Original Article

QJEP

Quarterly Journal of Experimental Psychology
2020, Vol. 73(11) 1784–1795

DOI: 10.1177/1747021820932916
qjep.sagepub.com

The apparent action causation: Using a magician forcing technique to investigate our illusory sense of agency over the outcome of our choices


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Abstract

We often fall victim of an illusory sense of control and agency over our thoughts and actions. Magicians are masters at exploiting these illusions, and forcing techniques provide a powerful way to study apparent action causation—the illusion that our action caused the outcome we get. In this article, we used the Criss-Cross force to study whether people can tell the difference between an action which had an impact on the outcome they get and one which has no impact. In the Criss-Cross force, participants are asked to cut to a card, and while they are genuinely free to cut the cards at any position, the cut does not affect the card they are given (i.e., they always get the top card). We investigate the psychological processes that underpin the success of this force. Experiment 1 ($N = 60$) showed that participants cannot tell the difference between a forced and a controlled outcome. Experiment 2 ($N = 90$) showed that contrary to common magicians' knowledge, misdirection does not play a role in the success of the force. Finally, Experiment 3 ($N = 60$) suggests that rather than misdirection, an attribute substitution error explains why people fail to understand that their action does not have an impact on the outcome they get. Debriefing also shows the importance of participants' expectations in the perception of the trick, as well as the role of prediction of the outcome in participants' sense of agency over the events.

Keywords

Magic tricks; sense of agency; illusion of control; forcing techniques; free will; misdirection

Received: 15 November 2019; revised: 30 April 2020; accepted: 4 May 2020

Introduction

Although we generally like to feel in control over our environment and the outcome of our actions, we often fall victim to an illusory sense of control and agency over our thoughts and actions (Bargh & Chartrand, 1999; Fast et al., 2009; Langer, 1975; Sweeney et al., 1979). Back in 1853, Faraday conducted an ingenious experiment to study the table-turning phenomenon, commonly reported in Victorian Spiritualist séances. His empirical investigation revealed an intriguing dissociation between our sense of control and our actions. The ghostly movements resulted from people moving the table, without experiencing any will over their motor movements. However, we often overestimate our ability to control random events (Langer, 1975), and report illusory causality between unrelated events (Matute et al., 2015). These findings demonstrate that we are pretty poor at evaluating the true outcome of an action, or event. Sense of agency refers to our feeling of controlling external events through our own actions (Chambon et al., 2014), and it is relatively easy to provoke an illusory sense of control over the outcome of an action (Barlas & Laurier, 2016; Barlas & Obhi, 2013; Lynn et al., 2010; Tobias-Webb et al., 2017). Wegner's *apparent mental causation* (2003) points out the illusion that our *thoughts* are the cause of an action. In the same way, we sometimes seem to experience what we call here an

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apparent action causation, providing the illusion that our *actions* caused an outcome. This apparent causation is what gives us the illusion that we are controlling the result of an event.

Psychologists are competent at studying illusions, but magicians are true masters at exploiting them, and the illusion of apparent action causation is central to magic. In a magic trick, the audience experiences wonder because they erroneously attribute a magical cause, rather than the true cause (the secret method), to what they have just seen (Kuhn, 2019). More specifically, the principle of forcing is entirely based on this apparent action causation. Forces refer to tricks where magicians subtly and covertly influence a spectator's choice. We have recently started to categorise this wide range of forcing techniques (Pailhès & Kuhn, 2019) and come to the conclusion that there are two main types of forcing categories: techniques that directly influence the spectator's choice, as the typical definition suggests, and techniques which provide the spectators a genuinely free choice, but in which the outcome of the decision is manipulated (Annemann, 1940; Banachek, 2002; Jones, 1994).

Let us now take a closer look at these two types of forces. *Choice forces* refer to techniques in which the magician covertly influences a person's choice, and several of these techniques have been empirically investigated (Kuhn et al., 2020). Shalom and colleagues studied the "Classic Force," which involves asking a spectator to choose a card by physically picking it. The magician is handling the cards so that the target card reaches the person's fingers at the moment he or she picks one. Empirical studies have shown that this force was successful 45% of the time, and participants reported the same amount of freedom for forced choices and unforced choices. Another forcing technique, known as the Visual Force (Olson et al., 2015), consists of riffling through a deck of cards in front of a spectator's eyes while asking them to mentally pick one they see in the riffle. During the riffle, the target card is shown slightly longer than the others, which makes it more salient, restricting the spectator's choice and influencing him or her to pick it. Olson and colleagues found that 98% of participants chose the forced card, and, again, they reported feeling that they had a free choice, even though they were manipulated.

We would like to investigate a second category of forces—*outcome forces*. Outcome forces rely on the apparent action causation illusion, and they are the most commonly used conjuring force. Outcome forces typically consist of letting the spectator make a genuinely free choice, but unknown to the spectator, this choice has no impact on the outcome of the selection. For example, the magician might ask the spectator to choose a card, and while the spectator genuinely has some control over the selection process, the outcome of this choice always results in him or her ending up with the same card. In other words, the magician provides the illusion that the selection causes that particular outcome.

