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You Can't Judge Me! Virtual Observers Do Not Influence Moral Judgments in Virtual Environments

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Abstract

Prior research has shown that individuals tend to make norm-based (deontological) moral choices more frequently when observed by real humans. Our aim in this study was to explore whether this phenomenon extends to virtual observers. Sixty-two participants (39 women, 22 men and 1 non-binary) with mean age of 24.95 (SD = 5.70, age range 19–44) were presented with textual moral dilemmas, both in the presence of a virtual observer and alone. Prior to making the moral judgment, Skin Conductance Response (SCR) was recorded upon presentation of the moral dilemma in order to assess potential modulation of moral decisions by physiological arousal. Moral judgments were modulated by both the physiological arousal immediately preceding the decision and the directness of the dilemma (a personal dilemma involves direct harm; an impersonal one does not). Higher arousal was associated with more frequent utilitarian choices in personal dilemmas, but no effect in impersonal choices. We did not observe any impact of the virtual character's presence on the moral decisions, thus demonstrating the potential bounds within which a virtual character can shape human behavior.

Keywords: moral dilemmas; virtual reality; virtual observer; social influence; VR

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Introduction

The Prior Literature

Moral decisions are driven not only by rational, cognitive factors (as e.g., Kohlberg & Kramer, 1969 advocated), but also by non-rational, emotional ones. In a series of experiments, Greene et al. (2001, 2004, 2008, review 2009) observed that the type of moral dilemma matters, i.e., whether it directly (personal dilemma) or only indirectly (impersonal dilemma) causes harm, as both types involve different processes: emotional in the case of the former and cognitive in case of the latter. According to dual-process theory (Greene, 2007), emotional moral decision processing is fast and unconscious, leading to deontological (norm-based) decisions. On the contrary, controlled cognitive processes are characterized by a slow response and result in utilitarian (consequence-based) decisions. This distinction leads to different frequencies of certain moral judgments: deontological decisions are more frequent in personal than in impersonal dilemmas (Lee et al., 2018).

Recent studies show that not only internal emotional or cognitive factors play a role in moral decision-making, but also contextual ones. In the study of Lee et al. (2018), participants responded to a series of moral dilemmas (personal, impersonal and non-moral) with and without human observers present. Presence of a human observer increased the probability of deontological moral decision-making, decreased confidence in the judgment, and prolonged the time needed to make the decision. Apparently, social observation induces reputation concern, which leads to higher rates of deontological decisions as they are perceived as more culturally accepted, are associated with positive personality traits, and therefore are more likely to be viewed positively by potential observers (Lee et al., 2018).

In recent years, Virtual Reality (VR) has become an important tool for studying moral decision-making (discussion: Parsons, 2015; Ramirez & LaBarge, 2018) including studies that use virtual characters as participants in moral dilemmas (e.g., Niforatos et al., 2020; Pan & Slater, 2011; Skulmowski et al., 2014). VR enabled experimental designs offer convenient and ethical alternative to studies that might pose mental or physical danger to participants as in case of obedience (e.g., Slater et al., 2006) or moral dilemmas experiments (Francis et al., 2016). At the same time number of studies have proven that VR moral dilemmas provide reliable experimental platform as they can elicit realistic responses both on the emotional level as indexed by physiological arousal (e.g., Francis et al., 2016; Patil et al., 2014) and on the level of judgements (e.g., Skulmowski et al., 2014).

Current Study

Here, leveraging advantages of VR environment, we aim to explore whether virtual characters, despite lacking morality and tangible existence, can influence people in moral tasks in the same way as real individuals do. Number of studies showed that mere presence of virtual characters can alter simple behaviors such as task performance (e.g., Hoyt et al., 2003; Park & Catrambone, 2007; Zanbaka et al., 2007; Sterna et al., 2024; see Sterna et al., 2019 for review), but can this influence be extended to complex processes such as moral decision-making? To the best of our knowledge, no prior research has explored if our moral decisions are affected by the presence of a virtual character specifically serving as an observer (like in Lee et al., 2018).

Furthermore, should virtual character impact our moral choices, we want to establish if this effect is mediated by emotional arousal, as proposed by dual-process theory (Greene, 2007). While several VR studies have attempted to test these predictions, the current results remain inconclusive. Although some studies suggest a relationship between physiological arousal (a proxy for measuring affective processes) and specific moral decisions (utilitarian in Patil et al., 2014; or deontological in McDonald et al., 2017; Navarette et al., 2012), others do not (Francis et al., 2016). In attempt to resolve this issue we examine emotional arousal accompanying moral decisions by measuring Skin Conductance Response (SCR), the phasic, event-related component of Electrodermal Activity (EDA), widely employed in psychological research on emotions (e.g., Bradley et al., 2008), as well as in studies of non-moral (e.g., Swiderska et al., 2019) and moral decision-making (e.g., Cecchetto et al., 2017; Patil et al., 2014).

To enhance the likelihood of observing the effects of social observation in a VR environment, we aim to increase the level of co-presence (the feeling of being with “someone” in a virtual space; Oh et al., 2018), which is considered a necessary factor for social influence in VR environments (Swinth & Blascovich, 2002). To this end, using an immersive medium (head-mounted display), we display a detailed virtual observer which makes realistic eye contact with participants, a known factor in co-presence (Oh et al., 2018). The co-presence was achieved by using a virtual character which was assessed during two pre-tests (as explained in detail in Appendix D).

Hypotheses

Based on a study by Lee et al. (2018), we hypothesize that the presence of a virtual character would significantly increase the frequency of making deontological instead of utilitarian judgments, as compared to solving the same dilemmas without a virtual observer. This hypothesis followed the original reasoning of the authors (Lee et al., 2018) in which the reputation concern induced by being observed while making moral judgments led to increased frequencies of deontological (and more culturally accepted) decisions. This is further supported by Computers as Social Actors (CASA) paradigm, by Nass & Moon (2000), postulating that people interact with computers and digital entities as if they were human, applying social rules and expectations to these interactions. CASA paradigm is supported by an extensive list of studies demonstrating that people indeed do treat virtual entities as human-like (Fogg & Nass, 1997; Moon & Nass, 1998; Nass & Moon, 2002; Slater et al., 2006).

Moreover, we predict that reputation concern increasing rate of deontological judgments would be the most apparent in personal moral dilemmas and would not be visible in non-moral dilemmas (Lee et al., 2018). Personal dilemmas involve direct harm and require violation of social norms (e.g., of not killing other people) hence should elicit the strongest reputation concern. In contrast, we assume that the rates of judgements due to virtual character's presence would not change in non-moral dilemmas as they are emotionally neutral and do not involve violation of any social norms.

Furthermore, we expect that the level of arousal at the time of a decision, reflecting intensity of ongoing emotional processes related to moral decision-making, would predict the kind of moral judgment (deontological vs. utilitarian). This follow the dual-process theory (Greene, 2007; Greene et al., 2001) which linked types of moral judgements with activity in different areas of the brain, emotional for deontological decisions, and cognitive for utilitarian ones. However, because of the mixed results in the VR literature (McDonald et al., 2017; Navarette et al., 2012; Patil et al., 2014), we decided to refrain from making specific predictions regarding which type of judgment (deontological vs. utilitarian) would be related to arousal. In previous studies, emotional arousal linked with later deontological decisions (McDonald et al., 2017; Navarette et al., 2012) was interpreted as an aversive reaction, preventing harmful actions. Conversely, when emotional arousal was linked with later utilitarian judgments (Patil et al., 2014), it was seen as a sign of increased conflict resolution (e.g., "I need to commit a harmful action for a greater good"). Importantly, authors (McDonald et al., 2017; Patil et al., 2014) underline that these interpretations need to be taken with caution due to small effect size (in McDonald et al., 2017) or low variability in decisions made in the study (Patil et al., 2014). Regardless of the interpretation, measuring emotional arousal at the moment of decision-making allows us to track participants' internal states in real-time, and relate those to later moral judgments (as in McDonald et al., 2017; Navarette et al., 2012; Patil et al., 2014)

In summary we propose following hypotheses:

H1: The presence of a virtual character will significantly increase the frequency of making deontological instead of utilitarian judgments, as compared to solving the same dilemmas without a virtual observer.

H2: The effect of increased rate of deontological judgments when observed will be the most apparent in personal moral dilemmas and would not be visible in non-moral dilemmas.

H3: The level of arousal at the time of a decision, reflecting emotional processes related to moral decision-making, will predict the moral judgment.

Methods

Materials

Moral Dilemmas

Fourty-six (17 personal, 14 impersonal and 15 non-moral) moral dilemmas, selected from the 50 dilemmas used by Lee et al. (2018), were used in the study. Four dilemmas from the original study were excluded and two were modified. The rationale for these changes as well as the list of dilemmas used in the study are presented in Appendix A.

Equipment

The presentation of the stimuli was conducted in VR environment and implemented using Unity 2020.2.1f1, delivered through the HTC Vive Pro head-mounted display. The participants remained seated throughout the whole experiment. The biosignalsplux Explorer Research Kit (PLUX Wireless Biosignals, Lisbon, Portugal) with 2 kHz sampling frequency was used to record the electrodermal (EDA) data.

Virtual Observer

The study used a highly realistic virtual character that is capable of evoking a sense of co-presence, which is the feeling of being with another in a virtual space (Swinth & Blascovich, 2002). This virtual character was selected deliberately to maximize the potential for social influence, as both theoretical predictions (Swinth & Blascovich,

2002) and experimental evidence (Strojny et al., 2020) suggest that co-presence, influenced by realism, plays a crucial role in facilitating social influence. For a detailed review of the virtual character selection process, refer to Appendix D. The virtual character was specifically located in the VR environment to be visible but also undistracting to the participant (Figure 1). When present, virtual character displayed idle motion throughout the experiment and kept looking at the participant. The same virtual character (male) was used for the whole experiment.

