

# Perceived Similarity Explains Beliefs About Possibility

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No one has ever performed a successful brain transplant or traveled the Milky Way, but people often see these events as within the realm of possibility. Across six preregistered experiments ( $N = 1,472$ ) we explore whether American adults' beliefs about possibility are driven by perceptions of similarity to known events. We find that people's confidence in the possibility of hypothetical future events is strongly predicted by how similar they think the events are to events that have already happened. We find that perceived similarity explains possibility ratings better than how desirable people think the events are, or how morally good or bad they think it would be to accomplish them. We also show that similarity to past events is a better predictor of people's beliefs about future possibilities than counterfactual similarity or similarity to events in fiction. We find mixed evidence regarding whether prompting participants to consider similarity shifts their beliefs about possibility. Our findings suggest that people may reflexively use memories of known events to guide their inferences about what is possible.

## **Public Significance Statement**

Beliefs about what is possible constrain people's plans and expectations for the future and their willingness to believe what others tell them. We find that people's judgments about whether hypothetical future events are possible closely mirror their assessments of how similar the events are to things that have already happened. This suggests that rather than consider whether future events fit with, or violate, causal laws, people may often assess possibility by relying on memory.

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If we call prodigies or miracles whatever our reason cannot reach, how many of these appear continually to our eyes! Let us consider through what clouds and how gropingly we are led to the knowledge of most of the things that are right in our hands; assuredly we shall find that it is rather familiarity than knowledge that takes away their strangeness....—Michel de Montaigne

The ability to decide whether unfamiliar and strange events are possible is important. Recognizing the possibility of flight allowed the Wright brothers to realize outcomes that had been rejected out of hand by many others. By contrast, many would-be inventors labored in vain because they failed to see the impossibility of creating a perpetual motion machine. In daily life, people often judge that currently unattainable events, such as traversing the Milky Way or

performing a successful brain transplant, are within the realm of possibility, while they reject other events like time travel as impossible (Shtulman & Tong, 2013). How do people make these judgments?

Inferences about possibility sometimes depend on knowledge of causal circumstances. For example, when denying that an event is possible, adults often cite causal laws that would prevent it from happening (e.g., Shtulman, 2009; Shtulman & Tong, 2013; for related findings with children see Schult & Wellman, 1997; Woolley & Cornelius, 2017). But other mechanisms also contribute to people's reasoning about possibility. For instance, people are hesitant to endorse the possibility of events that violate moral rules or social customs (Phillips & Cushman, 2017; Shtulman & Tong, 2013; for findings in children see Chernyak et al., 2013; Cimpian & Salomon, 2014; Komatsu & Galotti, 1986). Some work suggests that adults may even

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Brandon Goulding served as lead for formal analysis, investigation, methodology, project administration, visualization, and writing—original

draft and served in a supporting role for resources. Ori Friedman served as lead for funding acquisition, and resources and served in a supporting role for writing—original draft. Brandon Goulding and Ori Friedman contributed equally to conceptualization, and writing—review and editing.

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struggle to imagine fictional events and worlds that violate their moral intuitions (Barnes & Black, 2016; Black & Barnes, 2020).

In this article, we explore another mechanism for judging possibility: similarity. Specifically, we examine whether people assess the possibility of events by considering whether they are similar to known events (Goulding & Friedman, 2021; Woolley & Ghossainy, 2013). If people think an event is akin to something that has already happened, they will say it is possible; if the event looks wholly unfamiliar, they will say it is impossible. For example, people may judge a brain transplant as possible because it is similar to a heart transplant, and may view traveling the Milky Way as possible because it is similar to traveling to the moon. Similarity has a long, and even controversial, history as an explanatory construct in psychology (e.g., Goodman, 1972; Medin et al., 1993), and has been proposed to underlie many aspects of cognition, including inductive reasoning (e.g., Heit, 2000; Heit & Rubinstein, 1994), category learning (e.g., Erickson & Kruschke, 1998; Namy & Gentner, 2002; Nosofsky, 1988), and social reasoning (e.g., Bian & Baillargeon, 2022; Siegrist et al., 2000). Nonetheless, it has not been viewed as central in accounts of how adults assess whether events are possible, as these judgments have instead been proposed to depend on causal reasoning and moral acceptability (e.g., McCoy & Ullman, 2019; Phillips & Cushman, 2017; Shtulman & Morgan, 2017; Shtulman & Phillips, 2018; Shtulman & Tong, 2013).

A comparable account was proposed by Michel de Montaigne, who wrote an essay in the 16th century addressing two accounts for inferring possibility. His accounts bear a striking resemblance to the causal-circumstances and similarity-based accounts. Regarding how we come to understand which events are possible rather than impossible, he advocated for familiarity over causal knowledge, asserting that “assuredly we shall find that it is rather familiarity than knowledge that takes away their strangeness” (Montaigne, 1958). Our account follows his in suggesting that perceiving an event as being *like* something known is more likely to lead people to affirm it than knowing *how* it might occur. This said, familiarity and similarity are not interchangeable; for instance, things can feel familiar simply because they were processed more quickly (Song & Schwarz, 2009; Westerman et al., 2015). Also, familiarity increases with multiple exposures to something, whereas this may be less relevant for similarity. Our similarity account also resembles the availability heuristic (Tversky & Kahneman, 1973), but involves recalling events that are only *similar* to the event in question rather than an instance of the event itself.

Our suggestion that people judge possibility by comparing potential events to known events assumes that people draw on their memories and knowledge of what has happened when confronted with hypothetical future outcomes. When people attempt to guess what their *own* uncertain futures will be like, they often draw on episodic memories and attempt to preexperience future events (Atance & O'Neill, 2001; Schacter et al., 2017; Tulving, 2005). This seems like a plausible approach to inferring how personal future events will unfold, like going to a new dentist or visiting a new country. However, people may look beyond episodic memory when thinking about the possibility of future brain transplants and intergalactic travel. When reasoning about these kinds of hypotheticals, people may also rely on their semantic knowledge of what has already happened (Atance & O'Neill, 2001), including information learned from sources like books, TV, the internet, and the news. Indeed, people’s confidence that events really happened may vary depending on

where and how they learned about them (see Danovitch & Lane, 2020; Lane et al., 2018). Here, we argue that people may draw on information from *any* of these sources to identify whether a target event is similar to something known to have occurred.

One reason to suspect that similarity to known events affects people’s beliefs about possibility is because people may often have no other basis for determining whether events are possible. For example, events like living for 120 years and living for 200 years receive markedly different possibility ratings (Shtulman, 2009; Shtulman & Tong, 2013). But most people are unlikely to know the causal principles that might prevent (or enable) one outcome but not the other. Instead, the difference could arise because people know of individuals living to ages approaching 120 years, but not to ages approaching 200. This is especially likely to be true when people affirm hypothetical future events, like brain transplants and intergalactic travel (Shtulman & Tong, 2013). The circumstances that might enable these events *cannot* be known, as these events have yet to occur and cannot currently be enabled. But they may *resemble* events that have already happened; for instance, a brain transplant might seem similar to a heart transplant, and intergalactic travel may seem similar to visiting the Moon or sending a probe beyond our solar system.

Recent work suggests that children use a similarity-based strategy to infer the possibility of improbable events. Young children normally deny the possibility of unusual events like a person drinking onion juice or catching a fly with chopsticks (Shtulman, 2009; Shtulman & Carey, 2007; also see Cook & Sobel, 2011; Lane et al., 2016). However, 5- and 6-year-olds will often affirm the events are possible if they are first informed about similar events; for instance, they are more likely to say that a person could have a pet zebra if they first learn about a person who has a pet elephant (Goulding & Friedman, 2021). Related work has found that similarity may also affect adults’ judgments of possibility, but in a *different* way than proposed here. In line with philosophical accounts of counterfactuals (see Starr, 2019), adults are more likely to judge alternative, counterfactual worlds (e.g., a world in which fire freezes) as plausible if they also see these worlds as being similar to reality (De Brigard et al., 2021). They are also more likely to say that counterfactual outcomes could have occurred (e.g., getting a better grade on an exam) if they view that outcome as similar to what actually happened (Stanley et al., 2017). But the present experiments are the first to explore whether adults use knowledge of similar events to infer whether extraordinary events are possible in reality.

