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Magic is an art form that allows us to experience the impossible, but some magic tricks are more implausible than others. We present two experiments that examined whether the objective probability of a trick occurring by chance influences how people experience the trick. In Experiment 1, participants watched different versions of a magic trick in which we manipulated the statistical probability of the trick occurring by chance. We found that the objective probability had no significant impact on how much people enjoyed the trick or how impressed they were by it. Our participants enjoyed the trick equally when there was a 25% chance of it succeeding by chance as when it was virtually impossible. The same was true for how impressed they were by the performance. However, tricks that were less likely to succeed by chance were rated as more difficult and impossible. More implausible tricks resulted in more participant explanations stating they did not know how the trick was done, as well as explanations implying it was fake. In a follow-up experiment, participants were presented with vignettes describing the same trick, and they were asked to judge the magician's chances of succeeding. The statistical probability of the trick occurring by chance did not affect these judgments adversely, but they did do so when the same feat was performed by a nonmagician.

Keywords: magic, emotions, event perception, probability

Magic is an art form in which objects appear and disappear from nowhere and magicians perform illusions that defy our understanding of human nature. Yet, despite its ancient origins, we know relatively little about the emotions that magic elicits (Danek et al., 2013; Leddington, 2017; Ozono et al., 2021) or the psychological factors that affect how these illusions are experienced. The illusion of impossibility lies at the heart of this mysterious art form, and we aimed to investigate the relationship between impossibility and magic more systematically.

In recent years, scientists have started to dissect many of the methods magicians use to create their illusions, and they have acquired a comprehensive understanding of the psychological techniques used to manipulate people's conscious experiences (Ekroll & Wagemans,

2016; Kuhn et al., 2008; Macknik et al., 2008; Pailhès & Kuhn, 2021; Rensink & Kuhn, 2015; Thomas et al., 2015). However, far less is known about the emotions that such illusions elicit. Teller of *Penn and Teller* describes magic as "a form of theatre that depicts impossible events as though they were really happening" (Stromberg, 2012). Similarly, Ortiz (2006, p. 30) defined magic as being "about creating an illusion, the illusion of impossibility." Simon Aronson also famously described the magic experience as:

> [The spectator] knows what has just happened, and yet also knows that it cannot happen, that it defies the controlling laws that govern our world. And yet, [the magician] did it. A magician's paramount goal is to manipulate the spectator's mind and senses to bring about this state of impossibility. (Jay et al., 2018, p. 35)

Scientists and philosophers have also become interested in understanding the unique experience that magic elicits. Leddington put forward a theory of magic that describes the experience of magic as resulting from a cognitive conflict, which arises from an incongruity between perceiving something as impossible, knowing that our perception is fake, and yet lacking any evidence to explain why our perception is fake (Kuhn, 2019; Lamont, 2013; Leddington, 2016). Magic elicits a range of emotions that result from experiencing seemingly impossible things, but the strength and the nature of these emotions vary according to the type of magic performance that is being witnessed. Some magic tricks are framed as being humorous, while others are scary or even bizarre. This framing, as well as the nature of the performer, has a significant impact on how the audience experiences the trick. Magic tricks also vary in terms of the strength of the deception and the extent to which they violate our beliefs about the world. Kuhn (2019) described magic as a general conflict in beliefs: The belief in what the audience believes to be possible and the strength of the belief in what they have experienced. According to Kuhn, the strength of an effect directly relates to the strength of the conflict.

Grassi and Bartels (2021) recently developed a Bayesian account of magic, which explains the experience of magic within a Bayesian predictive coding theory. This computational theory operationalizes the "wow" effect that magic elicits as an increase in surprise evoked by the prediction error between the expected and observed data. In this case, the expected data refer to people's beliefs about what is possible, while the observed data refer to the strength of the effect. This computational theory makes firm predictions about how people will experience magic, and it captures the notion that our beliefs about the probabilities by which the effect has been created affect how the audience experiences the effect. However, our beliefs about the world are not entirely rational, and they are often influenced by cognitive biases. Since our experience of magic is a product of our beliefs about the world, the experience of magic may also be susceptible to cognitive biases and blind spots, observed in human reasoning.

To date, relatively little empirical research has directly investigated the emotions that magic elicits or the psychological factors that modulate our enjoyment of magic. Neurological studies show that magic tricks elicit neural activations in brain areas that are involved in experiencing and resolving cognitive conflicts (Danek et al., 2015; Parris et al., 2009). Griffiths (2015) has shown that different types of magical transformations elicit more or less interest in the magical effect, which suggests that our enjoyment of magic is directly related to internal worldviews. Lewry et al. (2021) directly investigated the relationship between people's interest in magical transformations and the age in infancy at which they learned that the transformations violated their understanding of the world. Their study revealed a close link between interest in magic and the strength of our beliefs that such transformations are impossible.

Bagienski and Kuhn (2023) investigated the relationship between people's enjoyment of a magic trick and the extent to which they believed it to be impossible. Participants watched a live performance of a magic trick in which the performer balanced different objects on top of each other, creating an increasingly impossible sculpture. Participants were then asked to rate the extent to which they believed that what they were seeing was impossible as well as how much they enjoyed it at different time points of the trick. Analysis revealed that people's enjoyment of the magical effect relates to their perceived impossibility of the magic trick, in that participants enjoyed the performance more as it became more implausible.

In the current experiment, we aimed to investigate how the implausibility of an illusion affects how people experience the trick. Are people

more impressed by magic tricks that appear to be more impossible, and do they enjoy such tricks more? Intuitively, one would assume that people should be more impressed by a magic trick that demonstrates an impossible feat than one in which there is a fair chance of the trick being achieved by chance. However, much of the research on reasoning and decision making has shown that people's decisions are not necessarily driven by probabilistic reasoning (Chater et al., 2020). Instead, much of our reasoning is influenced by heuristics (Kahneman, 2011), and people often get muddled up when calculating probabilities or ignore them entirely. For example, the availability heuristics demonstrates people's reluctance to take baseline probabilities into consideration during decision-making processes (Tversky & Kahneman, 1973). It is therefore possible that people's implicit and explicit reasoning about a magic trick is not affected by such baseline probabilities.

