Forcing agency:

Exploring illusory sense of agency and free will over choice with magicians' forcing techniques.

Alice Pailhès

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Department of Psychology

Goldsmiths, University of London

London

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Contents

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Abstract

Magicians have developed a wide range of techniques that allow them to covertly influence their spectators' choices: 'forcing' particular outcomes while, at the same time, presenting the illusion of freedom. Across five articles, I demonstrate how magicians' forces, also called forcing techniques, can be adapted into novel behavioural research methods that can shed light on decision-making processes and illusory sense of agency. The first article proposes a psychologically-based taxonomy of forcing techniques, which used the magic literature to identify psychological principles that underpin different types of forcing techniques. Following on from this taxonomy, this thesis is then divided in two sections: Outcome Forces and Decision Forces.

The first section of the thesis concerns Outcome Forces. Chapter 3 presents an investigation of the Criss-Cross Force, in which the magicians exploit spectators' illusory sense of agency over an outcome card that is completely controlled by the magician. In chapter 4, I present studies of the Magician's Choice Force. Here we exploited semantic ambiguities and people's failure to notice inconsistencies to ensure that participants ended up with a pre-determined outcome without being aware of this.

The second section of the thesis concerns Decision Forces. Chapter 5 presents the Position Force, a force that relies on the strategic physical positioning of the items. We manipulated whether participants were reminded that they were making a decision or not when asked to select one of four cards. Finally, Chapter 6 investigated the Mental Priming force. We used video and live performance of this force, which relies on subtle non-verbal and verbal conversational primes to influence spectators to choose the three of Diamonds.

These studies demonstrate that forcing techniques allow scientists to shed a light on decision-making processes and illusory agency and freedom over choices and their outcomes.

Contributions

In Chapter 2, I led the writing of the manuscript and created the taxonomy of forcing. Ronald Rensink and Gustav Kuhn have contributed to the design of the classification and editing of the manuscript. The manuscript has been published in *Consciousness and Cognition* (Pailhès, Rensink & Kuhn, 2020).

In Chapter 3, I designed and conducted the experiments helped by Nergis Darmon, conducted the statistical analyses, and led the writing of the manuscript. Gustav Kuhn has supervised the studies and assisted with manuscript writing and editing. The manuscript has been published in *Quarterly Journal of Experimental Psychology* (Pailhès & Kuhn, 2020c).

In Chapter 4, I led the writing of the manuscript, designed the experiments, and led the statistical analyses. Shringi Kumari helped design the first experiment and contributed to data collection. Sara Lang, Vivian Kwok and Megan Know have helped collect the data for the third experiment. Gustav Kuhn supervised the studies and assisted with manuscript editing. The manuscript has been published in the *Journal of Experimental Psychology: General* (Pailhès, Kumari, & Kuhn, 2020).

In Chapter 5, I designed the studies, collected the data with the help of Radoslaw Wincza, conducted the analyses and wrote the manuscript. Gustav Kuhn has helped design the experiments and has assisted writing and editing the manuscript. The paper has been published in *Psychological Research* (Pailhès & Kuhn, 2020b).

In Chapter 6, I collected and analysed the data and wrote the manuscript. Gustav Kuhn contributed to the design and editing. The manuscript has been published in *Proceedings of the National Academy of Science* (Pailhès & Kuhn, 2020a).

I am the sole author of Chapter 1 and 7.

1. Introduction

1.1. The science of magic

Doves appear, a key bends, an assistant is cut in half, and cards magically teleport to impossible locations… Magicians have dazzled and deceived audiences for centuries. Throughout this time, they have developed many techniques to manipulate our conscious experiences (e.g. Kuhn, 2019). Distorting our perception, manipulating our attention, and even influencing the decisions we make, conjurers' methods have many links with psychology. These conjuring methods are now regarded as a novel source of insight into the human mind: however, the idea of investigating the psychology of magic is not new. Already at the end of the 19th century, some of the early pioneers in psychology such as Alfred Binet and Norman Triplett became interested in magic tricks, and what they could bring to the understanding of the human mind (Binet, 1894; Triplett, 1900). These researchers recognized the links between psychology and magic, collaborated with magicians in an attempt to uncover the source of their deception, and they published their findings in scientific papers (Thomas, Didierjean, & Nicolas, 2016). Triplett, in his extensive 72-page thesis entitled "The Psychology of Conjuring Deceptions", discussed the role of attention in magic, noting that magic tricks might provide the "perfect psychological experiments whose efficiency have been proved on thousands of people" (Triplett, 1900, p.439). Likewise, Alfred Binet worked with famous contemporary magicians such as Gustave Arnould and Edouard-Joseph Raynaly to study psychological processes, such as misdirection and suggestion (Binet, 1894). These early investigations showed that magicians hold a wide range of intuitive knowledge about the cognitive processes governing the human mind, and current scientific research supports this approach.

Magicians' methods provide a valuable toolbox that can help inform psychologists about the mechanisms that underpin cognitive, social, developmental and even transcultural processes (Kuhn, Amlani, & Rensink, 2008a; Rensink & Kuhn, 2015). Moreover, magicians' deceptive methods allow scientists to create innovative ways of studying human behaviour and cognition. Indeed, the last decade has seen a sharp rise in scientific interest in the use of magic as a tool to study many psychological processes. A new wave of interest has recently arisen, with scientists investigating processes such as *attention* (Cui, Otero-Millan, Macknik, King, & Martinez-conde, 2011; Hergovich & Oberfichtner, 2016; Kuhn, Tatler, Findlay, & Cole, 2008; Leech, 1960; Otero-Millan, J., Macknik, Robbins, & Martinez-conde, 2011; Tachibana & Gyoba, 2015), *memory distortions* (Pärnamets, Hall, & Johansson, 2015; Subbotsky, 1996; K. Wilson & French, 2014; Wiseman, Greening, & Smith, 2003), *belief formation* (Lan, Mohr, Hu, & Kuhn, 2018; Lesaffre, Kuhn, Abu-Akel, Rochat, & Mohr, 2018; Mohr, Koutrakis, & Kuhn, 2014; Mohr, Lesaffre, & Kuhn, 2019; Mohr & Kuhn, 2020) or *reasoning* (Danek, Fraps, von Müller, Grothe, & Öllinger, 2014; Thomas & Didierjean, 2016a; Thomas, Didierjean, & Kuhn, 2018b). A quick look at the number of papers on the science of magic shows that there has been a spurt of interest on the topic, which seems to grow exponentially (Figure 1.1.).

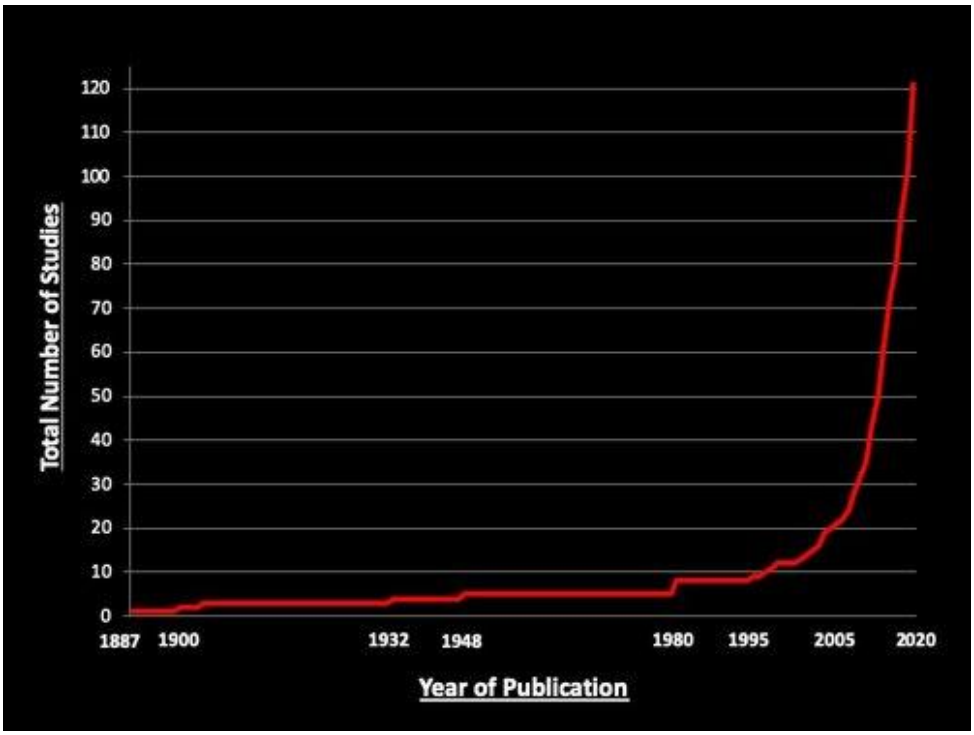

Figure 1.1 Papers published on the science of magic. Experimental research related to adults experiencing or performing magic, since 1887 (from Tompkins, 2021). This does not include reviews and theoretical papers.

The science of magic has become a worthy field of study (Kuhn, Olson, & Raz, 2016), and in 2014 the Science of Magic Association (SoMA) was formed. SoMA consists of members from different backgrounds including science, humanities and practicing magicians and gathers every two years for academic conferences on the science of magic. Thanks to this interest, discoveries in psychology have been made, suggesting that magicians' intuitions about the human mind might be a real treasure trove for scientists.

Recently, the focus has shifted towards understanding how magicians' control our choices. Magicians have developed a wide range of psychological tricks to covertly influence people's choices (Pailhès & Kuhn, 2021). These forces are often extremely effective, and illustrate various weaknesses in our sense of control over decisions and their outcomes.

The present thesis focuses on this new area – forcing. Forcing techniques, or forces, are magicians' mind control tricks. The principle of forcing is linked to many other magic techniques – controlling the spectator's attention or influencing their reasoning or beliefs are parts of tricks involving forcing techniques. In the last decade, scientists have learnt much about the mechanisms that underpin all these different principles, as well as the methods used to study them. Thanks to this, it is becoming easier to investigate forcing techniques, identify and isolate their principles to create the illusion of free choice and agency.

1.1.1. Magic to study attention and perception

Much of the research on the science of magic has focused on how magicians control their spectators' attention by using misdirection. Defined as the ability to manipulate the spectator away from the secret method of a magic effect (Kuhn, Caffaratti, Teszka, & Rensink, 2014), misdirection is one of the corner stones of magic. In 2014, Kuhn and colleagues developed a psychologically based taxonomy of misdirection, which links conjuring principles with cognitive processes involved in misdirection (Kuhn et al., 2014). According to this theory, misdirection involves three main psychological principles that are of interest to psychologists: perception, memory, and reasoning. The scientific studies of misdirection have shed light on the nature of the attentional processes and they have highlighted vast gaps in our conscious perception. Research on attentional misdirection suggest that magicians use a range of cues to misdirect the audience's attention away from salient and secret events. For instance, a magician can drop a cigarette or lighter from their hand in their lap in full view and prevent most participants from noticing this event thanks to social cues such as their gaze (see Figure 1.2., Kuhn & Tatler, 2005). Subsequent studies have also shown that participants largely

overestimate the extent to which other people would have noticed the event (Ortega, Montañes, Barnhart, & Kuhn, 2018).

Figure 1.2. Schematic representation of the lighter trick. a) The magician is seated at a table across from the viewer. A lighter is on the table. b) He picks up the lighter and flicks it on c)-f) He pretends to take the flame away and make it vanish, providing a gaze cue as misdirection away from his other hand. At f), the lighter is visibly dropped into his lap. g)-h) The lighter appears to have vanished. Figure from Friebertshauser, Teszka, & Kuhn, 2014.

Likewise, many studies of attentional misdirection have investigated the links between gaze, visual fixations, and conscious perceptions (e.g. Ortega et al., 2018). For example, using the same misdirection trick, which involved dropping the lighter in full view, Kuhn and colleagues (Kuhn, Tatler, Findlay, & Cole, 2008) showed that there was no significant relationship between participants' gaze and whether they detected the lighter dropping or not. Even some participants who looked directly at the lighter as it fell reported having no conscious experience of that event and were subsequently unable to explain how it had vanished. A number of other studies have shown similar effects (Barnhart & Goldinger, 2014; Kuhn,

Teszka, Tenaw, & Kingstone, 2016; Smith, Lamont, & Henderson, 2012), contradicting our intuitive assumption that looking equates seeing. This type of research has provided, among other things, insights into the mechanisms underpinning our attention, and the importance of social cues in attentional distraction (e.g. Simons & Chabris, 1999; Simons & Levin, 1997). Moreover, magic provides additional tools for exploring perception in more naturalistic dynamic scenes – as opposed to tasks such as flickering dots/shapes, or Gabor patches.

Research focusing on The Vanishing Ball Illusion is an excellent example of how a magic trick can be adapted to explore psychological questions, in this case, the relationship between expectations and perceptual experiences. In this trick, a magician appears to cause a small ball to 'vanish' into thin air (Figure 1.3). To accomplish this illusion, the performer genuinely tosses the ball into the air and catches it twice. Then, they appear to throw it into the air a third time. However, on this third throw, the performer only pantomimes the action of tossing the ball, while really concealing the ball in their hand. A variation of this trick was first investigated by Triplett in 1900, and more recent scientific studies of this trick showed that mimicking throwing the ball into the air was sufficient to make most participants see it vanish in mid-air (Kuhn & Rensink, 2016). This paradigm demonstrates that our perception of moving objects is influenced by our expectations, and has driven multiple published studies, showing that a simple trick can lead to a rich collection of publishable research (see Kuhn & Land, 2006; Thomas & Didierjean, 2016b; Tompkins, Woods, & Aimola Davies, 2016).

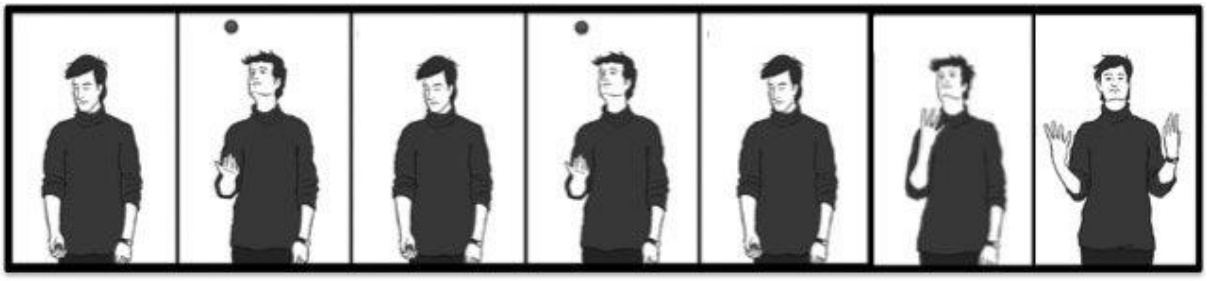

Figure 1.3. Vanishing ball illusion. Figure reproduced from Kuhn, 2019.