## The Current Experiments

In six experiments, we explore whether people’s beliefs about the possibility of future events are explained by how similar they think the events are to things that have already happened. These events have never been accomplished, and the causal forces that might enable them are unknown. To this end, we asked adults to rate how similar they thought events were to events that have happened in the past, and how confident they were that the events could actually happen in the future. We then measured how well similarity ratings predicted possibility ratings. Experiment 1 explores this with a between-subjects design, and also compares how well possibility ratings are predicted by the events’ perceived desirability. Experiment 2 explores the relation between similarity and possibility in a fully within-subjects design, and investigates whether thinking about similarity promotes

greater belief in possibility. Experiment 3 compares how well the perceived similarity, desirability, and morality of an event can explain people's possibility judgments, and whether thinking about these three aspects of an event shifts people's beliefs about its possibility. Experiments 4 and 5 replicate the relation between similarity and possibility ratings with two additional sets of items. Finally, Experiment 6 compares our similarity account with two other ways people might consider similarity in inferring possibility.

In all experiments, we measured beliefs about possibility by asking participants to indicate their confidence that events could actually happen. We asked for confidence ratings because we wanted to capture a gradient in people's beliefs about what is possible, but also wanted to minimize the concern that our measure would capture something else. For instance, we worried that asking "How possible is this event?" might instead track judgments about the *probability* of events occurring—such judgments might result in low ratings for events that are entirely possible but very unusual.<sup>1</sup>

Throughout these experiments, we compared judgments of similarity to judgments of desirability (i.e., whether participants wanted the events to occur) and judgments of morality (i.e., whether participants thought the events ought to occur). We did this to discover whether similarity to known events was a uniquely strong predictor of possibility judgments. People generally have an optimism bias and expect good outcomes to be more likely than bad ones (see Sharot, 2011). People are also more likely to reject the possibility of events if they view them as morally undesirable (Phillips & Cushman, 2017), and may even use feelings of morality to guide inferences about an event's possibility (Acierno et al., 2022). We, therefore, expected that these judgments might predict beliefs about future possibilities. However, we predicted that similarity would best predict people's confidence that events could occur.

## General Method

In each experiment, we sought to recruit enough participants so that we would have approximately 100 participants per between-subjects condition. We based this target on recent work that used similar designs (e.g., Bear et al., 2020; De Brigard et al., 2021). All participants were residents of the United States and tested using Qualtrics and CloudResearch. We used the "block low-quality participants" option and required participants to have a HIT approval rate of 95%–100% over at least 100 prior HITs. From Experiment 2 onward, we blocked individuals who had completed any prior experiment in the series. After completing the main task in each experiment, participants answered multiple-choice attention checks and questions about their age and gender.

All analyses were performed in R. Experiment 1 used the base "lm" function for the main analyses. The other experiments used the "lme4" package (Bates et al., 2015) to run linear mixed-effects regressions (LMERs), and packages "geepack" (Højsgaard et al., 2006) and "emmeans" (Lenth et al., 2018) to run generalized estimating equations (GEEs) models and pairwise tests comparing responses across conditions. All LMERs included participant and event as random intercepts. The *p*-values for all LMERs were estimated using the "afex" package (Singmann et al., 2022). Model comparisons were performed using the "AICmodavg" package (Mazerolle, 2020); this approach was inspired by Bear et al. (2020). The trendlines in each figure are derived from the main analyses, as are the ribbons representing 95% CIs; these are plotted with the "ggeffects" package (Lüdecke, 2018).

## Transparency and Openness

Preregistrations, data, supplemental materials, and code for all experiments are available on OSF at <https://osf.io/k7t9x>. Studies received approval from the Office of Research Ethics at the University of Waterloo. In all experiments, we disclose all measures, manipulations, and exclusions.

## Experiment 1

### Method

#### Participants

We tested 326 participants ( $M_{age} = 40$  years, range = 19–74 years, 178 male, 145 female, and three participants indicating "other or prefer not to answer"). We excluded an additional 23 participants for failing attention checks (described below).

#### Procedure

Participants were randomly assigned to one of three between-subjects conditions: possibility, similarity, or desirability. In each condition, participants first read that they would see a list of events that humanity might accomplish in the future. The instructions then explained that participants would either indicate their confidence that the events could actually happen (possibility), how similar the events were to things that have already been accomplished (similarity), or how much the participants would want humanity to actually achieve the events (desirability).

Participants then rated each of the 16 events from Shtulman and Tong (2013) on a scale ranging from 0 to 100; see Figure 1. They rated with a slider initially anchored at 50. Each event appeared on a separate screen. Instructions above each item reminded participants what they were rating (e.g., "How confident are you that this thing could actually happen?") and explained the meaning of the scale endpoints (e.g., "Note that 0% means that it definitely can't happen, and 100% means it definitely can").

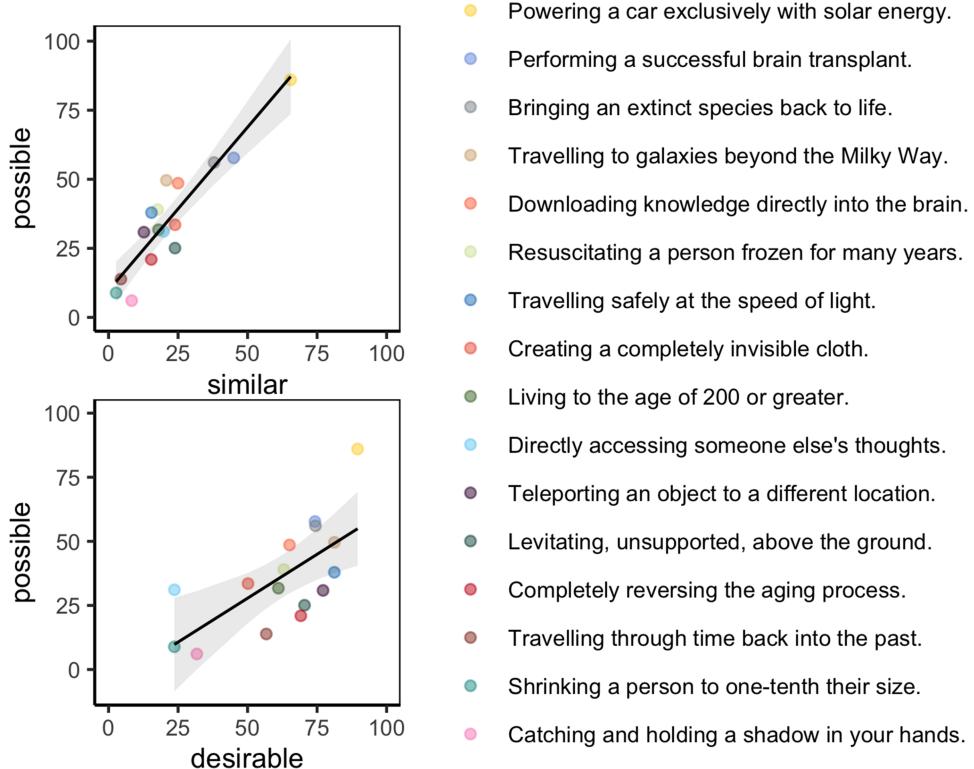
After completing the main task, participants saw a further slider question instructing them to place the slider between 15 and 25 on scale. Following this, participants were asked two multiple-choice questions confirming they had read the main instructions and events carefully ("In this survey, which question were you asked?" and "Which thing were you not asked about?"). Participants were excluded if they failed any of these checks or if they responded to fewer than 14 of the 16 items.