Outcome forces are closely related to choice blindness (Hall et al., 2006; Hall & Johansson, 2008), a phenomenon in which people fail to notice the mismatch between their choice and its outcome, and often end up justifying their choice based on information they never had in the first place. For example, Johansson et al. (2005) asked people to choose between two female faces, after which the experimenter surreptitiously switched the chosen picture for the rejected one. Most participants failed to notice the switch, and when asked to explain their choice, and came up with elaborate justifications. Because these justifications were based on the previously rejected image, these explanations cannot reflect the true source of their decision. In other words, they were blind of their choice (Hall et al., 2013; Rieznik et al., 2017).

Magicians have developed a wide range of outcome forces, and these techniques provide powerful and reliable ways to study the illusory sense of agency we have over the outcome of the decisions and actions we make—apparent action causation. The sense of control over the outcome of our actions has been repeatedly shown to be important in health and well-being (Lachman & Weaver, 1998; Lang & Heckhausen, 2001; Seligman, 1975). Understanding the underlying psychological processes involved in the success of these forces could shed light onto more general cognitive processes involved in people's sense of control over their environment, therefore providing new ways to enhance it.

The present article examines one of these outcome forces, known as the Criss-Cross force, and aims to (1) investigate whether people can be tricked into experiencing an illusory sense of agency over an outcome they do not control (Experiment 1) and (2) understand the underlying psychological mechanisms that underpin this force (Experiments 2 and 3).

The Criss-Cross force

The Criss-Cross force is a simple forcing technique, which ensures that the spectator will end up with a predetermined card (see Supplemental Material for a video of the force). The spectator is asked to freely cut a deck of cards wherever they want (see Figure 1b). The magician then takes the bottom pile and places it on the top of the top one in a crossed figure (Figure 1c and d). After this, some misdirection takes place, and the magician diverts the spectator's attention away from the deck, thus preventing them from encoding the relevant information (during d and before e). A common way of doing this is to ask the spectator a question while establishing eye contact. Indeed Kuhn et al. (2016) have shown that this form of social misdirection prevents people from noticing highly salient changes in their environment (i.e., the back of playing cards changing from blue to red). We predict that this form of social misdirection will make it harder for people to mentally retrace the events and thus realise that they are taking the top card.

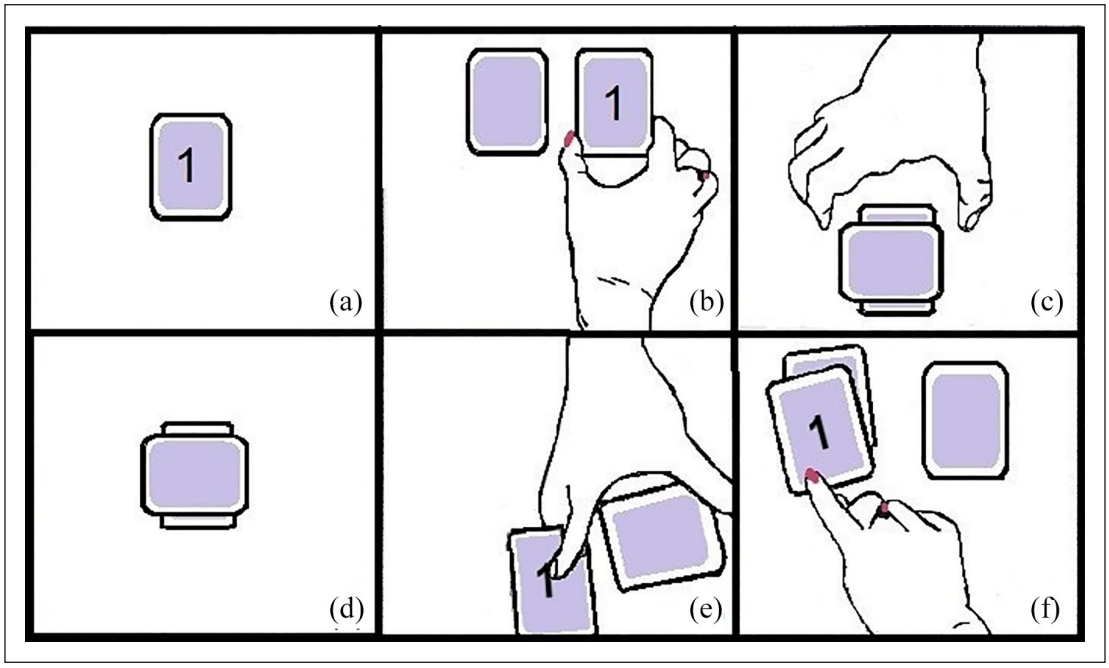

Figure 1. Criss-Cross force main steps: From the beginning, (a) the forced card is on the top of the deck (numbered 1 here to facilitate the comprehension to the reader). (b) The spectator cuts the deck of cards. (c, d) The magician puts the bottom pile on the top of the top one in a cross shape. (e) The magician removes the top pile and tells the spectator to take "his or her card" by pointing at the forced card. (f) The spectator ends up with the forced card which he or she believes to be the other card, selected by the cut.

After this, the magician goes back to the deck of cards and asks the spectator to look at the card he or she "freely selected thanks to his or her cut." To do this, the conjurer takes the top pile of the cross away, points at the first card of the bottom pile while asking them to take the card "they selected." But if read carefully, what just happened is that the magician pointed at the card which was the top card of the deck from the very beginning (card labelled Number 1 on Figure 1), and not a card resulting in the spectator's choice and action. The spectator had absolutely no control over the outcome of the trick, here the card chosen by the magician in advance, which he or she puts at the top of the deck before the trick began.