The views among magicians are rather split on whether baseline probabilities will affect the strength of a magic trick. Magicians often go to great lengths to design tricks that appear as though they cannot be achieved through chance, and there is an implicit assumption that such effects are more effective. For example, in Joshua Jay's signature piece (impossible number on t-shirt), he predicts a number that has been chosen by the audience, and he goes through great lengths to make this number as random and impossible to predict. However, magicians may have overestimated the importance that such baseline probabilities play. Anecdotal evidence suggests that the probability of a trick occurring by chance may have very little impact on how people perceive it. For example, Max Maven's B'Wave effect involves the performer predicting a freely chosen card. Even though Maven's effect has a one-in-four chance of succeeding simply by chance, B'Wave remains an extremely popular effect. Research on forcing has shown that people are genuinely surprised by effects in which the magician correctly predicts a spectator's chosen card, even when there is a 25% chance of this occurring by chance (Kuhn et al., 2020; Pailhès et al., 2020). It is possible that people are not aware of the probabilities with which such predictions can be successfully made. We therefore added an additional condition in which we explicitly informed participants about the chances of the trick succeeding by chance. We predicted that the explicit nature of the probability would strengthen the probability effect.

We asked participants to watch a video clip of a magician performing a mind reading trick in which the magician correctly identified a number that a volunteer was thinking of. We created six different versions of this trick, each varying in its objective implausibility, in order to develop our understanding of the relationship between impossibility and the experience of the effect. In the least implausible version, the spectator was asked to think of a number between 1 and 4, meaning that there was a 25% chance of the magician naming the thought of number by chance. This contrasted with the most implausible version, an otherwise identical performance except that the spectator was instructed to think of *any* number, making it virtually impossible to guess the right number by chance. All performances were staged in that they relied on a confederate or "stooge." However, participants were misled to believe that the performances were genuine. After watching the trick, participants were asked to rate the performance in terms of enjoyment, impressiveness, impossibility, and difficulty. If our experience of magic is directly linked to impossibility, we would expect higher ratings for effects that are less likely to succeed by chance.

Our second objective was to examine how the implausibility of an effect affects the type of explanations provided by people. Some magic tricks seem too implausible to be true, and we predicted that people would be more suspicious of effects that appeared too implausible. For example, the too perfect theory states that some magic tricks can be enhanced by adding a level of imperfection to the trick (Pailhès et al., 2022). We have recently shown that such imperfections do not necessarily increase people's enjoyment of the trick (imperfect tricks were enjoyed less) but that they do affect the type of explanations that people provide for how they believe that the tricks were done (Pailhès et al., 2022). It is likely that the impossibility of an effect influences the type of explanations that people provide about how they believe the effect has been achieved. We asked participants to explain how they thought the trick was done and coded these explanations using three themes: those who simply did not know how the trick was done, those who provided

explanations based on a pseudoscientific explanation, and those who thought the entire effect was faked. We predicted that people should be more likely to suspect that the effect had been faked when it appeared more implausible and that people should be more likely to attribute the effect to pseudoscientific principles for more plausible versions of the trick. We had no clear prediction of how the effect's impossibility would affect whether or not people would know how the trick was done.

Our final objective was to investigate how the different explanations influence how people enjoy the performance. Magicians work hard to prevent their audience from discovering the true cause of the effect, given that not knowing how a trick is done is central to magic. We predicted that people would be more impressed and enjoy tricks more if they did not know how the trick was done. Similarly, we predicted that people would enjoy them the least when they felt that the trick had been staged.

Experiment 1

In the first experiment, we examined whether the objective probability of a trick occurring by chance influences how people experienced the trick. Participants watched different versions of a magic trick in which we manipulated the statistical probability of the trick occurring by chance and we asked them to rate them in terms of enjoyment, difficulty, impossibility, and how much they enjoyed it. We also asked them to explain how they thought the trick was done.

Method

Participants

Four hundred sixty-one participants (217 female, sevn other) between 18 and 65 years old ($M = 24.0$, $SD = 7.98$), who were all recruited via Prolific, took part in the experiment. Goldsmiths Psychology Department provided ethical approval for the experiments. Prior to the experiment, we ran a power calculation for an analysis of variance (ANOVA) with main effects and interactions with $\alpha = .05$, a small effect size of .17, and power of .80. The output of the calculation was a total sample size of 450 participants. We confirm that we report all measures in this article.

Procedure

The survey was implemented online via Prolific. After reading the information page and General Data Protection Regulations, participants confirmed they accepted to take part in the study and signed the consent form. Then, participants watched one of 12 video clips in which a magician claimed to correctly guess the spectator's choice (the performance was staged with a confederate). The videos started with a message stating that no cooperation between the magician and the spectator existed and that what participants were about to see was exactly what they would have experienced if the magician was performing for them in person. The magician asked the spectator to think of a number between different ranges according to the condition. He then wrote the number on a notepad, showed it to the camera, and either explicitly stated the odds of correctly finding the spectator's number or not before showing it to the spectator.

After watching the video, participants reported how impressed they were by the demonstration, how difficult they thought this piece was to perform, how much they enjoyed the trick, how impressed they were, and how impossible the trick was on scales from 0 (*not at all*) to 100 (*very much*). Participants also had to describe in a few sentences how they thought the demonstration was accomplished. The videos can be accessed from the following link: https://osf.io/zq6pv/?view_only=e549198e66f049058e6ecde35c1ea2ef (Pailhes, 2023).

Design

The experiment used a 6×2 between-subject design. The first independent variable was the *number range* from which the spectator was invited to choose his number. This between-subject variable had six levels (1–4, 1–10, 1–100, 1–1,000, 1–10,000, any). The second independent variable was *probability declaration*, which referred to whether the spectator was explicitly informed about the probability of the magician naming the correct card or not. This variable had two levels (yes, no). Since magic tricks

are typically designed to be viewed once, each participant watched one version of the trick.

