^2(2) = 12.05$, $p = .002$, $w = 0.024$. However, the effect of question frame was qualified by outcome certainty, $\Delta G^2(1) = 12.03$, $p < .001$, $w = 0.023$, with norm sensitivity differing between the action and acceptability conditions in the high certainty condition, $\Delta G^2(1) = 12.04$, $p < .001$, $d = 0.404$, but not thelow certainty condition, $\Delta G^2(1) = 0.01$, $p = .921$, $d = 0.012$.

TABLE 9 Correlations between individual-level CNI model parameters and mean subjective certainty (Study 4).

		C parameter	*N* parameter	*I* parameter	α	Inter-item correlation
Across Question Frames (*N* = 588)	*C* parameter	1			.38	.26
	N parameter	−0.07	1		.45	.29
	I parameter	0.00	0.20**	1	.26	.15
	Mean subjective certainty	0.05	−0.10*	0.03	.96	.38
Action (*n* = 297)	*C* parameter	1				
	N parameter	0.00	1			
	I parameter	−0.01	0.21**	1		
	Mean subjective certainty	0.03	−0.02	0.03		
Acceptability (*n* = 291)	*C* parameter	1				
	N parameter	−0.14*	1			
	I parameter	0.01	0.21**	1		
	Mean subjective certainty	0.07	−0.19**	0.02		

Note: To obtain the internal consistency estimates, we split participants' responses to the moral dilemmas into two test-halves (odd-numbered and even-numbered dilemmas) and estimated two sets of CNI parameter scores.
*$p < .05$.
**$p < .01$.
***$p < .001$.

For general preference for inaction versus action, the analyses revealed no significant effect of outcome certainty, $\Delta G^2(2) = 1.84$, $p = .398$, $w = 0.009$, and the effect of outcome certainty did not depend on question frame, $\Delta G^2(1) = 0.49$, $p = .484$, $w = 0.005$. Confirming Hypothesis 4, general preference for inaction versus action was stronger for action judgments than acceptability judgments, $\Delta G^2(2) = 18.25$, $p < .001$, $w = 0.029$. Outcome certainty did not qualify this effect, $\Delta G^2(1) = 3.49$, $p = .062$, $w = 0.013$, with participants showing a stronger general preference for inaction versus action in the action condition than the acceptability condition regardless of certainty levels, $\Delta G^2(1)$s > 7.38, ps < .001, ds > 0.315.

5.2.4 | CNI model individual-level analysis

Confirming Hypothesis 1a, the 2 (Outcome Certainty: high vs. low) × 2 (Question Frame: action vs. acceptability) ANOVA yielded a significant main effect of outcome certainty on the *C* parameter, $F(1, 584) = 37.06$, $p < .001$, $\eta_p^2 = 0.060$, indicating that participants in the low outcome-certainty condition ($M = 0.21$, $SD = 0.14$) were significantly less sensitive to consequences than those in the high outcome-certainty condition ($M = 0.28$, $SD = 0.17$).[2] Confirming Hypotheses 1b and 1c, this difference emerged within the action condition, $t(272.10) = -4.43$, $p < .001$, $d = 0.516$, and within the acceptability condition, $t(285.44) = -4.18$, $p < .001$, $d = 0.486$. The main effect of question frame and the interaction between question frame and outcome certainty were not statistically significant (Fs < .98, ps > .32).

For sensitivity to moral norms, the 2 (Outcome Certainty: high vs. low) × 2 (Question Frame: action vs. acceptability) ANOVA did not yield any significant main or interaction effects (Fs < 1.77, ps > .18). Disconfirming Hypothesis 3, participants did not show stronger sensitivity to moral norms for acceptability judgments than action judgments, $F(1, 584) = 0.86$, $p = .355$, $\eta_p^2 = 0.001$.

