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Original Article

EVOLUTION AND THE TROLLEY PROBLEM: PEOPLE SAVE FIVE OVER ONE UNLESS THE ONE IS YOUNG, GENETICALLY RELATED, OR A ROMANTIC PARTNER

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Abstract: We investigated men's and women's responses to variations of an ethical thought experiment known as the Trolley Problem. In the original Trolley Problem, readers must decide whether they will save the lives of five people tied to a track by pulling a lever to sacrifice the life of one person tied to an alternate track. According to W. D. Hamilton's (1964) formulation of inclusive fitness, people's moral decisions should favor the well-being of those who are reproductively viable, share genes, and provide reproductive opportunity. In two studies (*N*s = 652 and 956), we manipulated the sex, age (2, 20, 45, and 70 years old), genetic relatedness (0, .125, .25, and .50), and potential reproductive opportunity of the one person tied to the alternate track. As expected, men and women were less likely to sacrifice one life for five lives if the one hypothetical life was young, a genetic relative, or a current mate.

Key Words: Trolley Problem, Moral Decisions, Morality, Hypothetical Scenarios

Evolution and the Trolley Problem: People Save Five over One Unless The One Is Young, Genetically Related, or A Romantic Partner

In the study of moral reasoning, philosophers have used an ethical thought experiment known as the *Trolley Problem* to understand implicit rules that govern humans' moral decisions. A classic formulation of the Trolley Problem reads as follows:

> A trolley is running out of control down a track. In its path are five people who have been tied to the track by a madman. Fortunately, you can flip a switch that will lead the trolley down a different track to safety. Unfortunately, there is a single person tied to that track.
> Would you flip the switch?

The reader must decide whether he or she would save the lives of five people tied to the main track by flipping a switch to sacrifice the life of one person tied to the alternate track. One key decision in the Trolley Problem involves a judgment of whether the utilitarian benefit of saving five exceeds the perceived immorality of killing one. In response to the scenario above, the majority of people do opt to flip the switch (sacrifice the life of one). However, like other artificial dilemmas such as the burning building dilemma (Burnstein, Crandall, & Kitayama, 1994), the trolley problem is useful because researchers can manipulate its parameters, one by one, to shed light on which aspects of the dilemma influence people's decisions (Hauser, 2006). For example, if the wording is slightly modified so that one must push a lone person onto the track to save the five people, thus harming the one person as a *means* to save five (rather than as an unintended *consequence* of saving five), individuals are less likely to sacrifice the lone person (Hauser, 2006). Individuals also respond to framing effects. For example, they agree more with the option of "saving" five people than with the option of "killing" one person, even though the two options are consequentially equivalent (Petrinovich & O'Neill, 1996). Individuals also respond to variations in the species involved, with a tendency to spare human lives over non-human lives (O'Neill & Petrinovich, 1998).

A selfish gene perspective (Dawkins, 1989) and the logic of Inclusive Fitness Theory (Hamilton, 1964) implicate genetic relatedness, age, and reproductive opportunity (of the person on the alternate track) as additional parameters that should undermine a utilitarian response to the Trolley Problem. Over evolutionary history, individuals who saved the lives of those who (a) were likely to share genes with them, (b) had their reproductive lives ahead of them, and (c) were likely to provide reproductive opportunity, would have been more likely, on average, to pass their genes on to subsequent generations than would individuals who did not save those lives. Research using the Trolley Problem has offered support for people's bias toward saving kin (O'Neill & Petrinovich, 1998; Petrinovich, O'Neill, & Jorgensen, 1993); and research using other hypothetical helping dilemmas (Burnstein et al., 1994) has illustrated people's concern for the welfare of targets depicted as genetically related or as very young (i.e., one year old), particularly under life-and-death conditions. However, past studies suffer from two

primary limitations. First, they have utilized within-subjects designs; between-subjects designs provide a stricter test of the hypotheses. Second, they have not investigated systematically the effects of age, varying degrees of genetic relatedness, and reproductive viability on people's decisions.

In the current studies, we use a between-subjects design to investigate the effects of multiple independent variables. We refer to the one life on the alternate track as the lone *target*. In the first study, we investigate the effects of target sex, target age, and target genetic relatedness on participants' decision to sacrifice the target in order to save five lives. In the second study, we investigate the effect of target's reproductive opportunity on participants' decision.