## Results

We explored whether people's confidence in the possibility of future events is explained by how similar they think the events are to past accomplishments, and by how desirable they think the events are. To this end, we ran three linear regressions to see how well each

<sup>1</sup> These concerns raise the question of whether possibility judgments might always incorporate considerations of probability. One reason to suspect otherwise, though, is that people see some impossible events as more impossible than others (McCoy & Ullman, 2019; Shtulman & Morgan, 2017). For example, people think it is more impossible to walk through a wall made of stone than to walk through one made of wood, even though they would likely say that walking through both walls is strictly impossible (i.e., zero probability of happening).

**Figure 1**  
*Findings of Experiment 1*



*Note.* Top left shows a scatterplot of the relationship between similarity and possibility, while the bottom left shows the same for desirability and possibility. The legend lists all 16 events in descending order of possibility. See the online article for the color version of this figure.

event's *average* possibility rating was predicted by: (a) its average similarity rating, (b) its average desirability rating, and (c) similarity and desirability together; see Figure 1.

People's overall confidence that events could happen was predicted by how similar the events were viewed to previous accomplishments,  $b = 1.18$ ,  $SE = 0.14$ ,  $p < .001$ , and by how desirable the events were,  $b = 0.69$ ,  $SE = 0.20$ ,  $p = .004$ . In the model where both factors jointly predicted possibility, similarity was the strongest predictor,  $b = 1.00$ ,  $SE = 0.15$ ,  $p < .001$ , though desirability also accounted for variance in possibility ratings,  $b = 0.25$ ,  $SE = 0.11$ ,  $p = .046$ . These models were compared using the Akaike Information Criterion (AIC), following the convention that models with a delta-AIC of 2 or greater have weaker explanatory power than the best model (Burnham & Anderson, 2004). The joint model best explained possibility judgments, AIC = 118.10, though the similarity-only model was substantially supported, AIC = 119.53,  $\Delta$ AIC = 1.43. The desirability-only model was not supported, AIC = 139.01,  $\Delta$ AIC = 20.91.

## Discussion

People's confidence that events could happen in the future was better predicted by the participants' perceived similarity of these events to previous accomplishments than by their beliefs about whether the events were desirable. These findings provide preliminary support for the similarity account. However, because the

analyses used ratings averaged across participants, we cannot be sure this strong link between possibility and similarity emerges for *individual* participants (see Monin & Oppenheimer, 2005). Also, because our analyses were correlational, we cannot be sure that perceived similarity causally influenced people's possibility judgments. To address these limitations, the next experiment used a within-subjects design to examine whether similarity ratings predict possibility ratings. This experiment also explores whether assessing similarity first affects subsequent possibility judgments.

## Experiment 2

### Method

#### Participants

We tested 205 participants ( $M_{age} = 38$  years, range = 20–73 years, 113 male, 91 female, and one participant who did not respond to the gender question). We excluded an additional 45 participants for failing attention checks (described below).

#### Procedure

The experiment used a within-subjects design, where each participant provided both possibility ratings and similarity ratings for the 16 events. These judgments were given in separate blocks; participants completed all judgments of one type before commencing judgments of

the other type. The presentation order of the two blocks was randomized across participants. In contrast with the first experiment, participants saw and rated eight events on each screen. The presentation of the events was randomized across blocks and participants. As before, instructions at the top of the screen reminded participants what they were rating (e.g., "How confident are you that this thing could actually happen?") and explained the meaning of the scale endpoints.

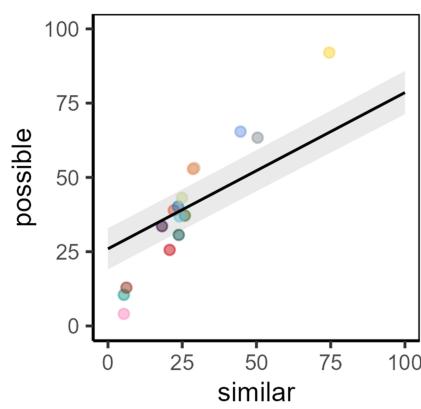
After completing the main task, participants were asked two multiple-choice questions confirming they had read the instructions and events carefully: "In this survey, which question were you asked first?" and "Which thing were you not asked about?". Participants were excluded if they failed either of these checks or if they responded to fewer than 30 of the 32 items in the main experiment. As preregistered, we also excluded participants based on their responses to two questions in the possibility condition. To be included in the experiment, participants had to give a possibility rating exceeding 50 for "Powering a car exclusively with solar energy," and a rating under 50 for "Catching and holding a shadow in your hands."

## Results

We ran an LMER to determine whether similarity ratings predicted possibility ratings (see Figure 2). People were more confident in the possibility of events that they thought were more similar to past accomplishments,  $b = 0.53$ ,  $SE = 0.02$ ,  $p < .001$ .

We then ran an exploratory GEE (Gaussian) to see if thinking about similarity *first* shifted participants' ratings of possibility relative to baseline. We did this by entering block (first-block, second-block)

**Figure 2**  
*Findings of Experiment 2*



and judgment (similarity, possibility) as predictors of participants' ratings, and we also included item as a factor. We found that ratings were higher in the second than the first block,  $F(1) = 48.54$ ,  $p < .001$ . However, this effect was not significantly greater for possibility than similarity ratings; there was no two-way interaction between block and judgment,  $F(15) = 1.72$ ,  $p = .189$ , and no three-way interaction between these factors and item,  $F(15) = 1.14$ ,  $p < .309$ .

## Discussion

People's confidence in the possibility of future events was predicted by how similar they thought the events were to previous accomplishments. We also examined whether assessments of possibility are impacted by considering similarity, but the findings provided no support for this.

In our next experiment, we explored this question further, and also examined whether similarity better predicts possibility judgments than two other predictors, desirability of outcome (as we examined in Experiment 1 using a between-subject design) and morality of outcomes.

## Experiment 3

### Method

#### Participants

We tested 283 participants ( $M_{age} = 40$  years, range = 21–76 years, 130 male, 148 female, and five participants indicating "other or prefer

- Powering a car exclusively with solar energy.
- Bringing an extinct species back to life.
- Performing a successful brain transplant.
- Travelling to galaxies beyond the Milky Way.
- Downloading knowledge directly into the brain.
- Resuscitating a person frozen for many years.
- Living to the age of 200 or greater.
- Directly accessing someone else's thoughts.
- Creating a completely invisible cloth.
- Travelling safely at the speed of light.
- Teleporting an object to a different location.
- Completely reversing the aging process.
- Levitating, unsupported, above the ground.
- Travelling through time back into the past.
- Shrinking a person to one-tenth their size.
- Catching and holding a shadow in your hands.

*Note.* Scatterplot of the relationship between similarity and possibility; the legend shows all 16 events in descending order of possibility. See the online article for the color version of this figure.

not to answer"). We excluded an additional 67 participants for failing attention checks (described below).

### Procedure

Participants first rated the 16 events in one of three between-subjects conditions: they either rated how similar the events are to things people have already accomplished (similarity), how much they would like the events to be achieved (desirability), or how moral it would be to accomplish the events (morality). Participants in each condition then gave possibility ratings for the 16 items.