For general preference for inaction versus action, the 2 (Outcome Certainty: high vs. low) × 2 (Question Frame: action vs. acceptability) ANOVA yielded a significant main effect of question frame, $F(1, 584) = 8.69$, $p = .003$, $\eta_p^2 = 0.015$. Confirming Hypothesis 4, participants in the acceptability condition ($M = 0.62$, $SD = 0.31$) showed a significantly weaker general preference for inaction versus action than those in the action condition ($M = 0.69$, $SD = 0.33$). The main effect of outcome certainty and the interaction between question frame and outcome certainty were not statistically significant (Fs < 2.61, ps > .11).

5.2.5 | Correlational analysis

Correlations between individual-level estimates of the three CNI model parameters and subjective certainty are provided in Table 9. Confirming Hypothesis 2a, individual-level *N* parameter estimates showed a significant negative correlation with subjective certainty across question-frame conditions. However, when analysed separately for the two question-frame conditions, the correlation reached statistical significance only within the acceptability condition but not the action condition, thus supporting Hypothesis

[2] Because the Levene's test indicated unequal variances for the analyses on the *C* parameter, $F(3, 584) = 3.66$, $p = .012$, and *I* parameter, $F(3, 584) = 2.71$, $p = .045$, we re-ran the analyses using a bootstrapped sample of 10,000, which did not produce any results inconsistent with the original analyses.

2c but not Hypothesis 2b. Individual-level estimates for the *C* and the *I* parameters were not significantly correlated with subjective certainty.

5.3 | Discussion

Replicating the experimental effect of outcome certainty found in the previous three studies, Study 4 revealed that participants in the high outcome-certainty condition were significantly more sensitive to consequences than those in the low outcome-certainty condition (confirming Hypothesis 1a), and this effect emerged regardless of whether participants were asked to judge if they would perform the described actions (confirming Hypothesis 1b) or if they deem the described actions acceptable (confirming Hypothesis 1c). The results pertaining to sensitivity to moral norms were less robust, with the group-level analysis suggesting a potential experimental effect of outcome certainty whereas the individual-level analysis did not. Consistent with the results of Studies 1 and 3, Study 4 yielded a significant negative correlation between subjective certainty and sensitivity to moral norms (confirming Hypothesis 2a). However, when analysed separately for the two question-framing conditions, this correlation was statistically significant only within the acceptability condition (confirming Hypothesis 2c) but not the action condition (disconfirming Hypothesis 2b). The effect of question frame on norm sensitivity remained unclear, in that sensitivity to moral norms was greater in the acceptability condition than the action condition in the group-level but not individual-level analysis (rendering the evidence regarding Hypothesis 3 inconclusive). Yet, a reliable effect of question frame emerged for the *I* parameter, such that participants in the action condition showed a greater general preference for inaction versus action than those in the acceptability condition (confirming Hypothesis 4). Together, these results corroborate the conclusion that outcome certainty influences moral-dilemma judgments via sensitivity to consequences, and they further demonstrate the generality of this effect across question frames.

6 | INTERNAL META-ANALYSIS

To obtain an estimate of the average size of the effects of outcome certainty across studies, we conducted an internal meta-analysis. Given that the procedures and methods were largely identical across the four studies, we conducted the internal meta-analysis using a fixed-effects method. The internal meta-analysis was conducted using the R package metafor version 3.8-1 (Viechtbauer, 2010).

The results of the internal meta-analysis are presented in Figure 2. The analysis yielded medium-size effects for the group-level *C* parameter, $Z = 10.57$, $p < .0001$, $d = 0.577$, 95% CI [0.47, 0.68], and individual-level *C* parameter, $Z = 9.48$, $p < .0001$, $d = 0.515$, 95% CI [0.41, 0.62], suggesting a robust experimental effect of outcome-certainty on sensitivity to consequences regardless of analytic approach. For the *N* parameter, the meta-analytic effect fell below the conventional benchmark for a small effect for the group-level approach, $Z = -2.20$, $p = .028$, $d = -0.118$, 95% CI [−0.22, −0.01], and the individual-level approach, $Z = -2.00$, $p = .046$, $d = -0.107$, 95% CI [−0.21, −0.00].[3] Lastly, for the *I* parameter, the internal meta-analysis yielded a null effect for both the group-level approach, $Z = 1.02$, $p = .309$, $d = 0.055$, 95% CI [−0.05, 0.16], and the individual-level approach, $Z = 1.10$, $p = .273$, $d = 0.059$, 95% CI [−0.05, 0.16].