STUDY 1

In Study 1, we hypothesized that participants would be less likely to flip the switch on genetically related targets. Because youth is an indicator of life left to live and reproductive viability, we also hypothesized that participants would be less likely to flip the switch on younger targets. Because past research has documented a greater tendency toward inaction among women than among men in helping situations (Lay, Allen, & Kassirer, 1974) and in response to life-or-death dilemmas (Petrinovich et al., 1993), we also expected that female participants would be less likely than male participants, overall, to flip the switch.

Method

Participants

A total of 239 men and 413 women from a suburban community in the United States participated. Participants ranged from 15-86 years (M = 31.23, SD = 15.41).

Measures

We created 32 versions of the original Trolley Problem by manipulating the sex, age, and genetic relatedness of the person tied to the alternate track (see Table 1). Participants were exposed to one version of the problem. An example is as follows (key manipulated area in italics):

> A trolley is running out of control down a track. In its path are 5 people who have been tied to the track by a madman. Fortunately, you can flip a switch that will lead the trolley down a different track to safety. Unfortunately, *your 20 year-old male cousin* is tied to that track.

We provided no additional information about the "five people" tied to the main track. The experiment included one subject variable (participant sex) and three true independent variables (target sex, target age, and target relatedness), for a 2x2x4x4 between-subjects design.

Table 1. Study 1: Independent Variables Combined to Form 32 Versions of the Lone Target Depicted in the Trolley Problem, and Number of Participants (N) Exposed to Each Version

IV1. Relatedness	IV2. Age	IV3. Sex	Target Depicted	N
.00	2	Male	Male Stranger	20
		Female	Female Stranger	21
	20	Male	Male Stranger	22
		Female	Female Stranger	21
	45	Male	Male Stranger	21
		Female	Female Stranger	20
	70	Male	Male Stranger	21
		Female	Female Stranger	22
.125	2	Male	Male Cousin	20
		Female	Female Cousin	17
	20	Male	Male Cousin	25
		Female	Female Cousin	22
	45	Male	Male Cousin	20
		Female	Female Cousin	21
	70	Male	Great Uncle	17
		Female	Great Aunt	22
.25	2	Male	Nephew	18
		Female	Niece	20
	20	Male	Half Brother	18
		Female	Half Sister	18
	45	Male	Uncle	19
		Female	Aunt	21
	70	Male	Grandfather	21
		Female	Grandmother	21
.50	2	Male	Son	20
		Female	Daughter	20
	20	Male	Brother	22
		Female	Sister	21
	45	Male	Father	21
		Female	Mother	21
	70	Male	Father	21
		Female	Mother	20

Procedure

We approached individuals as they were passing through a local farmer's market. Upon consent, each participant read one of the 32 versions of the Trolley Problem, and then checked Yes or No in response to the question, "Would you flip the switch in this situation?" To emulate a real-life situation, we asked participants to answer as quickly as possible. Participants also reported their age and sex; they were debriefed in writing.

Results

Overall, 53% of participants opted to flip the switch on the lone target (to save the five people). We conducted multinomial logistic regression analyses to test the main and interactive effects of participant sex, target sex, target age, and target genetic relatedness on likelihood of flipping the switch. We treated all variables as categorical, including our dependent variable, "flip the switch." Using a forward entry procedure with hierarchical constraints in place, the best-fitting model included three main effects and no higher order interactions. Table 2 provides the parameter estimates and fit statistics (Peng, Lee, & Ingersoll, 2002) for the final reduced model. This model had an overall correct prediction rate of 67.2%.

The three significant main effects in the final reduced model, displayed in the three panels of Figure 1, supported our hypotheses. First (upper panel), participants were increasingly unwilling to flip the switch on targets of increasing levels of genetic relatedness. Second (middle panel), participants were less likely to flip the switch on a very young lone target than on the other lone targets. Third (lower panel), women were less likely than men to flip the switch on the lone target. Figure 2 displays the effects of target age and target genetic relatedness, across participant sex, on participants' decision to sacrifice the target to save the five passengers.

STUDY 2

In Study 2, we focused on the effect of reproductive opportunity on willingness to sacrifice one life for five lives. We acquired a sample of young adults, and in every scenario we described passengers and targets as being of the same age as the participant. We hypothesized that participants would be less likely to sacrifice a target who was likely to provide reproductive opportunity – specifically, a target depicted as their "current romantic partner." We predicted that participants would be especially unwilling to sacrifice a hypothetical romantic partner if they were actually currently involved in a romantic relationship because they would be more likely to visualize a specific person.