To summarise, the Criss-Cross force is commonly used by magicians, and while there is much anecdotal evidence supporting the idea that it works, it has never been empirically tested.

Experiment 1 aimed to examine how effective the Criss-Cross was by comparing participants' sense of control for a forced outcome to a controlled one. Experiments 2 and 3 aimed to investigate the underpinning mechanisms of the success of this trick, looking into misdirection (Experiment 2) and attribute substitution (Experiment 3).

Experiment 1

The aim of the first experiment was to objectively evaluate whether the Criss-Cross force could be used to effectively force a card without people realising that their choice was forced. In other words, can people tell the difference between an action which had an impact on the outcome they get (controlled outcome) and an action which has no impact (forced outcome)? To do so, we asked participants to cut to a card and either select the card they genuinely cut to, or one that was forced through the Criss-Cross procedure. Participants' sense of agency over the outcome of the event was measured using common scales—asking about the feeling of control over the outcome card (Barlas et al., 2018; Ebert & Wegner, 2010; Linser & Goschke, 2007; Metcalfe & Greene, 2007; Sato & Yasuda, 2005).

Because this forcing technique is commonly used among magicians, we predicted that participants would not be able to tell the difference between a genuine free selection and a forced selection.

Method

Participants. Sixty participants (35 women, 25 men) between 18 and 50 years old ($M = 24.3$, $SD = 5.85$) recruited on Goldsmiths University campus took part in the experiment. Goldsmiths Psychology Department provided ethical approval for the three experiments.

Procedure. Thanks to a simple change in the event sequence of the trick, we were able to get someone to have the forced card, or their actual chosen card (i.e., the card they cut to in

the deck). For this, the magician/experimenter simply has to invert the piles when doing the cross shape: if, instead of taking the left pile (Figure 1c) she takes the right pile to put it on the top of the other, and then, as for the force, points at the card which is at the centre of the cross (Figure 1e), this time this card is indeed the participant's chosen card.

Based on the prior descriptions, we had two experimental conditions: a final card controlled by the participant, thanks to his or her action of cutting the deck (controlled outcome), and one which was controlled and forced by the experimenter, thanks to the manipulation of the right pile when doing the cross (forced choice). Each participant was randomly assigned to one of the two conditions.

The experimenter was sitting at a table in the university cafeteria, with the deck of cards already on the table. The experiment was presented as a study about magic tricks and decision-making. We decided not to shuffle the deck before the trick so that this would not affect their sense of control over what happened. The experimenter asked the participant to cut the deck wherever they wanted and put their pile next to the bottom one. The experimenter then, depending on the condition, took one of the piles to put it on the top of the other in a cross shape. After the cross shape was done, she deployed her misdirection by asking "I'm sorry, what is your name again?"; it is important to note that this misdirection did not distract participants from perceiving the cut sequence, as it occurred after, rather than during the cut procedure. The misdirection was simply intended to prevent participants from correctly remembering, and reconstructing the event sequence.

After the participant responded, the experimenter took away the top pile and pointed at the target card while instructing the participant to "take their card." The participants were asked not to look at the card before answering the questionnaire, to prevent any bias linked to the card selection. Then, they completed a paper questionnaire with two questions about (1) how free they felt about cutting the deck wherever they wanted and (2) how much control they felt they had over the card they selected. The questions were on a scale from 0 (not free at all, no control at all) to 100 (extremely free and in control). We asked how free participants felt about cutting the deck because participants are directly involved in most of the event sequence—they cut to a random card. In other words, it is the action of cutting the deck and being involved "determining" the chosen card that provides the illusory sense of control over the outcome that participants report.

We also recorded whether participants in the forced condition understood that their card was forced (during the trick or the debriefing) before they were fully debriefed. If the participant was in the forced choice condition, the experimenter revealed she knew the card the participant had before they looked at it and asked them if they had an idea about how she knew about it.

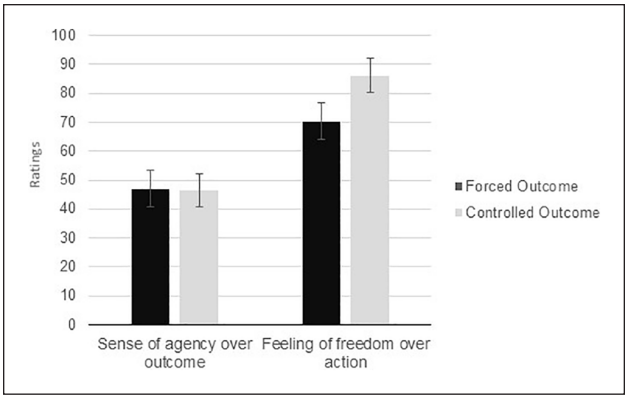

Figure 2. Feeling of freedom over the action of cutting the deck and sense of agency over the outcome card across the two experimental conditions. Error bars are represented for 95% confidence intervals.

Results and discussion

Of the 30 participants in the forced choice condition, only two understood that their card was forced. This confirms that the Criss-Cross force is very effective at fooling people into thinking their action/choice caused the outcome they get. Gathering both conditions, the mean feeling of freedom for cutting the deck wherever they wanted was 78.3 and the mean feeling of control over the outcome was 46.8 (see Figure 2).

As the data were not normally distributed, we used a Bayesian Mann–Whitney test. The Bayesian analysis allowed us to look for evidence for our null hypothesis, showing that participants could not differentiate between a forced and a controlled outcome (Figure 2).