7 | GENERAL DISCUSSION

Previous research using the traditional dilemma approach suggests that people make fewer utilitarian choices when the outcomes in moral dilemmas are uncertain (Kortenkamp & Moore, 2014). However, given the limitations inherent to the traditional moral-dilemma paradigm, the mechanism underlying these findings remains unclear. The objective of the current research was to investigate the processes by which uncertainty shapes moral choices. Towards this end, we used a battery of moral dilemmas that included scenarios wherein (1) the benefits of the action were either greater or smaller than the costs and (2) the moral norm violated by a given choice was either proscriptive or prescriptive in nature. Outcome certainty was experimentally manipulated using deterministic versus probabilistic language, with moral dilemmas phrased with the modal verbs 'will' versus 'might' in the high outcome-certainty and low outcome-certainty conditions, respectively (see Kortenkamp & Moore, 2014). Using the CNI model of moral decision-making (Gawronski et al., 2017), we examined if outcome certainty shapes moral-dilemma responses through (1) sensitivity to consequences, (2) sensitivity to moral norms, or (3) general preference for inaction versus action. To verify the psychological effects induced by the experimental manipulation, we included manipulation-check measures capturing subjective certainty, subjective likelihood, and general state uncertainty.

The first route tested in the current research was that uncertainty influences moral choices via discounting of cost-benefit ratios. In the CNI model of moral decision-making, a generalised discounting of cost-benefit ratios under uncertainty would be captured by a weaker sensitivity to consequences on the CNI model's *C* parameter. The current findings garnered support for this hypothesis. Across four studies, a robust effect on sensitivity to consequences emerged and this effect replicated across two analytical methods with Cohen's *d*s > 0.5 (see Figure 2). Specifically, when moral dilemmas were phrased with greater uncertainty about outcomes, participants were less sensitive to whether the benefits associated with the action were greater or smaller than the costs, and this effect emerged regardless of whether participants were asked to judge if they would perform the described actions or if they deem the described actions acceptable.

The second route tested in the current research was that uncertainty influences moral choices via enhanced reliance on rules as a means to reduce uncertainty. In the CNI model of moral

[3] To avoid false-positives, we re-analysed the borderline meta-analytic effect on the *N* parameter using a random effects approach, which yielded the same effect for the individual-level approach, $Z = -2.00$, $p = .046$, $d = -0.107$, 95% CI [−0.21, −0.00], but a null effect for the group-level approach, $Z = -1.48$, $p = .138$, $d = -0.119$, 95% CI [−0.28, 0.04].