Method

Participants

Participants were 956 (352 men and 604 women) students from a public university. They ranged from 16-27 years, with 97% between 18 and 22 (M = 18.92, SD = 1.36).

Table 2. Study 1: Logistic Regression Analysis of Participants' Decision to Flip the Switch on a Lone Target

Predictor	**β**	***SE* β**	**Wald's χ^2**	***df***	***p***
Constant	.164	.252	.423	1	.515
Target relatedness = 0	2.039	.260	61.551	1	.000
Target relatedness = .125	.769	.235	10.674	1	.001
Target relatedness = .25	.567	.239	5.613	1	.018
Target relatedness = .50	----	----	----	0	----
Target age = 2 years old	1.353	.254	28.414	1	.000
Target age = 20 years old	-.299	.239	1.565	1	.211
Target age = 45 years old	-.198	.241	.673	1	.412
Target age = 70 years old	----	----	----	0	----
Participant sex = female	-.661	.180	13.415	1	.000
Participant sex = male	----	----	----	0	----

Final Reduced Model	**χ^2**	***df***	***p***
Overall model evaluation (against intercept-only model)			
Likelihood ratio test	116.85	7	.000
Model fitting criteria			
AIC	147.051	NA	NA
BIC	182.891	NA	NA
-2 log likelihood	131.051	NA	NA
Goodness-of-fit test			
Pearson chi-square	29.592	24	.199

Note. The last category of each predictor variable served as the reference category. For the dependent variable "flip the switch," the reference category is "No." Cox and Snell R^2 = .164. Nagelkerke R^2 = .219. For model with intercept only, AIC = 249.916, BIC = 254.396, -2 log likelihood = 247.916. NA = not applicable