We analysed the data with JASP. An annotated .jasp file, including distribution plots, data, and input options is available at https://osf.io/hbmn8.

First, we discuss the results for hypothesis testing regarding participants' sense of agency. The null hypothesis states that there is no difference in the feeling of control between the groups and therefore H0: $\delta = 0$, and δ was assigned a Cauchy prior distribution with $r = .707$. Figure 3a shows that the Bayes factor indicates evidence for H0; specifically, $BF01 = 3.79$, which means that the data are approximately 3.8 times more likely to occur under H0 than under H1. This result indicates moderate evidence in favour of H0.

Regarding the results for parameter estimation, of interest is the posterior distribution of the standardised effect size δ (i.e., the population version of Cohen's *d*, the standardised difference in mean sense of control). Figure 3a shows that the resulting posterior distribution peaks at $\delta = .003$ (the posterior median) with a central 95% credible interval for δ that ranges from −0.48 to 0.47, which provide more evidence for our null hypothesis. Both descriptive (Figure 2) and Bayesian analyses (Figure 3a)

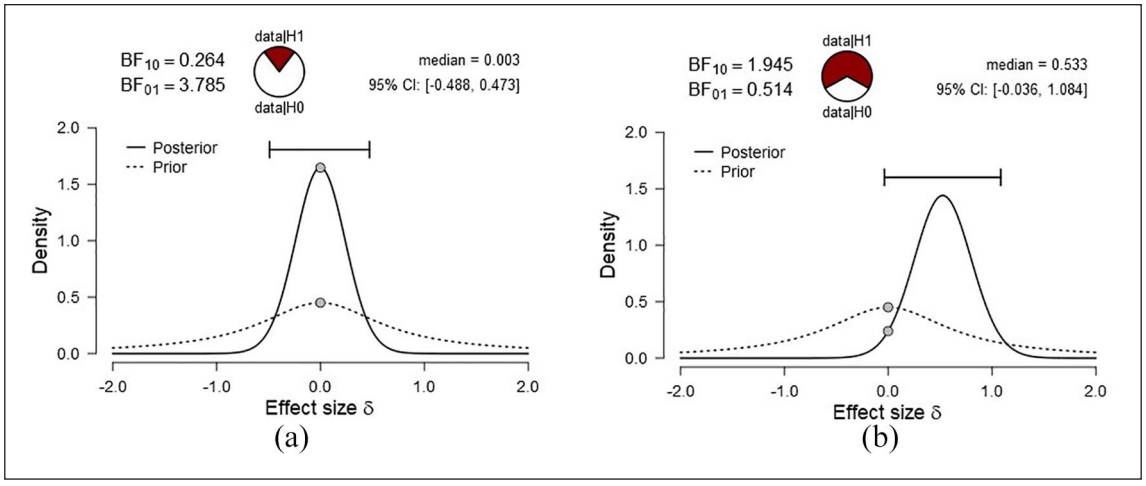

Figure 3. Bayesian Mann–Whitney test showing prior and posterior distributions for the (a) sense of agency and (b) feeling of freedom.

provide evidence that participants do not feel different sense of control over the outcome they get (i.e., the card) from the Criss-Cross, confirming that the trick makes it difficult to understand their choice has no impact on the result they have.

For the feeling of freedom, we also had a null hypothesis stating that participants would feel the same amount of freedom as they were free to cut the deck where they wanted in both conditions. Figure 3b shows that the Bayes factor indicates some anecdotal evidence for the alternative hypothesis, with a Bayes factor of B10 = 1.95. Figure 3 shows that mean feeling of freedom tended to be weaker in the forced outcome condition than in the controlled outcome one. This is interesting, as both groups were indeed free to cut the deck wherever they wanted and could suggest a type of unconscious knowledge from forced participants that they have been somewhat manipulated. We also cannot rule out the possibility that the experimenter non-intentionally behave differently when doing the different sequence events. The resulting posterior distribution peaks at δ = .533 with a central 95% credible interval for δ ranging from −0.04 to 1.08. If the effect is assumed to exist, there remains substantial uncertainty about its size, with values close to 0 having the same posterior density as values close to 1.

To conclude, these first results confirm that the Criss-Cross is a very powerful force, although really simple. Very few participants (2, 6%) understood their action did not have any impact on their outcome, and participants felt the same amount of control across the two experimental conditions.

Experiment 2

The second experiment aimed to investigate the psychological processes underpinning the Criss-Cross force.

The magic literature suggests that the Criss-Cross force relies on misdirection, in that it prevents the spectator from encoding the relevant information and thus confusing the spectator about the card selection. For example Fajuri (2003) suggests to "pause for a moment. [to] do something to take the spectator's mind off the cards." and that "once they've forgotten about the pack for a moment or two, [to] come back to it and ask the spectator to remove the card from the spot they cut to" (p. 6). Moreover, we asked 91 magicians to rate on scales from 0 (not important at all) to 100 (very important) the importance of eight different factors for the trick to success (among the magician's expertise, the time delay between the crucial steps of the trick, the expectations of the spectator, the unusual dealing of the cards, the misdirection during the time delay, the age of the spectator, the environment in which the trick is performed, and "other"). The results showed that magicians think the most important factor on which the Criss-Cross force relies is the time delay between the cross shape done by the magician and the moment he asks the spectator to take the forced card ($M = 82.4$, $SD = 20.0$). The second most chosen factor, closely following the delay, was the misdirection introduced during this time delay (79.5, $SD = 20.0$). Then came the magician's expertise about the trick (59.0, $SD = 33.4$).