These scientific investigations into magicians' practical knowledge of illusions also highlight the importance of developing taxonomies that link between magicians' performance experience with scientific theory. They further illustrate the way in which magic principles used in practice can be broken down and studied in the laboratory (Kuhn et al., 2014).

Magicians have developed a vast range of techniques that allow them to systematically, yet covertly, influence people's decisions. However, although a handful have been investigated scientifically (Olson, Amlani, Raz, & Rensink, 2015; Shalom et al., 2013) and seem reliable, the magic literature is vast, uneven, and sometimes contradictory. A lot of these techniques seem to be based on intuitions rather than empirical knowledge, suggesting that behavioural experiments are necessary to distinguish robust techniques from very unreliable ones. The magic literature needs to be read carefully and subjected to empirical testing. The first step of this thesis involves developing an operational definition and theoretical basis of forcing, and establishing a taxonomy of forcing, analogous to what has been done on misdirection (Kuhn et al., 2014). A psychologically based taxonomy of forcing techniques will help identify the psychological mechanisms that underlie these techniques, and facilitate the knowledge transfer between magicians and psychologists.

1.1.2. Magic to study cognition

Magicians not only manipulate people's perceptions, but also how people interpret and reason about what they perceive. For instance, some techniques rely on the theory of false solution, in which magicians prevent their spectators from discovering the secret method of a trick by manipulating how people reason about what they experienced. The Principle of False Solutions corresponds to methods in which the magician explicitly or implicitly suggests explanations

that are not the ones used to achieve their trick (Kuhn et al., 2014; Lamont & Wiseman, 2005; Thomas & Didierjean, 2016a; Thomas, Didierjean, & Kuhn, 2018a). A magician, can, for example, falsely claim that they are using subtle 'micro-expressions' to read the spectator's mind (Lan et al., 2018), when, in reality, they used a different method, therefore misdirecting the audience away from the real secret of the trick (e.g. having an electronic device allowing them to know what colour of a dice the spectator chose). Scientific investigations of this principle have shown that implicitly providing a false solution to a trick also prevents people from discovering an obvious solution, even when the false solution is directly debunked (Thomas & Didierjean, 2016a; Thomas et al., 2018a). Forcing techniques often use this principle of false solutions in that they must cover the fact that the magician controlled the spectators' choice, therefore providing another alternative solution. For instance, a magician can physically control which card the spectator selects thanks to a subtle sleight of hand, while acting as if they are reading the spectator's mind when they are thinking about this selected card.

Other techniques allow magicians to lead their spectators to establish erroneous causal links between events of the performance (Macknik et al., 2008). Dovetailing with illusory correlation studies (Chapman, 1967), these studies showed that when an event A precedes event B, people often deduce that A is the cause of B, even if "it violated the expected causal relationships that form an implicit belief system about what is possible in the world around us" (Danek, Öllinger, Fraps, Grothe, & Flanagin, 2015, p.1). Magic has also been used to investigate belief formation processes. For instance, several studies have shown that exposing participants to a magic trick that was framed as a demonstration of psychic powers increased participants' belief in psychic phenomena (e.g. Benassi, Singer, & Reynolds, 1980; Mohr et al., 2014). Likewise, magic performances have been used to study magical thinking in both adults and children (Subbotsky, 2010). Scientific investigations of forcing techniques provide a useful toolkit to understand

cognitive processes linked to decision-making and judgment of agency and freedom over choice.

1.1.3. Magic to create new scientific methods

All of the studies presented so far used magic as a subject of investigation and tried to uncover the psychological processes involved. However, other researchers have used magic as a method to study – and even discover - diverse psychological phenomena that are independent of the tricks involved. There has been a long tradition of using deception to study psychological processes (Binet, 1894; Dessoir, 1893; Triplett, 1900), and magic tricks often provide a valuable deceptive tool to study cognition. The conjuring techniques in performance magic allow us to experience things that we believe to be impossible (Kuhn, 2019). Throughout history, conjurers have learnt to use clever psychological tricks to create compelling illusory phenomena that violate our understanding of the world (e.g. violations of the laws of physics- objects that float in defiance of gravity, or seem to pass from existence to non-existence and back). Magicians have also developed tricks that allow them to push the limits of what their audiences believe is possible. Among other things, they often proclaim that they can insert specific thoughts into people's minds or unconsciously manipulate their behaviour. This form of magic is known as *mentalism*, and the context of such performances varies widely. For example, some performers attribute the effects to paranormal and psychic abilities while others frame it as psychological skills such as reading body language or using subtle suggestion techniques.

Until now, a small subsection of psychological research has used mentalism techniques to create two main new scientific methods: choice blindness and placebo procedures. Choice blindness refers to the fact that people often fail to notice the mismatch between their choice and the outcome of this choice, and end up justifying a choice they never made in the first place

(Johansson Petter, Hall Lars, Sikstrom Sverker, & Olsson, 2005). In their seminal study, Johansson and colleagues showed participants pairs of faces printed on playing-sized-pieces of paper. They asked participants to choose the picture that they found most attractive. After the participant had indicated their selection, the experimenter handed the participant their chosen picture, who then had to explain their choice. However, thanks to subtle sleight of hand, in some critical trials, the experimenter covertly switched the chosen image for the rejected one. The results showed that most people fail to notice this change and even generated elaborate justifications to explain why they chose the face they previously rejected. These results have now been replicated across different contexts and for diverse items, ranging from jars of jam (Hall, Johansson, Tärning, Sikström, & Deutgen, 2010) to moral and political questionnaires (Hall et al., 2013; Rieznik et al., 2017). The phenomenon seems to be as robust as it is surprising. For instance, a recent study demonstrated that despite political polarization of American politics, a simple manipulation based on a mentalism technique made people endorse and express less polarized views about competing political candidates of the 2016 presential election (Strandberg, Olson, Hall, Woods, & Johansson, 2020). Here, participants first completed a paper survey evaluating Donald Trump and Hilary Clinton on various personality traits. After this, the experimenter used a magic technique to covertly manipulate the survey thanks to a trick, so that most of the participants' answer favouring one of the two candidates switched to a moderate response. Very few participants noticed the change – 94% of them (N=136) accepted the manipulated responses as their own. Even though they first reported polarized views, these participants rationalised the new neutral position accordingly.

These studies exemplify how magic trick methods can be used to drive novel research. The Choice Blindness paradigm relies on magic methods to perform the switches between participants' initial choice and the manipulated one. Thanks to these methods, scientists have

discovered how false feedback can powerfully change and shape people's preferences, from pictures of faces, to consumer preferences, to political views.

Mentalism magic methods have also been instrumental in the development of novel placebo procedures. Recently, Olson and colleagues investigated whether it was possible to make people believe that a machine was influencing their thoughts and mental choices by using mentalism magic tricks to help create illusory proof of the machine's power (Olson, Landry, Appourchaux, & Raz, 2016). Using a technique from magic (Corinda, 1961) combined with a dummy fMRI machine, the researchers created a novel deceptive paradigm. They told participants that they were taking part in a study to examine how a brain scanner could read thoughts and influence their mind. Participants had to lie in the dummy scanner and the procedure involved two conditions: a *mind reading* task, and a *mind influencing* one. Thanks to the mentalism technique, the scanner appeared to correctly guess the participants' choice of numbers and to influence their choice of numbers. Participants felt significantly less sense of control over their thoughts when they believed that the machine was influencing their mind than only reading it. These results were replicated in a second experiment, also showing that most subjects felt a range of physical and mental symptoms resulting in the machine's influence. Participants reported feeling things such as numbers "popping in" their head, voices dragging them from a number to the other, feeling "some kind of force" or even being stuck on one number.

These experiments are the first to have used mentalism magic trick methods to simulate thought insertion, and both quantitative and qualitative results indicated that most participants were convinced that the machine was controlling their thoughts. This belief resulted in a distorted sense of agency that was expressed differently across participants. Like the Choice Blindness paradigm described above, this study demonstrates the usefulness of magic

techniques in scientific experiments. In this instance, instead of being used to covertly switch stimuli, deceptive techniques from magic were used to provide the illusion that it was possible to influence participants' minds. The present thesis focuses on techniques that genuinely influence a person's choice, or the outcome of the choice without them being aware of this manipulation.

Pilot data from our research program and using a similar procedure suggest that the alleged proof provided by the magic technique (i.e. showing the matching number) seems to be a significant factor contributing to the observed effects. It seems that the deceptive mentalism methods allow participants to be more confident in the procedure and enhance their expectations in what the machine is capable to do to their brain activity. I have reviewed different ways in which these mentalism tools can be used to create the illusion of thought insertion (Pailhès, Olson, & Kuhn, under review).

This type of paradigm, much like the ones using hypnosis (Connors, 2015; Walsh et al., 2014), allows researchers to model symptoms of mental disorders and explore loss of agency over thoughts with a high level of control in non-clinical populations. Likewise, it opens several possibilities for future research. If it is possible to make participants believe that a machine can read and influence thoughts, it might extend to inserting other phenomena such as memories, judgments, or emotions. Adapting established techniques from magic and mentalism performances therefore offers a powerful tool to create experimental methods to investigate distorted sense of agency.

In mentalism, magicians simulate thought insertion and these techniques provide valuable tools to manipulate people's thoughts and behaviours (Pailhès et al., under review). In this thesis, I will focus on forcing techniques where the magicians genuinely influence and manipulate the spectator's thoughts and choices while providing and illusory sense of agency and free will over these choices.

1.1.4. Magic to study free will and agency?

The insight that magic trick methods can be used to study people's sense of free will and agency can be traced back to the earliest days of experimental psychology. Back in 1893, Dessoir noted that magicians have powerful ways of influencing people's decisions, and that these processes provide a useful tool to study our sense of free will and agency: describing forcing techniques, he noted "I do not think that anything could offer a better illustration of the determinism of all our actions" (Dessoir, 1893, p. 16). More than a hundred years later, current psychological research highlights that our subjective experience of free will may indeed be an illusion and that many of our choices are influenced by unconscious factors. I propose that magic trick methods, combined with contemporary behavioural research methods, can lead to novel insights into these age-old questions.

There is no easy way of assessing whether humans have free will or not, and the matter of free will has entranced and entangled philosophers, scientists and theologians for millennia (Waller, 2019). However, the "experience" of free will is something that is more easily addressed by behavioural research, and research on the sense of agency shows that we often have the experience of agency, even in situations where we have no control over the event or its outcome. More broadly, psychological studies show that many of our behaviours are automatic and unconsciously influenced by external parameters (e.g. the number of people present in a room, the clothes someone wears, the physical location of an item, etc.), this mostly in unconscious ways (Nisbett & Wilson, 1977). Several theories and approaches suggest that freewill might be more limited than what we would like to think. For instance, Kahneman suggests that we use our system 1 type of thinking most of the time – using our automatic and impulsive behaviours rather than deliberative ones (Kahneman, 2011). Compliance-without-pressure techniques (Pascual, Felonneau, Guéguen, & Lafaille, 2014; Pascual et al., 2012) show

that subtle changes in the way a request is framed affect our compliance with a range of requests, such as asking a small unrelated request before making the bigger target one (Freedman & Fraser, 1966). Likewise, research on the neuroscience of free will shows that our brain makes unconscious decisions several milliseconds or even seconds before we become aware of them (Brass, Furstenberg, & Mele, 2019; Libet, 1985, 1999). In other words, the psychological literature consistently shows that we are less rational beings than we would like to think. Moreover, we are easily influenced by external factors without being aware of this influence, which further questions the existence of freedom of choice. Indeed, the suggestion that nonconscious, automatic processes are the causes of our actions has had a major impact on theories of conscious free will. However, as psychologists, it might be more appropriate to investigate feelings of freedom rather than free will itself.

For centuries, magicians have refined their techniques and discovered ways to reliably manipulate their spectators' choice, while providing them a powerful illusory feeling of freedom for these choices (Binet, 1894; Dessoir, 1893; Triplett, 1900). Magicians have understood that our sense of free will and agency can be illusory, and they have created tricks that rely on this principle. Indeed, back in 1884, Binet noted that magicians know how to exploit the spectators' "path of least resistance", the fact that when one option is made easier than the others, most people tend to select it without giving too much thought to the process (Binet, 1894). Indeed, magicians have developed forcing techniques, also called forces, that allow them to influence, or appear to influence, people's decisions without their awareness.

Two main types of forcing techniques have been identified by psychologists (Kuhn, Amlani, et al., 2008a), and to our knowledge, only three scientific investigations of forcing had been conducted before the present thesis (Olson et al., 2015; Shalom et al., 2013; Trinkaus, 1980). *Physical Forcing* involves influencing a spectator's selection when asked to physically

select an object such as a card. A widely known technique relying on this principle – the classic force – requires the performer to handle the cards in such a way that the forced card is the one under the spectator's fingers when they reach out to touch one of them (Archive, n.d.; Scot, 1584). This technique has been studied scientifically and the results showed that 54% of participants picked the forced card while feeling completely free for this choice (Shalom et al., 2013). The second type is *Psychological* or *Mental Forcing*, which exploits psychological biases. In these cases, spectators are asked to think of a card and the performer manipulates the presentation of the cards to favour a particular choice. Olson and colleagues used the Visual Riffle Force, in which the magician flips through a deck of cards and asks the spectator to mentally select one (Olson et al., 2015). Unbeknownst to the spectator, the target card is shown longer than the others and becomes more visually salient. The large majority of participants (98%) chose the forced card while being unaware that their choice had been influenced.

The present research presents scientific investigations of four different forces, none of which have previously been the subject of empirical study. Each of these forces relies on different techniques and psychological processes (e.g. verbal vs. non-verbal influence), involving different success rates and degrees of objective influence. My empirical investigations into these techniques demonstrate that integrating forcing techniques into behavioural experiments can improve our understanding of illusory freedom and agency over choices: These magicians' forces illustrate a powerful error in the sense of free will and agency over choice. Studying the processes involved in this illusion provides, among other things, valuable insights into decision-making processes as well as a better understanding of cognitive mechanisms that lead people to experience a distorted sense of agency.

1.2. Illusory agency and magic

1.2.1. Sense of Agency

We generally feel we have control over our actions. Without even thinking about it, we continuously make a huge number of decisions and feel that we are in charge of these actions. We grab something to eat when we are hungry, press the light switch when it gets dark, and choose a TV channel to watch something we like. In other words, we feel as if *we* are in charge - we have a sense of our agency. Sense of agency refers to the feeling of control over our actions and their consequences. As Haggard stated, "the sense of agency is the feeling of making something happen" (Haggard, 2017, p. 2).

The idea that we are in control, that we are causal agents of what we think and do, lies at the heart of our conception of ourselves. Understanding the psychological factors that can lead to an erroneous sense of agency is therefore of great importance, and it has wide ranging implications outside the laboratory, from forensic assessments of criminal responsibility, criminal punishments to public policies derived from this (Frith, 2014). Given the importance of sense of agency for establishing responsibility, scientific investigations have implications for the legal system. Likewise, sense of agency research has important implications in the context of health and well-being. For instance, it is related to pathologies such as schizophrenia in which patients can experience abnormal sense of agency over their thoughts or actions (J. Moore, 2016).