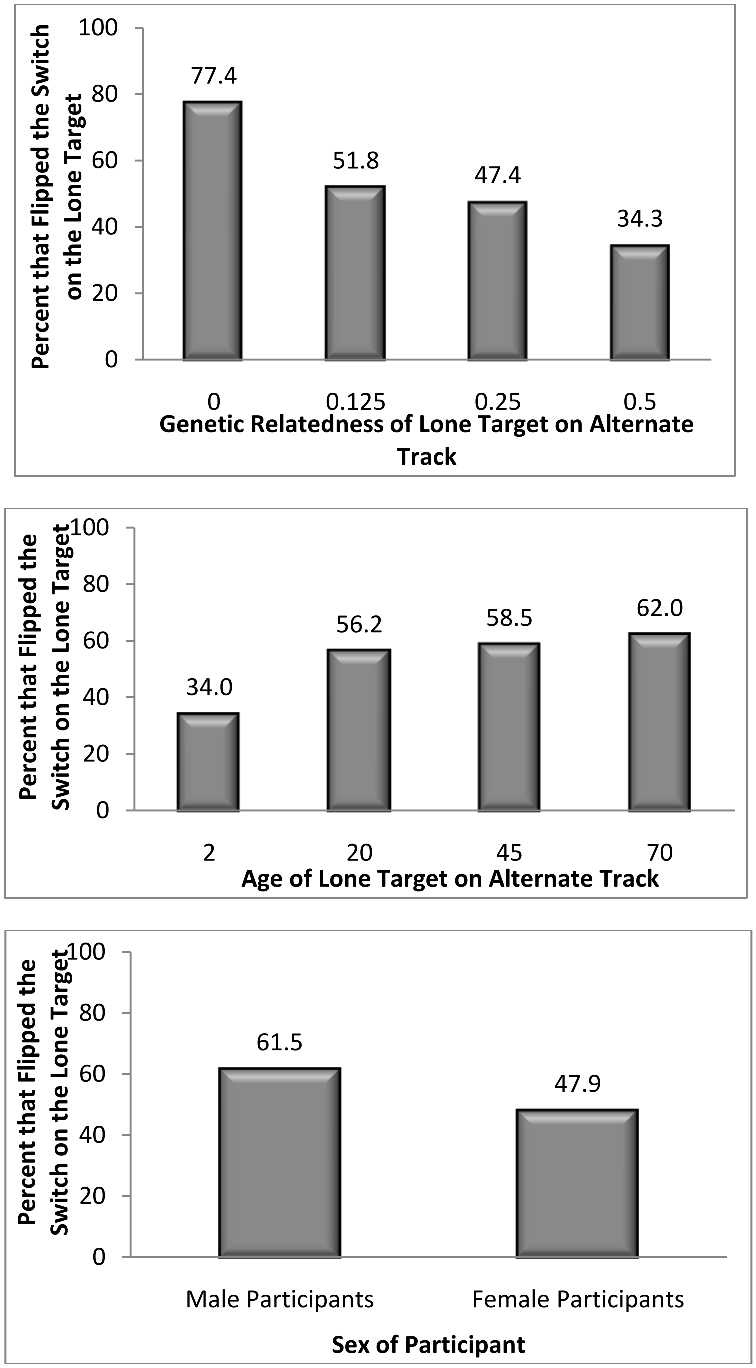

Figure 1. Study 1: Effects of target genetic relatedness (upper panel), target age (middle panel), and participant sex (lower panel) on likelihood of flipping the switch to sacrifice the lone target.

Measures

As shown in Table 3, we created 12 versions of the original Trolley Problem by manipulating the sex of the five people originally in danger (unstated, same-sex, and opposite-sex) and the sex of the target who could be sacrificed to save them (unstated, same-sex, opposite-sex, and romantic partner). We refined the general dilemma to include more detail as well as clarification of the consequences of each decision.

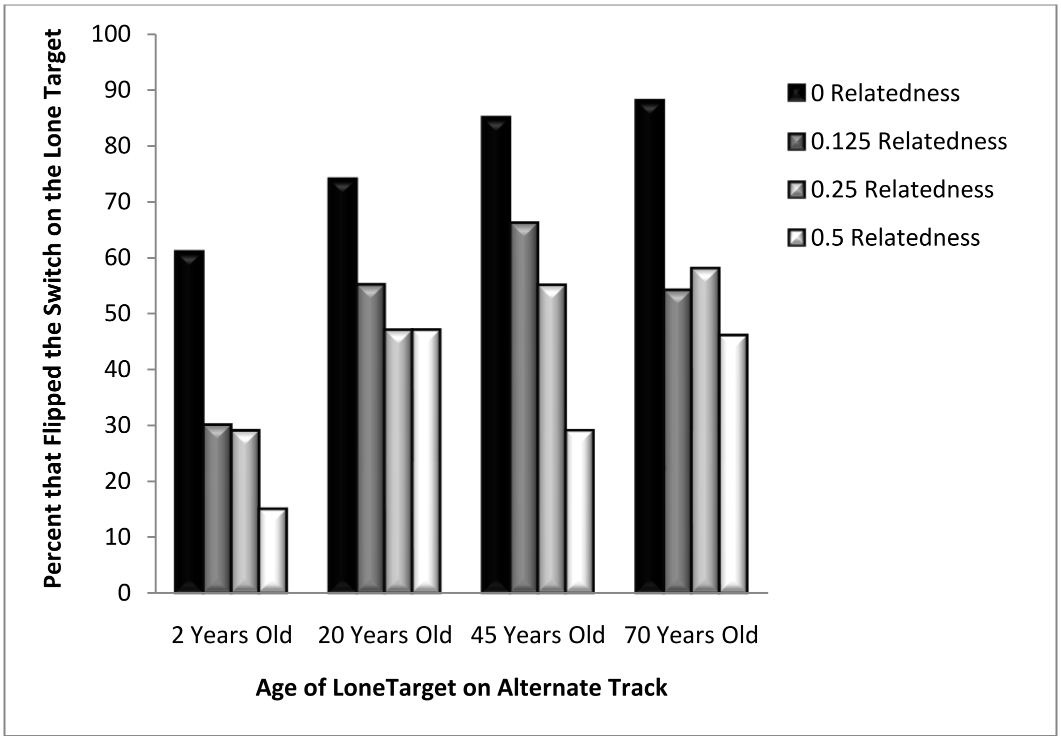

Figure 2. Study 1: Effects of target genetic relatedness and target age, across participant sex, on likelihood of flipping the switch to sacrifice the lone target.

An example of the refined scenario is as follows (key manipulated areas in italics):

> It's a lovely day out, and you decide to go for a walk along the trolley tracks that crisscross your town. As you walk, you hear a trolley behind you, and you step away from the tracks. But as the trolley gets closer, you hear sounds of panic -- the *five men* on board, who are about your age, are shouting for help. The trolley's brakes have gone out, and it's gathering speed. It is going to crash and kill the passengers.