Therefore, two different types of misdirection seem to be invovled for the Criss Cross to work—memory and attentional misidrections (Kuhn et al., 2014). Following Kuhn et al. misdirection taxonomy, attentional misdirection involves diverting attention away from the deck of cards through the help of social cues (e.g., asking his or her name, or any other random question). This interaction also acts as time misdirection in that it creates a time delay between the cut and the card selection process, which should enhance the chances of misremembering the exact action sequence.

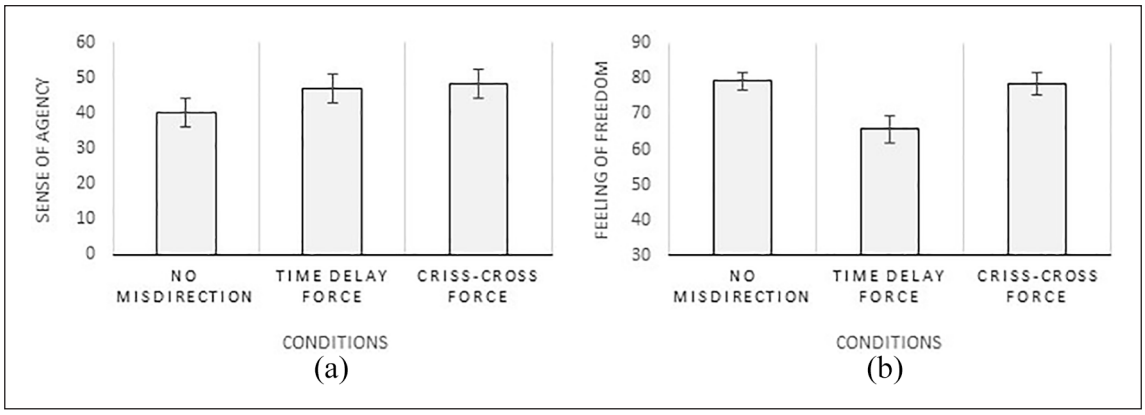

Figure 4. Mean (a) sense of agency over the outcome and (b) feeling of freedom for the action across the three experimental conditions. Errors bars are shown with 95% confidence intervals.

We therefore investigated two variables, namely, the attentional misdirection and time delay. We predicted that participants would understand the trick more often in the condition without misdirection, less in the time delay force condition, and the lesser in the baseline force. At the inverse, we predicted that participants would feel more control in the Criss-Cross condition, less in the time delay force condition, and the lesser in the no misdirection force condition, as following this order, the trick was becoming easier to understand. As in Experiment 1, we did not expect any difference regarding the feeling of freedom.

Method

Participants. Ninety participants (54 women, 36 men) between 18 and 50 years old ($M = 24.7$, $SD = 7.64$) recruited on the same spot as Experiment 1 in Goldsmiths took part in the experiment. Before the experiment, we ran an a priori power analysis for an analysis of variance (ANOVA) with $f = 0.35$ (moderate effect size), $\alpha = .05$, and a power of .8. The output of the analysis advised for 84 participants, and we chose a moderate effect size based on the fact that the investigated factors are believed to be the two keys to the success of the trick. We therefore estimated the impact of each of them separately to be of moderate size, and an effect of .35 seemed one to be worth finding.

Procedure. To investigate our hypothesis, we had three experimental conditions. In the first condition, the Criss-Cross was performed in the usual way with attentional misdirection which also created a natural time delay (Criss-Cross force). In the second condition, only time delay was used (time delay force) without diverting attention away from the cards. Here, the experimenter simply stared at the deck for 5 s before instructing the participants to take "their card" by pointing at the forced card. This allowed us to create a time delay without trying to divert the participant's attention away from the deck. The third condition used no misdirection or time delay (no misdirection condition). Each participant was randomly assigned to one of the conditions.

As in the first experiment, after the participants took their card without looking at it, they were asked to answer the questions about their feeling of freedom for cutting the deck and their feeling of control for the outcome card. We also wrote down whether the participants understood the trick and asked them to repeat the whole event sequence they remembered, including the experimenter's gestures, to investigate if they misremembered what happened.

Results and discussion

Of the 90 participants, only four understood that their action did not have any impact on the outcome card they had selected, which confirms results from Experiment 1 showing that the Criss-Cross is a solid forcing technique. From these four participants, two were in the Criss-Cross force condition, one in the time delay force condition, and one in the no misdirection force condition.

A Bayesian chi-square test comparing these proportions across the three experimental conditions showed very strong evidence in favour of the null hypothesis (B01 = 50.2), suggesting that the data were 50 times more likely to occur under the null rather than alternative hypothesis. This shows that the experimental conditions had no impact on participants' understanding of the fact they were forced.

We then investigated the effect of our experimental conditions on participants' sense of control and feeling of freedom. Bayesian ANOVAs[1] with default prior scales revealed that the null hypothesis was preferred to the alternative hypothesis by a Bayes factor of 7.29 for the sense of control and 2.12 for the feeling of freedom. The data provide substantial evidence against the hypothesis that time delay and attentional misdirection are important keys for the success of the trick. In the same way, these results provide some anecdotal evidence against the hypothesis that these factors affect participants' feeling of freedom when cutting the deck of card (Figure 4).