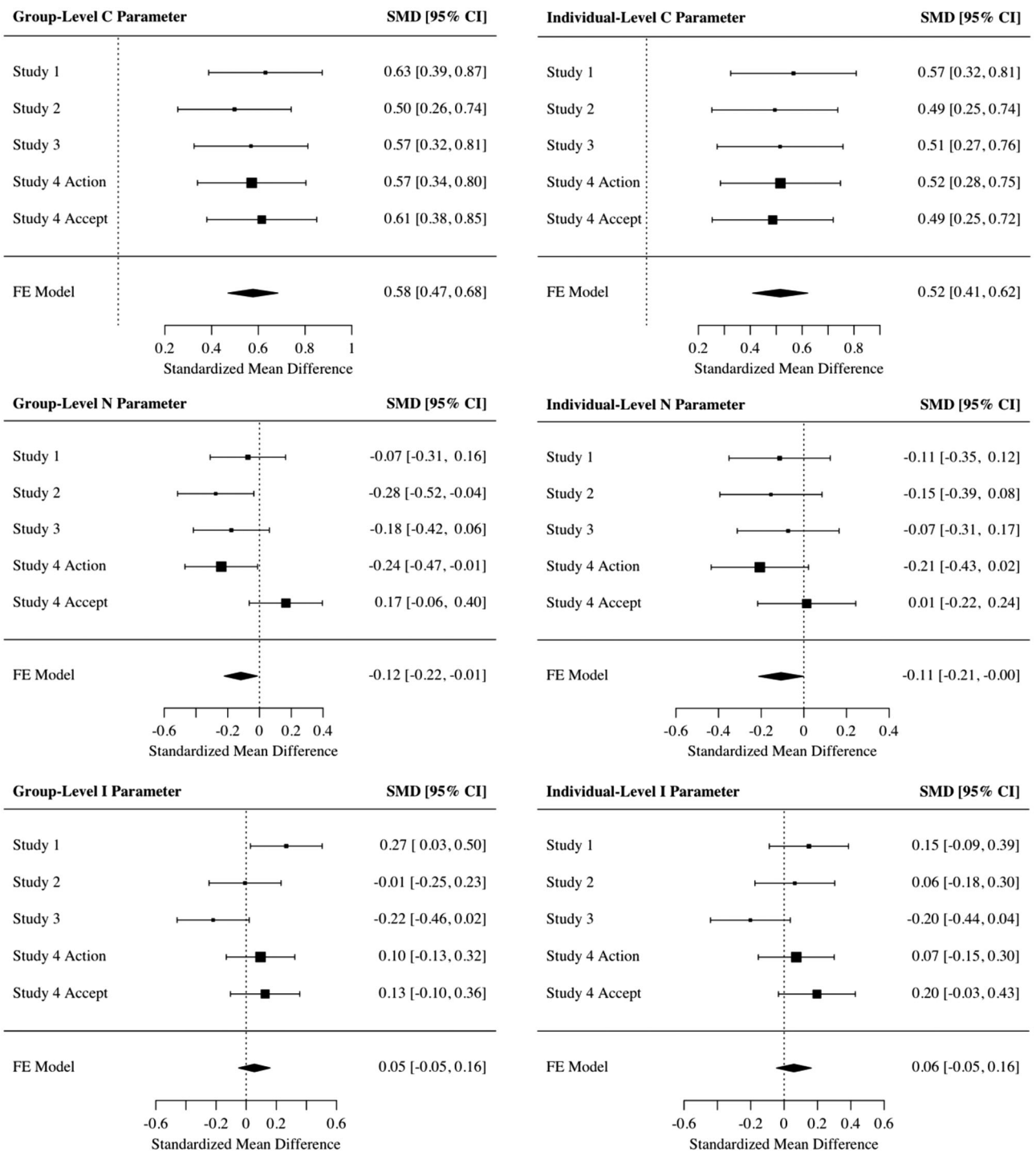

FIGURE 2 Forest plots of standardised differences in the CNI model parameters as a function of outcome certainty. Left and right panels depict the results of the group-level and individual-level analytic approaches, respectively. Effects are depicted as Cohen's *d*. Error bars indicate 95% confidence intervals. FE = fixed effects; SMD = standardised mean difference.

decision-making, a heightened reliance on rules under uncertainty would be captured by a stronger sensitivity to moral norms on the CNI model's *N* parameter. In comparison to the robust effects on the *C* parameter, the effects of uncertainty on sensitivity to moral norms remains unclear. There was no reliable experimental effect on the *N* parameter across the four experiments and two analytic approaches. Moreover, although subjective uncertainty was negatively associated with norm sensitivity in Studies 1 and 3, Study 4 replicated this association only for acceptability judgments but not action judgments. The current studies thus do not provide robust evidence that uncertainty influences moral-dilemma responses via enhanced reliance on rules to reduce uncertainty. Future research should further clarify

potential links between subjective uncertainty and norm sensitivity in moral-dilemma responses.