> You find that you just happen to be standing next to a side track that veers into a sand pit, which would provide safety for the trolley's five passengers. All you have to do is pull a hand lever to switch the tracks, and you'll save the *five men*. But there's a problem. Along this offshoot of track leading to the sandpit stands *a woman* about your age who is totally unaware of the trolley's problem and the action you're considering. There's no time to warn *her*. So by pulling the lever and guiding the trolley to safety, you'll save the *five men*. But you'll kill *the woman*.

The experiment included two subject variables (participant sex and participant relationship involvement) and two independent variables (passenger sex and target sex) for a 2x2x3x4 between-subjects design.

Procedure

We approached students on orientation day on a university campus. Upon consent, each participant read one of the 12 versions of the Trolley Problem. Then, participants checked their decision to either *Pull the hand lever* or *Don't pull the hand lever*. Again, we asked participants to answer as quickly as possible. They then reported their age, sex, and whether or not they were currently involved in a romantic relationship. They were debriefed in writing.

Table 3. Study 2: Independent Variables Combined to Form 12 Versions of the Trolley Problem, and Number of Participants (N) Exposed to Each Version

IV1. Sex of Lone Target	IV2. Sex of Passengers	N
Unstated	Unstated	79
	Same-sex	88
	Opposite-sex	71
Same-sex	Unstated	81
	Same-sex	75
	Opposite-sex	86
Opposite-sex	Unstated	82
	Same-sex	72
	Opposite-sex	81
Romantic Partner	Unstated	81
	Same-sex	82
	Opposite-sex	76

Results

Overall, 66% of participants opted to pull the lever to sacrifice the target and save the five passengers. We conducted multinomial logistic regression analyses to test the main and interactive effects of participant sex, participant involvement, target sex, and passenger sex on likelihood of pulling the lever to sacrifice the target. Using a forward entry procedure with hierarchical constraints in place, the best-fitting model included two main effects and one higher order interaction (this pattern replicated with a general loglinear analysis). Table 4 provides the parameter estimates and fit statistics for the final reduced model, which had an overall correct prediction rate of 72.7%.

Contrary to our findings in Study 1, male and female participants in Study 2 did not differ in the frequency with which they opted to pull the lever, p =.61. As displayed in Figure 3, however, our hypothesis that participants would be unwilling to sacrifice their romantic partner in order to save five others was supported. And, as implicated in the interaction between target sex and participant involvement, the negative effect of romantic involvement on willingness to pull the lever was apparent only when the lone target was depicted as the participant's romantic partner.