Figure 1. *The Experimental Environment With the Virtual Observer.*

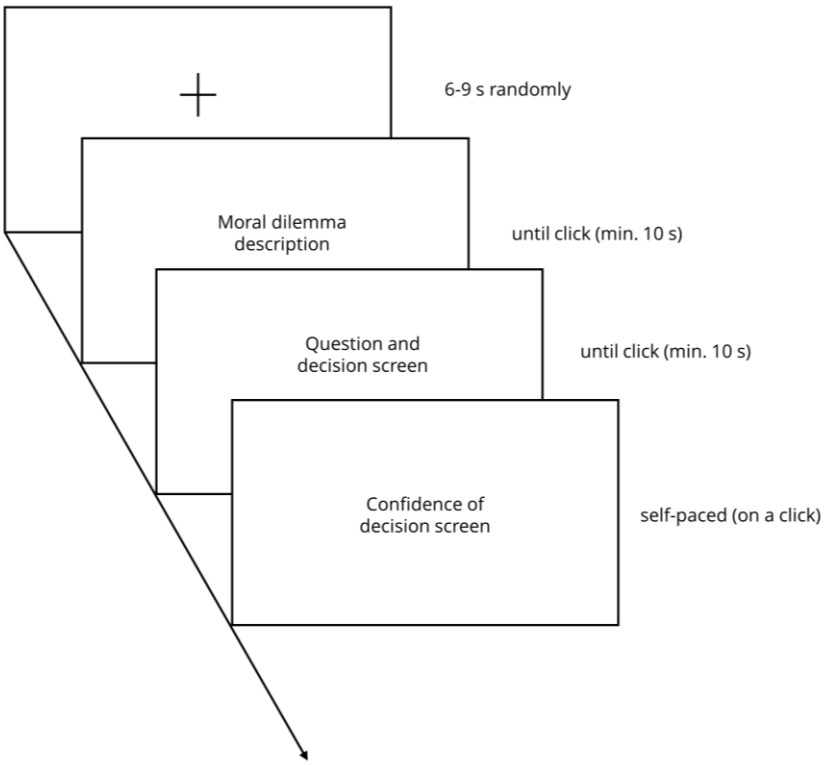
Note. On the slide, one of the non-moral dilemmas used in the study is presented in Polish. All of the dilemmas used in the study can be found in Appendix A. The English translation of the text visible on the slide: *You have decided to make a batch of brownies for yourself. You open your recipe book and find a recipe for brownies. The recipe calls for a cup of chopped walnuts. You don't like walnuts, but you do like macadamia nuts. As it happens, you have both kinds of nuts available to you.*

Procedure

The session took about 40 minutes per participant. At the beginning, the participants were asked to sign the informed consent form. Then, the EDA electrodes were attached and the researcher helped the participant put on the VR headset. Before the main session, participants completed three practice trials (see appendix for dilemmas used). Then, the main experiment started, in which participants were asked to make moral judgments. The study was divided into two blocks: one with the virtual observer and one without. Before each block, the participants were asked to look around to make sure that the virtual observer could be seen. In each of the blocks, 7 personal, 7 impersonal and 7 non-moral dilemmas were presented. The order of the blocks and the dilemmas was random.

A 4-step trial course was used. First, participants were instructed to gaze at the fixation cross (displayed for 6–9s randomly) at the center of the screen. Next, the moral dilemma was presented until the participant clicked the button on the controller (but not before 10s after the dilemma onset). After reading the dilemma, the question and decision screen (example question: *Is it appropriate for you to push the stranger on to the tracks in order to save the five workmen?*) appeared, and participants were asked to indicate whether a certain behavior was appropriate (utilitarian judgment) or inappropriate (deontological judgment). The question and decision screen were visible until the participants decided by clicking the respective button (but not before 10s after the decision screen onset). Next, participants were asked to choose how confident they were in their previous judgment: from 1—the action is very inappropriate (strong confidence, deontological judgment) to 4—the action is very appropriate (strong confidence, utilitarian judgment). The confidence screen was presented without any time constraints until participants made a decision. After this, the next trial started.

Figure 2. *The Course of the Trial With Respective Timings.*



Participants

Sixty-two participants, recruited through university system (voluntary response sampling), took part in the study. Three participants were excluded from the analyses due to the failure of the psychophysiological measuring device and two due to high levels of artifacts (coming mainly from participants' movement artifacts and inadvertent contact with the electrodes) in the signal. As a result, in the analyses, fifty-seven participants (39 women and 18 men) with mean age of 24.97 (*SD* = 5.69, age range 19–44) were included.

All participants had normal or corrected-to-normal visual acuity, normal color vision, lack of neurological diseases, no history of psychiatric disorders, and were not prone to motion sickness. Before the study, participants were informed that the dilemmas contained emotional content and that they could quit the study at any point. In compliance with local ethics committee guidelines and the Declaration of Helsinki, all participants signed informed consent before the study. All participants were financially reimbursed for their participation or received course credit. The study was conducted in July, 2022. The study was announced as the VR study on perception of virtual characters.

Data Processing

Behavioral Data

Similarly to Lee et al. (2018), all raw confidence rating scores were converted into values of 1 and 2 so that higher numbers indicated higher decision confidence for both utilitarian and deontological judgments.

Electrodermal Activity

The electrodermal activity data were analyzed using Ledalab V3.2.4 (http://www.ledalab.de). Before the analyses, the data were downsampled to 10 Hz. Next, the data were visually inspected for artifacts and artifacts-afflicted trials were removed. Consequently, a continuous decomposition analysis (CDA; Benedek & Kaernbach, 2010) was conducted. For the analyses, we extracted the Skin Conductance Response (SCR) parameter, which reflects short-term phasic response, calculated with amplitude threshold of .01 μS in the time window 1 to 4 sec after the question and decision screen onset. To check the effectiveness of the manipulation of the presence of a virtual

observer, we extracted the tonic part of the signal (which reflects a slowly changing component of electrodermal activity) provided by Ledalab. The mean tonic activity was calculated in the 1s to 10s time window after the decision screen onset, adjusted for baseline (20s before the experiment started).

Statistical Analyses

As a manipulation check, we performed mixed-models analysis using the Jamovi statistical package (Jamovi v2.3, Jamovi Project, 2022) to test the influence of the presence of the virtual observer on tonic electrodermal activity. We expected the tonic activity to rise when the virtual observer was present. This effect was predicted by Zajonc and Sales (1966) and experimentally shown in the VR context in our previous study on social influence effects in simple visual-search task (Sterna et al., 2024). In this study, we also observed that the presence of a virtual observer increases arousal measured by tonic EDA. The presence of the observer and the block number served as the factorial predictor; the order of the trials within each block served as the covariate predictor. Participant's ID was specified as a random effect. The model included the main effects of the fixed-effect predictors as well as their 2-way and 3-way interactions. The covariate was centered for the analyses. We included the 2-way and 3-way interactions between block number, trial order, and agent presence because, knowing that all those factors by themselves affect arousal, we predicted that they would all contribute to changes in tonic EDA. Additionally, as mentioned factors affect tonic EDA differently, hence their mixture in our experimental design might have yielded unknown combined effects necessitating investigation using 2-way and 3-way interactions. Specifically, we anticipated that the participants' tonic EDA would decrease over time due to habituation (Dawson et al., 2007) which would be reflected by the trial order as well as block number variables effect. We also considered whether the virtual character was introduced in the first or second block to be significant, as this could influence the arousal response, reflecting an effect of the novelty of the environment as predicted by the Orienting Response framework in which EDA change is part of a larger compound of bodily responses to novel and thus requiring attention, stimuli (Sokolov, 1963 as cited in MacDonald & Barry, 2020).

In the main analyses, we conducted three generalized mixed-model analyses using the Jamovi statistical package (Jamovi v2.3, Jamovi Project, 2022).

Firstly, we tested the effect of the presence of the virtual character on decisions in both moral (impersonal, personal) as well as non-moral dilemmas. The presence of the virtual character, the dilemma type (impersonal, personal, non-moral), and the block number were included as the factorial predictors.

Secondly, we tested the influence of virtual character presence and SCR evoked by the question and decision screen on decisions made only in response to moral dilemmas. Presence of the virtual character, dilemma type (impersonal, personal), and block number were included as the factorial predictors, and the SCR in each trial was included as a covariate predictor.

Thirdly, we tested the effects of virtual character presence, SCR evoked by the question and decision screen, and decision type (deontological vs. utilitarian) on decision confidence in moral dilemmas. Presence of the virtual character, dilemma type (impersonal, personal), block number, and decision type (deontological vs. utilitarian) were included as the factorial predictors, and the SCR in each trial was included as a covariate predictor.

In all three models, participants' ID was specified as a random effect. The models included all the main effects of the fixed-effects predictors, as well as their two-way and three-way interactions. Covariates were centered for the analyses. All three models were conducted using the logit link function.

Results

Manipulation Check: Influence of Virtual Observer Presence on Arousal

Tonic EDA was modulated by the presence of the virtual observer, block number, order of trials within a block, the 2-way interaction between block number and trial order within a block, as well as the 3-way interaction between block number, virtual observer presence and trial order within a block. Tonic EDA was higher when the observer was present, $\beta = 0.22$, $SE = 0.057$, $t(2331) = 3.86$, $p < .001$, and in the second block, $\beta = 0.19$, $SE = 0.057$, $t(2331) = 3.31$, $p < .001$. Tonic EDA decreased over time within each block, as indicated by the β coefficient for trial

order within a block, β = −0.01, *SE* = 0.005, *t*(2331) = −2.71, *p* = .007. See Table 1, Figure 3 and Table B1 (in Appendix B) for details.