These first analyses thus suggest, contrary to our predictions and to common knowledge among magicians, that the Criss-Cross force does not rely on misdirection. Our results illustrate that participants struggle to understand the event sequence even when the trick is performed without time delay. Participants failed to realise that their action had no impact on the outcome, the card they end up with. Also, when asked to repeat the events themselves, most participants showed they misremembered what happened, and they were either not able to remember what happened after they cut the deck or they remembered that the magician told them to take the top card of the top pile for example.

Experiment 3

Experiment 2 shows that the Criss-Cross force works, regardless of whether attention is misdirected or not. In the final experiment, we tried to break the illusion by explicitly demonstrating that the chosen card was independent of their action.

To do so, we numbered the back of every card from 1 to 52, making it easy to see that the outcome card is the same as the card which was at the top of the deck from the beginning. Like this, we could be sure participants do not fail to correctly see which card is on top, and which one is the one resulting from their action. This time, however, we compared the Criss-Cross with an even more simplified version of the trick, using a more usual way of dealing with cards, to investigate whether the Criss-Cross event sequence explains the success of the force.

We predicted that participants will more often understand that their choice was manipulated in a simpler sequence of the trick rather than in the Criss-Cross force. Thus, the Criss-Cross procedure should be more effective than a normal cut.

Method

Participants. Sixty participants (35 women, 25 men, *M* age = 23.7, *SD* = 6.95), recruited in the same venue as Experiments 1 and 2, took part in this experiment. An a priori power analysis was run before the experiment, for a chi-square test with $w = .4$ (moderate to strong effect size), $\alpha = .05$, and a power of .8. The output required a sample size of 50 participants. We based our effect size on the fact that the cross shape seemed to be the last element of the trick possibly making it work, therefore expecting it to have a quite strong effect on participants' sense of control and understanding of the trick.

Procedure. We randomly numbered the back of every card from 1 to 52 and had two experimental conditions. In the first condition, the Criss-Cross force was performed as in our second experiment with no misdirection condition, without any time delay or attentional misdirection. The only change was the numbers on the back of the cards. For the second condition, we used a simpler event sequence: the cards were also numbered on their back, and the experimenter simply asked the participants to cut the deck of card. Then, she directly asked them to "take their card," but still pointing at the forced one, which was the one on the top of the deck from the beginning. Because this procedure did not contain the cross, participants should be able to understand their choice is manipulated.

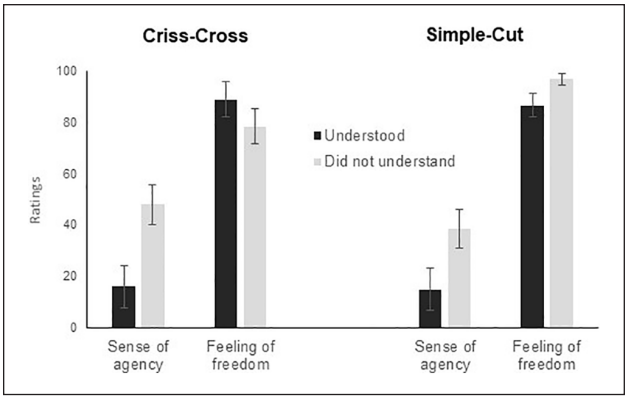

Figure 5. Sense of agency and feeling of freedom across participants who understood the trick and those who did not for both experimental conditions.

Results and discussion

Of the 60 participants, 19 understood their action did not have any impact on their outcome card. Five were in the Criss-Cross condition, and 14 in the Simple-Cut sequence. A Bayesian chi-square provided substantial evidence for the alternative hypothesis (B10 = 6.26). These results suggest that the data are approximately six times more likely to occur under H1 than H0 (see Figure 5) and validates our hypothesis. Participants were significantly more likely to realise their actions had no impact on the Simple-Cut condition. However, even though participants had all the visual information to follow the force procedure correctly (numbers on the back of the cards), only 17% of them realised that their actions had no impact on the outcome. A plausible mechanism which could explain this failure results from the unusual way of dealing the cards. We suggest that this procedure provokes an attribute substitution error in which participants think they have the outcome of their cut. Attribute substitution consists of substituting an element/information of an ambiguous or complex problem for a more usual/easier one (Kahneman & Frederick, 2012; Kahneman & Frederick, 2002). The attribution substitution error may account for the Criss-Cross force, in that a complex and unusual way of cutting the cards is substituted for a simpler one. However, in the Simple-Cut condition, the event sequence would not require participants to substitute

any element of the sequence, and yet less than half the participants realised that their actions had no impact.

This time again, when showing what they remembered from the sequence, most of the participants thought they took the top card that they cut to or did not remembered which pile was put on the top of the other by the experimenter. Surprisingly, still more than half of the participants in the Simple-Cut condition did not understand they were forced. When questioned, they typically explained that because they just expected to have the card they cut at in the deck, they assumed it was the one the experimenter told them to take, without paying attention to the numbers on the back.

Regarding participants' feelings of control and freedom, we used a Bayesian Mann–Whitney *U* test with a Cauchy prior of .707. The Bayes factors did not provide any evidence for the alternative hypothesis (B10 = 0.806 for the sense of control and B10 = 0.525 for the feeling of freedom).