Results

Figure 1 shows the mean ratings for each of the conditions. Subjects with missing data were excluded from the analysis. We ran separate 2×6 between-subject ANOVAs on each of the four ratings to establish whether the probability declaration and the number range affected participants' ratings. Table 1 shows the statistics for the ANOVAs.

In terms of impressiveness ratings and enjoyment ratings, none of the main effects or the interaction were significant. The probability declaration and the number range therefore had no significant impact on how impressed participants were or how much they enjoyed the performance.

In terms of difficulty ratings, there was no significant main effect of probability declaration, no significant interaction, but a significant main effect of number range. We conducted Bonferroni-corrected t tests to establish whether the increased number range increased difficulty ratings. Bonferroni-corrected t test found no significant difference between the 1–4 and 1–10 range, $t(449) = 1.09$, $p = 1$, $d = 0.175$, but a significant difference between the 1–10 and the 1–100 range, $t(449) = 4.79, p < .001, d = 0.76$. There was no significant difference between the 1–100 and the 1–1,000 range, $t(449) = 1.59$,

Figure 1

Mean Ratings for Each of the Number Ranges for Each Dependent Variable
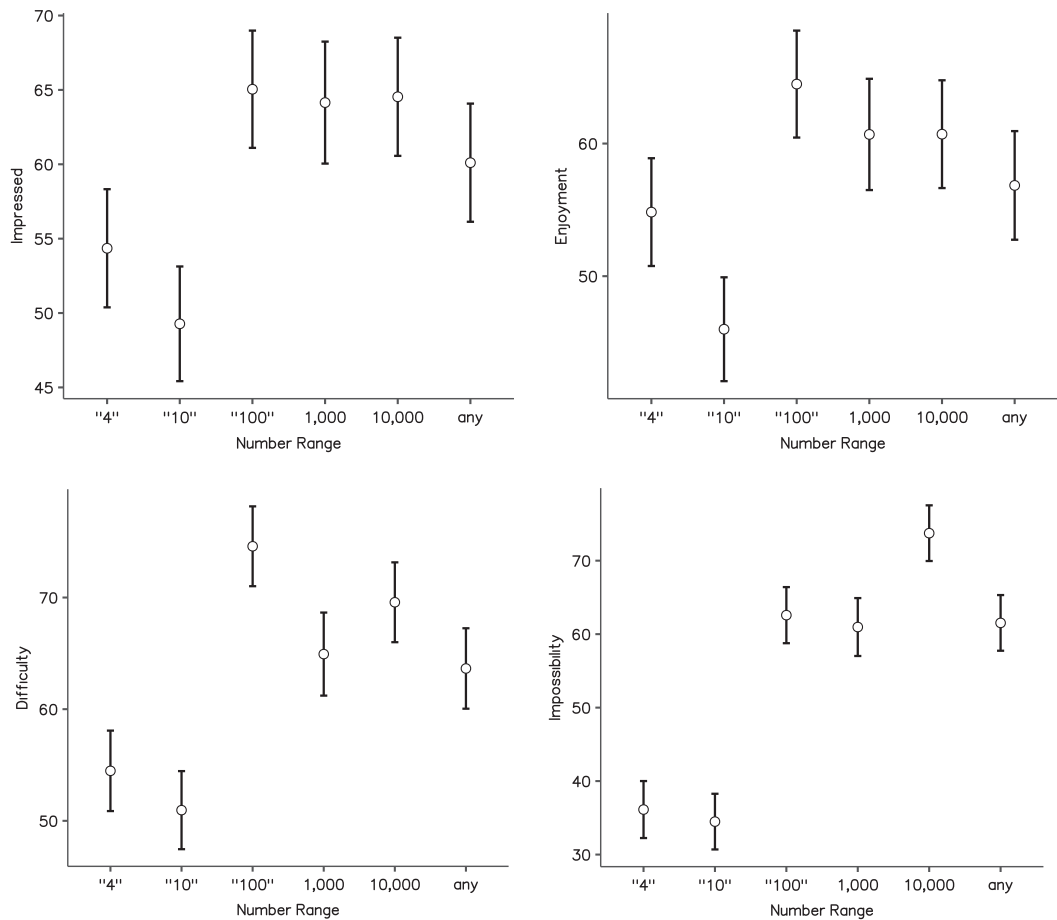
Note. Error bars denote *SEMs*. SEMs = standard error of means.

Table 1
Statistics for Number Range by Probability Declaration ANOVAs

Variable	Main effect of number range	Main effect of probability declaration	Interaction
Impressiveness	$F(5, 448) = 1.69$, $p = .14$, $\eta^2 = .018$	$F(1, 448) = 0.030$, $p = .86$, $\eta^2 = .0000$	$F(1, 448) = 0.184$, $p = .96$, $\eta^2 = .0002$
Enjoyment	$F(5, 448) = 1.86$, $p = .10$, $\eta^2 = .020$	$F(1, 448) = 0.008$, $p = .93$, $\eta^2 = .0000$	$F(1, 448) = 043$, $p = .83$, $\eta^2 = .005$
Difficulty	$F(5, 449) = 6.25$, $p < .001$, $\eta^2 = .064$	$F(1, 449) = 0.54$, $p = .46$, $\eta^2 = .001$	$F(1, 449) = 1.68$, $p = .13$, $\eta^2 = .017$
Impossible	$F(5, 444) = 17.5$, $p < .001$, $\eta^2 = .16$	$F(1, 444) = 0.63$, $p = .43$, $\eta^2 = .001$	$F(1, 444) = 0.69$, $p = .63$, $\eta^2 = .006$

Note. ANOVAs = analyses of variance.