Table 1. *Fixed Effects of the Predictors With Tonic EDA as the Dependent Variable.*

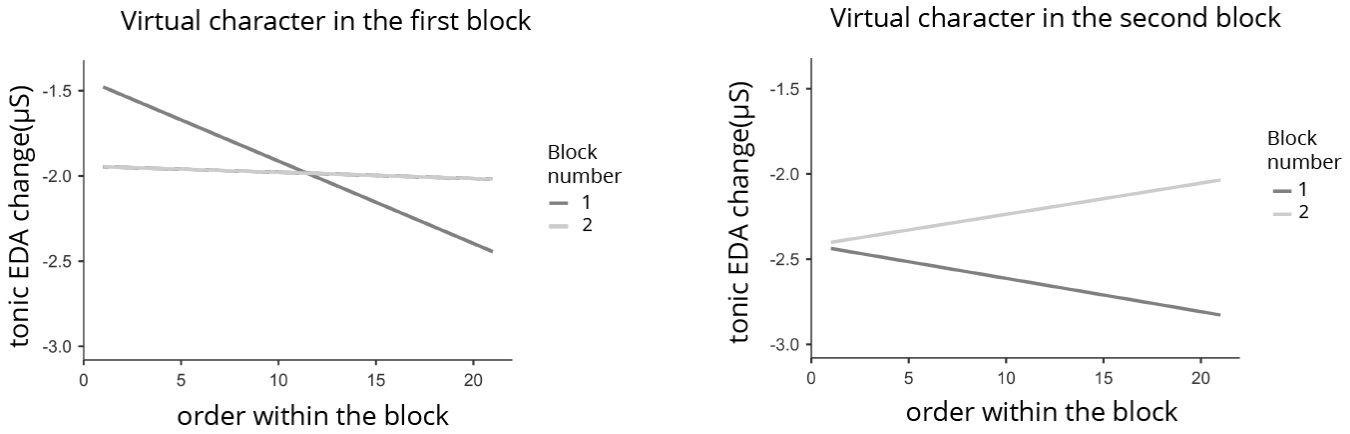
	F	Num *df*	Den *df*	*p*
trial order within a block	7.389	1	2331	.007
VC presence	14.925	1	2331	< .001
block number	10.990	1	2331	< .001
VC presence*block number	0.423	1	55	.518
order within a block*VC presence	0.049	1	2331	.826
order within a block*block number	18.946	1	2331	< .001
order within block*VC presence*block number	7.191	1	2331	.007

Note. VC presence = virtual character presence.

Simple-effects analysis of the 3-way interaction between block number, virtual observer presence and trial order within a block revealed that the decrease of EDA over time was significant only when the virtual character was present in the first block, β = −0.05, *SE* = 0.008, *t*(2331) = −5.81, *p* < .001.

Upon examining the visual presentation of the interaction (Figure 3), it becomes evident that the main factor contributing to the observed effects is the presence of the virtual character. When the observer was present in the first block, it led to an increase in arousal at the beginning (dark-gray line, left panel), which over time started to fall, whereas in the second block (light-gray line, left panel) it remained stable. The opposite relationship can be observed when the virtual character appeared in the second block (light-gray line, right panel): a gradual increase of tonic EDA, which reflects the influence of its presence, preceded by a subtle decrease of EDA over time in the first block (dark-gray line, right panel).

Figure 3. *Interaction Between Block Number, Virtual Observer Presence and Order of Trials Within the Block—Influence on Change of Tonic EDA From Baseline.*



Decision as the Dependent Variable: Analysis With Both Moral and Non-Moral Dilemmas

The decision was modulated by the dilemma type. Participants indicated a significantly higher level of appropriateness for a particular action in impersonal dilemmas (56% rated as 'appropriate') compared to personal dilemmas (37% rated as 'appropriate'). Moreover, the endorsement of the action was even greater in non-moral dilemmas, with 72% of participants deeming it 'appropriate', surpassing both impersonal and personal dilemmas (all of the post-hoc comparisons, *p* < .001). The detailed results are presented in Table 2 and Tables B2–5 (in Appendix B).

Table 2. *Fixed Effects of the Predictors, With Decision as the Dependent Variable.*

Predictor	X^2	*df*	*p*
block number	0.04	1.00	.836
dilemma type	181.47	2.00	< .001
VC presence	0.09	1.00	.761
block number*dilemma type	1.33	2.00	.514
block number*VC presence	0.05	1.00	.830
dilemma type*VC presence	0.98	2.00	.612
block number*dilemma type*VC presence	0.80	2.00	.671

Note. VC presence = virtual character presence.

To test whether we had sufficient power to detect expected effects we conducted a simulated post-hoc sensitivity analyses based on our empirical data. It showed that we had a minimum of 80% power to detect effects of sizes OR = 0.775 (main effect of virtual character presence), OR = 1.360 and OR = 0.741 (main effect of the dilemma type), OR = 0.536 and OR = 0.532 (interaction between dilemma type and virtual character presence). All of the effects are considered very small or small-medium according to Chen et al.'s (2010) criteria. Notably, in the study of Lee et al. (2018) the effect sizes for the influence of a virtual character and interaction between virtual character presence and dilemma type were medium-large. This shows that our study was powered enough to detect effects of sizes reported by Lee et al. (2018). For detailed description of sensitivity analyses please see Appendix C.

Decision Made as the Dependent Variable: Analysis With Moral Dilemmas Only

The moral decision was modulated by the dilemma type, SCR, as well as the interaction between the dilemma type and SCR. Participants significantly more often indicated that a particular action was appropriate (utilitarian judgment) in impersonal (56% of utilitarian responses) than in personal dilemmas (37% of utilitarian responses). The higher the SCR, the higher the chance of making a utilitarian judgment (OR = 46.29, *SE* = 1.80, *z* = 2.13, *p* = .033). The detailed results are presented in Table 3 and Table B6 (in Appendix B).

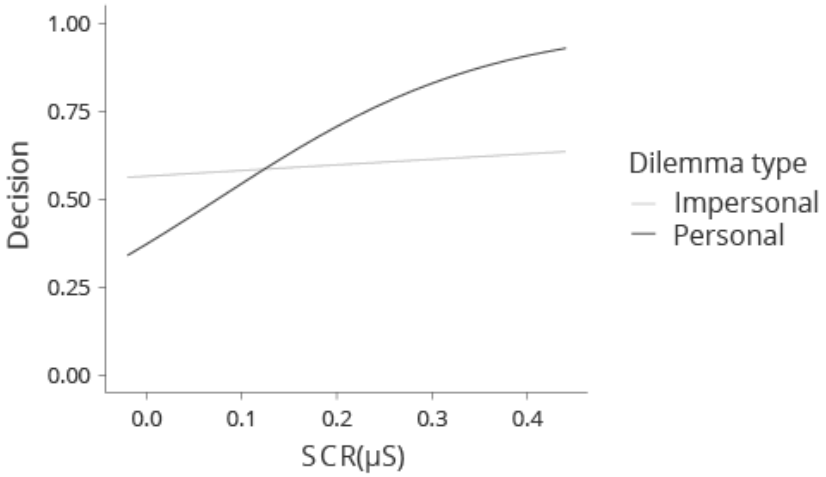
Table 3. *Fixed Effects of the Predictors, with Decision as the Dependent Variable.*

Predictor	X^2	*p*
block number	0.30	.580
dilemma type	50.69	< .001
VC presence	0.21	.648
SCR	4.54	.033
block number*dilemma type	0.22	.639
block number*VC presence	0.29	.594
dilemma type*VC presence	1.88	.170
block number*SCR	0.64	.423
dilemma type*SCR	4.43	.035
VC presence*SCR	0.26	.613
block number*dilemma type*VC presence	1.34	.248
block number*dilemma type*SCR	1.37	.242
block number*VC presence*SCR	1.54	.215
dilemma type*VC presence*SCR	1.58	.209

Note. VC presence = virtual character presence. *df* = 1.

Simple-effects analysis revealed that SCR modulated the decision, but only in personal dilemmas (OR = 1103.86, *SE* = 2.45, *z* = 2.86, *p* = .004), with no effect in impersonal ones (OR = 1.94, *SE* = 2.24, *z* = 0.30, *p* = .767). In personal dilemmas, higher arousal was associated with higher frequencies of utilitarian judgments (Figure 4).

Figure 4. *Influence of the Interaction Between Dilemma Type and SCR on Decision Type. Y Axis—Probability of Making an Utilitarian Decision.*



Decision Confidence as the Dependent Variable

Decision confidence was modulated by the decision made and the interaction between the decision and the dilemma type. Utilitarian decisions were associated with lower confidence (*M* = 1.36, *SD* = 0.50) than deontological ones (*M* = 1.55, *SD* = 0.48). The detailed results are presented in Table 4 and Table B7 (in Appendix B).

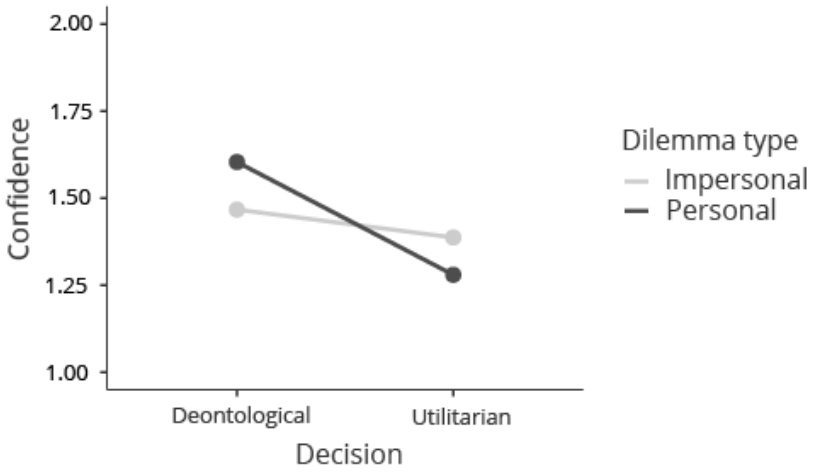
Table 4. *Fixed Effects of the Predictors With Decision Confidence as the Dependent Variable.*

Predictor	X^2	*p*
block number	1.49	.223
dilemma type	0.08	.772
VC presence	1.95	.163
decision	50.47	< .001
SCR	1.03	.310
block number*dilemma type	0.02	.883
block number*VC presence	2.47×10^{-4}	.987
dilemma type*VC presence	0.69	.406
block number*decision	0.13	.717
dilemma type*decision	20.63	< .001
VC presence*decision	0.02	.888
block number*SCR	0.12	.725
dilemma type*SCR	1.31	.252
VC presence*SCR	0.01	.908
decision*SCR	0.68	.409
block number*dilemma type*VC presence	0.81	.368
block number*dilemma type*decision	2.39	.122
block number*VC presence*decision	0.05	.817
dilemma type*VC presence*decision	0.25	.618
block number*dilemma type*SCR	0.17	.681
block number*VC presence*SCR	0.28	.596
dilemma type*VC presence*SCR	0.63	.426
block number*decision*SCR	0.59	.443
dilemma type*decision*SCR	0.30	.582
VC presence*decision*SCR	1.38	.240

Note. VC presence = virtual character presence. *df* = 1.