1.2.1.1.Theories of sense of agency

Two central theories of sense of agency have been proposed. Namely, the 'Comparator Model' by Frith et al. (Frith, 2005; Frith, Blakemore, & Wolpert, 2000) and the 'Theory of apparent mental causation' developed by Wegner and Wheatley (Wegner, 2002; Wegner, 2003a; Wegner

& Wheatley, 1999). According to the comparator model, our sense of agency arises from internal processes within our motor system. The comparator model is based on a predictive model, that relies on the processes dedicated to the preparation and prediction of voluntary actions and it is the relationship between these processes that determine our sense of agency. According to this model an individual feels agency when the predicted state matches the outcome of the action. Accordingly, people feel a sense of agency over events which are predicted given their motor commands. This view suggests that individuals compare the visual feedback predicted from their own motor commands with the movement they see (Farrer, Bouchereau, Jeannerod, & Franck, 2008; Farrer & Frith, 2002). If there is a mismatch in this comparison the individual will experience a reduced or absent sense of agency. According to the comparator model, sense of agency is the result of a lack of prediction error. This model primarily applies to sensorimotor effects of movements (Bays, Flanagan, & Wolpert, 2006; Blakemore, Wolpert, & Frith, 2000; Reznik, Henkin, Levy, & Mukamel, 2015).

The apparent mental causation model proposes that our sense of agency is primarily based on external, situational cues. This model suggests that our sense of agency steams from the relationship we perceive between our intentions and our actions. According to this view, we do not have conscious access to the unconscious causal pathway that is responsible for our actions and their associated thoughts. Wegner therefore suggests that (Wegner, 2003; Wegner & Wheatley, 1999) the relationship between our thought and the action is what determine our sense of agency: if our intention to do something arises *before* we do it, is *consistent* with this action and is appears as the *only plausible cause*, then we then feel as though we have caused this action. However, Wegner importantly underlines that this feeling of agency is an illusion, and that the inference we make – our thoughts caused our actions – is erroneous, as the unconscious pathways are the true causes of our actions. In the next section, I will examine

some of the evidence that supports Wegner's theory and demonstrate how it relates to the principle of forcing.

1.2.1.2. Measuring sense of agency

The last 20 years have seen a sharp increase in scientific investigations into the sense of agency. The most widely used measure of sense of agency is intentional binding (for a review see Moore & Obhi, 2012). This measure was developed by Haggard et al. (Haggard, Clark, & Kalogeras, 2002), who found that when people make a voluntary action, they perceived the time of the action and its outcome as shifting toward each other. This measure relies on time perception, and it is taken to be a robust implicit marker of people's sense of agency and it is widely used (Barlas, Hockley, & Obhi, 2018; Braun, Thorne, Hildebrandt, & Debener, 2014; Moore & Obhi, 2012; Ruess, Thomaschke, & Kiesel, 2020; Wen, Yamashita, & Asama, 2015; Wolpe, Haggard, Siebner, & Rowe, 2013).

On the other hand, explicit measures directly ask participants to report about their agentic experience (Moore, 2016). Some studies require participants to make action recognition judgments. For instance, Farrer and colleagues (Farrer et al., 2008) asked participants to perform finger tapping movements while wearing a glove without directly seeing these movements. Participants watched video feedback of the movement on a screen with a delay inserted between their movement and the feedback. They were told that the movement was either their own or an experimenter performing the same movement, although they were always their own. Participants had to indicate when they thought they were seeing feedback from their own movement or not. The results showed that people experience judgments of agency spontaneously switching between themselves and the experimenter.

Other explicit measures simply require participants to report on their feeling of agency for their actions and their outcomes. For instance, participants have to state and judge how much they felt that their action of pressing a key caused an outcome after a variable delay (Valérian Chambon, Moore, & Haggard, 2015; Shanks, Pearson, & Dickinson, 1989). This kind of explicit measure tends to tap into different aspects of the agentic experience than action recognition judgment, in that it focuses on the outcome component rather than on the action element itself (Moore, 2016). Studies using such explicit agency measures show that people tend to overestimate their agency and misattribute to themselves results which are in fact unrelated to their actions (Tsakiris, Haggard, Franck, Mainy, & Sirigu, 2005; Wegner & Wheatley, 1999). In other words, studies on the sense of agency, whether they use implicit or explicit measures, show an important dissociation between people's true, objective control over their actions and their outcomes, and the feelings and judgments that they make about it.

1.2.2. Illusory agency

There is much empirical evidence demonstrating that our feeling of agency may be an illusion, and this evidence not only supports Wegner's theory of agency (Wegner & Wheatley, 1999), but it can also explain the ease by which magicians' forcing techniques can covertly manipulate people's decisions. For example, Wegner and Wheatley (1999) conducted a seminal study that highlighted the role of situational cues on agency. The study demonstrated that participants felt agency over movements they had in fact not performed. In this experiment, participants had to move a Ouija-like pointer, placing their fingertips on the side of the board at the same time as a confederate (Figure 1.4).

Figure 1.4. Picture from the I Spy experiment. Participant and confederate move the computer mouse together in the I Spy experiment by Wegner and Wheatley (1999).

They had to move the mouse to move a cursor around a computer screen that was visible to both of them. The screen displayed pictures of fifty small objects, and the pair were to stop moving the board approximately every 30 seconds and rate how much they had intended to make the stop. Moreover, participants heard words related to the objects depicted on the screen in their headphones before each trial. The results showed that priming participants with relevant thoughts (e.g. hearing 'table' before the cursor ended on the illustration of table on the screen) led them to rate the action as self-caused, even though unbeknownst to them, the confederate was the only one in charge of the pointer.

Since this study, other experiments have consistently revealed a gap between our sense of control over an event and the actual control we have over the event (Aarts, Custers, & Wegner, 2005; Pronin, Wegner, McCarthy, & Rodriguez, 2006; Wegner, Sparrow, & Winerman, 2004). Likewise, studies show that diverse factors can easily influence people's sense of agency. For instance, fluent or easy action selection leads to a stronger sense of agency than more difficult

selection, and conflict in action selection reduce agency ratings over following outcomes (Sidarus & Haggard, 2016). Likewise, people's sense of agency is higher for highly predictable outcomes (Moore, Lagnado, Deal, & Haggard, 2009), as well as outcomes that are highly contingent on an executed action (Moore & Haggard, 2008). These studies consistently show that our sense of agency may arise even in situations in which we do not play any objective role in the outcome result of a situation. Likewise, magic literature suggests that spectators often feel in control of an outcome card or object which was in fact completely controlled and predetermined by the magician. Magicians indeed take advantage of our tendency to feel illusory sense of agency over events which are outside our control, allowing them to make us experience the impossible. For instance, if I feel I am in control of the card I end up with, I will be way more amazed to see that the magician predicted this alleged choice. The present thesis uses forcing techniques, to provide a novel way of investigating the illusory agency over our action and their outcomes.

1.3. Structure of the thesis

The aims of the present thesis are to identify and investigate ways in which magicians covertly influence our decision making through forcing. The project aims to 1) identify effective forcing techniques, 2) identify the psychological mechanisms that underpin these forces, and 3) investigate psychological factors that contribute to people's illusory sense of free will.

The research presented here used the magic literature to help identify effective forcing techniques. These forcing techniques were then adapted into novel behavioural experiments that were designed to empirically investigate the psychological mechanisms that contribute to their effectiveness.

Chapter 2 constitutes a first theoretical introduction to magicians' forcing techniques and presents a psychologically-based taxonomy of these techniques. Based on the two main categories of this classification – Outcome and Decision forces – , the thesis is then divided in two sections, presenting two examples of each category. The section on Outcome forces presents Chapter 3 with a scientific investigation of the Criss-cross force, and Chapter 4 with three experiments on the Magician's choice forcing technique. The section on Decision forces gathers Chapter 5 on the Position force technique, and Chapter 6 on the Mental Priming force. All chapters except Chapter 1 (Introduction) and 7 (Discussion) have been published in peer-reviewed academic journals.

2. A Psychologically Based Taxonomy of Magicians' Forcing Techniques: How magicians influence our choices, and how to use this to study psychological mechanisms.

2.1. Abstract

Magicians have developed a wide range of techniques to influence and control spectators' choices of such things as card, word, or number. These techniques are what is called forcing. The present paper develops a psychologically-based taxonomy of forcing techniques with two goals in mind. Firstly, it should help uncover the different psychological mechanisms that underlie forcing techniques. Secondly, it should facilitate knowledge transfer between magicians and psychologists. The main division present two basic categories that can be used as a way of focussing separately on (1) decision-making processes and external influences on choices, and (2) links between sense of agency over action and outcome as well as the illusion of control over this outcome. This taxonomy allows us to clearly differentiate between forces in which there is or is not a free choice, and whether this choice has an impact on the following events.

2.2. Introduction

"Pick a card, any card. This has to be a completely free choice." the magician tells you. But is it really? Although we like to think that we are using our free will to make our decisions, research in psychology has shown that many of our behaviours are automatic and unconsciously influenced by external stimuli (Ariely, 2008; Bargh & Chartrand, 1999; Newell & Shanks, 2014; Nisbett & Wilson, 1977), and that we are often oblivious to the cognitive mechanisms that underpin our decision (Wegner, 2002, 2003). Magicians have exploited this illusory sense of agency for a long time, and have developed a wide range of techniques to influence and control spectators' choices of such things as card, word, or number (Annemann, 1933; Banachek, 2002; Jones, 1994; Turner, 2015). These techniques are instances of what is called *forcing*.

Many forces are extremely effective, illustrating various weaknesses in our sense of control over decisions and their outcomes. Researchers have started to investigate them in various ways (Kuhn, Pailhès, & Lan, 2020; Olson et al., 2015; Pailhès & Kuhn, 2020b, 2020c; Shalom et al., 2013) and are beginning to obtain valuable insights into decision-making processes as well as a better understanding of the cognitive mechanisms that lead people to experience an illusory sense of free will and of agency.

Although magicians have acquired large amounts of knowledge in covertly controlling people's choices, much of this knowledge is only discussed in the context of individual magic tricks, or in books that are not readily accessible to non-magicans. As we and others have argued elsewhere (Ekroll, Sayim, & Wagemans, 2017; Kuhn, 2019; Kuhn, Amlani, & Rensink, 2008; Kuhn, Caffaratti, Teszka, & Rensink, 2014; Macknik et al., 2008; Olson et al., 2015; Olson, Landry, Appourchaux, & Raz, 2016; Shalom et al., 2013; Thomas, Didierjean, Maquestiaux, & Gygax, 2015), a particularly effective way of making this knowledge more available is via the

creation of taxonomies centered around psychological mechanisms (Rensink & Kuhn, 2015). For example, the psychologically based taxonomy of misdirection (Kuhn et al., 2014) helps draw links between misdirection and formal theories of perception and cognition.

Our aim here is to apply a similar process to the knowledge magicians have about forcing. The present paper develops a psychologically based taxonomy of forcing techniques with two goals in mind. Firstly, it should help uncover the various psychological mechanisms that underlie forcing techniques. Secondly, it should facilitate knowledge transfer between magicians and psychologists. Among other things, this knowledge will allow researchers to gain new insights into the mechanisms underlying decision-making, and the feeling of free will and of agency over choice. We start by defining the magician's force and then look at some of the past classifications of forcing.

2.2.1. What is forcing?

Although there is no universally accepted definition of a magician's force, it can be thought of as a way of influencing spectators' choice without them becoming aware of this influence (Kuhn, Amlani, & Rensink, 2008; Olson et al., 2015; Shalom et al., 2013; Thomas et al., 2015) (Here, we use "choice" as an umbrella term comprising the spectator's decision as well as the item or thought that results). While frequently a part of card tricks, forces are also used in a much wider range of situations. In some instances, the magician has full control over the process, while in others they simply increase the probability of the person choosing a particular item. It is important to note that forces are distinct from techniques such as sales pitches: in the magician's force, the choice has been affected, but the person is not aware that the magician tried to aim at a particular outcome. Indeed, once the spectator realizes that his/her decision has

been influenced, the magical effect typically evaporates. A lack of awareness of the force is therefore essential.

A successful force has two key components: 1) the technique has to significantly affect the spectators' decision or the outcome of their choice, and 2) the spectator involved has to feel free in their choice, and in control of the outcome they get. Because of this second component, we will not consider techniques where the illusory freedom over a choice is only provided to the audience, but not the person making it (e.g. when the magician explicitly asks the spectator to choose a particular card unbeknownst to the rest of the audience); these techniques are similar to using a confederate, and so do not tell us much about forcing. Likewise, we do not include those techniques which allow the magician to know which card was freely selected—e.g., when the magician uses a marked deck (cf. Cole, 2020). As the main focus of our taxonomy is on spectators' illusory freedom and agency over their choice, such techniques do not fit in these situations.

Forcing is sometimes described as "the act in which a subject reports to have made a free decision among equal possibilities while manipulated by the performer" (Shalom et al, 2013), or "forcing occurs when a magician influences the audience's decision without their awareness" (Olson et al, 2015), suggesting that the force must affect the subject's decision. But as pointed out in a critique of forcing as a method for psychological research (Cole, 2020), many forcing techniques allow the spectator to make a genuinely free decision, but their decision has—unbeknownst to the spectator—no impact on the item they end up with. As Lewis Jones states "there are two types of selection that a spectator can make. In one, the selection is indeed forced. But in the other, the selection is genuinely free" (Jones, 1994, p.8). In some tricks, then, a magician can influence the spectator's decision with subtle verbal and nonverbal cues; in others, the spectator has a free decision but the outcome is unavoidable.

2.2.2. Free will and agency in forcing

An important part of a force is the spectator's feelings of free will and agency during the trick. Interestingly, in spite of an apparent consensus as to the experience of free will , there is little consensus as how to define it; indeed, the possibility of its existence has been debated for centuries. As psychologists, however, we are simply interested in what makes one act *feel* freer than another; as such, we believe that the most useful view of free will is in terms of degrees (see also Appourchaux, 2014; Baumeister, 2008; Pailhès & Kuhn, 2020a). Here, we take the view that two systems guide our behaviour. One, often called System 1 (Kahneman, 2011), runs the show most of the time and uses automatic processes. The other, called System 2, can intervene to make changes; it relies on more deliberate, conscious behaviour. As Baumeister notes, "free will should be understood not as the starter or motor action but rather as a passenger who occasionally grabs the steering wheel" (2008, p.14). In this case, free will involves self-regulation and conscious decision-making. Indeed, conscious deliberation that acts against our own short-term interest tends to make people feel that their actions are freer (Stillman, Sparks, Baumeister, & Tice as reported in Baumeister, 2008).