$p = 1$, $d = 0.25$; the 1–1,000 and the 1–10,000 range, $t(449) = 0.71$, $p = 1$, $d = 0.112$; or the 10,000 and the any range, $t(449) = 1.26$, $p = 1$, $d = 0.205$. These results show that participants rated the 1–4 and the 1–10 ranges as less difficult than the other ranges, but none of the other distinctions seemed to have made an impact.

In terms of impossibility ratings, there was no significant main effect of probability declaration, no significant interaction, but a significant main effect of number range. The probability declaration had no impact on how impossible participants rated the magic trick but the number range did have an impact. We conducted Bonferroni-corrected *t* tests to establish whether the increased number range increased difficulty ratings. Bonferroni-corrected *t* test found no significant difference between the 1–4 and 1–10 range, $t(444) = 0.308$, $p = 1$, $d = 0.050$, but a significant difference between the 1–10 and the 1–100 range, $t(444) = 4.98$, $p < .001$, $d = 0.80$. There was no significant difference between the 1–100 and the 1–1,000 range, $t(444) = 0.222$, $p = 1$, $d = 0.036$; the 1–1,000 and the 1–10,000 range, $t(444) = 2.13$, $p = .50$, $d = 0.345$; or the 10,000 and the any range, $t(444) = 2.23$, $p = 39$, $d = 0361$. These results show that participants rated the 1–4 and the 1–10 ranges as less impossible than the other ranges, but none of the other distinctions seemed to have made an impact.

Next, we examined the correlations between the four measures. Table 2 shows the Pearson correlations between each of the variables. It is clear from the correlations that all variables correlate positively with one another. However, the strongest correlation was between enjoyment and how impressed they were by the trick.

In the next analysis, we examined the type of explanations participants provided for how they thought the trick had been done. We expected that participants would be more suspicious of the performance that involved a higher number range than those that have a lower range and thus be more likely to state that the trick had been faked. After reading all the responses, we came up with three categories to classify each of the statements.

- *Don't know:* Explanations that explicitly or implicitly state that they do not know how the trick is done. This includes cases where people state that they do not know how it is

done but follow up with general specula-
tions. It also includes descriptions where
they claim it was simply magic.
- *Pseudoscientific explanation:* Explanations
  that mention scientific and pseudoscientific
  mechanisms such as simply exploiting
  chance (e.g., claiming the magician was
  simply guessing), cognitive biases based
  on probability, priming, suggestions, body
  language, cold reading, and mind reading.
- *Fake:* Explanations that cast doubt on whether
  the performance was real. Participants have
  some awareness of cooperation, or confeder-
  ate, predetermined. This included cases where
  participants stated it was stooged but followed
  up with other suggestions.
- *Undefined:* Explanations that were impos-
  sible to define.

Two of the authors (Gustav Kuhn and Alice
Pailhès) used these categories to blindly (i.e., the
raters were unaware of the condition that they
were coding) code the responses. There was a
93% agreement between the raters. For all cases
where there was disagreement, the raters dis-
cussed further to find agreement. Cases where
no agreement could be found were defined as
undefined. Eleven percent of the responses were
categorized as undefined and removed from the
analysis. Please note that since probability
declaration had no significant impact on the
measures, we excluded this variable.

Figure 2 shows a distribution of the types
of explanations provided as a function of the
number range. A chi-square test with explanation
type ("don't know"—pseudoscientific—fake)
and number range (1–4, 1–10, 1–100, 1–1,000,

Figure 2

Percentage of Participants Who Provide Each of the Explanations as a Function of Number Range
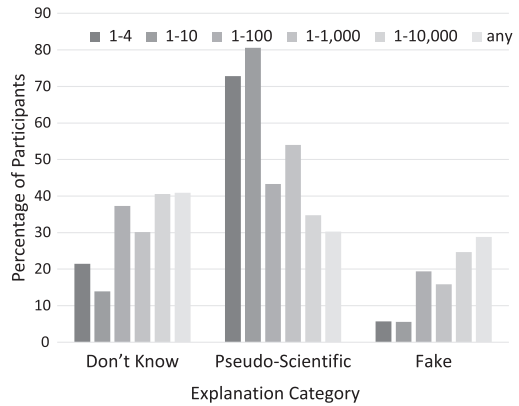
1–10,000, any) found a significant difference,
$\chi^2(10, 407) = 60.9$, $p < .001$.

Next, we broke down the contingency table
to examine whether the frequency of explanation
types was affected by the number range. For the
"don't know" category, there was a significant
difference, $\chi^2(5, 407) = 20.2$, $p = .001$. As is
apparent from the graph, there was an increase in
"don't know" responses between number ranges
lower than 10 and those above 100, but no
difference between the other categories. For the
pseudoscientific explanations, there was a signif-
icant difference, $\chi^2(5, 407) = 58.4$, $p < .001$. As is
apparent from the graph, there was a reduction
in pseudoscientific explanations as the number
range increased. In terms of fake explanations, the
opposite pattern emerged, with fake explanations
increasing as the number range increased, $\chi^2(5, 407) = 23.2$, $p < .001$.

In the next analysis, we examined the relation-
ship between the different method[1] explanations
and people's experience of the magic trick (see
Figure 3). We ran separate one-way between-
subject ANOVA to establish whether the ex-
planations affected the ratings.

In terms of impressed ratings, there was a
significant main effect of method, $F(2, 389) = 33.4$, $p < .001$, $\eta^2 = .015$. Bonferroni t tests found
a significant difference between the "don't know"
and the pseudoscientific condition, $t(389) = 3.61$,
$p < .001$, $d = 0.49$; "don't know" and the fake

Table 2

Pearson's Correlations Between the Four Ratings for Experiments 1 and 2

Experiment 1	Impressed	Difficulty	Enjoyment
Difficulty	0.50*		
Enjoyment	0.83*	0.48*	
Impossible	0.33*	0.54*	0.28*

Experiment 2	Enjoyment	Difficulty	Impressed
Difficulty	0.49*		
Impressed	0.77*	0.57*	
Chances of success	0.06	−0.35*	−0.18*

* $p < .001$.