Simple-effects analyses revealed that in both impersonal (OR = 0.72, *SE* = 0.16, *z* = −2.09, *p* = .037) and personal dilemmas (OR = 0.26, *SE* = 0.17, *z* = −7.91, *p* < .001) the confidence was lower when a utilitarian judgment was made, but this difference was larger for personal than impersonal dilemmas (Figure 5).

Figure 5. *Interaction Between Dilemma Type and Decision—Influence on Decision Confidence.*



Discussion

Prior research has shown that people are inclined to make norm-based (deontological) moral choices more frequently when observed by real humans. In this study, we sought to investigate if this trend holds when the observers are virtual. The moral judgments were not influenced by the presence of the virtual observer, but they were influenced by arousal and the directness of the dilemma. Even though the moral dilemmas were hypothetical, text-based, and presented in a virtual world, we observed that people engaged with them, and their responses were affectively driven. This is a classic pattern of response that corresponds closely to the predictions of dual process theory (Greene, 2007).

Although multiple studies have shown the influence of virtual observers on task performance (e.g., Hoyt et al., 2003; Liu & Yu, 2018; Park & Catrambone, 2007; for review Sterna et al., 2019), our results suggest that moral reasoning remains insensitive to the influence of a virtual character. We did not observe any effect of a virtual observer on the decisions made by the participants. There was also no interaction between dilemma type and the presence of a virtual character. Both these findings are contrary to our expectations and show the boundaries of the virtual character's influence on moral judgements.

The results of studies that have employed virtual characters as subjects of moral dilemmas show mixed results. Some of them report similar rates of utilitarian judgements as in classic text-based moral dilemmas involving people (Navarette et al., 2012; Skulmowski et al., 2014), while others show increased utilitarianism in virtual simulations (Francis et al., 2016; McDonald et al., 2017; Patil et al., 2014) as compared to text-based dilemmas. Therefore, we do not yet know what moral status is attributed to virtual characters or whether they are treated similarly to real humans. What our study contributes to this discussion is the recognition that people's moral decisions are not influenced by being observed by virtual characters. Following the reasoning of Lee et al. (2018), this suggests that when observed by a virtual character, no concern for reputation is induced, unlike with real people, and thus the effects of social observation do not occur. This is supported by the results of Mol et al. (2020), who tested the impact of social observation on cheating behavior in an economic game and found that the presence of the virtual observer did not have a significant effect on cheating behaviors in comparison to the condition without an observer. Both Mol et al.'s (2020) study and ours show that being observed by virtual others does not lead to reputation concern—as would be expected when observed by a real person—and therefore does not influence the moral judgment (as in our study) or behavior (as in Mol et al., 2020).

An alternative explanation of why our findings differ from Lee et al.'s (2018) could be based on the virtual character used in our study. We used a virtual character previously tested to induce high levels of co-presence and exhibiting realistic behaviors (eye-gaze and movement), yet it did not induce social observation effects. This supports the distinction between the low-level and high-level response systems introduced in Swinth and Blascovich's (2002) model of social influence in virtual environments. The low-level response system involves automatic and mostly

unconscious actions and processes; it primarily depends on co-presence to enable social influence. In contrast, the high-level response system entails conscious and deliberate actions that necessitate social verification (the feeling of engaging in an interaction with another) along with co-presence in order to exert social influence. Therefore, moral decision-making, being a conscious and deliberate action, needs social verification if it is to be influenced by a virtual character. This explanation might account for why our study and Mol et al.'s study (2020) did not observe the expected social influence effects. In both cases, the virtual characters exhibited eye-gaze and movement, which are key factors in increasing co-presence (Oh et al., 2018), but they did not engage in a meaningful exchange which would increase social verification. Subsequent research could investigate whether incorporating a form of interaction at the outset of the study (similar to Miller et al., 2019) could facilitate the observation of these effects.

Although the presence of the observer did not impact the moral judgments made by participants, it did significantly affect their arousal, similarly to the presence of a human observer (Zajonc & Sales, 1966). Yet, this was not enough to influence moral decision-making. This finding may further support the aforementioned distinction between low- and high-level response systems (Swinth & Blascovich, 2002). Our study demonstrates that virtual observers—even when inducing arousal—do not influence moral decision-making, which appears to be part of the high-level response system and requires a feeling of being able to interact with a virtual character to observe social influence.

Even though the presence of the virtual observer did not influence the moral judgments, we observed other factors that did influence this process, one of which is the type of dilemma. We replicated effects that show that personal dilemmas are linked to a higher frequency of deontological decisions (Greene et al., 2001), as is predicted by the dual-process theory (Greene, 2007). Moreover, we observed that arousal in personal dilemmas is a predictor of higher rates of utilitarian judgements, which can be understood in two ways (Moretto et al., 2010).

On the one hand, the relationship between arousal and utilitarian judgments may be indicative of conflict resolution, which is known to be related to autonomic arousal, which can be measured with, e.g., SCR (Kobayashi et al., 2007). This finding aligns with another study conducted in a VR setting (Patil et al., 2014), where higher arousal was associated with a greater likelihood of making utilitarian choices. Researchers (Patil et al., 2014) have proposed that heightened arousal might reflect the clash between emotional responses and the cognitive cost-benefit analysis that is often experienced in moral dilemmas, such as the classic trolley dilemma (a choice between killing one person or letting five die; Thomson, 1986). This interpretation is supported by an fMRI study conducted by Greene et al. (2004), in which utilitarian judgments were linked to increased activity in brain regions responsible for both cognitive control (dorsolateral prefrontal cortex) and emotions (posterior cingulate).

Greene et al. (2004, p. 390) described moral dilemmas that involve direct harm in order to maximize welfare as "eliciting negative social-emotional responses related to the harm, conflicting with cognitive analysis of gains and losses". This would explain why, in our study, arousal predicted the moral judgments in personal dilemmas, thus reflecting the demanding conflict resolution process inherent to utilitarian judgments. This interpretation is further supported by the fact that participants had less confidence in their utilitarian judgements than in the deontological ones, and this difference was more pronounced in personal dilemmas. This highlights the highly conflictual nature of utilitarian choices, which intensifies in the context of personal dilemmas.

On the other hand, the heightened SCRs (known also to index emotional processing; Dawson et al., 2011) before a utilitarian choice is endorsed can be interpreted as an emotional, aversive response to possible personal moral transgressions (Cushman & Greene, 2012). This finding aligns with the results of Moretto et al. (2010), where increased SCRs preceding a moral judgment were related to utilitarian choices. In his model of moral judgments, Cushman (2013) also highlighted that certain acts are inherently linked to aversion (e.g., violence), independently of the actual outcome (positive, neutral or negative). This might explain why, in our experiment, approving harm done to somebody in utilitarian judgments, even if done for the greater good, is preceded by an emotional response ("visceral aversion", Gamez-Djokic & Molden, 2016), which is reflected in SCR.

An alternative approach to these two interpretations could be derived from the findings of Navarette et al. (2012), who observed that arousal tends to be higher when individuals are faced with resolving a dilemma through taking action, compared to situations in which they need to actively abstain from acting. In our experiment, each dilemma required participants to approve of an action in order to resolve it in a utilitarian manner (e.g., pulling the switch in the trolley dilemma). Therefore, the relationship between utilitarian judgments and arousal might be attributed to the fact that participants were specifically asked whether it would be appropriate to act in a certain manner rather than abstain; however, it is crucial to consider that this explanation requires further investigation. Rather

than solely providing judgments as we did in our experiment, Navarette et al. (2012) conducted their study using a 3D simulation in which participants were actively engaged in specific behaviors.

Conclusions

We observed that moral judgments in a VR environment are influenced by arousal and the directness of the dilemma. The higher the arousal, the greater the chance of making a utilitarian judgment in personal dilemmas, but this does not apply to impersonal dilemmas.

Furthermore, we have shown that while people engage with moral dilemmas and the virtual observer, unlike with real life observers, in VR presence of virtual character does not affect their decisions This shows the boundaries of a virtual character's influence on human behavior. A practical implication of this study is that virtual characters may not be effective in altering moral decisions in virtual environments, indicating that virtual observers might be more suited for tasks that do not rely on moral judgment but rather require simpler processes such as performance-based activities as in social facilitation/inhibition paradigm.

Limitations and Future Directions

The limitation of the study is that it used only text-based dilemmas that were not combined with 3D simulations. In future studies, the impact of observers might be retested when acting on the dilemma instead of only judging.

Another limitation is that we did not formally assess participants' perceptions of virtual characters as those which can judge moral decisions, limiting our analysis to presumptions about participants' feelings toward the virtual character rather than their explicit declarations. Future studies should include formal assessments of participants' perceptions of virtual observers.

As discussed earlier, it is possible that we did not observe social influence, because moral decision-making needs not only co-presence, but also social verification if it is to be influenced by a virtual character (as in the model of Swinth & Blascovich, 2002). Future research could explore whether incorporating a form of interaction to enhance social verification could facilitate the detection of these effects.