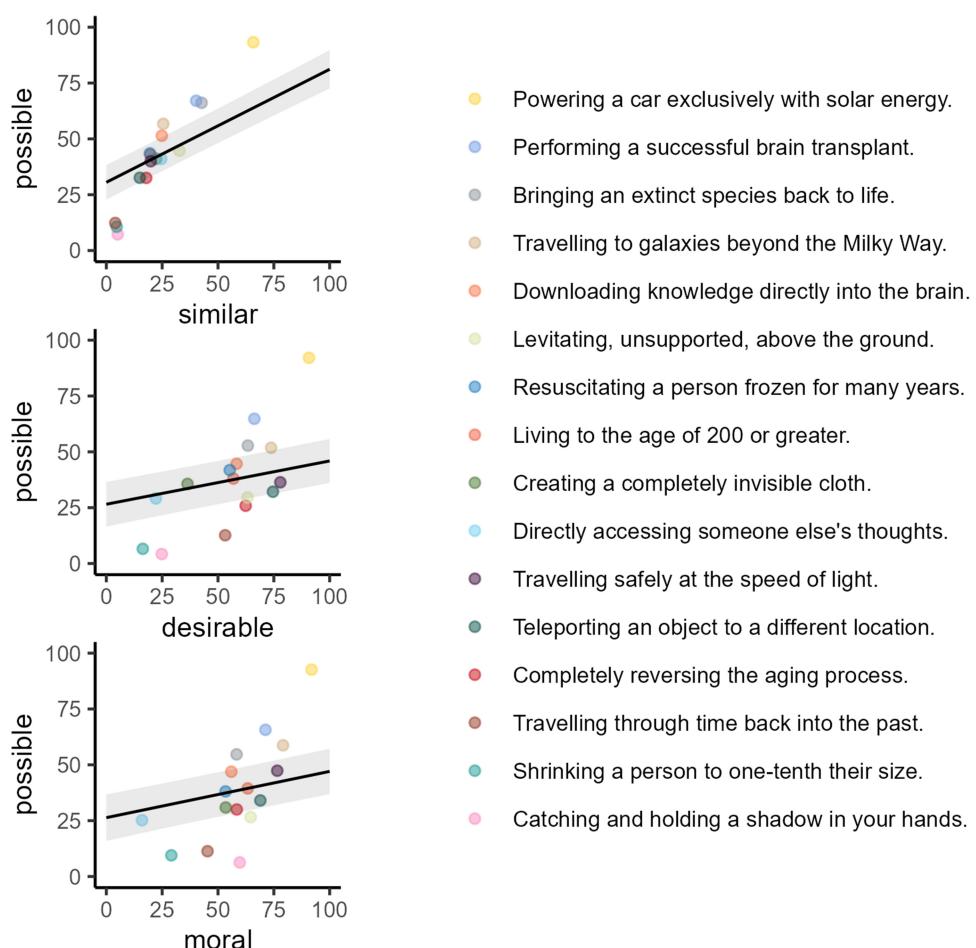
As in the previous experiment, participants saw the events in groups of eight, beneath instructions reminding them of the rating dimension and the meaning of the scale endpoints. As before, the presentation order of the items was randomized across blocks and participants. This experiment also used the same comprehension checks and exclusion criteria as the previous experiment.

### Results

We ran three separate LMERs to see how well people's similarity, desirability, and morality ratings for the 16 events explained their confidence that the events could happen in the future; see Figure 3. All three ratings significantly predicted beliefs about possibility: people were more confident that events could happen if they viewed the events as being more similar to past accomplishments,  $b = 0.51$ ,  $SE = 0.03$ ,  $p < .001$ , if they viewed the events to be more desirable outcomes,  $b = 0.19$ ,  $SE = 0.02$ ,  $p < .001$ , and if they viewed the events as more morally good,  $b = 0.21$ ,  $SE = 0.03$ ,  $p < .001$ . The model comparison showed that similarity was the strongest predictor of possibility ratings, AIC = 13,423, followed by desirability, AIC = 13,643,  $\Delta$ AIC = 220, and lastly by morality, AIC = 14,825,  $\Delta$ AIC = 1,402. Neither the desirability nor morality model was substantially supported relative to the best (similarity) model.

We then ran a GEE (Gaussian) to determine how participants' first judgment (similarity, desirability, morality) affected their

**Figure 3**  
*Findings of Experiment 3*



*Note.* Scatterplots show how similarity, desirability, and morality predict possibility ratings. The legend is derived from the top plot and shows all 16 events in descending order of possibility (but note that this order differs slightly in the other two plots). See the online article for the color version of this figure.

subsequent possibility ratings, with item included as an additional predictor; see [Figure S1 in the online materials](#) on OSF. The main effect of first judgment was not significant,  $F(2) = 2.53$ ,  $p = .079$ , but there was a main effect of the item,  $F(15) = 617.03$ ,  $p < .001$ , and an interaction between the two,  $F(30) = 2.50$ ,  $p < .001$ . Tukey post hoc tests showed that ratings were higher for three items after first considering similarity than after considering desirability or morality: “Bringing an extinct species back to life,”  $p_{vs\text{-}desirability} = .014$ ,  $p_{vs\text{-}morality} = .033$ ; “Directly accessing someone else’s thoughts,”  $p_{vs\text{-}desirability} = .032$ ,  $p_{vs\text{-}morality} = .001$ ; and “Levitating, unsupported, above the ground,”  $p_{vs\text{-}desirability} = .005$ ,  $p_{vs\text{-}morality} < .001$ . The other 13 items had comparable ratings across all judgments, and ratings given after judging desirability or morality never differed,  $ps \geq .052$ .

## Discussion

Possibility was better predicted by ratings of similarity than by ratings of desirability and morality. Moreover, three events were rated more possible when participants first considered their similarity to previous accomplishments, compared with when participants first assessed the desirability and the morality of accomplishing the events. This provides some causal evidence that considering similarity impacts assessments of possibility.

One limitation of the experiments so far, though, is that they used a restricted range of items—the 16 events from [Shtulman and Tong \(2013\)](#). The next two experiments therefore examined if our main findings would extend to possibility judgments for other events. In these experiments, participants rated the possibility of a different set of events, and we examined if these judgments were better

predicted by ratings of the events’ similarity to known events, or by ratings of the desirability of the events.

## Experiments 4 and 5

### Method

#### Participants

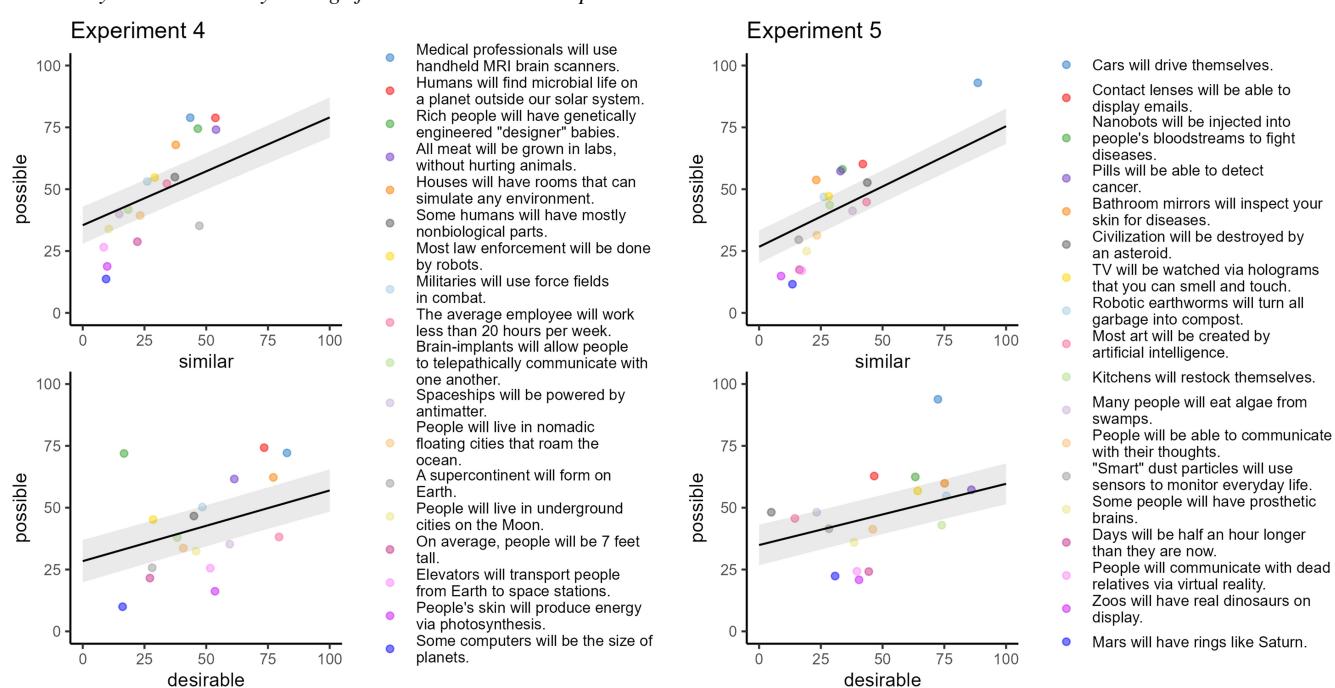
In Experiment 4, we tested 179 participants ( $M_{age} = 40$  years, range = 20–69 years, 105 male, 73 female, and one participant indicating “other or prefer not to answer”). We excluded an additional 71 participants for failing attention checks. In Experiment 5, we tested 193 participants ( $M_{age} = 40$  years, range = 19–76 years, 93 male, 98 female, and two participants indicating “other or prefer not to answer”). We excluded an additional 56 participants for failing attention checks.