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[1] Method refers to the deceptive method magicians use to create their effects.

Figure 3
Mean Ratings for Each of the Number Ranges as a Function of Explanation Type
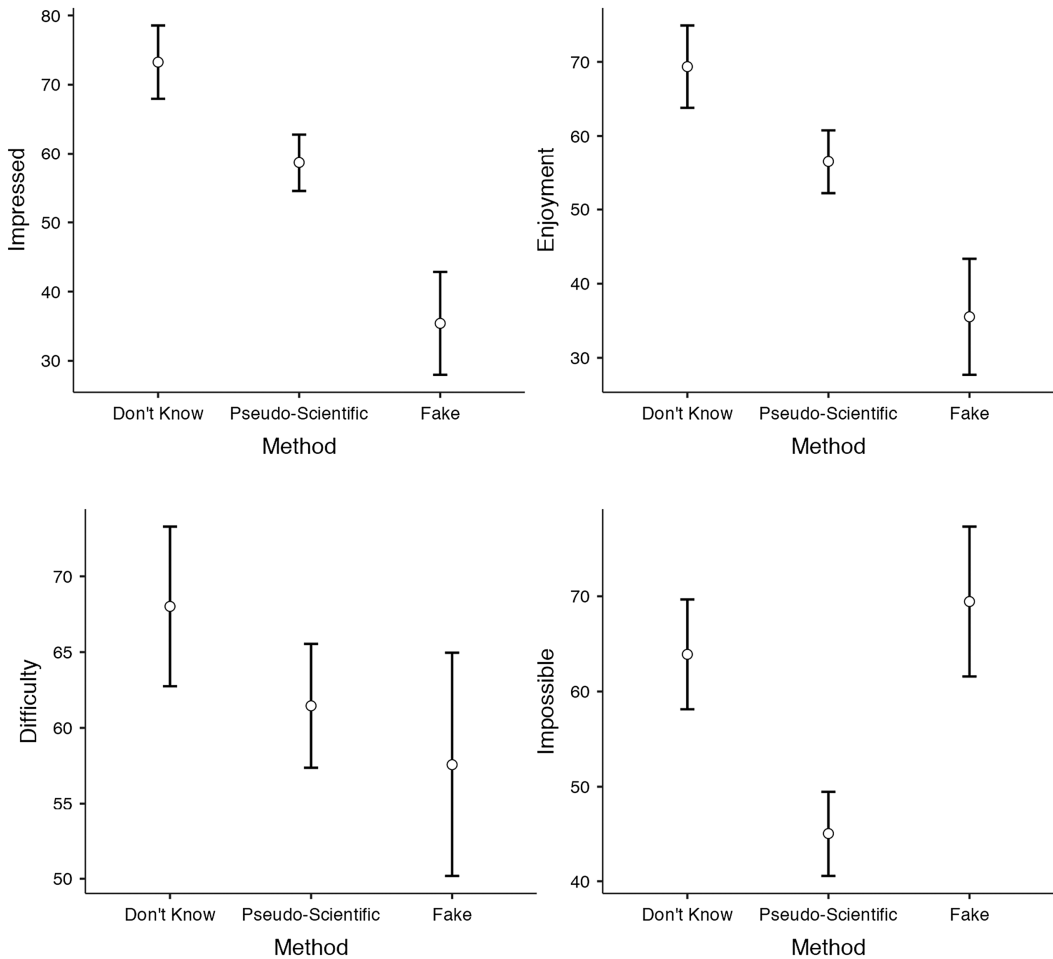
Note.   Errors bars denote *SEMs*. SEMs = standard error of means.

condition, $t(389) = 8.15$, $p < .001$, $d = 1.26$; and the pseudoscientific and the fake condition, $t(389) = 5.38$, $p < .001$, $d = 0.78$.

In terms of enjoyment ratings, there was a significant main effect of method, $F(2, 389) = 24.1$, $p < .001$, $\eta^2 = .011$. Bonferroni *t* tests found a significant difference between the "don't know" and the pseudoscientific condition, $t(389) = 3.61$, $p = .001$, $d = 0.41$; "don't know" and the fake condition, $t(389) = 6.93$, $p < .001$, $d = 1.08$; and the pseudoscientific and the fake condition, $t(389) = 4.62$, $p < .001$, $d = 0.67$.

In terms of difficulty ratings, there was a significant main effect of method, $F(2, 390) =$

3.07, $p = .048$, $\eta^2 = .011$. Bonferroni *t* tests found no significant difference between the "don't know" and the pseudoscientific condition, $t(390) = 1.94$, $p = .16$, $d = 0.22$; "don't know" and the fake condition, $t(390) = 2.26$, $p = .073$, $d = 0.35$; and the pseudoscientific and the fake condition, $t(390) = 0.90$, $p = 1$, $d = 0.13$.

In terms of impossible ratings, there was a significant main effect of method, $F(2, 386) = 20.9$, $p < .001$, $\eta^2 = .01$. Bonferroni *t* tests found a significant difference between the "don't know" and the pseudoscientific condition, $t(386) = 5.10$, $p < .001$, $d = 0.59$, but no significant difference between the "don't know" and the fake condition,

$t(386) = 1.12$, $p = .79$, $d = 0.17$, and significant difference between the pseudoscientific and the fake condition, $t(386) = 5.31$, $p < .001$, $d = 0.76$.

Experiment 2

Experiment 1 revealed that the probability by which the magic trick could have been achieved by chance affected responses that required an analytical assessment of the trick (i.e., difficulty and impossibility ratings). However, participants' enjoyment and the extent to which they were impressed by the trick were immune to the probability of the trick being achieved through chance. People frequently ignore baseline probabilities (Chater et al., 2020), and it is possible that people ignore such prior probabilities when evaluating the trick in terms of enjoyment. Alternatively, people may interpret a magic trick based on what they believe the magician can do in general, rather than what they have experienced on this occurrence. As our participants witness the magician correctly predicting a person's number, they may implicitly assume that magicians can achieve this regardless of the size of the number range.