This suggests that although participants understood their action did not have any impact on the outcome card they had, they felt the same amount of control for the result of the trick. The overall feeling of control over the outcome card was relatively low across both conditions ($M = 35.1$) and there was a large variation in responses ($SD = 36.5$). We suggest that our scale and phrasing may not have been optimal to measure the sense of agency the participants felt for the outcome of their action. During debriefing, a typical answer to explain their response on the agency scale was that they did not feel much in control because they were instructed to take a specific card, and could not choose between several. Other responses were that because they could not see in advance the card they were taking, they felt unable to predict the outcome of the card.

We then separated participants between those who understood they were forced and those who did not, to look at whether they experienced different feelings of control and freedom during the trick (Figure 5). Bayesian Mann–Whitney *U* tests showed some substantial evidence for the alternative hypotheses stating that participants who understood they were forced should experience significantly less control over the outcome card than the participants who did not understand, this for both experimental conditions (B10 = 3.30 for the Criss-Cross condition, and B10 = 4.37 for the Simple-Cut condition). However, no or very anecdotal evidence was found for the alternative hypotheses regarding participants' feeling of freedom both in the Criss-Cross condition (B10 = 0.39) and the Simple-Cut condition (B10 = 1.31). These results suggest that when participants understood the trick, they understood the fact that they were not in control for the outcome card, although they were free to cut wherever they wanted in the deck and were able to distinguish whether they were manipulated or not.

Finally, we compared the group of the Criss-Cross condition with the one of our second experiment (no misdirection condition) to see whether the numbers on the back had any significant effect on our dependent variables. Bayesian Mann–Whitney and chi-squared tests with default priors regarding participants' feeling of freedom (B10 = 0.30), sense of agency (B10 = 0.39), or their understanding of the trick (B10 = 0.74) did not provide any evidence for the alternative hypotheses. This suggests that even when participants could rely on a strong visual to follow the event sequence, they were unable to understand they were forced.

General discussion

We investigated a magician's forcing technique—the Criss-Cross force—which provides a simple way to give the illusion that we choose our outcome (i.e., here, a card), when it was in fact forced upon us, and predetermined. We demonstrate how people can think they controlled an outcome even though their action was meaningless, and instead controlled by another person.

Results from Experiment 1 showed that participants were unable to differentiate between an outcome they controlled and one that was forced upon them. In other words, participants felt as much control over their outcome card when this card was forced, as when it was the card they themselves selected. Very few (two of 30) participants understood that the card was forced and that their action of freely cutting the deck had no impact on the outcome. These results add to the illusion of control and sense of agency literature, showing that even when facing a relatively simple event sequence, people fail to understand they do not control the outcome of their actions. The experiment, therefore, confirmed that the Criss-Cross force is a simple yet effective way to provide an illusory sense of agency over the outcome of an action. This provides new insights into the literature about how our sense of agency is fallible. Previous research on priming has shown that it is possible to mislead people into thinking and feeling they controlled something when they did not (Aarts et al., 2005; Pronin et al., 2006; Wegner et al., 2004). Here, without priming, we showed that it is possible to provide such an illusory sense of agency over an event—more precisely over a choice of card. This suggests that we sometimes fail to understand whether we are the agent causing something in our environment in our day-today life. Experiments 2 and 3 explain the plausible mechanisms that underpin this illusion.

In Experiment 2, we investigated whether misdirection was the key to the success of this force. Our survey on magicians revealed that misdirection in the form of diverting attention away from the cards and creating a time delay before forcing the card should be the most important factors driving the illusion. However, our results do not

confirm this view. Attentional misdirection and a time delay had no impact on participants' awareness of the force. These results were truly unexpected and confirm that magicians do not always know why their tricks work. Our previous research (Kuhn et al., 2020) has shown that magicians are good at estimating the effectiveness of a force, but their intuitions about its mechanism are not necessarily correct. A more scientific approach to the art of magic can illustrate why their tricks work, which in turn might help them develop more refined and more powerful deceptive principles (Kuhn, 2019; Rensink & Kuhn, 2015). Our results also show that distraction is not necessary to experience an illusory sense of control over a simple event sequence. Most of our participants failed to correctly remember the exact event sequence even without time delay or attentional distraction. This suggests that even when we are paying attention to an event, we can fall victim to an illusory sense of control over it.

In the final experiment, we tried to break the illusion by explicitly demonstrating that the chosen card was independent of their action. The back of each card was numbered, making it obvious that they were choosing the top card. Rather surprisingly, even without time, or attentional misdirection, the force remained successful. The Criss-Cross procedure resulted in a significantly greater illusory sense of agency over the outcome, than when participants are simply asked to cut to a card and asked to select the top card from the original pack. These results suggest that the Criss-Cross event procedure itself is largely responsible for the illusion.

Thomas and colleagues (2018) reported on the Flushtration Count illusion, a perceptual reasoning illusion that results from people falsely substituting a complex event sequence with a simpler version. We propose that the Criss-Cross force relies on a similar attribute substitution error in which people substitute the complex and unfamiliar cutting procedure with a simpler and more typical one. In our context, people expect to see a simple set of actions (i.e., they cut to a card and get this one), but in reality, they witness a rather more complex set of actions. Participants were unable to correctly represent the event sequence, even though they had the visual capacities to follow what happened. Most participants were oblivious to the force and simply expected to end up with the card they cut to.