In the context of forcing, then, a spectator would make a freer decision when this decision appears to have fewer restrictions and biases imposed by the magician. As we will see later, some forces use diverse psychological biases and restrictions to influence the spectator's decision (see Decision forces section), while others do not (see Outcome forces section). In this latter case, the spectator makes a completely free decision which is deliberate and controlled, but has no impact on the outcome. Interestingly, spectators generally fail to notice that their decision has no impact.

Sense of agency is defined as a person's sense that they are the author of their own actions and their consequences. Explicit measures commonly require participants to state how much control

they feel they had over the outcome of their action (e.g. Balslev, Cole, & Miall, 2007; Ebert & Wegner, 2010; Metcalfe & Greene, 2007; Sato & Yasuda, 2005). We suggest that this is an important measure to consider in forcing, as it provides an implicit way of assessing whether the spectator understands that their decision had no impact on the outcome.

2.3. Previous classifications

Forcing is central to magic (Kuhn et al., 2008), and magicians have developed several informal classifications or taxonomies. These predominantly focus on the methods (e.g., prepared decks, "stop" forces, switches of cards) or objects (e.g., cards, numbers, envelopes, ropes) used to realize the tricks.

Among the earliest classifications is that by Theo Annemann, who wrote *202 Methods of Forcing* (Annemann, 1933). Here, forces are classified based on the broad method or object used: Unprepared cards, prepared cards, deck changes, number forces and miscellaneous forces. This classification tends to group techniques which do not provide the same guarantee of result, or for which very different methods are used. Indeed, Annemann states that he "has found it next to impossible to actually classify every method because it would mean cross-indexing practically everything [he has] written". The author also presents techniques which he considers to be forces and that we will not, either because the spectator has no feeling of control over the outcome or because the magician discretely peeps at it. For example, in one technique a card is freely selected, but the magician knows which one it is thanks to a system of marks. Again, we will not consider such techniques as forces, as they do not fit our working definition and likely have little interest for psychologists (see What is forcing? section).

A more systematic approach was developed by Sharpe in "Conjuror's Psychological Secrets" (1988) in which forcing techniques were divided into two main categories: direct and indirect (Figure 2.1).

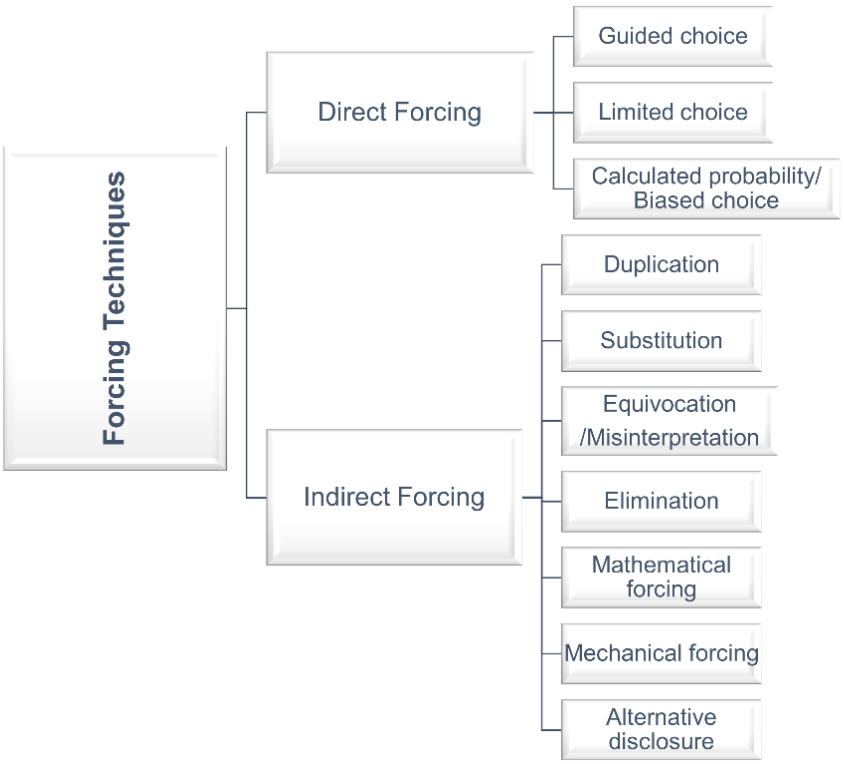

Figure 2.1. Schematic diagram of Sharpe's classification of forcing techniques. The higher levels are organized according to psychological mechanisms involved, while lower ones are organized according to the methods used.

Direct forcing refers to situations in which the spectator is "allowed to make an apparently free choice; yet the conjurer skillfully causes him to select the one he desires" (p.39). These were subdivided into 3 categories: Guided Choice, Limited Choice and Calculated

Probability. It is noted that such forcing relies on a good understanding of "mental reactions"—e.g., people tend to follow a path of least resistance unless they have a reason to do otherwise. Meanwhile, *indirect forcing* refers to all other techniques, in which a genuinely free and uninfluenced choice is made but in which some artifice is used to end up with the conjurer's predetermined outcome. Based on the methods involved, Sharpe divides these into 7 types: Duplication, Substitution, Equivocation/misinterpretation, Elimination, Mathematical Forcing, Mechnical Forcing and Alternative Discosure (Figure 1).

Almost a decade later, Lewis Jones wrote the *Encyclopaedia of Impromptu Card Forces* (Jones, 1994), which describes techniques that the magician can use without any special preparation. Jones classifies forces in various ways, such as "combination forces" (using combinations of objects such as cards and coins, envelopes or calendars) and "multiple forces" (made to force several cards). One of the categories, "probability forces", groups forces that increase the likelihood that the desired card will be chosen. This classification therefore bases its categories on the methods used by the performer (e.g. combination force), the goal of the trick (e.g. multiple force) and even its efficiency (e.g. probability forces). No psychological principles are used.

Banachek wrote three influential books on forcing (*Psychological Subtleties* 1-3, Banachek, 2002a, 2006, 2009), including forces that can be used for mimicking psychic powers such as mind-reading or telepathy. These techniques rely on what magicians refer to as *psychological forcing*. Some rely on spectators providing stereotypical answers when asked to think about shapes, animals or numbers. (For instance, if a spectator is asked to choose a number between one and five, the most common answer is three.) Other techniques rely on the cards' visual saliency, or use verbal or non-verbal primes to force a shape or specific card. These books also describe many other techniques. For example, chapter 8 deals with combining techniques

to influence spectators' choices (e.g. card positioning, visual riffle, reverse psychology), and techniques aimed at finding the spectator's chosen card thanks to ideomotor effect or changes in pupil size. Once again, the forces are not systematically categorized, and are intermixed with techniques which we do not consider to be forces.

Finally, Peter Turner's book (Turner, 2015) focuses entirely on psychological forces. The author states that "a psychological card force relies on nothing more than subtle verbal guidance, there is no deck of cards, they never take one out, they simply think of it" (p.4). Turner mentions that this type of force does not provide the magician with a 100% success rate and often needs back-up plans. However, his book does not formally organise these forces, and combines forces that rely on very different techniques, such as stereotypical choice of cards and semantic ambiguity, as well as tricks we do not consider to be forces—e.g. techniques that rely on ideomotor effects to find the card that the spectator freely chose.

2.4. A psychologically based taxonomy

The primary purpose of any taxonomy of magic is to organize the methods and effects used in known magic tricks (Kuhn et al., 2014; Rensink & Kuhn, 2015). Most forcing techniques can only be carried out with specific items, such as cards. As such, past taxonomies tended to focus on the nature of the object being forced or the method used. But since we are interested in connecting tricks with the cognitive mechanisms involved, our taxonomy follows the principle of *maximal mechanism*: as much as possible, it should be based on general psychological mechanisms rather than particular methods (Kuhn et al., 2014). Consequently, the basic unit of the taxonomy is the component involving a single perceptual or cognitive mechanism; the force can be in several categories if it is a compound effect drawing upon several processes

(e.g., a method that depends on errors both in reasoning and memory). To the best of our knowledge, no such classification of forcing techniques has been attempted yet. Our taxonomy begins by dividing forces into two main categories, based on the two kinds of mechanisms that magicians try to influence: Decision forces and Outcome forces[*].

2.4.1. Decision Forces

The first main category is the set of *decision forces*. These are techniques in which the magician directly manipulates the decisions made—for example, the magician increases the likelihood that a particular card will be selected by making it more visually salient or physically accessible. Here, the spectator's decision (e.g. to think of a particular card) is not entirely free, but instead has – if the force is successful – been altered from what it would have been.[†] For most decision forces, there is a considerable risk of failure. This means that they are only employed in situations where the performer can cover the failure through some other technique. But when they do work, they are extremely powerful, because it is virtually impossible to work out how the trick is done.

[*] As magic literature often does not reference the creators of tricks such as the ones mentioned in this paper, we have found it difficult to crediting magicians for the creation of all the mentioned forces. We tried our best and consulted experts in the field, but cannot guarantee that we gave full appropriate credits for all the techniques.

[†] This is similar to Direct forcing in Sharpe's taxonomy (Figure 2.1). However, all divisions in the taxonomy here are based on perceptual and cognitive mechanisms rather than mechanical aspects of the trick.

Figure 2.2 Schematic diagram of decision forces. Here, the initial level is based on the general kind of cognitive error used (psychological biases or failure to notice restrictions). Later divisions are based on the particular perceptual and cognitive mechanisms.

Our working definition of a decision force includes the magician influencing a spectator's decision without them noticing that their choice has been manipulated. To be effective, then, a force must exploit mechanisms that participants are unaware of. Within this category, we can identify two types of force: *psychological biases*, and *restrictions*.

2.4.1.1.Psychological biases

Many forces exploit people's natural behavioural and cognitive biases, i.e., their inherent tendencies to choose particular items or actions over others. Magicians can often influence

these by manipulating the situational context. Three psychological principles are commonly used: priming, stereotypical behaviour, saliency, and reactance.

Priming

The idea of using unconscious stimuli to influence people's thoughts and behaviours has long attracted public and scientific interest (see Nørretranders, 1999). Not surprisingly, then, this idea has also been applied to magic, in the form of *priming forces*. These are techniques where the magician alters the tendency of the spectator to name a target object. Conjurers typically use both verbal and nonverbal primes. For example, in the Mechanical breakdown force (by Christian David, in Banachek, 2006) the spectator is asked to imagine a specific situation (e.g., a shopping afternoon during which your car breaks down) using a script filled with words such as "negative", "positive" and "electrified". David claims that when the spectator is asked to name the outcome of the story (i.e. what do you look at under the hood of your car), most people will answer "battery". Here, the keywords are believed to prime the spectator's mind with the predetermined outcome.

It is unclear how well that particular force works in practice, but we have investigated a related force and found relatively high success rates (Pailhès & Kuhn, 2020a). Derren Brown's force (Brown, 2002) relies on techniques that use subtle hand gestures to prime people to name the three of Diamonds. These gestures, combined with verbal cues, significantly increase the chances of people doing so: 18% of participants chose the three of Diamonds (the most commonly chosen card), and nearly 40% chose a three of any suit, with most participants oblivious to the prime's influence. Further investigation showed that both verbal and nonverbal primes can have a significant impact on card choices (Pailhès & Kuhn, in preparation). Although this kind of force has relatively low success rates, the subtlety by which it influences participants' choice is very powerful. We believe this type of technique opens the door to many

interesting opportunities to investigate phenomena such as priming with gestures, the influencing of thoughts and decisions, and the failure to notice that choice is being manipulated.

Stereotypical behaviours

Back in 1894, Alfred Binet investigated magicians' techniques scientifically, observing that conjurers often exploit spectators' "laziness" without the spectators becoming aware of it (Binet, 1894). Forcing techniques often use this natural laziness, making one option easier than the others. In particular, they often exploit stereotypical behaviour (French, 1992; Marks & Kammann, 1980), using the fact that when presented with a specific situation or question, most people choose and answer the same thing.

We can divide such behaviours into mental selections and behavioural actions. For example, if asked to name a number between 1 and 10, people are most likely to name 7 (Banachek, 2002; French, 1992). French has shown that 37% of subjects chose the number 7 when asked to choose a number between 1 and 10 that is not 3. In unpublished work, we showed that even without excluding the number 3, 7 is still the most common choice (25% of choices, with 3 being chosen 7% of the time). Banachek's "pretty flower" force relies on a similar principle (Banachek, 2002); he notes that, when asked to name a pretty flower, most spectators will name a rose. Unpublished pilot data from our lab confirms this. Magicians also exploit the fact that some cards are more commonly named than others (e.g. Ace of Spades). Olson and colleagues (Olson, Amlani, & Rensink, 2012) found systematic differences in the probability of people naming various playing cards; an informal online study using more than 350 000 choices provided very similar results, with the most commonly chosen cards being the Ace of Spades, Queen of Hearts, Ace of Hearts, Ace of Diamonds and King of Hearts (Scam Nation, n.d.). One potential issue with investigating this type of force is that spectators may be aware

of these biases. Indeed, unpublished pilot work from our lab shows that when explicitly asked about the proportion of people who would name the same object as them, people are surprisingly good at judging it.

Meanwhile, much of our behaviour is highly predictable, and such stereotypical actions are commonly exploited. For example, in the Position force the magician places four cards in a row on a table and asks the spectator to touch one; since people tend to select items that are more reachable, right-handed people will choose the third card from their left more frequently (Banachek, 2002; Hugard, 1974; Pailhès & Kuhn, 2020b). We investigated this technique (Kuhn et al., 2020; Pailhès & Kuhn, 2020b) and showed that around 60% of participants choose the forced card. Interestingly, participants again seemed oblivious to this bias, significantly underestimating the number of people they thought would also select this card, and reporting feeling free and in control of their decision.

Saliency

A popular way of biasing a person's decision is to increase the saliency of target items (i.e., the extent to which they visually stand out from their surround), making these more likely to be chosen. This echoes various theories of visual attention in which attention is guided by saliency (Itti, 2001; Koch & Ullman, 1984; Ouerhani, Von Wartburg, Hugli, & Muri, 2003; Treue, 2003). Magicians have developed a wide range of forces that rely on this principle, which is essentially a form of attentional misdirection (Kuhn et al., 2014).

The use of saliency in playing cards has been widely documented (Banachek, 2002; Hugard, 1974; Jones, 1994). For example, Olson et al. (2015) used the Visual riffle force in which the magician flips through a deck of cards and asks the spectator to visually select one of them. Unbeknownst to the spectator, the target card was shown slightly longer than the others

and so became more salient. Under some conditions a large majority (98% of participants) chose the target card while being unaware that their choice had been influenced, and feeling completely free in their choice. A related example is the spreading of a deck of cards on a table, with one of the cards' surfaces being more exposed than all the others (see Figure 2.3).