In a follow-up experiment, we examined whether people's reasoning about a magic trick differs from that when they make judgments about nonmagicians performing similar tasks. Shtulman and Morgan (2017) have shown that beliefs about the physical world can influence people's beliefs about the difficulty in performing fictional magical feats. However, these effects were rather modest. We therefore expect that the probability by which the phenomenon can be achieved by chance to have a bigger impact when people judge events that are not achieved through magic tricks. To test this hypothesis, we asked participants to read vignettes that outlined the first part of the magic trick without revealing the accurate prediction. We then asked participants to predict the likelihood of the magician successfully predicting the correct number, and we contrasted this to a condition in which the same demonstration was achieved by a nonmagician—a psychologist. If judgments about magic tricks are based on what people believe that magicians can achieve in general, we would expect the number range to have a bigger impact in the nonmagical context than the magic context. We also added the previous measures (enjoyment, difficulty, and impressiveness) and expected similar results as reported in the previous experiment.

Method

Participants

Three hundred sixty-eight participants (185 female, 176 male, three other, five missing data) between 18 and 65 years old ($M = 38.7$, $SD = 12.1$), who were all recruited via Prolific, took part in the experiment. Goldsmiths Psychology Department provided ethical approval for the experiments.

Procedure

The survey was implemented online via Prolific. After reading the information page and General Data Protection Regulations, participants confirmed that they accepted to take part in the study and signed the consent form. Then, participants were presented with one of two different types of vignettes. In the magic vignette, participants were told that

> John is a professional magician. John is about to perform his signature trick for a small group of people. He starts by writing down a number on a piece of paper which he shows to all of the people except for the person sitting right in front of him. He then invites this person to think of a number between [number range] and name it out aloud.

We used the same number ranges as were used in the previous experiment.

In the nonmagician vignette, participants were told that

> John is a professional psychologist. John is about to perform an informal experiment on a small group of people. He starts by writing down a number on a piece of paper which he shows to all of the people except for the person sitting right in front of him. He then invites this person to think of a number between [number range] and name it out aloud.

After reading the vignette, participants were asked to rate how impressed and how enjoyable they would be if John succeeded. They were also asked to rate how difficult it would be for John to succeed and to predict the chances that John's prediction matches the number that has been named. All responses were provided on scales from 0 (*not at all*) to 100 (*very much*).

Design

The experiment used a 6 × 2 between-subject design. The first independent variable was the *number range* from which the spectator was invited to choose his number. This between-subject variable had six levels (1–4, 1–10, 1–100, 1–1,000, 1–10,000, any). The second independent variable was *performer*, which referred to whether participants were informed whether John was a magician or a psychologist. This variable had two levels. Each participant only rated one version of the vignette.

Results

Figure 4 shows the mean ratings for each of the conditions. We ran separate 2 × 6 between-subject ANOVAs on each of the four ratings

to establish whether the performer and the number range affected participants' ratings. Table 3 shows the statistics for the ANOVAs.

In terms of chances of success ratings, we found a significant main effect of performer and a significant interaction, but no main effect of number range. As predicted, participants used different criteria to judge the chances of the magician and the psychologist to successfully achieve the feat.

We broke down the interaction using Bonferroni-corrected *t*-tests to examine the different ratings between the magician and the psychologists at each of the number ranges. There was no significant difference between the two performer conditions for the 1–4, $t(356) = 0.88$, $p = 1$, $d = 0.21$; the 1–10, $t(356) = 0.203$; and the any $t(356) = 2.79$, $d = 0.71$ ranges. However, the chance of success was rated significantly

Figure 4

Mean Ratings for Each of the Number Ranges for Each Dependent Variable
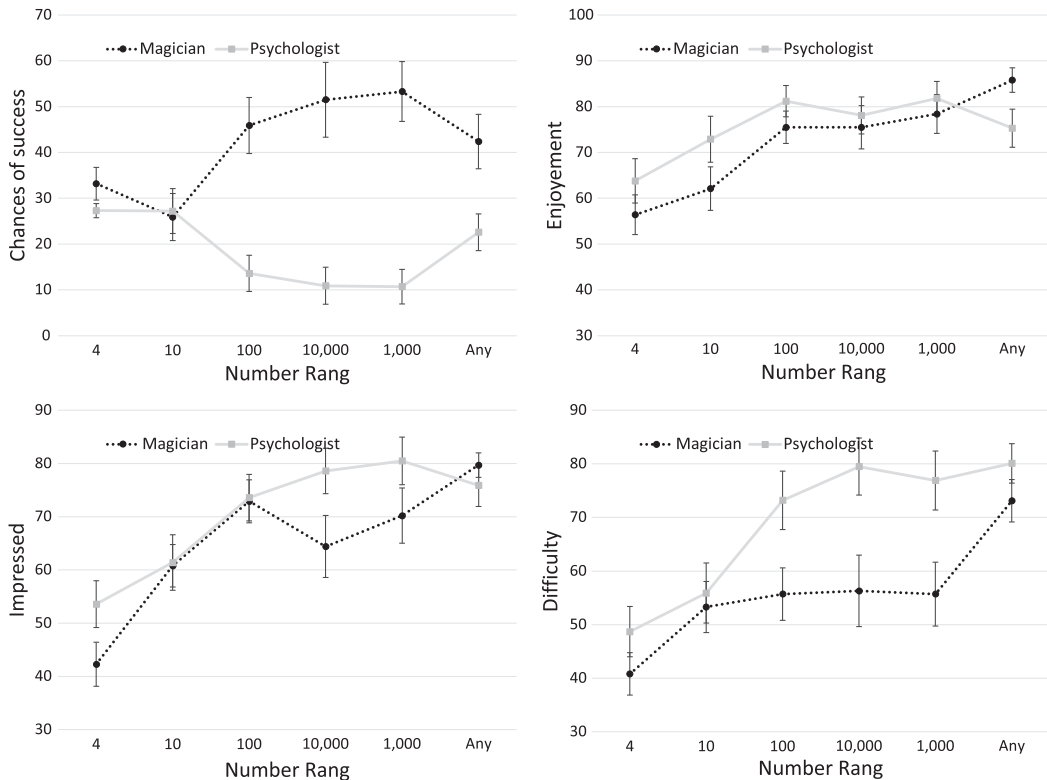
Note. Errors bars denote *SEMs*. SEMs = standard error of means.