Conflict of Interest

The authors have no conflicts of interest to declare.

Authors' Contribution

Radosław Sterna: conceptualization, data curation; formal analysis, project administration, writing—original draft, writing—review & editing. **Joanna Pilarczyk:** writing—review & editing, conceptualization, supervision. **Jakub Szczugieł:** software, resources. **Teresa Kulej:** writing—original draft, data curation. **Michał Kuniecki:** writing—review & editing, conceptualization, supervision

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The datasets with accompanying analyses can be accessed at:
https://osf.io/c8jrv/?view_only=ae197acce8d8457d867ec7d03184db9d

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Appendices

Appendix A: The Dilemmas Used in the Study

The reasonable behind exclusion and modification of some of the dilemmas:

We excluded 4 dilemmas ("Country Road", "Hired Rapist", "Grandson", "Donation") due to the fact that they do not fit in the classic distinction between utilitarian and deontological moral judgments. In this theory the decisions are driven by two principles: deontology (an action depends on the intrinsic nature of the action e.g., harming others is wrong regardless of its consequences) and utilitarianism (an action is determined by its consequences (e.g., harming others is acceptable if it increases the well-being of a greater number of people; Conway & Gawronski, 2013, p. 216).

In all 4 dilemmas which we excluded, the distinction is not between not harming others in any way and harming others for a greater benefit of more (as in trolley dilemma), but between harming others for your own limited reward and either not harming at all (as in e.g., "Grandson", "Hired Rapist") or benefiting others (as in "Donation"). It is specifically vivid in the "Donation" dilemma in which you are asked to choose between donating money to a charity which would benefit more people than yourself (clearly utilitarian choice) and saving the money to yourself (clearly egoistic choice).

We also modified two dilemmas ("Five-for-Seven Trolley", "Three-for-Seven Fumes", marked where edited) to fit the response pattern where appropriate means utilitarian decision and inappropriate means deontological decision.

Personal Dilemmas (Lee et al., 2018)

Transplant. You are a doctor. You have five patients, each of whom is about to die due to a failing organ of some kind. You have another patient who is healthy. The only way that you can save the lives of the first five patients is to transplant five of this young man's organs (against his will) into the bodies of the other five patients. If you do this, the young man will die, but the other five patients will live. Is it appropriate for you to perform this transplant in order to save five of your patients?

Footbridge. A runaway trolley is heading down the tracks toward five workmen who will be killed if the trolley proceeds on its present course. You are on a footbridge over the tracks, in between the approaching trolley and the five workmen. Next to you on this footbridge is a stranger who happens to be very large. The only way to save the lives of the five workmen is to push this stranger off the bridge and onto the tracks below where his large body will stop the trolley. The stranger will die if you do this, but the five workmen will be saved. Is it appropriate for you to push the stranger on to the tracks in order to save the five workmen?

Architect. You are a young architect visiting one of your construction sites with your boss. Your boss is a despicable individual who makes everyone around him miserable including you. It occurs to you that if you were to push him off of the building you are inspecting he would fall to his death and everyone would think it was an accident. Is it appropriate for you to push your boss off of the building in order to get him out of your life?

Smother for dollars. You are in hospital lounge waiting to visit a sick friend. A young man sitting next to you explains that his father is very ill. The doctors believe that he has a week to live at most. He explains further that his father has a substantial life insurance policy that expires at midnight. If his father dies before midnight, this young man will receive a very large sum of money. He says that the money would mean a great deal to him and that no good will come from his father's living a few more days. He offers you half a million dollars to go up to his father's room and smother his father with a pillow. Is it appropriate for you to kill this man's father in order to get money for yourself and this young man?

Safari. You and a group of ecologists are studying the wildlife in a remote stretch of jungle when you are captured by a group of paramilitary terrorists. You are held hostage for several days. One of the terrorists takes a liking to you. He informs you that his leader intends to kill you and the rest of the hostages the following morning. He says that he is willing to help you escape, but that he needs some assurance that you will not go to the police. He devises the following plan. He will videotape you while you kill one of your sleeping colleagues. The tape will ensure your silence, making it possible for you to escape. Is it appropriate for you to kill your colleague in order to escape from the terrorists and save your own life?

Plane Crash. Your plane has crashed in the Himalayas. The only survivors are yourself, another man, and a young boy. The three of you travel for days, battling extreme cold and wind. Your only chance at survival is to find your way to small a village on the other side of the mountain, several days away. The boy has a broken leg and cannot move very quickly. His chances of surviving the journey are essentially zero. Without food, you and the other man will probably die as well. The other man suggests that you sacrifice the boy and eat his remains over the next few days. Is it appropriate to kill this boy so that you and the other man may survive your journey to safety?

Infanticide. You are a fifteen-year-old girl who has become pregnant. By wearing loose clothing and deliberately putting on weight you have managed to keep your pregnancy a secret. One day, while at school, your water breaks. You run to the girls' locker room and hide for several hours while you deliver the baby. You are sure that you are not prepared to care for this baby. You think to yourself that it would be such a relief to simply clean up the mess you've made in the locker room, wrap the baby in some towels, throw the baby in the dumpster behind the school, and act as if nothing had ever happened. Is it appropriate for you to throw your baby in the dumpster in order to move on with your life?

Preventing the Spread. You are a doctor. One of your patients, whom you diagnosed as HIV positive, is about to be released from the hospital. He has told you, in the confidence of your doctor-patient relationship, that he intends to infect as many people as possible with HIV starting that evening. Because you are bound by doctor-patient confidentiality, there is no legal way to stop this man from carrying out his plan. It occurs to you that you could contaminate his medication with an untraceable poison that will kill him before he gets a chance to infect others. Is it appropriate for you to poison this man in order to prevent him from spreading HIV?

Modified Lifeboat. You are on a cruise ship when there is a fire on board, and the ship has to be abandoned. The lifeboats are carrying many more people than they were designed to carry. The lifeboat you're in is sitting dangerously low in the water—a few inches lower and it will sink. The seas start to get rough, and the boat begins to fill with water. If nothing is done it will sink before the rescue boats arrive and everyone on board will die. However, there is an injured person who will not survive in any case. If you throw that person overboard the boat will stay afloat and the remaining passengers will be saved. Is it appropriate for you to throw this person overboard in order to save the lives of the remaining passengers?

Modified Preventing the Spread. You are a waiter. You overhear one of your customers say that he is about to go to jail and that in his last forty-eight hours of freedom he plans to infect as many people as possible with HIV. You know him well enough to know that he is telling the truth and that he has access to many potential victims. You happen to know that he has a very strong allergy to poppy seeds. If he eats even one he will go into convulsions and have to be hospitalized. for at least forty-eight hours. Is it appropriate for you to cause this man to have a serious allergy attack in order to prevent him from spreading HIV?

Modified Safari. You are part of a group of ecologists who live in a remote stretch of jungle. The entire group, which includes eight children, has been taken hostage by a group of paramilitary terrorists. One of the terrorists takes a liking to you. He informs you that his leader intends to kill you and the rest of the hostages the following morning. He is willing to help you and the children escape, but as an act of good faith he wants you to kill one of your fellow hostages whom he does not like. If you refuse his offer all the hostages including the children and yourself will die. If you accept his offer then the others will die in the morning but you and the eight children will escape. Is it appropriate for you to kill one of your fellow hostages in order to escape from the terrorists and save the lives of the eight children?

Modified Bomb. You are negotiating with a powerful and determined terrorist who is about to set off a bomb in a crowded area. Your one advantage is that you have his teen-age son in your custody. There is only one thing that you can do to stop him from detonating his bomb, which will kill thousands of people if detonated. To stop him, you must contact him over the satellite hook-up that he has established and, in front of the camera, break one of his son's arms and then threaten to break the other one if he does not give himself up. Is it appropriate for you to break the terrorist's son's arm in order to prevent the terrorist from killing thousands of people with his bomb?

Submarine. You are the captain of a military submarine travelling underneath a large iceberg. An onboard explosion has caused you to lose most of your oxygen supply and has injured one of your crew who is quickly losing blood. The injured crew member is going to die from his wounds no matter what happens. The remaining oxygen is not sufficient for the entire crew to make it to the surface. The only way to save the other crew members is to shoot dead the injured crew member so that there will be just enough oxygen for the rest of the crew to

survive. Is it appropriate for you to kill the fatally injured crew member in order to save the lives of the remaining crew members?

Sacrifice. You, your husband, and your four children are crossing a mountain range on your return journey to your homeland. You have inadvertently set up camp on a local clan's sacred burial ground. The leader of the clan says that according to the local laws, you and your family must be put to death. However, he will let yourself, your husband, and your three other children live if you yourself will kill your oldest son. Is it appropriate for you to kill your oldest son in order to save your husband and your other three children?

Sophie's choice. It is wartime and you and your two children, ages eight and five, are living in a territory that has been occupied by the enemy. At the enemy's headquarters is a doctor who performs painful experiments on humans that inevitably lead to death. He intends to perform experiments on one of your children, but he will allow you to choose which of your children will be experimented upon. You have twenty-four hours to bring one of your children to his laboratory. If you refuse to bring one of your children to his laboratory he will find them both and experiment on both of them. Is it appropriate for you to bring one of your children to the laboratory in order to avoid having them both die?

Vitamins. You are the leader of a mountaineering expedition that is stranded in the wilderness. Your expedition includes a family of six that has a genetically caused vitamin deficiency. A few people's kidneys contain large amounts of this vitamin. There is one such person in your party. The only way to save the lives of the six members of this family is to remove one of this man's kidneys so that the necessary vitamins may be extracted from it. The man will not die if you do this, but his health will be compromised. The man is opposed to this plan, but you have the power to do as you see fit. Is it appropriate for you to forcibly remove this man's kidney in order to save the lives of the six vitamin-deficient people.