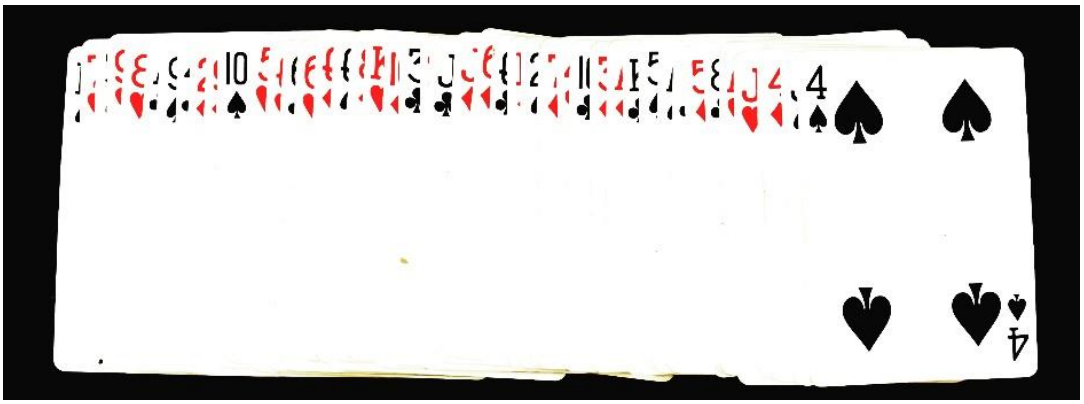

Figure 2.3. Example of a spread of cards using saliency forcing. Here, exposing the 10 of Spades more than the other cards causes it to be selected more often than it otherwise would.

Reactance

Some forces use what amounts to reverse psychology. In these, the spectator tries to maintain their freedom of choice by choosing the least obvious / most odd card—and in doing so, ends up in the trap. *Reactance* is the psychological process which occurs when one's freedom is perceived as threatened, and one then acts to re-establish this freedom (Brehm, 1966; Brehm & Brehm, 1981; Steindl, Jonas, Sittenthaler, Traut-Mattausch, & Greenberg, 2015; Torrance & Brehm, 1968). In these forces the magician uses what has been named *strategic self-anticonformity* (MacDonald, Nail, & Harper, 2011). As MacDonald et al. note, "in these situations, an influence source may have success by misrepresenting their true desires assuming that the target's proclivity for disagreement will result in the target adopting the position that

the source secretly desires" (p.2). Although the risk in using this strategy is that the person will agree with what is asked, magicians usually push for reactance, saying for example, "This has to be a free choice, do not let me influence you, alright ?".

A famous example of this is Dai Vernon's five-cards force (Banachek, 2002; Hugard, 1974). This technique consists in putting on a table five carefully chosen cards, typically the King of Hearts, seven of Clubs, Ace of Diamonds, four of Hearts and nine of Diamonds, presented from left to right. These cards are chosen to make some of them less appealing than the others, both because of their value (e.g. four of Hearts compared to an Ace) and their position (4^{th} position from the left of the spectator rather than the far-left position not often chosen). The magic literature reports that because of this, the four of Hearts is the most commonly chosen card, followed by the nine of Diamonds (Banachek, 2002). In an empirical investigation of this (Pailhès & Kuhn, in preparation), we found that the four of Hearts was indeed the most chosen card (32% of choices), followed by the nine of Diamonds (26%). But this happened only when reverse psychology instructions were used; if we presented these same cards to participants while simply asking them to make a choice, the Ace of Diamonds was chosen most often (33%). Thus, both the positions of the cards and task instructions affect participants' choices. Moreover, in Vernon's original script, when presenting these cards, the magician emphasizes that the Ace is a famous card and is in the middle, and that the seven is the only black card, which is supposed to increase the spectator's suspicion about them (Hugard, 1974). Banachek states that "by mentioning [this], that leaves them with the King of Hearts, which is very suspicious because it is a picture card" and that the four of Hearts is more likely to be chosen as "it is not at the end of the spread and is in fourth position" (Banachek, 2002). However, contrary to this prediction, our data show that Vernon's original script made participants significantly less likely to choose the four of Hearts (13% of choices) compared to simple reverse psychology instructions (41% of choices, Pailhès & Kuhn, in preparation).

2.4.1.2.Restriction

A common way for magicians to force a particular decision is by restricting the number of options that the spectator will consider. These *restrictions* can be verbal, perceptual, or physical. Interestingly, in most cases the spectator fails to notice the restriction.

Verbal restriction

Several forces restrict the number of choices by including subtle constraints within the general verbal instructions given to the spectator. This narrowing down of possibilities can be done either by directly eliminating them or by naming them as examples. For instance, if the magician asks you to think of a simple geometric shape but announces "But not the square—it's too obvious", this enhances the probability that you will choose a triangle (Banachek, 2002). Simply naming or including items in the instructions is also known to be effective. For example, asking a spectator to choose a number "between one and ten" implicitly restricts their choice to eight numbers.

Two famous examples of verbal restriction are the 68 and 37 forces (Fulves, 1975; Gardner, 1956). Here, the conjurer asks the specator to think of a two digit number; the magician then specifies that the two digits are both odd, are different form one another, and the complete number is between 10 and 50. In this case, most people think of the number 37. Likewise, when asked the same thing and restricting the result to an even number between 50 and 100, the spectator will usually think of 68. Scientific studies have verified that for these instructions, the two target numbers are indeed chosen significantly more often (Trinkaus, 1980).

Perceptual restrictions

Sometimes, the spectator's choice is restricted by allowing them to see only a limited number of items properly. For instance, the visual riffle force can be performed in such a way that the

predetermined card is not only more salient but also the only visible card of the deck. Likewise, the fan/spread types of forces can use the same principle.

Physical restriction

Many forces use physical constraints to make it more likely that the target card will be chosen. For example, the Classic force, one of the most popular forcing techniques, requires the magician to handle the cards in such a way that the forced card is the one under the spectator's fingers when he reaches out to touch one of them. Shalom et al (Shalom et al., 2013) investigated this force and showed that 54% of participants picked the forced card while feeling completely free of their choice.

2.4.2. Outcome Forces

Magicians use a wide range of psychological principles to influence a spectator's decision, with some of these principles being more successful than others. However, most forces rely on manipulating the impact of the spectator's decision, rather than the actual decision made (Cole, 2020). For these *outcome forces*, the spectator has—and makes—a genuinely free decision, but unknown to them, this decision has no impact on the outcome of the trick. A key principle here is that the spectator does not understand that their choice cannot affect the outcome of the procedure. For example, imagine you are asked to select a playing card from a deck where all cards are identical; even though you are free to choose any card, each selection will have the same outcome. These forces guarantee that the spectator will end up with the forced item because the choice is either ignored, or the chosen item is covertly switched for another one. That is, the freedom to decide is not impaired, but the spectator has no control, no impact, over the outcome of this decision. Three main kinds of error can be exploited in these forces: perceptual, memory and reasoning errors (Figure 2.4).

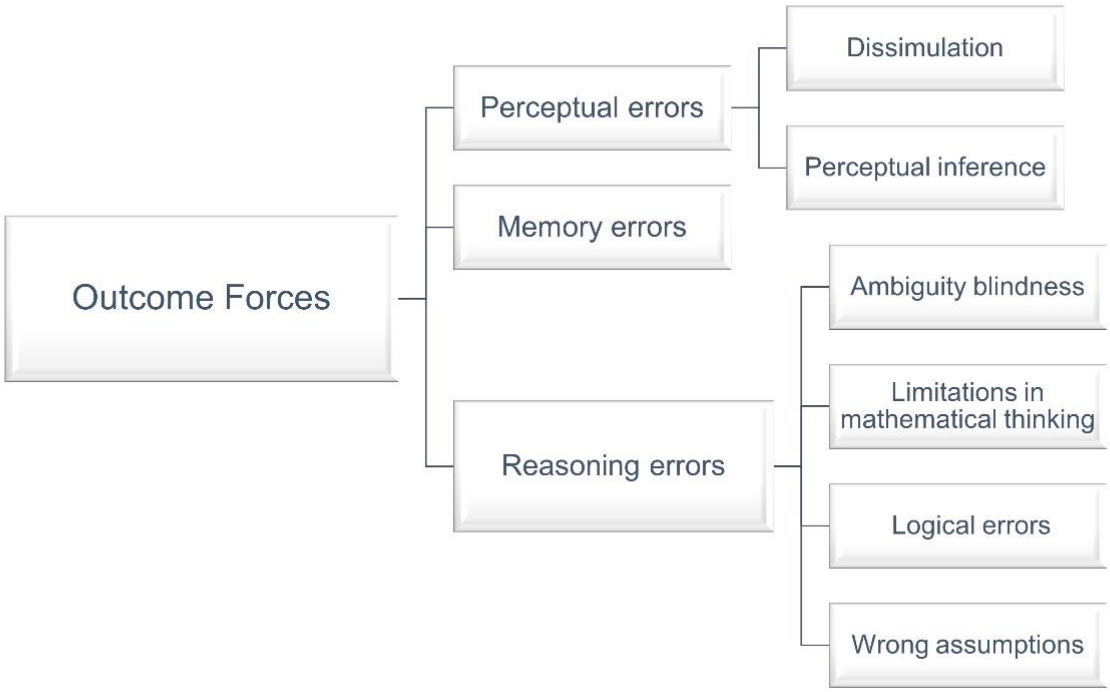

Figure. 2.4 Schematic diagram of outcome forces. The initial level is based on the general type of cognitive error used (perceptual, memory and reasoning errors). Later divisions are based on the particular perceptual or cognitive mechanisms involved.

2.4.2.1.Perceptual errors

A large number of forces rely on surreptitiously switching the chosen item for the force item. Such forces are based on the spectator's erroneous perception of the true event sequence. Typically, some part of the sequence is hidden from the spectator, or performed in a way that deliberately results in a perceptual error. For example, the spectator can freely touch a card among other cards spread out in a fan; the selected card is then covertly switched for the target card. Two principles can be used to influence the spectator's perception: dissimulation, and errors in perceptual inference.

Dissimulation

Here, the spectator simply does not see the true event sequence. For example, the spectator is asked to choose a card from a deck; their choice is covertly switched using sleight of hand, or by doing the trick under the table, or some similar method. An interesting application of this is choice blindness. Here, participants are asked to select one of two items shown; a concealed switch then forces participants to end up with the item they rejected in the first place (Hall & Johansson, 2005; Hall, Johansson, Tärning, Sikström, & Deutgen, 2010; Hall et al., 2013; Stille, Norin, & Sikström, 2017). Interestingly, people usually fail to notice they ended up with the item they initially rejected; when asked to justify their choice, people confabulate reasons as to why they chose the initially rejected item. A large number of forces fall within this category; magicians may use sleight of hand, gimmicked props or other mechanical devices to conceal the switch.

Errors in perceptual inference

Perceptual inference refers to the ability to make sense of the visual information given. Forcing techniques can rely on the complexity and speed of the movements performed to make it difficult for the spectator to correctly infer the true event sequence.

Consider, for example, the Hindu shuffle (Hugard, 1974; Figure 2.5). This consists in shuffling a deck by holding the cards in the right hand, taking some cards from the top of the deck with the left thumb and middle fingers, and then dropping them in the left hand; done repeatedly, this results in a shuffled deck of cards in the performer's left hand. The the spectator can say "stop" whenever they want the magician to stop shuffling. The magician then stops and shows the bottom card of the deck in their right hand.

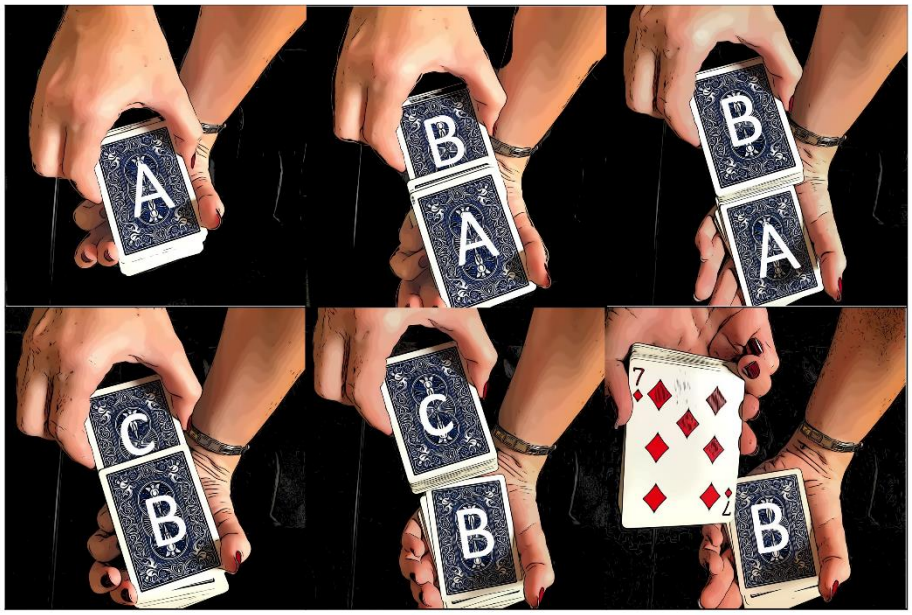

Figure 2.5. Illustration of the Hindu shuffle force. From the beginning the seven of Diamonds is at the bottom of the deck. The magician drops the top cards of the deck (A) in their left hand, and repeat the process (taking the B top cards and droping them as well). When the spectator says "stop", the magician simply turns their right wrist and shows the bottom card of the deck.

Because the actions are hard to follow, spectators end up thinking that the outcome card was determined by the moment they said "stop". If the spectator truly were in control, however, the card shown would be the top—not bottom—of the left- or right-hand pile. But the shuffle, done quickly and with a right-hand gesture going up and down each time some cards are taken

with the left hand, confuses the spectator, who then wrongly perceives the forced card as a shuffled one.

The same type of mechanism seem to be involved in the Flushtration Count trick (Thomas, Didierjean, Kuhn 2018), involving an illustion of having seen multiple cards with identical backs, when in fact only the back of one card is repeatedly shown.

2.4.2.2.Memory errors

Outcome forces can also cause the spectator to form an incorrect memory of an event sequence. A good example is the Criss-Cross force (Holden, 1925; Pailhès & Kuhn, 2020c, Figure 2.6). This consists of asking a spectator to cut a deck of cards and place the top pile next to the bottom one. The magician then takes the bottom pile and places it on the top one in a crossed figure. After this, the spectator is asked a question in order to direct their attention away from the deck and create a time delay. The magician then raises the top pile and asks the spectator to take the top card of the bottom pile (the top card of the original deck), casually stating "Go ahead, take your card". Magicians commonly believe that this moment is what makes this force successful, as it confuses the spectator about which card is where (Pailhès & Kuhn, 2020c). However, after investigating this force, we concluded that this misdirection is not the critical factor. Instead, the key mechanism appears to be attribute substitution (Kahneman & Frederick, 2002), a heuristic in which people replace a complex and unfamiliar event with a simpler and more typical one. Applied to the Criss-Cross, this means that spectators substitute the unfamiliar

cutting procedure with a more typical one, “remembering” that they cut to a card and got this one.