Across all experiments, most participants misremembered the event sequence when asked to show the experimenter what they recalled had just happened. Indeed, most of them failed to remember, or realised that the card they took was the forced one. We initially had two hypotheses about this misrepresentation. First, we expected that attentional misdirection led people's attention away from the trick, which means they should no longer experience the illusion. Attention plays an important role in determining what people see (Treisman, 2006), and attentional misdirection is crucial for most magic tricks (Kuhn et al., 2014). Likewise, we predicted that an increase in time delay between encoding and card selection would enhance the effectiveness of the force and increase memory distortions. As Roediger (1996) notes, "if the cognitive system can err in misrepresenting objects when they are present before the eyes, the opportunities for error when a person later tries to recreate happenings of the past must be even greater" (p. 79). Our results suggest that because of an attribute substitution, participants misperceived the Criss-Cross event sequence, therefore also misremembering what just happened. Debriefings showed that participants tended to misremember the event, thinking that they were asked to take the card they selected, thanks to their cut. Our memory and perceptual experiences are heavily influenced by expectations and prior experiences (de Lange et al., 2018; Kerzel, 2002; Martens & Fox, 2007). It is likely that people's expectations about what was supposed to happen (i.e., getting the card they chose) and therefore about how the cards are dealt with (i.e., doing a cross shape with the cards with the chosen cards being in the middle of the two piles) led them to alter their memory in a way which match these expectations. Our results have important implications for real-life situation such as eyewitness testimonies, and how people's expectations and prior beliefs influence our memory for complex event sequences. Previous research has shown that people's expectations arising from stereotypes about social groups influence how people mentally represent and event (Lenton et al., 2001; Slusher & Anderson, 1987). Participants frequently attribute events to an incorrect source, often belonging to the stereotyped group (Bayen et al., 2000; Bayen & Kuhlmann, 2011; Mather et al., 1999). For example, Bayen et al. (2000) showed that participants make schema-based guesses (i.e., whether a statement is more expected to be said by a doctor or lawyer) when they could not remember which source (i.e., the doctor or the lawyer) had presented a particular item (i.e., a statement). This phenomenon has been shown to be more prominent when perceivers are under restricted cognitive capacities (Sherman et al., 2003), and our results suggest that the complexity of the observed event could as well influence it.

Our results also add to classical findings in choice blindness (Hall et al., 2010; Hall & Johansson, 2008; Rieznik et al., 2017). In these studies, people often fail to detect the mismatch between their choice and the outcome of their choice, and although aspects of our paradigm are similar here, there are some crucial differences. In typical choice blindness paradigms, the experimenters use elaborate covert deceptive procedures to conceal the switch between the participants' choice to the changed outcome. In our paradigm, the deception occurs in full view and is blatantly obvious, as highlighted in Experiment 3. Our experiments show that people can easily be tricked into believing they have control over an outcome that has been predetermined all along.

During the debrief, participants were asked to explain their answers, and they often reported providing low ratings in terms of sense of control because they were instructed to take a particular card, or because they could not see the face of the card. In other words, their reports of control were not related to the manipulations employed here, but due to the general instructions given. This observation dovetails previous research showing that participants feel a lesser sense of agency when coercive instructions are given (Caspar et al., 2016), or when alternative actions decreased (Barlas et al., 2017, 2018; Barlas & Obhi, 2013). The comparator model (Carruthers, 2012; Miall & Wolpert, 1996) and several other studies (Moore & Haggard, 2008; Sidarus et al., 2017; Tanaka & Kawabata, 2019) further underline the role of prediction of our actions' outcomes in our sense of agency. However, this relates mainly to somatosensory or motor control contexts and for implicit sense of agency, measured by intentional binding (Beck et al., 2017; David et al., 2015; Farrer & Frith, 2002; Miall & Wolpert, 1996; Moore & Haggard, 2008; Sato, 2009). Our results suggest a confirmation of the role of choice alternatives, coercion, and prediction in the feeling of controlling participants' feel over the outcome of their actions.

Limitations

People's ability to distinguish between their own and others' actions and their self-report over how much control they experience over an outcome are not entirely equivalent. However, our findings in terms of judging the outcome of an action are central to our understanding of the sense of agency more generally. In Experiment 3, we showed that participants self-reported being significantly less in control when they understood that they were not the ones controlling the outcome. We are therefore fairly confident that our measures operationalise how much control they experience over the outcome. We believe finding the most appropriate explicit measure of the sense of agency is one of the main challenges of research in this field. What seems to be the most important things to look at in this case is to be sure that what is measured explains some part of the variance.

All the experiments were conducted in a café rather than a more isolated laboratory, and we cannot rule out the possibility that participants were distracted by their surroundings. However, much of our empirical work on forcing is conducted outside the traditional experimental laboratory as this provides a more natural way of studying the cognitive mechanism that underpins these illusions (see also Shalom et al., 2013).

To conclude, the Criss-Cross force provides us a powerful tool to explore what we called the apparent action causation, this illusion that our actions necessarily have an impact over the outcome of an event. We showed that people can easily be blind to the fact they are manipulated, even during a very simple event sequence.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Open practices

The data from the present experiment are publicly available at the Open Science Framework website: osf.io/q8n92 and https://osf.io/gshx3

Supplementary material

The supplementary material is available at qjep.sagepub.com

Note

1. Bayesian analyses of variance (ANOVAs) do not necessitate normally distributed data (Kruschke, 2010).

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