### Procedure

In both experiments, participants were randomly assigned to one of two between-subjects conditions: they either gave possibility and similarity ratings for events, or they gave possibility and desirability ratings. Judgment order within each condition was randomized: participants either completed a block of possibility judgments first or a block for the other judgment type (similarity or desirability). In each block, participants rated 20 items: 18 were test items, and the other two items were taken from the previous experiments and included as attention checks (see below).

The 18 test items differed across these two experiments (see [Figure 4](#)). We generated both sets by visiting websites with predictions of things that might be possible in the future. The items in Experiment

**Figure 4**  
*Possibility and Desirability Ratings for Each Item From Experiments 4 and 5*



*Note.* Legends are derived from top plots and show events in descending order of possibility. See the online article for the color version of this figure.

4 were generated by modifying items from <https://futuretimeline.net/>, and items in Experiment 5 were taken from <https://bestlifeonline.com/crazy-future-predictions/>. As before, the presentation order of the items was randomized across blocks and participants. This experiment also used the same comprehension checks and exclusion criteria as the previous experiment. To this end, we included the Shtulman and Tong (2013) items about a solar-powered car and catching a shadow as attention checks. As before, inclusion required ratings for the car to be over 50, and ratings for the shadow to be under it. We did not include these items in our analyses.

## Results

For each experiment, we ran two LMERs to determine whether similarity and desirability ratings predicted judgments of possibility. We then compared the models to determine whether similarity or desirability was the better predictor for each item set. In both experiments, people were more likely to affirm events if they viewed the events as similar to things that have already happened: Experiment 4,  $b = 0.44$ ,  $SE = 0.03$ ,  $p < .001$ ; Experiment 5,  $b = 0.49$ ,  $SE = 0.02$ ,  $p < .001$ . They were also more likely to affirm events that were more desirable: Experiment 4,  $b = 0.29$ ,  $SE = 0.02$ ,  $p < .001$ ; Experiment 5,  $b = 0.25$ ,  $SE = 0.02$ ,  $p < .001$ . However, model comparisons showed that similarity was a stronger predictor than desirability for both item sets: Experiment 4,  $AIC_{\text{similar}} = 14,023$ ,  $AIC_{\text{desirable}} = 15,851$ ,  $\Delta AIC = 1,829$ ; Experiment 5,  $AIC_{\text{similar}} = 15,242$ ,  $AIC_{\text{desirable}} = 17,277$ ,  $\Delta AIC = 2,034$ . Neither desirability model was substantially supported relative to the similarity models.

## Discussion

Possibility was again better predicted by ratings of similarity than by ratings of desirability. Because these experiments used two new sets of items, they show that the relation between future possibility and similarity to known events is not restricted to the item set used in Experiments 1–3.

The findings so far support our proposal that people often judge whether events are possible by considering their similarity to known events. However, similarity could also be implicated in possibility judgments in other ways. People might also judge whether events are possible by assessing the extent to which the real world is similar to a counterfactual world in which the events are true (for related findings, see De Brigard et al., 2021). Judgments of possibility could likewise be influenced by considering similarity to events described in different kinds of fiction—for example, people might think that travel to distant galaxies is possible because this is common in science fiction. The findings so far do not compare our similarity account against these other similarity-based approaches. Hence, we did this in our final experiment (Figure 5).

## Experiment 6

### Method

#### Participants

We tested 286 participants ( $M_{\text{age}} = 41$  years, range = 18–84 years, 145 male, 138 female, and three participants indicating “other or

prefer not to answer”). We excluded an additional 64 participants for failing attention checks (described below).

### Procedure

Participants first rated the possibility of the 16 events from Shtulman and Tong (2013). They then provided further ratings in a second block in one of three between-subjects conditions: they either rated how similar the events are to things that have already happened (past similarity); how similar the world would be, to how it actually is, if the events happened (counterfactual similarity); or how similar the events are to things that occur in different kinds of fiction including books, movies, and television shows (fictional similarity).

The counterfactual similarity question, where people are asked to consider whether the world would look different if an event happened, was based on previous work and has been shown to track beliefs about event possibility (De Brigard et al., 2021). We were unsure whether participants would interpret this question as intended, or even treat it as meaningfully different from our past similarity question. Despite these uncertainties, we thought including it could help us identify whether perceived similarity to past events is a uniquely strong predictor of people’s beliefs about possibility.

Participants saw the events in groups of eight, beneath instructions reminding them of the rating dimension and the meaning of the scale endpoints. Presentation order of the items was randomized across blocks and participants. This experiment also used the same comprehension checks and exclusion criteria as the previous experiment.

## Results

We ran three LMERs to determine which kind of similarity best-predicted judgments of possibility. People more strongly affirmed events if they viewed the events as similar to things that have already happened,  $b = 0.51$ ,  $SE = 0.03$ ,  $p < .001$ , if they thought the world would look similar if the event occurred,  $b = 0.24$ ,  $SE = 0.02$ ,  $p < .001$ , and if they thought the events were similar to fictional ones,  $b = 0.12$ ,  $SE = 0.02$ ,  $p < .001$ .<sup>2</sup> We then compared all three models. Past similarity was the strongest predictor of possibility ratings,  $AIC = 12,991$ , followed by counterfactual similarity,  $AIC = 14,438$ ,  $\Delta AIC = 1,446$ , and lastly by fictional similarity,  $AIC = 14,746$ ,  $\Delta AIC = 1,755$ . Neither the counterfactual similarity nor fictional similarity model was substantially supported relative to the best (past similarity) model.