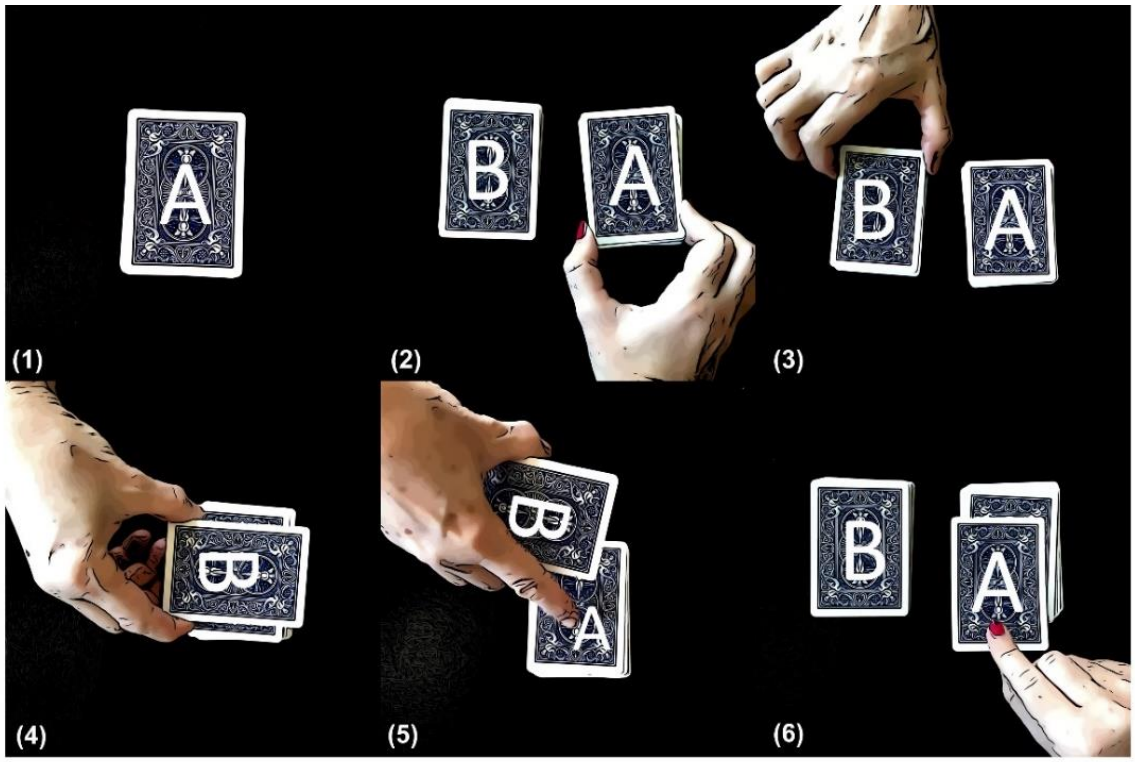

Figure 2.6. Criss Cross Force main steps. From the beginning the forced card is on the top of the deck (A). In (2) the spectator cuts the deck of cards, in (3/4) the magician puts the bottom pile on the top of the top one in a cross shape, (5) the magicians removes the top pile and tells the spectator to take “his/her card” by pointing at the forced card, and in (6) the spectators ends up with the forced card which he/she believes to be the other card, selected by the cut.

The Criss-Cross also constitutes a good example of a force using multiple mechanisms. Most participants misremembered the event sequence, and so failed to understand that they had no control over the outcome. But our results suggest that the unusual shape of the cross is also important: participants noticed that they were forced significantly more often when the cross shape was removed from the procedure. Both memory and perceptual inference therefore seem to be involved. Interestingly, our experiments also demonstrated that magicians sometimes

attribute a trick's success to the wrong factors. As such, more controlled types of experiments can not only bring new insights to psychological research, but also a better understanding of tricks for performers.

2.4.2.3.Reasoning errors

Outcome forces often rely on erroneous reasoning about the event sequence that led up to a selection—for example, the spectator can fail to understand that the calculation the magician asked them to make with their chosen number will always lead to the same final number. Four kinds of reasoning errors can be identified: 1) ambiguity blindness, 2) limitations in mathematical thinking, 3) logical errors, and 4) wrong assumptions.

Ambiguity blindness

These forces use what we called *ambiguity blindness*—the failure to recognize ambiguous siutations—to create an illusion of choice. For these, the spectator fails to notice that their choice could be interpreted in different ways. A famous example of this is the Équivoque, or Magician's Choice (Decremps, 1785). Here, the magician deals two cards on a table and asks the spectator to touch one. Suppose the conjurer wants the person to end up with the card on the spectator's right. If they touch this card, the magician keeps it and discards the other. But if the spectator touches the card on their left, the magician discards this choice and keeps the one on the right, resulting in the same outcome. This procedure can be applied to items other than cards, and is often used with a larger number of items.

The Équivoque is one of the most powerful forces in magic (Banachek, 2002). We have investigated this technique empirically, and found it to be highly effective in providing an illusory sense of control over the outcome of an action (Pailhès, Kumari, & Kuhn, 2020).

Interestingly, participants were often oblivious to the semantic inconsistencies in the procedure used to guide their decisions.

Many forces rely on ambiguity blindness. For example, place two pairs of cards face down on a table and ask the spectator to choose one. One pile consists of a three and a four, and the other pile two sevens. Adding the values in the former pile results in a number seven, whilst the other pile constitutes of only sevens. While the spectator is free to choose either one, this will result in the same outcome – the number seven. After the selection, the magician can then show a written prediction that he had, stating "You will choose the seven pile". In this force the spectator lacks information that the outcome of their choice could have different meanings and another choice would have led to another interpretation of the outcome.

Limitations in mathematical thinking

A wide range of forces rely on clever mathematical tricks: by following a predetermined procedure, or using a specific device (e.g. trick dice), a fixed outcome is guaranteed, regardless of the starting point. These forces work because the spectator does not have the appropriate knowledge to see that their choice will not change the outcome. These techniques differ from ambiguity blindness forces in that the outcome of the spectator's action is never altered; the spectator simply fails to notice that the procedure necessarily results in the same outcome. For example, if you throw a die and add the two opposite numbers, you will always end up with a seven. Choosing a random number, (i.e. 27), multiplying it by 2 (54), adding 10 (64), dividing it by 2 (32) and then subtracting the chosen number chosen from this number (27) always ends up with the number 5 (Annemann, 1933).

Likewise, the Kruskal Principle (Nishiyama, 2013) uses probabilities to force a playing card. Here, the spectator shuffles a deck of cards and the cards are displayed on the table in

rows of ten. Then the spectator is asked to pick any card of the first row and use the value of that card to count along the deck (picture card being worth 5). When the spectator lands on a new card they then use the value of that card as their new number and repeats the process until they run out of cards (SingingBanana, 2010). Despite the seemingly random path, the conjurer can predict the spectator's last card: there is a 84% chance that the spectator ends up on the same card regardless of the first chosen card.

Logical errors

In contrast to tricks based on limitations of mathematical thinking, tricks based on logical errors use materials that require no calculation. An example is the Top Cards dealing force (Jones, 1994): the spectator is asked to take a deck of cards, and start dealing them by taking one card at a time from the top of the deck. The spectator chooses when they want to stop dealing. When the spectator stops, the magician asks them to do the same thing with the pile created, this time making two piles (dealing one card on the left side, the next one on the right side and so on). The magician then announces that the chosen card will be a combination of the two top cards of the piles: the value of one and the suit of the other.

Here, combining the different events (dealing cards, making a pile, making two different piles from it, combining the two top cards) and letting the spectator handle the cards for the entire duration of the trick provides an illusory sense of control over the outcome. The different actions and divisions of cards into different piles make it hard for a spectator to understand that what they just did had no influence over the result. Indeed, the top two outcome cards are in fact the two cards which the magician placed at the top of the deck before giving it to the spectator. The spectator's choice – when to stop dealing – as well as the fact that they were the only one touching the cards, had no impact on the outcome of the trick. This is intuitively hard

to understand as a relatively large number of cards is usually dealt by the spectator at the beginning. This type of trick illustrates Wegner's exclusivity principle (Wegner, 2002, 2003)—i.e., our feeling of control over events comes in part from the fact that we do not see any other possible cause for what happened.

Wrong assumptions

We all bring assumptions about the world to a magic performance. And in many instances, these assumptions are wrong. A large number of forcing techniques therefore exploit erroneous beliefs about the magician's actions, objects, or concepts. For example, you may assume that the magician uses a deck with 52 different cards when in reality all 52 are identical. If you freely choose one of the cards in such a deck, your assumption will cause you to incorrectly believe that your choice had an impact on the final outcome.

2.5. Conclusions

Magicians have developed an enormous number of forcing techniques. These rely on a wide range of psychological principles, but all aim at the spectator ending up with a predetermined outcome while having an illusory sense of free will and of control over their actions. These illusions touch on several important issues—e.g., understanding how we make our decisions, what makes one action feel 'freer' than another, and what makes us believe that we are in control of our actions. As we have shown here, studying the processes involved can provide valuable insights into decision-making, new ways to encourage better decisions in regards to health and well-being, and a better understanding of what leads people to experience a sense of agency. Moreover, we also believe it is important to raise awareness about how easily choices

can be manipulated, to protect people against unwanted influences (e.g. marketing, or political propaganda).

To facilitate the transfer of knowledge between magicians and researchers, our classification has organised knowledge based on the psychological mechanisms involved. The main division into decision and outcome forces can be used as a way of focussing separately on (1) decision-making processes, and (2) the sense of agency over actions and outcomes (including the illusion of control over these outcomes). The subcategories of this taxonomy can allow us to get a more detailed idea of which psychological principle is used for a particular force to be successful. Note that a particular technique can fit into several of our categories if it combines different principles (e.g. restriction and saliency for the Visual riffle force, reasoning and memory for the Criss-Cross).

Alternative taxonomies are of course possible, and we encourage future research to develop them. We believe these may also be useful for research, and help to cast further light on issues related to the feeling of free will and agency, and various aspects of decision making.

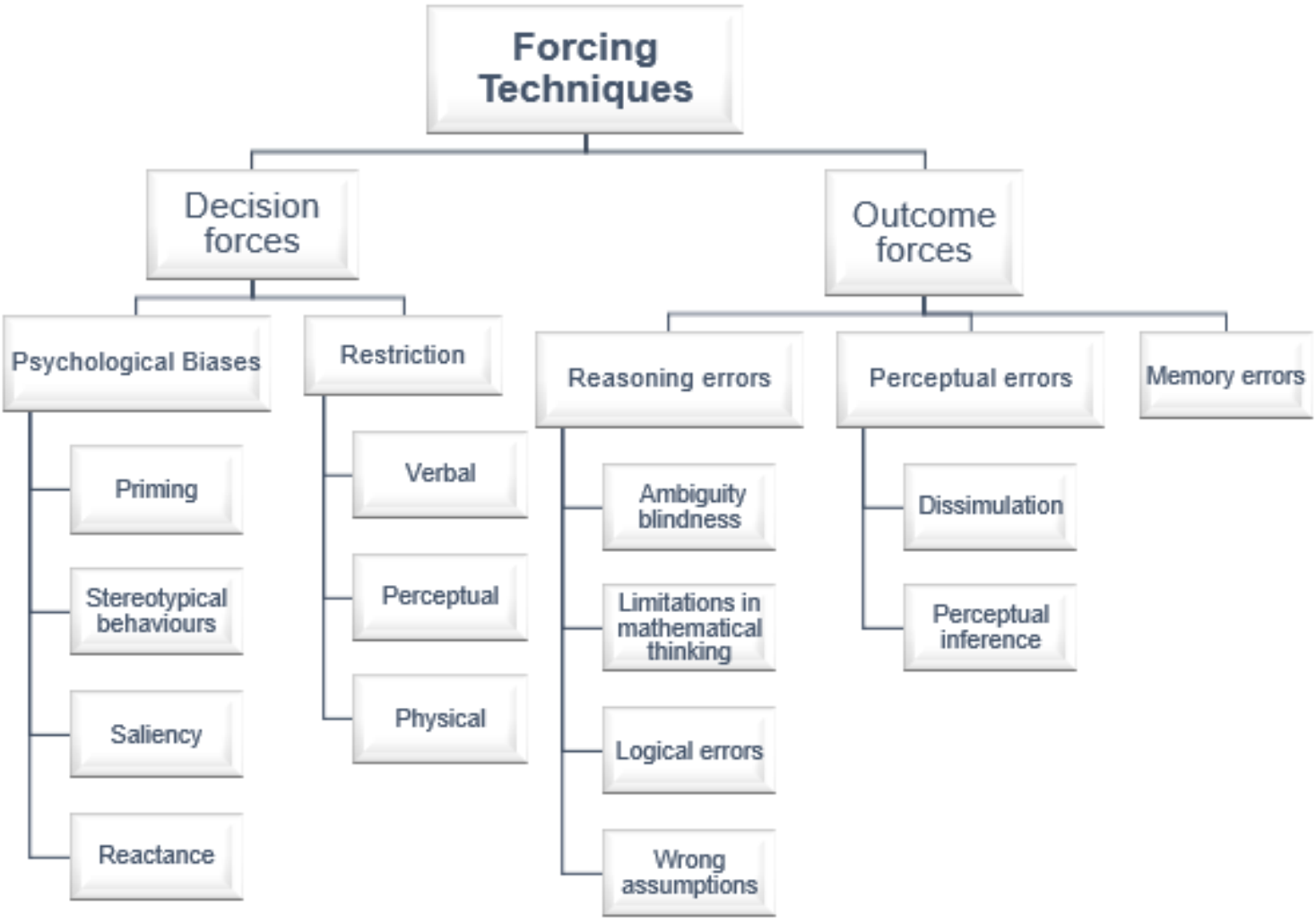

Figure 2.7. Schematic diagram of all the forcing techniques.

Outcome Forces

This section focuses on Outcome forces, which are the most used by magicians as they commonly provide very high success rates. I first present scientific investigations of the Criss-Cross force, followed by the Magician's choice forcing technique. According to the magic literature, these two techniques are simple, yet very effective (Annemann, 1933; Banachek, 2002; Jones, 1994) and we sought to empirically investigate their success rates as well as the psychological principles underpinning them.

3. The Apparent Action Causation: Using a magician forcing technique to investigate our illusory sense of agency over the outcome of our choices.

3.1. 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 paper, 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 whilst they are genuinely free to cut the cards at any position, the cut does not impact 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 do not have an impact on the outcome they get. Debriefings 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.

3.2. 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, Gruenfeld, Sivanathan, & Galinsky, 2009; Langer, 1975; Sweeney, Drevno, & Benassi, 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. On the other hand, 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 (Valérian Chambon, Sidarus, & Haggard, 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, Berger, Riddle, & Morsella, 2010; Tobias-Webb et al., 2017). Wegner's *apparent mental causation* (1999) 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 *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 categorize this wide range of forcing techniques (Pailhès, Rensink, & Kuhn, 2020) 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, 1933; Banachek, 2002; Jones, 1994).