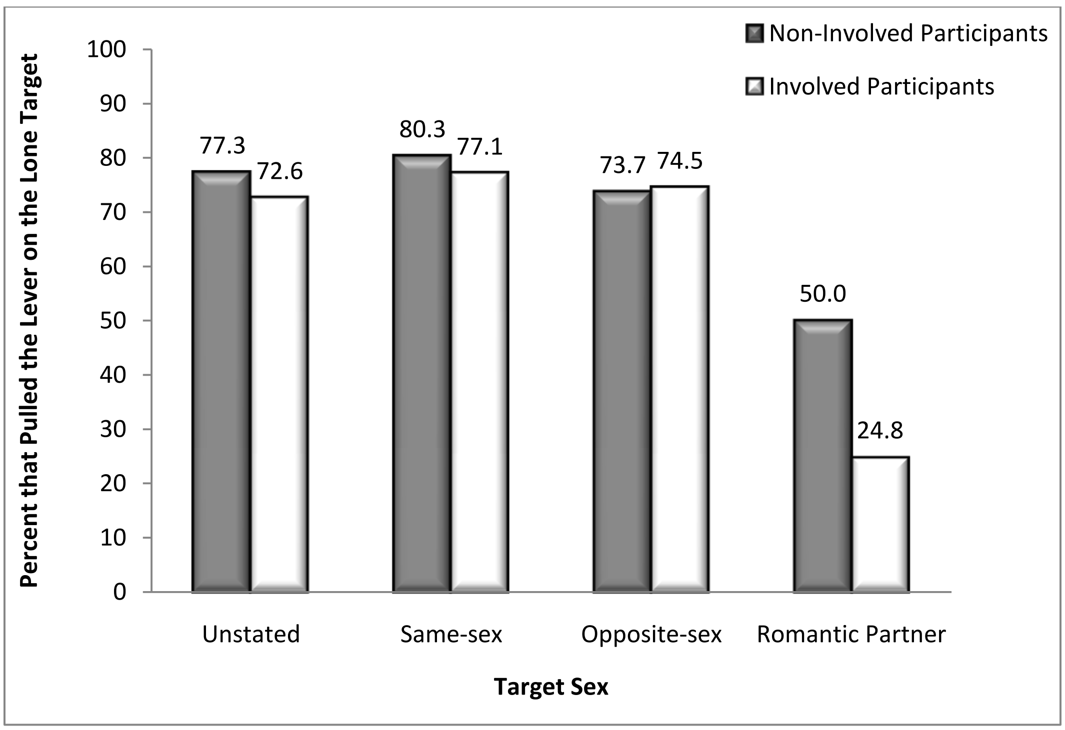

Figure 3. Study 2: Interactive effects of target sex and participant relationship involvement on likelihood of pulling the lever to sacrifice the lone target.

Table 4. Study 2: Logistic Regression Analysis of Participants' Decision to Pull the Lever on a Lone Target

Predictor	**β**	***SE* β**	**Wald's χ^2**	***df***	***p***	**e^{β} (odds ratio)**
Constant	-1.110	.211	27.782	1	.000	NA
Target sex = unstated	2.086	.303	47.413	1	.000	8.054
Target sex = same-sex	2.326	.314	55.022	1	.000	10.238
Target sex = opposite-sex	2.182	.310	49.639	1	.000	8.867
Target sex = romantic partner	----	----	----	0	----	----
Participant = not involved	1.110	.280	15.742	1	.000	3.033
Participant = involved	----	----	----	0	----	----
Target unstated, participant not inv.	-.862	.411	4.405	1	.036	.422
Target unstated, participant involved	----	----	----	0	----	----
Target same-sex, participant not inv.	-.921	.422	4.760	1	.029	.398
Target same-sex, participant involved	----	----	----	0	----	----
Target opp-sex, participant not inv.	-1.153	.411	7.880	1	.005	.316
Target opp-sex, participant involved	----	----	----	0	----	----
Target partner, participant not inv.	----	----	----	0	----	----
Target partner, participant involved	----	----	----	0	----	----

Final Reduced Model	**χ^2**	***df***	***p***
Overall model evaluation (against intercept-only model)			
Likelihood ratio test	135.591	7	.000
Model fitting criteria			
AIC	191.678	NA	NA
BIC	230.564		
-2 log likelihood	175.678		
Goodness-of-fit test			
Pearson chi-square	27.353	40	.936

Note. The last category of each predictor variable served as the reference category. For the dependent variable "pull the lever," the reference category is "No." Cox and Snell R^2 = .132. Nagelkerke R^2 = .184. For model with intercept only, AIC = 313.270, BIC = 318.130, and -2 log likelihood = 311.270. NA = not applicable.

Discussion

In two studies, we documented that people's hypothetical decisions follow the laws of Inclusive Fitness Theory. Participants appeared unwilling to sacrifice the life of a family member or reproductive partner, even when the alternative was to let five innocent people die. Our findings are particularly notable in light of our conservative between-subjects design and use of two distinct samples.

Although some might suggest that the use of hypothetical scenarios is a limitation of the present research, other researchers (e.g., Hauser, 2006) have noted that hypothetical moral dilemmas allow researchers to manipulate the very parameters they propose have an impact on moral decisions. Burning buildings and impending death of innocent victims do occur, but not predictably enough or close enough in time and space for researchers to chart their contexts and outcomes. Further, human ancestral environments involved warfare and raids, harsh environmental conditions, and tragic accidents with behavioral choices whose outcomes most certainly mirrored the Trolley Problem in its abstract form. Indeed, our participants told us they easily imagined themselves in the scenarios they read, and they frequently wanted to tell us about the exact person they had been asked to imagine. In future research we aim to test the hypothesis that the effects of target's genetic relatedness and reproductive opportunity are heightened when participants are placed under cognitive load, and minimized when emotional closeness to target is included as a covariate.

We conclude that the complex rules governing humans' moral intuitions surely lie in the interplay of our human evolutionary heritage, our individual dispositions, and the specific contextual factors of a given situation. Hypothetical dilemmas like the Trolley Problem provide an opportunity for psychologists and moral philosophers to collaborate in delineating how these factors interact to guide our moral attitudes and behaviors.

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