## Discussion

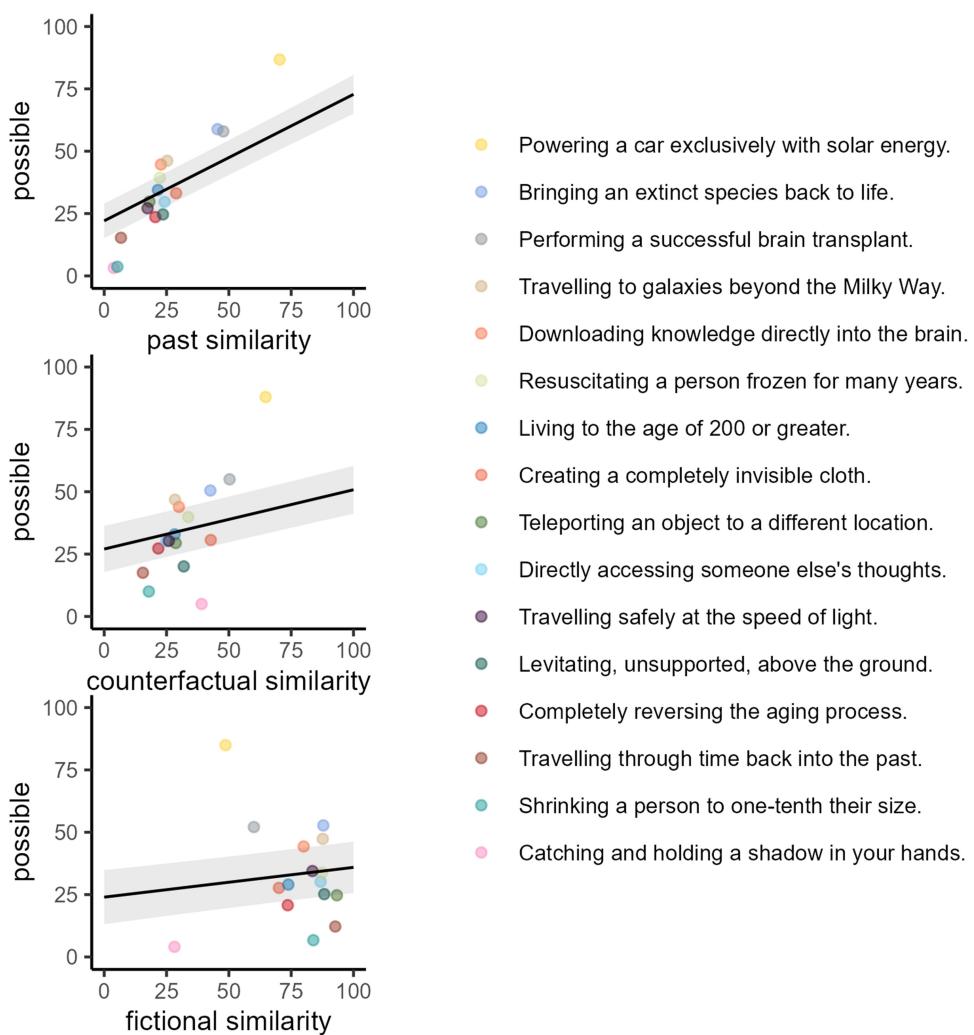
As in the previous experiment, judgments of possibility were most strongly predicted by similarity to known events. However, possibility was also predicted by two other kinds of similarity—the similarity between the actual world and counterfactual worlds where the various events are true, and the similarity between the events and those encountered in fiction. We further discuss these findings below.

## General Discussion

Across six experiments, adults were more likely to say that future events were possible if they viewed the events as similar to past

<sup>2</sup> The  $p$ -value for similarity to fiction was nonsignificant ( $p = .064$ ) when event was not included as a random intercept.

**Figure 5**  
*Findings of Experiment 6*



*Note.* Scatterplots show how past similarity, counterfactual similarity, and fictional similarity predict possibility ratings. The legend is derived from the top plot and shows all 16 events in descending order of possibility (but note that this order differs in the other two plots). See the online article for the color version of this figure.

events. We also found that beliefs about possibility were better predicted by similarity to past events than by participants' feelings about whether the events were desirable or morally good. Further, we found that past similarity was a better predictor of possibility ratings than counterfactual similarity or similarity to events in fiction.

Our findings provide evidence that beliefs about whether events are possible are often driven by assessments of how similar they are to known events. Considered together with recent developmental work, these findings also suggest that this way of assessing possibility may operate across the lifespan. Specifically, recent work suggests that young children also use this similarity-based strategy when deciding whether events are possible (e.g., Bowman-Smith et al., 2019; Goulding & Friedman, 2020, 2021). It might seem very odd to suggest that the same strategy underlies possibility judgments in both children and adults! After all, children and adults reach very different conclusions about whether events are possible—children often deny

the possibility of unusual events that adults overwhelmingly affirm (Cook & Sobel, 2011; Shtulman, 2009; Shtulman & Carey, 2007; Shtulman & Phillips, 2018). However, the account predicts such differences. Adults have more first- and second-hand knowledge than children, so they have more memories and knowledge to call to mind. Also, children and adults may differ in their ability to search memory for similar events (see Levy & Anderson, 2002) and may also differ in their ability to compare target events to known events (Chen, 1996; Chen & Klahr, 2008; see also Medin et al., 1993).

Besides finding that beliefs about possibility are predicted by similarity to known events, we also found that these beliefs are predicted (albeit less strongly) by both desirability and morality, and by counterfactual similarity. These findings are broadly consistent with previous work revealing connections between reasoning about possibility in both moral judgment (Phillips & Cushman, 2017; Shtulman & Phillips, 2018; Shtulman & Tong, 2013) and adhering

to social norms (Chernyak et al., 2019; Tworek & Cimpian, 2016), and with work linking possibility judgments to simulating counterfactual worlds (De Brigard et al., 2021). Our aim was not to show that people do not consider these things when reasoning about possibility—indeed, we demonstrate that morality and desirability consistently predict people's possibility judgments. Instead, we aimed to discover whether past similarity is as an *especially* powerful predictor of beliefs about possibility. Our findings suggest that it is.

Possibility was also predicted by the similarity between the target events and events encountered in fiction. This suggests that people's engagement with fiction might affect their understanding of what is possible. One reason is that events from fiction may be misremembered as true (Appel & Richter, 2007; Fazio & Marsh, 2008; Hopkins & Weisberg, 2017; Marsh & Fazio, 2006; Rapp et al., 2014), leading people to confuse their real-world and fictional knowledge about what has already occurred. However, another possibility is that people expect events common in science fiction to represent realistic expectations about the future. Most of our events—especially those from Shtulman and Tong (2013)—are direct references to tropes in science fiction; for instance, many movies and TV series prominently feature humans who have been frozen and later reanimated (e.g., the Alien films, Avatar, the Captain America films, Futurama, Star Wars), and bringing an extinct species back to life is a central element of the Jurassic Park franchise. People may come to view these events as reflecting genuine future predictions rather than fantastical scenarios, especially since science fiction stories are often explicitly set in the near or distant future.

We also examined whether asking participants to consider similarity to known events shifts their beliefs about possibility. These findings were mixed. We found no evidence in the second experiment. But in the third experiment, thinking about similarity increased participants' confidence in the possibility of three of the 16 events. This manipulation was inspired by work showing that considering similarity or dissimilarity shifts beliefs about the possibility of counterfactual worlds (De Brigard et al., 2021). However, these effects were not strongly predicted by our similarity account. It holds that adults judge whether events are possible by *spontaneously* attempting to call similar events to mind. So there may be no further effect of attempting to jumpstart this process.

While our findings suggest that people judged possibility on the basis of similarity to known events, this is clearly not the only way that people judge whether events are possible. As noted in the Introduction, inferences about possibility often depend on knowledge of causality, and adults and children alike often cite causal laws when explaining why events can or cannot happen (e.g., Shtulman, 2009; Shtulman & Tong, 2013). Our main aim here was to investigate how adults assess possibility when detailed causal knowledge is unlikely to suffice. Again, the events we asked about have not yet happened even once, and no one knows for sure how or when they could ever occur. Moreover, most people do not know enough about the kinds of events we asked about to even hazard guesses based on causal knowledge. For example, most people do not know enough about the determinants of longevity to consider factors that would enable a person to live to 120 but not 200 (see Rozenblit & Keil, 2002). The same is likely true of bloodstream nanobots and space elevators—yet people mostly affirmed the nanobots, but denied the elevators. Our suggestion is that nanobots feel more similar to known events than space elevators, despite both events being beyond our present causal understanding.

## Constraints on Generality

Our experiments mostly probed beliefs about events that were general and decontextualized—they were not described as involving specific individuals, locations, or times. Indeed, findings would likely differ with more specific events, as would happen if people considered whether the events could apply to their *own* futures. People often attempt to predict their own futures by drawing on episodic memories to preexperience events (Atance & O'Neill, 2001), and are especially likely to affirm events that are personally relevant or familiar (Ernst & D'Argembeau, 2017). So, people who endorse the possibility of humans living to age 200 might deny this outcome for themselves, due to using different strategies to reason about general versus specific possibilities. Further, increasing specificity in this way might allow people to draw on additional semantic knowledge, such as their current age and medical condition, and their sense of the current pace of medical progress. This limitation has a somewhat paradoxical implication: increasing similarity by adding context will sometimes decrease perceptions of possibility. For example, although people might readily agree that it will be possible for people in the future to discover new planets, they might disagree that it will be possible to discover new planets *in our solar system* even though adding this detail might seem to increase the similarity between the future accomplishment and what has already happened. As with other cases of adding context, specifying the location (i.e., our solar system) may allow people to consider additional information that undermines possibility.