Let us now take a closer look at these two types of forces. *Decision 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/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/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 forces. 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 whilst the spectator genuinely has some control over the selection process, the outcome of this choice always results

in him/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 & Johansson, 2008; Hall, Johansson, Sikström, Tärning, & Lind, 2006), 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 and Hall (2008) 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. Since 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, 1976). 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 paper 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).

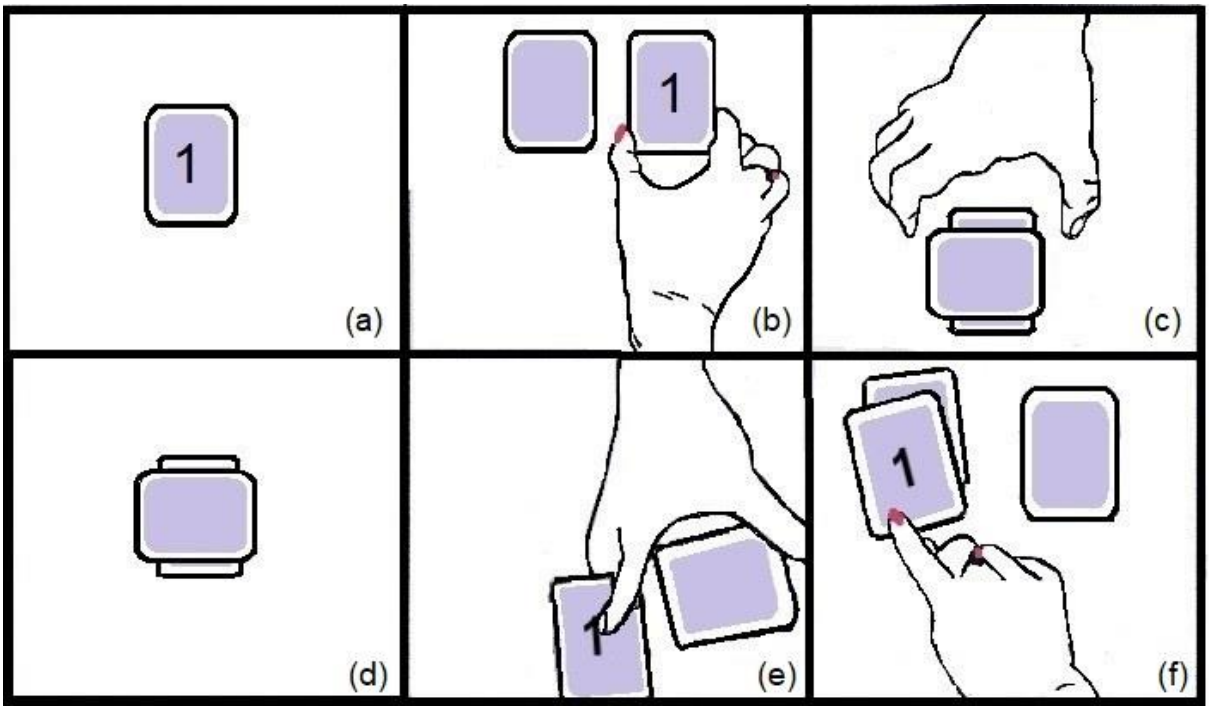

Figure 3.1. Criss Cross Force main steps. From the beginning the forced card is on the top of the deck (numbered 1 here to facilitate the comprehension to the reader). In (b) the spectator cuts the deck of cards, in (c/d) the magician puts the bottom pile on the top of the top one in a cross shape, (e) the magicians removes the top pile and tells the spectator to take "his/her card" by pointing at the forced card, and in (f) the spectators ends up with the forced card which he/she believes to be the other card, selected by the cut.

The Criss-Cross Force is a simple forcing technique, which ensures that the spectator will end up with a predetermined card. The spectator is asked to freely cut a deck of cards wherever they want (See Figure 3.1b). 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 whilst 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 realize that they are taking the top card. After this, the magician goes back to the deck of cards and asks the spectator to look at the card he/she "freely selected thanks to his/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 summarize, 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).

3.3. 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 realizing 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).

Since 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.

3.3.1. Method

Participants

60 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 1 c) 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 1 e), 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/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 impact 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. They then 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 chose 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 to the participant had before they looked at it and asked them if they had an idea about how she knew about it.

3.3.2. Results and Discussion

Out of the 30 participants in the forced choice condition, only 2 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 3.2).

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 3.2).

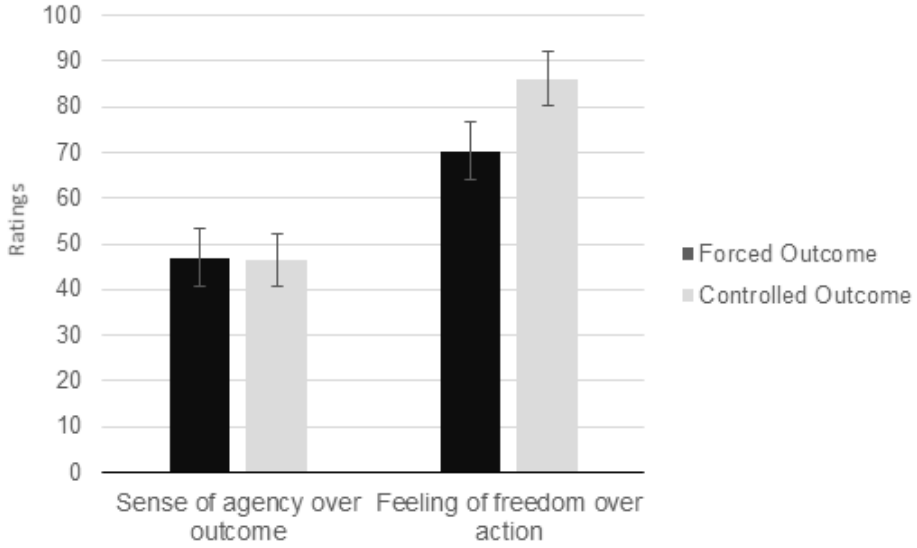

Figure 3.2. Feeling of freedom over the action of cutting the deck and sense of agency over the outcome card across the two experimental conditions. Error bars are represented for 95% confidence intervals.

We analysed the data with JASP (JASP Team, 2018). An annoted .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 H_0: $\delta = 0$, and δ was assigned a Cauchy prior distribution with r = .707. Figure 3a shows that the Bayes factor indicates evidence for H_0; specifically, $BF_{01} = 3.79$, which means that the data are approximately 3.8 times more likely to occur under H_0 than under H_1. This result indicates moderate evidence in favour of H_0.

Regarding the results for parameter estimation, of interest is the posterior distribution of the standardized effect size δ (i.e., the population version of Cohen's *d*, the standardized difference in mean sense of control). Figure 3a shows that the resulting posterior distribution peaks at $\delta = 0.003$ (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) 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 $B_{10} = 1.95$. Figure 3.3 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=0.533 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.

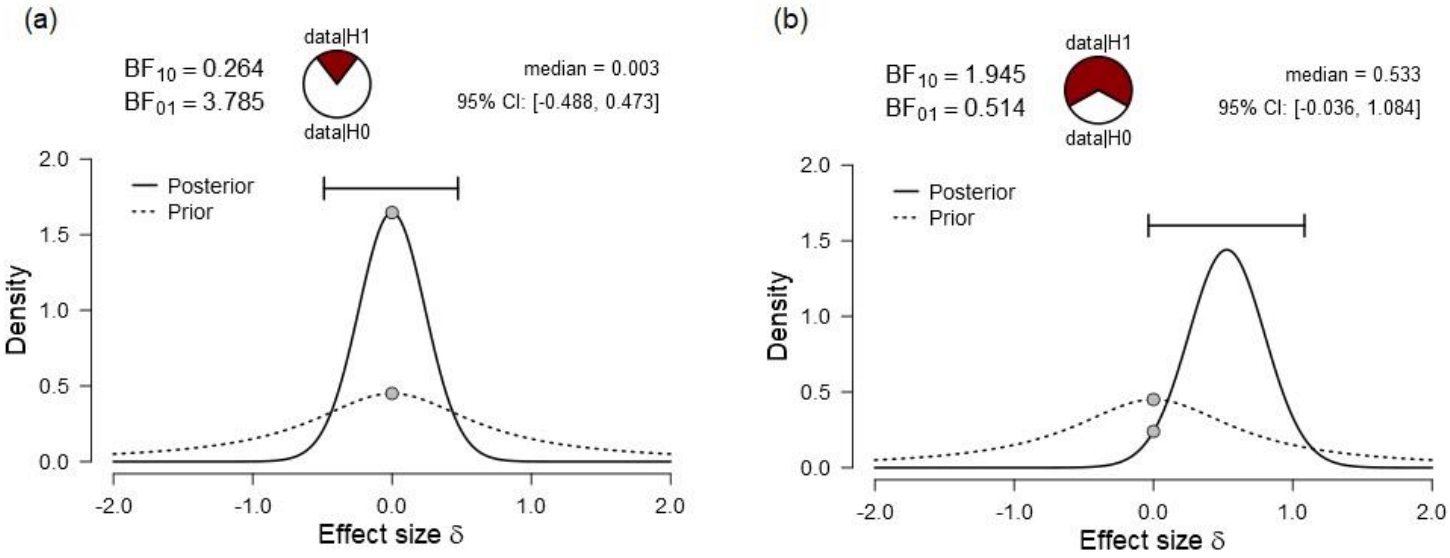

Figure 3.3. Bayesian Mann-Whitney test showing prior and posterior distributions for the sense of agency (a) and feeling of freedom (b).

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.

3.4. 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 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” (Fajuri, 2003, p.6). Moreover, we asked 91 magicians to rate on scales from 0 (not important at all) to 100 (very important) the importance of 8 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 unusal 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 involved for the Criss Cross to work - memory and attentional misidrections (Kuhn et al., 2014). Following Kuhn et al.’s 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.

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.

3.4.1. Method

Participants

90 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 ANOVA with $f = 0.35$ (moderate effect size), $\alpha = 0.05$, and a power of 0.8. 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 seconds 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.

3.4.2. Results and Discussion

Out of the 90 participants, only 4 understood that their action didn't 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 4 participants, 2 were in the Criss-Cross Force condition, 1 in the time delay force condition and 1 in the no misdirection force condition.

A Bayesian Chi-squared test comparing these proportions across the three experimental conditions showed very strong evidence in favour of the null hypothesis, (B_{01}=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* 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 impact participants' feeling of freedom when cutting the deck of card.

* Bayesian ANOVAs do not necessitate normally distributed data (Kruschke, 2010).

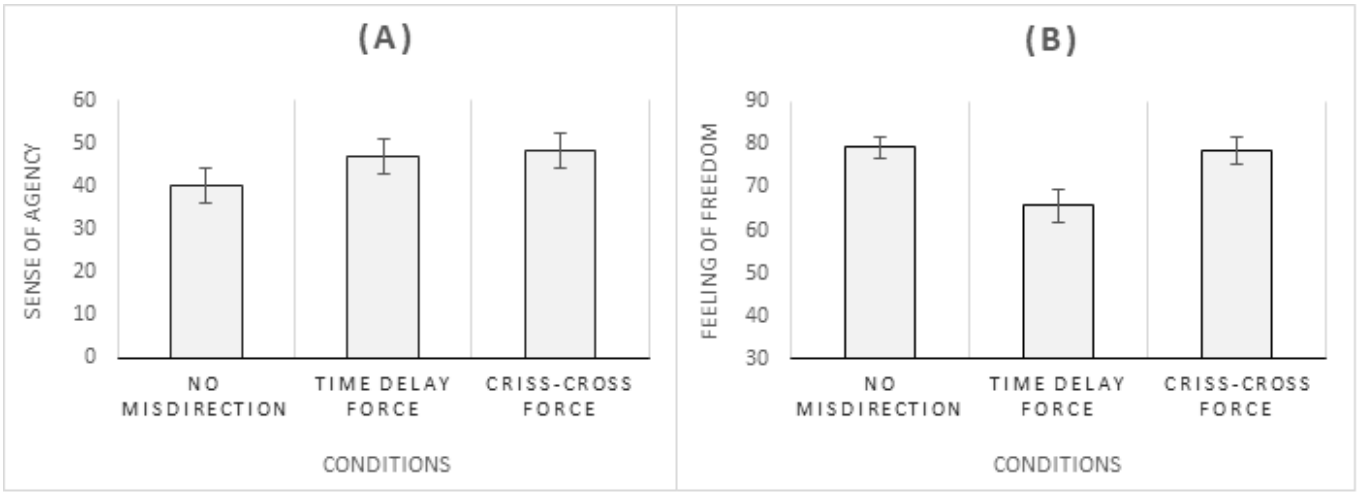

Figure 3.4. Mean sense of agency over the outcome (A) and feeling of freedom for the action (B) across the three experimental conditions. Errors bars are shown with 95% confidence intervals.

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 realize 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.

3.5. 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 with numbered 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 to 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.

3.5.1. Method

Participants

60 participants (35 women, 25 men, mean 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-squared test with w=0.4 (moderate to strong effect size), α= 0.05, and a power of 0.8. 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 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 ask 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. Since this procedure did not contain the cross, participants should be able to understand their choice is manipulated.

3.5.2. Results and Discussion

Out 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-squared provided substantial evidence for the alternative hypothesis (B_{10}=6.26). These results suggest that the data are approximately 6 times more likely to occur under H_1 than H_0 (see Figure 3.5), and validates our hypothesis. Participants were significantly more likely to realize their actions had no impact in 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 realized 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 et al., 2002; Kahneman, Frederick, Kahneman, & Frederick, 2001). 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 realized 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 (B_{10}=.806 for the sense of control and B_{10}=.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 3.5). 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 (B_{10}=3.30 for the Criss-Cross condition, and B_{10}=4.37 for the Simple-Cut condition). However, no or very anecdotal evidence were found for the alternative hypotheses regarding participants' feeling of freedom both in the Criss Cross condition (B_{10}=0.39) and the Simple-Cut condition (B_{10}=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 were they were manipulated or not.