The third route tested in the current research was that uncertainty influences moral choices through omission bias. Because harm caused by commission is often perceived to be worse than harm caused by omission, enhanced concerns about potential losses under uncertainty may trigger a generalised preference for inaction regardless of cost-benefit ratios and whether the norm governing the action is proscriptive or prescriptive in nature, thereby strengthening omission bias tendencies. Alternatively, uncertainty may reduce feelings of responsibility for potential losses, thereby attenuating omission bias tendencies. Such decision-making patterns would be captured by the CNI model's *I* parameter (i.e., general preference for inaction vs. action). Given the null experimental effects of outcome certainty and the absence of significant associations with the manipulation-check measures, the current research suggests that under uncertainty people do not exhibit a stereotypic response pattern that conforms to either of the two omission bias predictions.

7.1 | Outcome uncertainty versus psychological uncertainty

Because psychological uncertainty can manifest in various forms (e.g., uncertainty in dilemma outcomes, general feelings of uncertainty) and the research from which we adapted our experimental manipulation did not include manipulation checks (Kortenkamp & Moore, 2014), we sought to verify the precise psychological effects the experimental manipulation had on participants. In the current research, there was no evidence that the experimental effect of outcome certainty on sensitivity to consequences was driven by subjective likelihood (Study 2) or general state uncertainty (Study 3), given the non-significant between-group differences and correlations. Although we found marginal effects of outcome certainty on subjective certainty (Studies 1, 3, and 4), subjective certainty was not significantly correlated with sensitivity to consequences in any of the current studies. Because effects of a given manipulation on a proximal mediator measured with high reliability (here: subjective certainty) should be stronger, not weaker, than effects of that manipulation on a distal criterion measured with low reliability (here: sensitivity to consequences), and because a proposed mediator should be systematically related to the criterion, it seems highly unlikely that the observed pattern of results is due to low statistical power, especially if one considers the relatively strong effects on sensitivity to consequences (see Figure 2). Thus, further research investigating the psychological states that mediate the effect of outcome uncertainty on sensitivity to consequences is warranted at this stage.

More generally, the current findings underscore the importance of manipulation checks (Fiedler et al., 2021): without independent evidence corroborating the researchers' interpretation of the experimental manipulations, it would be premature to presume that the experimental manipulations had construct validity (see Shou et al., 2020). Yet, one procedural limitation of the current research ironically pertains to the inclusion of the manipulation checks: because the same subjective certainty (Studies 1, 3, and 4) and subjective likelihood (Study 2) manipulation-check items were always displayed after each dilemma vignette and moral-judgment question, the manipulation check could have inadvertently interfered with participants' responses to either the moral-judgment questions or the manipulation-check items themselves (Hauser et al., 2018). For example, because they were probed about how certain they were of the dilemma outcomes after making their decisions, participants' self-reported perceptions of certainty could have either been suppressed or bolstered in a bid to rationalise their responses post-hoc, much akin to a choice-supportive bias. Repeated questioning about how certain participants were could have also had a cumulative effect such that uncertainty was rendered more salient in subsequent dilemma trials than earlier ones. Future research identifying the form of psychological uncertainty that impacts sensitivity to consequences is therefore still needed.