A further constraint is that it is difficult to be sure whether our findings (and the conclusions they support) extend to people from other places and especially from other times. Although some work suggests that possibility judgments are stable across cultures (e.g., Davoodi et al., 2023; Gong & Shtulman, 2021), it is important to acknowledge that our participants were Americans living in the 21st century. This means they were all literate, had all received formal educations, and were all living in a time that has seen dramatic technological improvements. This also means that our participants were all probably familiar with at least some tropes from science fiction (e.g., time travel) and had likely considered ways the future might bring changes. Given all of this, our participants were equipped to understand the events we asked about regardless of whether they saw these as events as possible or not. But suppose we undertook time-travel ourselves and ran our experiments on people hundreds or thousands of years in the past. The events we asked about might make little sense to our participants (from long ago). And even if we could craft future events they would find intelligible, they might respond to them very differently. But the nature of this difference is difficult for us to anticipate.

## References

- Acierno, J., Mischel, S., & Phillips, J. (2022). Moral judgements reflect default representations of possibility. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 377(1866), Article 20210341. <https://doi.org/10.1098/rstb.2021.0341>
- Appel, M., & Richter, T. (2007). Persuasive effects of fictional narratives increase over time. *Media Psychology*, 10(1), 113–134. <https://doi.org/10.1080/15213260701301194>
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, 5(12), 533–539. [https://doi.org/10.1016/S1364-6613\(00\)01804-0](https://doi.org/10.1016/S1364-6613(00)01804-0)

- Barnes, J., & Black, J. (2016). Impossible or improbable: The difficulty of imagining morally deviant worlds. *Imagination, Cognition and Personality*, 36(1), 27–40. <https://doi.org/10.1177/0276236616643268>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Bear, A., Bensinger, S., Jara-Ettinger, J., Knobe, J., & Cushman, F. (2020). What comes to mind? *Cognition*, 194, Article 104057. <https://doi.org/10.1016/j.cognition.2019.104057>
- Bian, L., & Baillargeon, R. (2022). When are similar individuals a group? Early reasoning about similarity and in-group support. *Psychological Science*, 33(5), 752–764. <https://doi.org/10.1177/09567976211055185>
- Black, J. E., & Barnes, J. L. (2020). Morality and the imagination: Real-world moral beliefs interfere with imagining fictional content. *Philosophical Psychology*, 33(7), 1018–1044. <https://doi.org/10.1080/09515089.2020.1775799>
- Bowman-Smith, C. K., Shtulman, A., & Friedman, O. (2019). Distant lands make for distant possibilities: Children view improbable events as more possible in far-away locations. *Developmental Psychology*, 55(4), 722–728. <https://doi.org/10.1037/dev0000661>
- Burnham, K. P., & Anderson, D. R. (2004). Multimodel inference: understanding AIC and BIC in model selection. *Sociological Methods & Research*, 33(2), 261–304. <https://doi.org/https://doi.org/10.1177/0049124104268644>
- Chen, Z. (1996). Children's analogical problem solving: The effects of superficial, structural, and procedural similarity. *Journal of Experimental Child Psychology*, 62(3), 410–431. <https://doi.org/10.1006/jecp.1996.0037>
- Chen, Z., & Klahr, D. (2008). Remote transfer of scientific reasoning and problem-solving strategies in children. In R. V. Kail (Ed.), *Advances in child development and behavior* (Vol. 36, pp. 419–470). Elsevier. [https://doi.org/10.1016/S0065-2407\(08\)00010-4](https://doi.org/10.1016/S0065-2407(08)00010-4)
- Chernyak, N., Kang, C., & Kushnir, T. (2019). The cultural roots of free will beliefs: How Singaporean and U.S. children judge and explain possibilities for action in interpersonal contexts. *Developmental Psychology*, 55(4), 866–876. <https://doi.org/10.1037/dev0000670>
- Chernyak, N., Kushnir, T., Sullivan, K. M., & Wang, Q. (2013). A comparison of American and Nepalese children's concepts of freedom of choice and social constraint. *Cognitive Science*, 37(7), 1343–1355. <https://doi.org/10.1111/cogs.12046>
- Cimpian, A., & Salomon, E. (2014). The inference heuristic: An intuitive means of making sense of the world, and a potential precursor to psychological essentialism. *Behavioral and Brain Sciences*, 37(5), 461–480. <https://doi.org/10.1017/S0140525X13002197>
- Cook, C., & Sobel, D. M. (2011). Children's beliefs about the fantasy/reality status of hypothesized machines. *Developmental Science*, 14(1), 1–8. <https://doi.org/10.1111/j.1467-7687.2009.00949.x>
- Danovitch, J. H., & Lane, J. D. (2020). Children's belief in purported events: When claims reference hearsay, books, or the internet. *Journal of Experimental Child Psychology*, 193, Article 104808. <https://doi.org/10.1016/j.jecp.2020.104808>
- Davoodi, T., Jamshidi-Sianaki, M., Payir, A., Cui, Y. K., Clegg, J., McLoughlin, N., Harris, P. L., & Corriveau, K. H. (2023). Miraculous, magical, or mundane? The development of beliefs about stories with divine, magical, or realistic causation. *Memory & Cognition*, 51(3), 695–707. <https://doi.org/10.3758/s13421-021-01270-2>
- De Brigard, F., Henne, P., & Stanley, M. L. (2021). Perceived similarity of imagined possible worlds affects judgments of counterfactual plausibility. *Cognition*, 209, Article 104574. <https://doi.org/10.1016/j.cognition.2020.104574>
- Erickson, M. A., & Kruschke, J. K. (1998). Rules and exemplars in category learning. *Journal of Experimental Psychology: General*, 127(2), 107–140. <https://doi.org/10.1037/0096-3445.127.2.107>
- Ernst, A., & D'argembeau, A. (2017). Make it real: Belief in occurrence within episodic future thought. *Memory & Cognition*, 45(6), 1045–1061. <https://doi.org/10.3758/s13421-017-0714-3>
- Fazio, L. K., & Marsh, E. J. (2008). Older, not younger, children learn more false facts from stories. *Cognition*, 106(2), 1081–1089. <https://doi.org/10.1016/j.cognition.2007.04.012>
- Gong, T., & Shtulman, A. (2021). The plausible impossible: Chinese adults hold graded notions of impossibility. *Journal of Cognition and Culture*, 21(1-2), 76–93. <https://doi.org/10.1163/15685373-12340097>
- Goodman, N. (1972). *Problems and projects*. Bobbs-Merrill.
- Goulding, B. W., & Friedman, O. (2020). Children's beliefs about possibility differ across dreams, stories, and reality. *Child Development*, 91(6), 1843–1853. <https://doi.org/10.1111/cdev.13386>
- Goulding, B. W., & Friedman, O. (2021). A similarity heuristic in children's possibility judgments. *Child Development*, 92(2), 662–671. <https://doi.org/10.1111/cdev.13534>
- Heit, E. (2000). Properties of inductive reasoning. *Psychonomic Bulletin & Review*, 7(4), 569–592. <https://doi.org/10.3758/BF03212996>
- Heit, E., & Rubinstein, J. (1994). Similarity and property effects in inductive reasoning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 20(2), 411–422. <https://doi.org/10.1037/0278-7393.20.2.411>
- Højsgaard, S., Halekoh, U., & Yan, J. (2006). The R package geepack for generalized estimating equations. *Journal of Statistical Software*, 15(2), 1–11. <https://doi.org/10.18637/jss.v015.i02>
- Hopkins, E. J., & Weisberg, D. S. (2017). The youngest readers' dilemma: A review of children's learning from fictional sources. *Developmental Review*, 43, 48–70. <https://doi.org/10.1016/j.dr.2016.11.001>
- Komatsu, L. K., & Galotti, K. M. (1986). Children's reasoning about social, physical, and logical regularities: A look at two worlds. *Child Development*, 57(2), 413–420. <https://doi.org/10.2307/1130597>
- Lane, J. D., Ronfard, S., & El-Sherif, D. (2018). The influence of first-hand testimony and hearsay on children's belief in the improbable. *Child Development*, 89(4), 1133–1140. <https://doi.org/10.1111/cdev.12815>
- Lane, J. D., Ronfard, S., Francioli, S. P., & Harris, P. L. (2016). Children's imagination and belief: Prone to flights of fancy or grounded in reality? *Cognition*, 152, 127–140. <https://doi.org/10.1016/j.cognition.2016.03.022>
- Lenth, R., Singmann, H., Love, J., Buerkner, P., & Herve, M. (2018). Package 'emmeans' (R package version 1.8.5). <https://cran.r-project.org/web/packages/emmeans/index.html>
- Levy, B. J., & Anderson, M. C. (2002). Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Sciences*, 6(7), 299–305. [https://doi.org/10.1016/S1364-6613\(02\)01923-X](https://doi.org/10.1016/S1364-6613(02)01923-X)
- Lüdecke, D. (2018). Ggeffects: Tidy data frames of marginal effects from regression models. *Journal of Open Source Software*, 3(26), Article 772. <https://doi.org/10.21105/joss.00772>
- Marsh, E. J., & Fazio, L. K. (2006). Learning errors from fiction: Difficulties in reducing reliance on fictional stories. *Memory & Cognition*, 34(5), 1140–1149. <https://doi.org/10.3758/BF03193260>
- Mazerolle, M. J. (2020). *AICmodavg: Model selection and multimodel inference based on (Q)AIC(c)* (R package version 2.3- 1). <https://cran.r-project.org/package=AICmodavg>
- McCoy, J., & Ullman, T. (2019). Judgments of effort for magical violations of intuitive physics. *PLOS ONE*, 14(5), Article e0217513. <https://doi.org/10.1371/journal.pone.0217513>
- Medin, D. L., Goldstone, R. L., & Gentner, D. (1993). Respects for similarity. *Psychological Review*, 100(2), 254–278. <https://doi.org/10.1037/0033-295X.100.2.254>
- Monin, B., & Oppenheimer, D. M. (2005). Correlated averages vs. averaged correlations: Demonstrating the warm glow heuristic beyond aggregation. *Social Cognition*, 23(3), 257–278. <https://doi.org/10.1521/soco.2005.23.3.257>
- Montaigne, M. (1958). *The complete essays of montaigne* (D. Frame, Trans.). Stanford University Press.