Euthanasia. You are the leader of a small group of soldiers. You are on your way back from a completed mission deep in enemy territory when one of your men has stepped in trap that has been set by the enemy and is badly injured. The trap is connected to a radio device that by now has alerted the enemy to your presence. They will soon be on their way. If the enemy finds your injured man they will torture him and kill him. He begs you not to leave him behind, but if you try to take him with you your entire group will be captured. The only way to prevent this injured soldier from being tortured is to shoot him yourself. Is it appropriate for you to shoot this soldier in order to prevent him from being tortured by the enemy?

Impersonal Moral Dilemmas

Standard Trolley. You are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks extending to the left is a group of five railway workmen. On the tracks extending to the right is a single railway workman. If you do nothing the trolley will proceed to the left, causing the deaths of the five workmen. The only way to avoid the deaths of these workmen is to hit a switch on your dashboard that will cause the trolley to proceed to the right, causing the death of the single workman. Is it appropriate for you to hit the switch in order to avoid the deaths of the five workmen?

Standard Fumes. You are the late-night watchman in a hospital. Due to an accident in the building next door, there are deadly fumes rising up through the hospital's ventilation system. In a certain room of the hospital are three patients. In another room, there is a single patient. If you do nothing the fumes will rise up into the room containing the three patients and cause their deaths. The only way to avoid the deaths of these patients is to hit a certain switch, which will cause the fumes to bypass the room containing the three patients. As a result of doing this the fumes will enter the room containing the single patient, causing his death. Is it appropriate for you to hit the switch in order to avoid the deaths of the three patients?

Vaccine Policy. You work for the Bureau of Health, a government agency. You are deciding whether or not your agency should encourage the use of a certain recently developed vaccine. The vast majority of people who take the vaccine develop an immunity to a certain deadly disease, but a very small number of people who take the vaccine will actually get the disease that the vaccine is designed to prevent. All the available evidence, which is very strong, suggests that the chances of getting the disease due to lack of vaccination are much higher than the chances of getting the disease by taking the vaccine. Is it appropriate for you to direct your agency to encourage the use of this vaccine in order to promote national health?

Sculpture. You are visiting the sculpture garden of a wealthy art collector. The garden overlooks a valley containing a set of train tracks. A railway workman is working on the tracks, and an empty runaway trolley is heading down the tracks toward the workman. The only way to save the workman's life is to push one of the art collector's prized sculptures down into the valley so that it will roll onto the tracks and block the trolley's passage. Doing this will destroy the sculpture. Is it appropriate for you to destroy the sculpture in order to save this workman's life?

Speedboat. While on vacation on a remote island, you are fishing from a seaside dock. You observe a group of tourists board a small boat and set sail for a nearby island. Soon after their departure you hear over the radio that there is a violent storm brewing, a storm that is sure to intercept them. The only way that you can ensure their safety is to warn them by borrowing a nearby speedboat. The speedboat belongs to a miserly tycoon who would not take kindly to your borrowing his property. Is it appropriate for you to borrow the speedboat in order to warn the tourists about the storm?

Guarded Speedboat. While on vacation on a remote island, you are fishing from a seaside dock. You observe a group of tourists board a small boat and set sail for a nearby island. Soon after their departure you hear over the radio that there is a violent storm brewing, a storm that is sure to intercept them. The only way that you can ensure their safety is to warn them by borrowing a nearby speedboat. The speedboat belongs to a miserly tycoon who has hired a fiercely loyal guard to make sure that no one uses his boat without permission. To get to the speedboat you will have to lie to the guard. Is it appropriate for you to lie to the guard in order to borrow the speedboat and warn the tourists about the storm?

Five-for-Seven Trolley. You are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks extending to the left is a group of five railway workmen. On the tracks extending to the right is a group of *five (seven)* railway workmen. If you do nothing the trolley will proceed to the left, causing the deaths of the *seven (five)* workmen. The only way to save these workmen is to hit a switch on your dashboard that will cause the trolley to proceed to the right, causing the deaths of the *five (seven)* workmen on the other side. Is it appropriate for you to hit the switch in order to avoid the deaths of the *seven (five)* workmen?

Three-for-Seven Fumes. You are the late-night watchman in a hospital. Due to an accident in the building next door, there are deadly fumes rising up through the hospital's ventilation system. In a certain room of the hospital are three patients. In another room, there are seven patients. If you do nothing the fumes will rise up into the room containing the *seven (three)* patients and cause their deaths. The only way to save these patients is to hit a certain switch, which will cause the fumes to bypass the room containing the *seven (three)* people. As a result of doing this the fumes will enter the room containing the *three (seven)* patients, causing their deaths. Is it appropriate for you to hit the switch in order to avoid the deaths of the *seven (three)* patients?

Resume. You have a friend who has been trying to find a job lately without much success. He figured that he would be more likely to get hired if he had a more impressive resume. He decided to put some false information on his resume in order to make it more impressive. By doing this he ultimately managed to get hired, beating out several candidates who were actually more qualified than he. Was it appropriate for your friend to put false information on his resume in order to help him find employment?

Taxes. You are the owner of a small business trying to make ends meet. It occurs to you that you could lower your taxes by pretending that some of your personal expenses are business expenses. For example, you could pretend that the stereo in your bedroom is being used in the lounge at the office, or that your dinners out with your wife are dinners with clients. Is it appropriate for you to pretend that certain personal expenses are business expenses in order to lower your taxes?

Stock Tip. You are a management consultant working on a case for a large corporate client. You have access to confidential information that would be very useful to investors. You have a friend who plays the stock market. You owe this friend a sizable sum of money. By providing her with certain confidential information you could help her make a lot of money, considerably more than you owe her. If you did this, she would insist on canceling your debt. Releasing information in this way is strictly forbidden by federal law. Is it appropriate for you to release this information to your friend so that she will cancel your debt?

Illegal Lunch. You are a lawyer working on a big case. The judge presiding over the trial happens to be someone you knew from law school. The two of you were rather friendly back then, but now, decades later, it seems that your old friend barely remembers you. You're quite sure that if you were to talk to him over lunch, you could jog his memory and he would begin to see you as an old buddy, which would be very good for your work on this case.

It's illegal for judges and lawyers working on the same case to meet socially. Is it appropriate for you to meet with this judge socially in order to help you win your case?

Lost Wallet. You are walking down the street when you come across a wallet lying on the ground. You open the wallet and find that it contains several hundred dollars in cash as well the owner's driver's license. From the credit cards and other items in the wallet it's very clear that the wallet's owner is wealthy. You, on the other hand, have been hit by hard times recently and could really use some extra money. You consider sending the wallet back to the owner without the cash, keeping the cash for yourself. Is it appropriate for you to keep the money you found in the wallet in order to have more money for yourself?

Eyes. In the future, you are a veteran of a war during which both of your eyes were destroyed. Due to recent medical advances, it is now possible to perform eye transplants, but, much to your anger and amazement, there are no willing donors. A sympathetic black-market surgeon offers to help you. If you hire him, he and his associates will kidnap a randomly selected stranger, carve out one of his eyes, and transfer it to you. Is it appropriate for you to hire this surgeon to carve out a stranger's eye in order to help restore your vision?

Non-Moral Control Dilemma Scenarios

Standard Turnips. You are a farm worker driving a turnip-harvesting machine. You are approaching two diverging paths. By choosing the path on the left you will harvest ten bushels of turnips. By choosing the path on the right you will harvest twenty bushels of turnips. If you do nothing your turnip-harvesting machine will turn to the left. Is it appropriate for you to turn your turnip-picking machine to the right in order to harvest twenty bushels of turnips instead of ten?

Plant Transport. You are bringing home a number of plants from a store that is about two miles from your home. The trunk of your car, which you've lined with plastic to catch the mud from the plants, will hold most of the plants you've purchased. You could bring all the plants home in one trip, but this would require putting some of the plants in the back seat as well as in the trunk. By putting some of the plants in the back seat you will ruin your fine leather upholstery which would cost thousands of dollars to replace. Is it appropriate for you to make two trips home in order to avoid ruining the upholstery of your car?

Scheduling. You are in charge of scheduling appointments in a dentist's office. Two people, Mr. Morris and Mrs. Santiago have called to make appointments for next Monday. The only available times for next Monday are at 10:00 AM and at 3:00 PM. Mr. Morris's schedule is rather flexible. He can have his appointment either at 10:00 AM or at 3:00 PM. Mrs. Santiago's schedule is less flexible. She can only have her appointment at 10:00 AM. Is it appropriate for you to schedule Mr. Morris for 3:00 PM so that both he and Mrs. Santiago can have their appointments next Monday?

Generic Brand. You have a headache. You go to the pharmacy with the intention of buying a particular name-brand headache medicine. When you get there, you discover that the pharmacy is out of the brand you were looking for. The pharmacist, whom you've known for a long time and in whom you have a great deal of trust, tells you that he has in stock a generic product which is, in his words, "exactly the same" as the product you had originally intended to buy. Is it appropriate for you to purchase the generic brand instead of searching further for the name-brand product you were looking for?

Brownies. You have decided to make a batch of brownies for yourself. You open your recipe book and find a recipe for brownies. The recipe calls for a cup of chopped walnuts. You don't like walnuts, but you do like macadamia nuts. As it happens, you have both kinds of nuts available to you. Is it appropriate for you to substitute macadamia nuts for walnuts in order to avoid eating walnuts?

Train or Bus. You need to travel from New York to Boston in order to attend a meeting that starts at 2:00 PM. You can take either the train or the bus. The train will get you there just in time for your meeting no matter what. The bus is scheduled to arrive an hour before your meeting, but the bus is occasionally several hours late because of traffic. It would be nice to have an extra hour before the meeting, but you cannot afford to be late. Is it appropriate for you to take the train instead of the bus in order to ensure your not being late for your meeting?