Table 3
Statistics for Number Range by Performer ANOVAs

Variable	Main effect of number range	Main effect of performer	Interaction
Chances of success	$F_{(5, 356)} = 0.36$, $p = .87$, $\eta^2 = .004$	$F_{(1, 356)} = 64.7$, $p < .001$, $\eta^2 = .14$	$F_{(1, 356)} = 7.00$, $p < .001$, $\eta^2 = .074$
Impressiveness	$F_{(5, 356)} = 13.9$, $p < .001$, $\eta^2 = .16$	$F_{(5, 356)} = 4.71$, $p = .031$, $\eta^2 = .011$	$F_{(1, 356)} = 1.35$, $p = .24$, $\eta^2 = .015$
Difficulty	$F_{(5, 356)} = 10.2$, $p < .001$, $\eta^2 = .12$	$F_{(1, 356)} = 20.5$, $p < .001$, $\eta^2 = .05$	$F_{(1, 356)} = 1.41$, $p = .22$, $\eta^2 = .0016$
Enjoyment	$F_{(5, 356)} = 8.11$, $p < .001$, $\eta^2 = .10$	$F_{(1, 356)} = 1.75$, $p = .19$, $\eta^2 = .004$	$F_{(1, 356)} = 1.52$, $p = .18$, $\eta^2 = .019$

Note. ANOVAs = analyses of variance.

higher for the magician than the psychologist in the 1–100, $t_{(356)} = 4.41$, $p < .001$, $d = 1.17$; the 1–1,000, $t_{(356)} = 6.00$, $p < .001$, $d = 1.54$; and the 1–10,000, $t_{(356)} = 5.56$, $p < .001$, $d = 1.47$ ranges. Figure 4 reveals that participants' beliefs about the chances of the magician succeeding increased as the number range increased, while the opposite pattern of results was found for the psychologist framing.

In terms of impressiveness ratings, we found a significant main effect of the performer revealing that participants would be more impressed by the psychologist than the magician. There was also a significant main effect of the number range, but no significant interaction.

We conducted Bonferroni-corrected t tests to establish whether the increased number range increased impressiveness ratings. Bonferroni-corrected t test found a significant difference between the 1–4 and the 1–10 range, $t_{(356)} = 3.0$, $p = .03$, $d = 0.53$, but no significant difference between the 1–10 and the 1–100 range, $t_{(356)} = 2.71$, $p = .12$, $d = 0.50$. The was no significant difference between the 1–100 and the 1–1,000 range, $t_{(356)} = 0.5$, $p = 1$, $d = 0.09$; the 1–1,000 and the 1–10,000 range, $t_{(356)} = 0.87$, $p = 1$, $d = 0.16$; or the 10,000 and the any range, $t_{(356)} = 1.41$, $p = 1$, $d = 0.26$. These results show that participants rated the 1–4 range as less impressive than the 1–10 range, but none of the other distinctions seemed to have made a significant impact.

In terms of difficulty ratings, we found a significant main effect of performer, which reveals that participants thought the task was more difficult for a psychologist than a magician. There was also a significant main effect of number range, but no significant interaction.

We conducted Bonferroni-corrected t tests to establish whether the increased number range increased difficulty ratings. Bonferroni-corrected t test found no significant difference between the 1–4 and 1–10 range, $t_{(356)} = 2.0$, $p = .70$, $d = 0.35$; the 1–10 and the 1–100 range, $t_{(356)} = 1.9$, $p = .87$, $d = 0.35$; the 1–100 and the 1–1,000 range, $t_{(356)} = 0.37$, $p = 1$, $d = 0.067$; the 1–1,000 and the 1–10,000 range, $t_{(356)} = 0.30$, $p = 1$, $d = 0.06$; or the 10,000 and the any range, $t_{(356)} = 1.70$, $p = 1$, $d = 0.31$.

In terms of enjoyment ratings, we found no significant main effect of performer, a significant main effect of number range, but no significant interaction.

We conducted Bonferroni-corrected t tests to establish whether the increased number range increased enjoyment ratings. Bonferroni-corrected t test found no significant difference between the 1–4 and 1–10 range, $t(356) = 1.79$, $p = 1$, $d = 0.31$; the 1–10 and the 1–100 range, $t(356) = 2.5$, $p = .17$, $d = 0.47$; the 1–100 and the 1–1,000 range, $t(356) = 0.40$, $p = 1$, $d = 0.73$; the 1–1,000 and the 1–10,000 range, $t(356) = 0.77$, $p = 1$, $d = 0.14$; or the 10,000 and the any range, $t(356) = 0.87$, $p = 1$, $d = 0.16$.

Overall Discussion

Magic allows us to experience the impossible, but some magic tricks are more implausible than others. We examined whether the objective probability of a trick succeeding by chance influences how people experience the trick. In Experiment 1, participants watched different versions of a magic trick in which we manipulated the possibility of the trick succeeding by chance. The objective probability had no significant impact on how much people enjoyed the trick or how impressed they were by it. Our participants enjoyed the trick just as much when there was a 25% chance of it simply succeeding by chance as when it was virtually impossible. The same was true for how impressed they were by the performance.

One interpretation of this data is that participants struggled to compute or otherwise ignored the probabilities of the event occurring by chance. However, the number range did affect other judgments, such as judgments about how impossible or difficult the trick was. Tricks that had more than a 10% probability of occurring by chance were rated as less difficult and less impossible than those that had a lower probability. These findings show that people did process the probability of the events occurring by chance and that these objective probabilities did affect more analytical judgments.