- Namy, L. L., & Gentner, D. (2002). Making a silk purse out of two sow's ears: Young children's use of comparison in category learning. *Journal of Experimental Psychology: General*, 131(1), 5–15. <https://doi.org/10.1037/0096-3445.131.1.5>
- Nosofsky, R. M. (1988). Similarity, frequency, and category representations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14(1), 54–65. <https://doi.org/10.1037/0278-7393.14.1.54>
- Phillips, J., & Cushman, F. (2017). Morality constrains the default representation of what is possible. *Proceedings of the National Academy of Sciences*, 114(18), 4649–4654. <https://doi.org/10.1073/pnas.1619717114>
- Rapp, D. N., Hinze, S. R., Slaten, D. G., & Horton, W. S. (2014). Amazing stories: Acquiring and avoiding inaccurate information from fiction. *Discourse Processes*, 51(1-2), 50–74. <https://doi.org/10.1080/0163853X.2013.855048>
- Rozenblit, L., & Keil, F. (2002). The misunderstood limits of folk science: An illusion of explanatory depth. *Cognitive Science*, 26(5), 521–562. [https://doi.org/10.1207/s15516709cog2605\\_1](https://doi.org/10.1207/s15516709cog2605_1)
- Schacter, D. L., Benoit, R. G., & Szpunar, K. K. (2017). Episodic future thinking: Mechanisms and functions. *Current Opinion in Behavioral Sciences*, 17, 41–50. <https://doi.org/10.1016/j.cobeha.2017.06.002>
- Schult, C. A., & Wellman, H. M. (1997). Explaining human movements and actions: Children's understanding of the limits of psychological explanation. *Cognition*, 62(3), 291–324. [https://doi.org/10.1016/S0010-0277\(96\)00786-X](https://doi.org/10.1016/S0010-0277(96)00786-X)
- Sharot, T. (2011). The optimism bias. *Current Biology*, 21(23), R941–R945. <https://doi.org/10.1016/j.cub.2011.10.030>
- Shtulman, A. (2009). The development of possibility judgment within and across domains. *Cognitive Development*, 24(3), 293–309. <https://doi.org/10.1016/j.cogdev.2008.12.006>
- Shtulman, A., & Carey, S. (2007). Improbable or impossible? How children reason about the possibility of extraordinary events. *Child Development*, 78(3), 1015–1032. <https://doi.org/10.1111/j.1467-8624.2007.01047.x>
- Shtulman, A., & Morgan, C. (2017). The explanatory structure of unexplainable events: Causal constraints on magical reasoning. *Psychonomic Bulletin & Review*, 24(5), 1573–1585. <https://doi.org/10.3758/s13423-016-1206-3>
- Shtulman, A., & Phillips, J. (2018). Differentiating "could" from "should": Developmental changes in modal cognition. *Journal of Experimental Child Psychology*, 165, 161–182. <https://doi.org/10.1016/j.jecp.2017.05.012>
- Shtulman, A., & Tong, L. (2013). Cognitive parallels between moral judgment and modal judgment. *Psychonomic Bulletin & Review*, 20(6), 1327–1335. <https://doi.org/10.3758/s13423-013-0429-9>
- Siegrist, M., Cvetkovich, G., & Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. *Risk Analysis*, 20(3), 353–362. <https://doi.org/10.1111/0272-4332.203034>
- Singmann, H., Bolker, B., Westfall, J., Aust, F., & Ben-Shachar, M. (2022). *afex: Analysis of factorial experiments* (R package version 1.1-1). <https://CRAN.R-project.org/package=afex>
- Song, H., & Schwarz, N. (2009). If it's difficult to pronounce, it must be risky: Fluency, familiarity, and risk perception. *Psychological Science*, 20(2), 135–138. <https://doi.org/10.1111/j.1467-9280.2009.02267.x>
- Stanley, M. L., Stewart, G. W., & Brigard, F. D. (2017). Counterfactual plausibility and comparative similarity. *Cognitive Science*, 41, 1216–1228. <https://doi.org/10.1111/cogs.12451>
- Starr, W. (2019). Counterfactuals. In E. W. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Summer 2021 ed.). Stanford University. <https://plato.stanford.edu/entries/counterfactuals/#Bib>
- Tulving, E. (2005). Episodic memory and autonoiesis: Uniquely human? In H. S. Terrace & J. Metcalfe (Eds.), *The missing link in cognition: Origins of self-reflective consciousness* (pp. 3–56). Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195161564.003.0001>
- Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5(2), 207–232. [https://doi.org/10.1016/0010-0285\(73\)90033-9](https://doi.org/10.1016/0010-0285(73)90033-9)
- Tworek, C. M., & Cimpian, A. (2016). Why do people tend to infer "ought" from "is"? The role of biases in explanation. *Psychological Science*, 27(8), 1109–1122. <https://doi.org/10.1177/0956797616650875>
- Westerman, D. L., Lanska, M., & Olds, J. M. (2015). The effect of processing fluency on impressions of familiarity and liking. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 41(2), 426–438. <https://doi.org/10.1037/a0038356>
- Woolley, J. D., & Cornelius, C. A. (2017). Wondering how: Children's and adults' explanations for mundane, improbable, and extraordinary events. *Psychonomic Bulletin & Review*, 24(5), 1586–1596. <https://doi.org/10.3758/s13423-016-1127-1>
- Woolley, J. D., & Ghossainy, M. E. (2013). Revisiting the fantasy–reality distinction: Children as naïve skeptics. *Child Development*, 84(5), 1496–1510. <https://doi.org/10.1111/cdev.12081>

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