Computer. You are looking to buy a new computer. At the moment, the computer that you want costs $1000. A friend who knows the computer industry has told you that this computer's price will drop to $500 next month. If you wait until next month to buy your new computer you will have to use your old computer for a few weeks longer than you would like to. Nevertheless, you will be able to do everything you need to do using your old

computer during that time. Is it appropriate for you to use your old computer for a few more weeks in order to save $500 on the purchase of a new computer?

Survey. A representative of a reputable, national survey organization calls you at your home while you are having a quiet dinner by yourself. The representative explains that if you are willing to spend a half an hour answering questions about a variety of topics her organization will send you a check for $200. Is it appropriate for you to interrupt your dinner in order to earn $200?

Coupons. You have gone to a bookstore to buy $50 worth of books. You have with you two coupons. One of these coupons gives you 30% off of your purchase price. This coupon expires tomorrow. The other coupon gives you 25% off your purchase price, and this coupon does not expire for another year. Is it appropriate for you to use the 30%-off coupon for your present purchase so that you will have another coupon to use during the coming year?

Scenic Route. An old friend has invited you to spend the weekend with him at his summer home some ways up the coast from where you are. You intend to travel there by car, and there are two routes that you can take: the highway and the coastal road. The highway will get you to your friend's house in about three hours, but the scenery along the highway is very boring. The coastal route will get you to your friend's house in about three hours and fifteen minutes, and the scenery along the coastal road is breathtakingly beautiful. Is it appropriate for you to take the coastal route in order to observe the beautiful scenery as you drive?

Investment Offer. You are at home one day when the mail arrives. You receive a letter from a reputable corporation that provides financial services. They have invited you to invest in a mutual fund, beginning with an initial investment of one thousand dollars. As it happens, you are familiar with this particular mutual fund. It has not performed very well over the past few years, and, based on what you know, there is no reason to think that it will perform any better in the future. Is it appropriate for you to invest a thousand dollars in this mutual fund in order to make money?

Broken VCR. You have brought your broken VCR to the local repair shop. The woman working at the shop tells you that it will cost you about $100 to have it fixed. You noticed in the paper that morning that the electronics shop next door is having a sale on VCR's and that a certain new VCR which is slightly better than your old one is on sale for $100. Is it appropriate for you have your old VCR fixed in order to avoid spending money on a new one?

Choosing Classes. You are beginning your senior year of college. In order to fulfill your graduation requirements, you need to take a history class and a science class by the end of the year. During the fall term, the history class you want to take is scheduled at the same time as the science class you want to take. During the spring term the same history class is offered, but the science class is not. Is it appropriate for you to take the history class during the fall term in order to help you fulfill your graduation requirements?

Raffle. You've decided to buy a raffle ticket to support a local charity. They are separately raffling off two different cars: Car A and Car B. You have decided to buy one raffle ticket. You are a serious and knowledgeable car enthusiast, and you think that these two cars are equally good. Because there have been a lot of adds for Car B on TV recently, many more people have chosen to buy tickets for the Car B raffle. Since more people have bought tickets for the Car B raffle, your chances of winning are better in the Car A raffle than in the Car B raffle. Is it appropriate for you to buy a ticket for the Car B raffle in order to win a car?

Jogging. You intend to accomplish two things this afternoon: going for a jog and doing some paperwork. In general, you prefer to get your work done before you exercise. The weather is nice at the moment, but the weather forecast says that in a couple of hours it will start to rain. You very much dislike jogging in the rain, but you don't care what the weather is like while you do paperwork. Is it appropriate for you to do your paperwork now with the intention of jogging in a couple of hours in order to get your work done before you exercise?

Dilemmas Used in the Practice Session (Conway & Gawronski, 2013)

Time Machine. You find a time machine and travel back to the year 1920. While checking into a hotel, you meet a young Austrian artist and veteran of the First World War. You realize this is Adolf Hitler before his rise to power in Nazi Germany. He is staying in the hotel room next to yours and the doors are not locked. It would be easy to simply smother him with a pillow in his sleep and disappear, stopping the Second World War and the Nazi party before they even start. However, he has not committed any crimes yet and it seems wrong to hurt an innocent person. Is it appropriate for you to kill an innocent young Hitler in order to prevent the Second World War?

Car Accident. You are driving through a busy city street when all of a sudden a young mother carrying a child trips and falls into the path of your vehicle. You are going too fast to break in time; your only hope is to swerve out of the way. Unfortunately, the only place you can swerve is currently occupied by a little old lady. If you swerve to avoid the young mother and baby, you will seriously injure or kill the old lady. Is it appropriate to swerve and hit the old lady in order to avoid the young mother and child?

Animal Research. You have been hired by a pharmaceutical company to conduct research on their products. Since products must be fit for human use, they are first tried out on animals. Your job is to find out the effects various chemicals have on rats, pigeons, rabbits, and monkeys. Most chemicals have only minor effects on the animals, but some cause them discomfort or even permanent damage. The chemicals you are researching are slated to form part of a new acne facial cleanser that will give new hope to people with pimples and greasy skin. You anticipate making many people feel better about their appearance with the chemicals. Is it appropriate to test these chemicals on animals?

References

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Appendix B

Table B1. *Fixed Effects Parameter Estimates With Tonic EDA Change as the Dependent Variable.*

			95% CI				
Names	β	*SE*	Lower	Upper	*df*	*t*	*p*
(Intercept)	−2.22	0.355	−2.914	−1.521	55	−6.24	< .001
order within block	−0.01	0.005	−0.022	−0.004	2331	−2.72	.007
VC presence	0.22	0.057	0.109	0.333	2331	3.86	< .001
Block number	0.19	0.057	0.078	0.302	2331	3.32	< .001
VC presence * block number	−0.92	1.421	−3.710	1.862	55	−0.65	.518
order within block * VC presence	0.00	0.009	−0.021	0.016	2331	−0.22	.826
order within block * block number	0.04	0.009	0.023	0.06	2331	4.35	< .001
order within block * VC presence * block number	0.05	0.019	0.014	0.088	2331	2.68	.007

Note. CI = confidence interval. VC presence = Virtual Character presence. All the comparisons are made with references as: the first block (second block vs. first block), condition without an observer (with a virtual character vs. alone).

Table B2. *Fixed Effects Parameter Estimates With Moral Decision as the Dependent Variable: Analysis With Both Moral and Non-Moral Dilemmas.*

				95% CI			
Names	β	*SE*	OR	Lower	Upper	*z*	*p*
(Intercept)	0.25	0.066	1.28	1.125	1.454	3.76	< .001
block number	0.02	0.091	1.02	0.853	1.217	0.21	.836
dilemma type.1	−0.77	0.107	0.46	0.375	0.571	−7.17	< .001
dilemma type.2	0.76	0.112	2.15	1.721	2.672	6.80	< .001
VC	−0.03	0.091	0.97	0.815	1.162	−0.3	.761
block number * dilemma type.1	0.16	0.214	1.17	0.768	1.779	0.73	.468
block number * dilemma type.2	−0.1	0.224	0.9	0.582	1.402	−0.45	.650
block number * VC	0.06	0.262	1.06	0.633	1.768	0.22	.830
dilemma type.1 * VC	−0.21	0.214	0.81	0.532	1.233	−0.99	.325
dilemma type.2 * VC	−0.12	0.224	0.88	0.57	1.372	−0.55	.582
block number * dilemma type.1 * VC	0.37	0.429	1.45	0.624	3.353	0.86	.390
block number * dilemma type.2 * VC	0.08	0.448	1.09	0.451	2.616	0.19	.853

Note. VC presence = virtual character presence, CI = confidence interval, VC presence = Virtual Character presence. All the comparisons are made with references as: the first block (second block vs. first block), condition without an observer (with a virtual character vs. alone), impersonal dilemma (personal dilemma vs. impersonal dilemma = dilemma type.1; non-moral dilemma vs. impersonal dilemma = dilemma type. 2).

Table B3. *Simple Effects of Block Number: Parameter Estimates.*

				95% CI			
Dilemma Type	β	*SE*	OR	Lower	Upper	*z*	*p*
impersonal	7.37×10^{-4}	0.150	1	0.746	1.34	0.00	.996
personal	0.16	0.153	1.17	0.866	1.58	1.02	.308
non-moral	−0.10	0.167	0.9	0.652	1.25	−0.61	.545

Note. CI = confidence interval All the comparisons are made with reference as the first block (second block vs. first block).

Table B4. *Simple Effects of Block Number: Parameter Estimates.*

Moderator Levels					95% CI			
VC	Dilemma Type	β	*SE*	OR	Lower	Upper	*z*	*p*
Absent	impersonal	0.05	0.232	1.05	0.666	1.65	0.21	.836
	personal	0.02	0.236	1.02	0.642	1.62	0.08	.935
	non-moral	−0.10	0.256	0.91	0.551	1.5	−0.37	.710
Present	impersonal	−0.05	0.232	0.96	0.605	1.51	−0.20	.842
	personal	0.29	0.238	1.34	0.841	2.14	1.23	.217
	non-moral	−0.11	0.253	0.9	0.548	1.48	−0.42	.673

Note. CI = confidence interval. All the comparisons are made with reference as the first block (second block vs. first block).

Table B5. *Simple Effects of Virtual Character Presence: Parameter Estimates.*

Moderator Levels				95% CI			
Dilemma Type	β	*SE*	OR	Lower	Upper	*z*	*p*
impersonal	0.08	0.150	1.09	0.811	1.460	0.56	.575
personal	−0.13	0.153	0.88	0.652	1.190	−0.83	.407
non-moral	−0.04	0.167	0.96	0.693	1.330	−0.24	.814

Note. CI = confidence. All the comparisons are made with reference as the condition without a virtual observer (with a virtual character vs. alone).