Bagienski and Kuhn (2023) reported a close relationship between the perceived impossibility of a magic trick and people's enjoyment of the performance. Our study supports this finding in that there was a significant correlation between participants' perceived impossibility ratings and their enjoyment. These results suggest that people's enjoyment of the trick derives from the perceived impossibility rather than the objective impossibility of an effect. However, this correlation was far from perfect and there was a stronger relationship between how impressed participants were and enjoyment, rather than impossibility.

Our second objective was to investigate whether explicitly informing participants about the chances of the magician simply guessing the correct number would have an impact on how they experienced it. Contrary to our prediction, explicitly informing participants of the odds did not affect how they experienced the trick. These results dovetail many previous studies which have shown that such explicit framing has very little, if no impact on how people interpret magical events. For example, participants who were informed that the mentalism effect was performed by a magician who used tricks and deception were just as likely to interpret the performance as having been achieved through psychic means, as those who were told it had been performed by a psychic (Lesaffre et al., 2018, 2021). The same was true for performances that were framed as pseudoscientific demonstrations (Lan et al., 2018).

Our results showed that the number range only affected responses that required participants to analytically assess the trick in terms of difficulty and impossibility. However, there were clear boundaries that seemed to influence these ratings. Limiting a choice between 1–4 and 1–10 has little impact on how impossible and difficult participants thought the effect was. However, these ratings significantly increased for tricks that used less restrictions. Interestingly though, there was no difference between limiting a choice between 1 and 100 or giving them an entirely free choice. It is important to note that all our measures correlated significantly, and despite the number range only affecting impossibility and difficulty ratings.

In the second part of the analysis, we examined whether participants would come up with different explanations for how they thought the trick had been achieved as a function of how impossible it was. We categorized their explanations into three different categories: those who did not know how it was done, explanations based on pseudoscientific principles, and those who thought the video was fake. The number range significantly influenced the type of explanations that participants provided. Increasing the number range increased the proportion of participants who claimed they

did not know how the trick was done. However, the increased number range also increased the proportion of participants who claimed that the trick was fake. The number range also had a strong impact on the proportion of participants who came up with a false pseudoscientific explanation of the trick. These participants often came up with rather elaborate explanations of how the trick could have been achieved, many of which focused on how the magician either primed the spectator to name that number or that the magician managed to pick up subtle cues that allowed him to deduce the number. There was a relatively large number of participants who suggested that the volunteer named highly predictable numbers, which shows that people do have some awareness of these types of stereo-typical responses. These results clearly illustrate that the number range affects how participants explain the trick. We used a rather coarse way of coding these responses, and future work could examine the nature of these false explanations in more detail. For example, Gronchi and Zemla (2021) have shown that analytical thinkers tend to generate more rational explanations for a mentalism effect (e.g., explanations based on physical props), while intuitive thinkers tended to generate more irrational explanations that accord with the magician's backstory (e.g., subliminal cues). It would be interesting to see how such differences in cognitive processing style affect the type of explanations provided here. Moreover, it is possible that the number range would have a stronger impact on analytical than intuitive thinkers.

Our findings have important implications for how magicians design and frame their perfor-mances. Magicians often go to great lengths to make their effects seem as impossible as possible. For example, some magicians perform tricks in which they predict a 15-digit number. Our data suggest that such miracles are no more enjoyable, or impressive, than ones in which the performer predicts a number that has been chosen between 1 and 100. These findings took us by surprise, but they make sense in that most magic tricks represent improbable rather than impossible events. In a typical "pick a card" trick, the spectator chooses a playing card and the magician uses some elaborate procedure to reveal the card's identity. Objectively speaking, there is a one in 52 chance of this being achieved without any

special skill, and yet, these types of effects have captivated people for generations.

We ran a follow-up experiment in which we presented participants with text vignettes that describe the same magic trick, without revealing the prediction. Participants were asked to judge the likelihood that a magician would be able to predict the correct number, and we compared this to a psychologist carrying out the same feat. Increasing the number range had no negative impact on the judgments participants made about the magician. On the contrary, participants felt the magician was more likely to succeed as the number range increased. However, the reverse was true when participants made judgments about the psychologist's performance. We interpret these results as showing that people assume the magician will get it right regardless of the number range size. If the magician can truly predict the future, this should indeed be possible with any number and therefore independent of baseline probabilities.

Participants were also invited to reflect on how much they would enjoy the performance, how impressed they would be by seeing it, and the difficulty of the performance. All three measures were affected by the number range, regardless of whether the feat was performed by a magician or a psychologist. These results differ from what we found in Experiment 1. It is likely that reading about the performance rather than experiencing it elicits a more analytical processing mode, and thus participants' judgements will be more heavily influenced by the baseline probabilities.

Our study focused on a single effect, which allowed us to objectively manipulate the proba-bility of the effect occurring by chance. However, this does somewhat limit the extent to which we can extrapolate our findings to other contexts. That said, we believe that the basic principle applies to all magic, and future research could investigate this empirically. For example, some forms of levitation appear more plausible than others (Øhrn et al., 2019). Is a peanut that levitates 2 inches above the ground perceived as less impossible than a car that levitates 20 feet off the ground? How do people experience such viola-tions in causality? Shtulman and Morgan (2017) asked people to judge fictional magical transfor-mations that violate the same physical principle but varied in terms of their plausibility. For example, participants were asked to rate the

difficulty of levitating a bowling ball compared to a basketball or making a bush turn invisible, compared to a tree. In the fictional world, nothing is impossible, and yet, people still judge less plausible magical transformations as being more difficult. These results further illustrate that people's judgments about the difficulty of magical transformation are not necessarily bound to rational decisions or probabilities.

Our study shows that the objective probability of a magic trick occurring by chance does not affect people's enjoyment of the effect or how impressed they are by what they have just seen. That said, our manipulation did affect the type of explanations people provide for how this is done, these false attributions of the effect can potentially impact people's thoughts and feelings about the effect.

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