One potential explanation for the identified experimental effect on the *C* parameter might be that our manipulation of outcome certainty influenced sensitivity to consequences through participants' overall perception of consequences. That is, participants may have perceived the described consequences as less severe when the consequences were described with probabilistic language than when they were described with deterministic language. Because such an effect should weaken the manipulation of consequences underlying the estimation of the CNI model's *C* parameter, it might render the current findings trivial. There is, however, arguably little basis for this interpretation. Overall perception of consequences is akin to expected utility, which is typically assumed to be the product of expectancy and value (e.g., Edwards, 1954). Because value was held constant across conditions (e.g., the same number of lives lost), an interpretation in terms of overall perceptions of consequences would suggest that our manipulation affected expected utility through participants' expectations about the likelihood of the described outcomes. However, as demonstrated in Study 2, subjective likelihood did not account for the experimental effect on sensitivity to consequences. It therefore seems unlikely that the identified experimental effect on sensitivity to consequences is attributable simply to participants' overall perception of consequences.

7.2 | Limitations

Real-life moral dilemmas are often fraught with uncertainty, and decision-makers typically face an insurmountable challenge in ascertaining which decision option would produce the most benefits versus costs. Extant research on moral judgment and decision-making that embedded deterministic outcomes into hypothetical moral dilemmas neglected to account for this important contextual factor and thus lacks ecological validity (Bauman et al., 2014). The current research demonstrates that indeterministic and therefore more realistic moral dilemmas can produce moral judgments that are different from less realistic, deterministic dilemmas. Yet, whether our results would be generalisable beyond sacrificial moral scenarios remains unclear. The

utilitarian judgments captured by sacrificial moral dilemmas such as those used in the current studies have been claimed to solely reflect people's willingness to harm others for the greater good (i.e., instrumental harm), but not their impartial concern for the greater good (i.e., impartial beneficence; Kahane et al., 2018). Although some findings question the validity of this claim (e.g., Conway et al., 2018; Körner et al., 2020), the distinction between instrumental harm and impartial beneficence could potentially explain why utilitarian judgments in sacrificial moral scenarios only weakly translate into utilitarian judgments in non-sacrificial moral scenarios (e.g., donations; Kahane et al., 2015; Ng et al., 2022). Whether uncertainty would influence people's impartial concern for the greater good in a way that is distinct from people's willingness to harm others for the greater good remains unanswered and should be investigated to gain further clarity on how uncertainty affects utilitarian moral judgment and decision-making.

One methodological limitation worth addressing pertains to the hierarchical structure of the CNI model. Although there are conceptual reasons to include the *I* parameter at the lowest level in the processing tree (see Gawronski et al., 2017, 2020), the position of the *C* and *N* parameters are arbitrary in that a model in which the two parameters are included in reverse order (i.e., NCI) yields the same goodness-of-fit as the original CNI model. Nevertheless, estimates for the *N* and *C* parameters are different across the two models, because the parameter at the lower level is estimated conditional upon the parameter at the higher level, which could lead to different relations with the same external variable (e.g., outcome uncertainty). To address this critique, we re-analysed the current data using an alternative algorithm that algebraically calculates the three CNI model parameters concurrently rather than hierarchically (Liu & Liao, 2021). The results of these re-analyses indicate that the primary findings are independent of the CNI model's hierarchical structure, in that the experimental effect on sensitivity to consequences replicated with the alternative algorithm in all four studies (see Tables S1 to S5 in the Supplemental Materials).

Another important question pertains to aspects of some moral dilemmas used in the current set of studies. Most scenarios included in this research involved actions that would directly affect the dilemma outcomes. For example, in the organ donation dilemma (see Table 1), the focal action involves either removing (proscriptive dilemma variant) or giving (prescriptive dilemma variant) a patient a ventilator, both of which have direct implications on whether the patient survives. However, in two out of the nine scenarios used in the current studies, the focal action is not only proscribed or prescribed by moral norms of harm, but also differs in terms of whether it directly causes the outcomes (proscriptive dilemma variant) or prevents a third party from causing the outcomes (prescriptive dilemma variant). The norm manipulation for these two scenarios is thus confounded with whether one's action has direct or indirect effects on the dilemma outcomes. To address this confound, we excluded these two sets of dilemmas from the computation of the action/inaction indices and re-analysed participants' responses to the remaining seven sets of dilemmas. The results of this re-analysis converge with the primary findings, such that outcome certainty reliably influenced sensitivity to consequences (see Tables S6 and S7 in the Supplemental Materials).