Table B6. *Fixed Effects Parameter Estimates With Moral Decision as the Dependent Variable: Analysis of Only Moral Dilemmas.*

				95% CI			
Names	β	*SE*	OR	Lower	Upper	*z*	*p*
(Intercept)	−0.13	0.088	0.88	0.738	1.043	−1.49	.137
block number	0.06	0.110	1.06	0.857	1.318	0.55	.580
dilemma type	−0.79	0.110	0.46	0.367	0.566	−7.12	< .001
VC presence	−0.05	0.110	0.95	0.767	1.179	−0.46	.648
SCR	3.83	1.800	46.29	1.359	1577.028	2.13	.033
block number * dilemma type	0.1	0.221	1.11	0.719	1.710	0.47	.639
block number * VC presence	0.19	0.353	1.21	0.604	2.413	0.53	.594
dilemma type * VC presence	−0.3	0.222	0.74	0.478	1.139	−1.37	.170
block number * SCR	−2.55	3.184	0.08	1.52E-04	40.098	−0.8	.423
dilemma type * SCR	6.34	3.015	568.73	1.544	209493.050	2.1	.035
VC presence * SCR	−1.55	3.058	0.21	5.31E-04	85.512	−0.51	.613
block number * dilemma type * VC presence	0.51	0.441	1.67	0.701	3.955	1.16	.248
block number * dilemma type * SCR	−7.76	6.631	4.25E-04	9.64E-10	187.347	−1.17	.242
block number * VC presence * SCR	9.05	7.305	8540.85	0.005	1.41E+10	1.24	.215
dilemma type * VC presence * SCR	−8.48	6.748	2.07×10^{-4}	3.73×10^{-10}	114.742	−1.26	.209

Note. VC presence = virtual character presence, CI = confidence interval. All the comparisons are made with references as: the first block (second block vs. first block), condition without an observer (with a virtual character vs. alone), impersonal dilemma (personal dilemma vs. impersonal dilemma).

Table B7. *Fixed Effects Parameter Estimates With Decision Confidence as the Dependent Variable: Analysis With Only Moral Dilemmas.*

				95% CI			
Names	β	*SE*	OR	Lower	Upper	*z*	*p*
(Intercept)	−0.28	0.099	0.76	0.623	0.917	−2.83	.005
block number	0.14	0.116	1.15	0.918	1.446	1.22	.223
dilemma type	0.03	0.116	1.03	0.824	1.298	0.29	.772
VC	−0.16	0.116	0.85	0.677	1.068	−1.39	.163
decision	−0.85	0.119	0.43	0.339	0.542	−7.10	< .001
SCR	−2.19	2.154	0.11	0.002	7.652	−1.01	.310
block number * dilemma type	−0.03	0.235	0.97	0.609	1.531	−0.15	.883
block number * VC	0.01	0.391	1.01	0.467	2.166	0.016	.987
dilemma type * VC	−0.20	0.235	0.82	0.519	1.304	−0.83	.406
block number * decision	0.08	0.234	1.09	0.688	1.723	0.36	.717
dilemma type * decision	−1.04	0.229	0.35	0.226	0.554	−4.54	< .001
VC * decision	0.03	0.234	1.03	0.653	1.636	0.14	.888
block number * SCR	1.29	3.659	3.63	0.003	4721.539	0.35	.725
dilemma type * SCR	3.84	3.349	46.42	0.065	32914.487	1.15	.252
VC * SCR	0.42	3.642	1.52	0.001	1920.169	0.12	.908
decision * SCR	−2.634	3.191	0.07	1.38×10^{-4}	37.371	−0.83	.409
block number * dilemma type * VC	0.41	0.460	1.51	0.614	3.726	0.90	.368
block number * dilemma type * decision	0.72	0.465	2.05	0.825	5.101	1.55	.122
block number * VC * decision	−0.11	0.473	0.90	0.355	2.264	−0.23	.817
dilemma type * VC * decision	−0.23	0.465	0.79	0.319	1.972	−0.50	.618
block number * dilemma type * SCR	−3.34	8.125	0.04	4.30×10^{-9}	292678.810	−0.41	.681
block number * VC * SCR	−4.72	8.906	0.01	2.35×10^{-10}	340180.927	−0.53	.596
dilemma type * VC * SCR	6.50	8.178	667.76	7.30×10^{-5}	6.11×10^{9}	0.80	.426
block number * decision * SCR	−5.57	7.263	0.01	2.51×10^{-9}	5816.230	−0.77	.443
dilemma type * decision * SCR	3.75	6.812	42.52247	6.76×10^{-5}	2.67×10^{7}	0.55	.582
VC * decision * SCR	−8.52	7.247	1.99×10^{-4}	1.35×10^{-10}	293.210	−1.18	.240

Note. VC = virtual character presence, CI = confidence interval. All the comparisons are made with references as: the first block (second block vs. first block), condition without an observer (with a virtual character vs. alone), impersonal dilemma (personal dilemma vs. impersonal dilemma), deontological decision (utilitarian vs. deontological).

Appendix C

Sensitivity Analyses Description

We conducted sensitivity analyses using Monte Carlo simulation with the PowerSim function from the simr package (Green & MacLeod, 2016) and the glmer function from the lme4 package (Bates et al., 2009). These analyses were performed by iteratively changing the observed effect size to a range of hypothetical effect sizes (OR = 0.1 to 1 for negative effects, OR > 1 for positive effects), recalculating the model and testing the significance of it in multiple simulations. This approach, involving repetitive simulations with varying effect sizes, followed the work of Chang et al. (2019) as well as the solution described by Sicorello (2020).

Since our primary interest was to retest the findings of Lee et al. (2018) who detected an influence of the observer's presence on moral decision-making depending on the dilemma type, we conducted sensitivity analyses for the main effect of virtual character's presence as well as interaction between virtual character's presence and dilemma type—two effects which fell below the level of statistical significance in our study. Moreover, to further test the sensitivity of our study, we conducted the analysis for one of the effects which was statistically significant—the main effect of the dilemma type. The analyses were limited to the model which directly retests the effects reported by Lee et al. (2018)—section 3.2. in the main body of the text. Due to the computational demands, we chose to report the first effect size with three decimal places that exceeded the 80% power threshold and limited the analyses to this model. All analyses were conducted with an alpha level of .05 and included 1,000 simulations per effect size. Here are the results obtained:

For the effect of virtual character presence:

- Power was 82.5% at an Odds Ratio of 0.775.

For the effect of dilemma type:

- Power was 80.90% at an Odds Ratio of 1.360 for the comparison between non-moral dilemmas and impersonal dilemmas.
- Power was 80.40% at an Odds Ratio of 0.741 for the comparison between personal dilemmas and impersonal dilemmas.

For the interaction effect between dilemma type and virtual character presence:

- Power was 81.80% at an Odds Ratio of 0.536 for the comparison between personal dilemmas and impersonal dilemmas.
- Power was 80.60% at an Odds Ratio of 0.532 for the comparison between non-moral dilemmas and impersonal dilemmas.

The sensitivity analysis demonstrated that our study had sufficient statistical power to detect effect sizes categorized as very small or small-medium according to Chen et al.'s (2010) criteria. Notably, in the original study by Lee et al. (2018), the effects for the interaction between dilemma type and observer presence, as well as the main effect of observer presence, were medium to large. This suggests that our study was adequately powered to detect effects of comparable magnitudes.

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Appendix D

Virtual Character Selection Process

In the pretest studies (Sterna et al., 2021; 2023) we adopted the framework originally introduced by Swinth and Blascovich (2002), which classifies realism into three primary categories:

- Photo-realism: This category pertains to the extent to which the appearance of a virtual character resembles that of a real human, achieved through the incorporation of photorealistic elements, such as realistic reflections of human appearance.
- Behavioral realism: This category focuses on how closely virtual characters mimic the behaviors of their real-world counterparts. This includes aspects like replicating movements and behaviors exhibited by actual human beings.
- Interactional realism: This category concerns the extent to which virtual characters are capable of responding in socially meaningful and appropriate ways, essentially introducing a form of responsiveness into the virtual interaction.

To create the stimuli best suited for the current experiment, we engaged in a thorough preparation process, involving two studies.

Firstly, we performed a pretest of various levels of behavioral, photographic and interactional realism manipulations, as detailed in Sterna et al., 2021. During this pretest phase, we manipulated factors such as the presence and content of communication, level of appearance details, presence of eye contact.

To assess the realism of these manipulations, we invited a small group of participants (N = 13; 4F, 9M) to rate the virtual characters according to their realism, separately considering the photographic, behavioral, and interactional aspects of the manipulation. Our participant group consisted of individuals with expertise in virtual environments, including psychologists experienced in working with virtual environments (n = 11) and experienced gamers (n = 2). The results from this assessment revealed linear increases of realism ratings in response to the realism manipulations. Based on that, we chose 3 distinct levels of photographic realism, 3 distinct levels of behavioral realism and 2 distinct levels of interactional realism (see Tab. D1 below for details on the realism levels chosen) which were subsequently tested in the following experiment.

Secondly, we used these realism levels to create 18 virtual characters representing different combinations of realism levels: 3 levels of behavioral realism, 3 levels of photographic realism and 2 levels of interactional realism. These were tested in the experiment described in detail in Sterna et al., 2023. Forty-five participants (34F; 11M) recruited from the general population, passively viewed virtual characters while their heart rate and skin conductance were registered; then, they self-assessed the co-presence and other constructs related to the experience of interacting with the virtual characters. Based on these declarative responses, we chose the virtual character which would at the same time induce high levels of co-presence and could be used in the social observation paradigm. Therefore, this experiment utilized a virtual character exhibiting high levels of appearance details, natural movement and eye-contact with the participants.

Table D1. *Realism Types and Levels Used in the Second Pretest Study of the Virtual Character Used in the Current Experiment.*

Realism type and level	Description
Low photographic	low number of triangles, resolution of textures and shaders
Medium photographic	medium number of triangles, resolution of textures and shaders
High photographic	high number of triangles, resolution of textures and shaders
Low behavioral	virtual character not moving and not making eye-contact
Medium behavioral	virtual character moving smoothly and not making eye-contact
High behavioral	virtual character moving smoothly and making eye-contact
Low interactional	silent virtual character
High interactional	virtual character asking participant a meaningful question

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