7.3 | Implications

The current findings have important implications for trolley-dilemma research that compares responses to the 'impersonal' *switch* dilemma to the 'personal' *footbridge* dilemma. In both scenarios, a trolley is hurtling towards five individuals. In the switch dilemma, participants are asked if it is acceptable to pull a switch to redirect the trolley onto another track that has only one person (Foot, 1967); in the footbridge dilemma, participants are asked if it is acceptable to push a large man onto the tracks to stop the trolley (Thomson, 1985). Research comparing these two scenarios found that people show a greater preference for deontological over utilitarian judgments in the footbridge dilemma than the switch dilemma. Because the action in the footbridge dilemma involves directly pushing an individual into harm's way whereas the action in the switch dilemma merely involves pushing a switch which would then divert the trolley, the different responses in the two dilemma variants have been claimed to be driven by heightened negative emotional reactions to the idea of causing harm in the footbridge dilemma (Greene, 2007). The current research offers an alternative interpretation. As compared to the switch dilemma, there is arguably greater uncertainty about whether the act of pushing the large man onto the tracks would truly stop the trolley from killing the five individuals. If participants in past studies had perceived the footbridge dilemma to have low outcome certainty, our findings suggest that the participants would have probably discounted the cost-benefit ratios when forming their judgments. Any attenuation of utilitarian tendencies in footbridge-type dilemmas could therefore be attributed to greater outcome uncertainty rather than enhanced emotional reactions. Our findings thus pose a challenge to the widely accepted interpretation of the discrepancy between moral judgments in the switch and footbridge dilemmas.

Collectively, the results of the current research also have important implications for policymaking in times of uncertainty. When a situation is rife with uncertainty and the decision to be made involves a conflict between adherence to moral norms and maximisation of outcomes, how should policymakers go about convincing citizens that their decision is sensible? The present research suggests that placing an overt emphasis on costs and benefits when conveying the rationale for a policy may be ineffective. In the cruise ship scenario, a government's decision to refuse disembarkation may be judged immoral if the decision outcomes are uncertain and the decision is justified with the goal of preventing the virus from spreading. Likewise, the administration and mandating of COVID-19 vaccines may be deemed immoral if the decision outcomes are uncertain and vaccine campaigns solely focus on emphasising that the benefits of getting vaccinated outweigh the small risk of fatality or side effects. The current findings suggest that people are likely to discount the importance of consequences when they lack information about or understanding of the virus and vaccines, which may render utilitarian arguments referring to outcomes unpersuasive. Justifying decisions with reference to moral norms might be more effective in preventing backlash against policies during uncertain times, given that sensitivity to moral norms seems to

be unaffected by outcome uncertainty (and potentially enhanced by subjective uncertainty).

8 | CONCLUSION

By using the CNI model of moral decision-making to disentangle the effects of uncertainty on sensitivity to consequences, sensitivity to moral norms, and general preference for inaction versus action in moral-dilemma responses, the current research has clarified past findings suggesting that people show a weaker preference for utilitarian over deontological actions under uncertainty. Specifically, the results of the present research evince that people make fewer utilitarian choices under uncertainty because they discount the importance of consequences when responding to morally ambiguous situations. Alternative explanations surrounding omission bias tendencies were ruled out, but the influence of moral norms under uncertainty still requires further research for clarification.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest with respect to the research, authorship, and publication of this article.

ETHICS STATEMENT

The research was conducted in a manner consistent with the APA's ethical principles in the conduct of research with human participants.

DATA AVAILABILITY STATEMENT

All studies reported in this article were preregistered at OSF; the data and materials have been made publicly available via OSF and can be accessed at https://osf.io/hdq3x.

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SUPPORTING INFORMATION

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