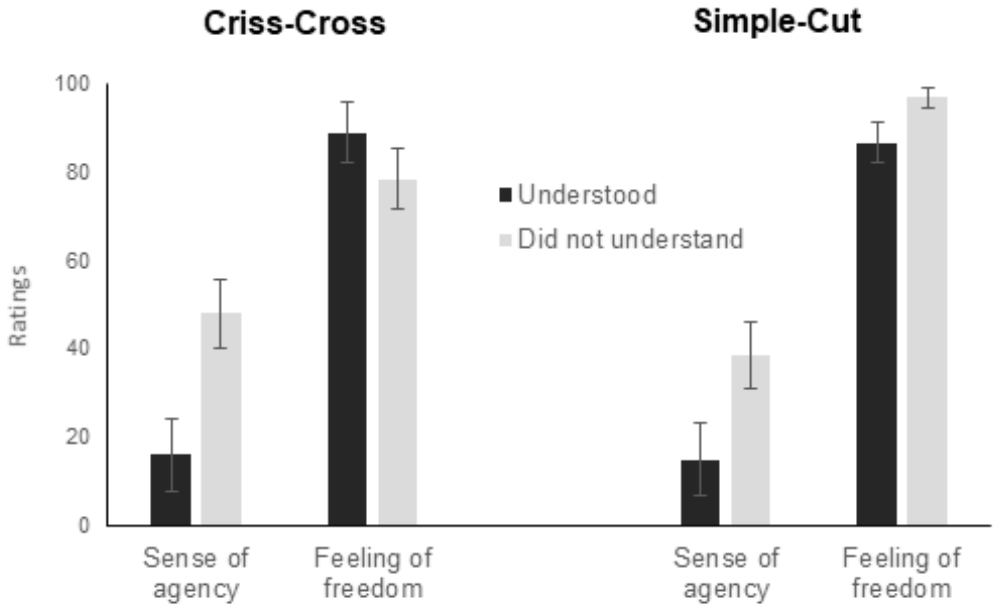

Figure 3.5. Sense of agency and feeling of freedom across participants who understood the trick and those who did not for both experimental conditions.

Finally, we compared the group of the Criss-Cross condition to the one of our second experiment (no misdirection condition) in order 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 (B_{10}=0.30), sense of agency

(B_{10}=0.39) or their understanding of the trick (B_{10}=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.

3.6. 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 (2 out 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 we 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 somethings in our environment in our day to day live. Experiment 2 and 3 explore 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 illuminate 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 of 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 sequences 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 realized that the card they took was the forced one. We initially had two hypotheses about this misrepresentation. Firstly, we expected that attentional misdirection leading 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 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" (Roediger, 1996, 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, Heilbron, & Kok, 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, Blair, & Hastie, 2001; Slusher & Anderson, 1987). Participants frequently attribute events to an incorrect source, often belonging to the stereotyped group (Bayen & Kuhlmann, 2011; Bayen, Nakamura, Dupuis, & Yang, 2000; Mather, Johnson, & De Leonardis, 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, Groom, Ehrenberg, & Klauer, 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 & Johansson, 2008; Hall et al., 2010; 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, Christensen, Cleeremans, & Haggard, 2016), or when alternative actions decreased (Barlas, Hockley, & Obhi, 2017; Barlas et al., 2018; Barlas & Obhi, 2013). The Comparator model (Carruthers, 2012; Miall & Wolpert, 1996) and several other studies (J. Moore & Haggard, 2008; Sidarus, Vuorre, & Haggard, 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, Di Costa, & Haggard, 2017; David, Obhi, & Moore, 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 control 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 operationalizing 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 of 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 underpin 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.

4. The Magician's Choice: Providing illusory choice and sense of agency with the Equivoque forcing technique.

4.1. Abstract

Forcing techniques allow magicians to subtly influence spectators' choices and the outcome of their actions, and they provide powerful tools to study decision-making and the illusory sense of agency and freedom over choices we make. We investigate the Equivoque force, a technique that exploits semantic ambiguities and people's failure to notice inconsistencies, to ensure that a spectator ends up with a pre-determined outcome. Similarly to choice blindness paradigms, the Equivoque forces participants to end up with an item they did not choose in the first place. However, here, the subterfuge is accomplished in full view. In three experiments, we showed that the Equivoque is highly effective in providing participants an illusory sense of agency over the outcome of their actions, even after 2 repetitions of the trick (experiment 2) and using items for which pre-existing preferences can be present (experiment 3). Across all experiments, participants were oblivious to inconsistencies in the procedure used to guide their decisions, and they were genuinely surprised by the experimenter's matching prediction. Contrary to our prediction, the Equivoque force did not significantly change participants' preference for the chosen item. We discuss the results with regards to other illusions of agency (e.g. forcing, choice blindness), failures in noticing semantic inconsistencies (e.g Moses illusion), and issues surrounding choice-induced-preference literature.

4.2. Introduction

We typically perceive ourselves as the causal agent of an event, even when our actions have no direct impact on the outcome. Such illusions of causality are well documented. For example, people often overestimate their ability to control random events (Langer, 1975; Presson & Benassi, 1996), or report illusory causality between unrelated events (Blanco, Matute, & Vadillo, 2011; Matute et al., 2015; Matute, Yarritu, & Vadillo, 2011). Wegner's apparent mental causation model suggests that our experience of willing an action simply arises from interpreting our thoughts as the cause of our actions (Wegner, 2002; Wegner & Wheatley, 1999). Wegner describes this as "the mind's best trick" (Wegner, 2003), in that we experience "conscious will" as we retrospectively attribute our action to the content of our thoughts. As we have suggested elsewhere (Pailhès & Kuhn, 2020c), people can also experience an apparent *action* causation, which provides the illusion that our *actions* caused an unrelated outcome of the event sequence.

Choice blindness is a cognitive failure that vividly illustrates the ease by which we fall into the trap of illusory causality, in that we fail to detect the mismatch between our choice and the outcome of this choice (Hall & Johansson, 2005, 2008; Johansson Petter, Hall Lars, Sikstrom Sverker, & Olsson, 2005). In these experiments people consciously choose item A and fail to notice that they ended up with item B - the experimenter surreptitiously switches the chosen item for the rejected one. When asked to justify their choice, people often confabulate reasons to justify why they chose the previously rejected item, which suggests that we have poor insights into the cognitive mechanisms that drive our choices. Choice blindness is a robust phenomenon and it has been demonstrated in a wide range of domains (e.g. attitude formation, consumer choices, political preferences) (Hall et al., 2010, 2013; Johansson, Hall, & Sikström, 2008). These findings suggest that we actively construct our sense of agency alongside the

feedback that we receive following our choice (see also Nisbett & Wilson, 1977). In other words, we accept the switched outcome as our own.

Choice blindness relies on elaborate covert deception to conceal the switch between the participants' choice to the changed outcome (e.g. Hall, Johansson, Tärning, Sikström, & Deutgen, 2010; Hall et al., 2013; Stille, Norin, & Sikström, 2017). However, we believe that it is possible to experience an illusory sense of agency over an event outcome even when the deception is fully transparent. Unlike previous choice blindness paradigm, the Equivoque principle – a magicians' forcing technique – does not rely on elaborate covert deception and instead exploits linguistic ambiguities, and our tendency to ignore inconsistencies.

Magicians are highly experienced in controlling our attribution processes (Kelley, 1980) and magic tricks provide a useful tool to study these illusory causalities (Kuhn, 2019; Rensink & Kuhn, 2015). A growing number of scientists are using magic tricks to study a wide range of psychological processes, such as attention (Demacheva, Ladouceur, Steinberg, Pogossova, & Raz, 2012; Kuhn & Findlay, 2010; Kuhn & Tatler, 2005; Kuhn, Teszka, et al., 2016), perception (Kuhn & Rensink, 2016; Thomas & Didierjean, 2016c), problem-solving (Thomas & Didierjean, 2016a; Thomas et al., 2018b), and belief formation (Lan et al., 2018; Mohr et al., 2019). Another promising area of research has focused on magicians' forcing techniques. Forcing techniques, also called 'forces', refer to magic principles that allow magicians to covertly influence a spectator's choice or the outcome of this choice. Forcing is often used to produce effects such as predictions or mind-reading, and they provide powerful tools to study diverse psychological mechanisms related to decision-making and illusory sense of agency and freedom over choice.

We have recently started to categorize forcing techniques (Pailhès, Rensink, et al., 2020) and have identified two main types of forcing categories: The first group of forces rely on directly influencing the spectator's choice (Annemann, 1933; Banachek, 2002; Jones, 1994).

These *Decision forces* encompass a large number of techniques in which magicians covertly influence spectators' choices, and several of these techniques have been empirically investigated. For example, people can be covertly influenced by the positioning of a card among others (Kuhn et al., 2020; Pailhès & Kuhn, 2020b), the timing on which cards are handled by the magician, subtly pushing the target card when the spectator's fingers are reaching the deck to take one (Shalom et al., 2013), the visual saliency of the target card (Olson et al., 2015), or even subtle gestures that prime a specific card (Pailhès & Kuhn, 2020a). It is important to note that whilst many of these techniques are highly effective, there is no guarantee that they will work. This is why in these instances, the magician will require a backup plan in case the force fails.

The second category of forces, are *Outcome forces*, and they provide the spectator with a genuinely free choice, but unknown to them, this choice has no impact on the outcome of the trick (i.e. the card or item the spectator ends up with). Unlike with the *Decision force*, *Outcome forces* guarantee that the spectator ends up the forced item, which is why they are frequently used by working magicians. To our knowledge, only one forcing principle that falls within this category – the Criss Cross force – has been studied scientifically (Pailhès & Kuhn, 2020c). Here participants are asked to cut to a playing card, and the magician uses a simple and transparent, yet highly deceptive procedure that ensures the spectator ends up with a predetermined card, rather than the one that he/she has cut to. We have recently shown that this type of force is highly effective in providing people with an illusory sense of agency over an outcome they did not control (i.e. they feel their card cutting actions had a direct impact on the card they received). A large number of different forces fall within this category, and many of them rely on a simple information gap or failure principle. In other words, the trick creates the illusion of a free decision in a situation where all choices lead to the same result, but the audience does not know that their choice has no impact on the outcome.

In this paper, we investigate one of these outcome forces called *Equivoque*. Also known as 'the magician's choice', the Equivoque is one of the strongest tool mentalists can use to force a card or item (Banachek, 2009, p.22), and it uses on using semantic ambiguity when asking spectators to make choices. The magician predetermines a target card, or object, among others, and provides the spectator with a set of alleged free choices. These choices are framed in such a way that each decision leads to the same outcome. For example, the magician deals four cards on a table and asks the spectator to touch two of them. From the beginning, the conjurer knows they want the audience member to end up with the card on the spectator's far right. If they choose to touch the two cards on their right, the magician keeps these choices and discards the others. If the spectator touches the cards on the left, the magician discards these choices and keeps the ones on the table. In the second phase, the magician asks the spectator to touch only one card, and the same principle is applied again, leaving the spectator with the predetermined card on the table. Although inconsistencies can appear in the magician's action (e.g. once keeping the spectator's choices, the next time discarding them, see figure 1), anecdotally the Equivoque produces a strong illusion of agency over the outcome card or item. The double entendre wording allows the spectator to be actively involved in the choices, but they have no impact on the outcome. The performer simply removes the items they do not want the spectator to end up with.

We believe that the Equivoque relies on the spectator's failure to register important inconsistencies in the selection process. In our day to day lives, we frequently accept small distortions even without noticing that they occurred. Indeed, much of the research shows that we are highly adaptive and tolerant of distortions so that we can function more optimally (Erickson & Mattson, 1981; Shafto & MacKay, 2000). Many of our daily cognitive operations are based on heuristics rather than systematic, analytical processes (Kahneman, 2002), and the "Moses Illusion" illustrates just how easily we tolerate inconsistencies. For example, when

asked "*How many animals of each kind did Moses take on the Ark*", most people answer "two", even though they know that Noah, and not Moses, took the animals on the Ark (Erickson & Mattson, 1981). The Moses Illusion demonstrates that people often fail to notice anomalies, and this occurs despite knowing the correct answer, and fully processing the question (Bottoms, Eslick, & Marsh, 2010; Davis & Abrams, 2016; Song & Schwarz, 2008). The Moses Illusion is well documented and several theoretical accounts for its occurrence have been proposed (Reder & Cleeremans, 1990; Reder & Kusbit, 1991). The partial-match hypothesis states that the illusion results from an incomplete match between the question probe and the retrieved information (Kamas, Reder, & Ayers, 1996; Reder & Kusbit, 1991). Accordingly, when the input does not completely match the stored representation, we still accept the distortion as long as there is a sufficient match. In normal verbal conversations, we often encounter small inconsistencies (e.g. subtle linguistic errors) and ignoring such inconsistencies eases comprehension. Indeed, the more semantically and phonologically related the distortion is to the stored representation about what is asked, the less likely the cognitive system flags up the mismatch, and the better the illusion works. Likewise, it has been proposed that if the erroneous term fits the global situation well or is out of focus, the anomaly can pass undetected (Sanford & Sturt, 2002). In much of our daily lives, ignoring such inconsistencies provides a useful strategy, or heuristic, to facilitate comprehension.

Similarly to the Moses illusion, we believe the Equivoque procedure is successful because people omit the possible inconsistencies happening to their choice, and the actions of taking away the selected items or the non-chosen ones are sufficiently similar not to be noticed. The inconsistencies in the magician's actions are performed fluently and without drawing any attention to them. Because of this, the spectator experiences an illusory sense of control over the forced card, and believe they freely chose it themselves.

Although the Equivoque is frequently used by magicians, and known to be a very powerful forcing principle (Annemann, 1933; Banachek, 2002, 2009; Turner, 2015), it has never been scientifically investigated. Research using forcing techniques have shown that participants tend to report free choices when they were objectively forced. Likewise, we argue the Equivoque provides a powerful tool to study illusory agency over an outcome, as well as to investigate choice-induced preference effect.

The current paper presents three experiments. We aimed to provide empirical evidence of the efficiency of the Equivoque (Experiment 1), investigate its robustness when repeated on the same spectator (Experiment 2) and test whether this principle could be applied to items for which people have pre-existing preferences (Experiment 3). Moreover, our last experiment examined whether the Equivoque procedure can change people's attitudes towards the chosen object (i.e. their preference).

4.3. Experiment 1.

The aim of the first experiment was to objectively evaluate whether the Equivoque can effectively force a card without people realizing that their choices had no impact on the outcome they get. In other words, we sought to investigate whether it was possible to induce an illusory sense of agency over the outcome card, which is predetermined and objectively forced by the experimenter. Moreover, we aimed to investigate whether the consistency of whether participants' choices are always kept/discarded or not has an impact on how much control they feel over the outcome card. We predicted that participants would feel high levels of freedom and control over the outcome card even though they were manipulated. Research on the Moses Illusion suggests that we ignore semantic inconsistencies when they are presented within the context of a question, even when participants are encouraged to monitor for inconsistencies

(Brédart & Docquier, 1989; Davis & Abrams, 2016; Erickson & Mattson, 1981; Song & Schwarz, 2008). We therefore expected participants to omit the inconsistencies of the experimenter's actions regarding their choice, and the procedure to be efficient regardless of the route consistency.

4.3.1. Methods

Participants

101 participants (56 females) were recruited on Goldsmiths University campus (Mean Age=26.6, *SD*= 10.11). Goldsmiths Psychology Department provided ethical approval for the three experiments. We ran an a priori power analysis for a t-test with a power of .80, α=.05, and a moderate effect size of .50. The output was a sample size of 101 participants. As the Equivoque was not previously investigated, we based our effect size estimate on the fact that the magic literature describes the force as a very powerful procedure (Annemann, 1933; Banachek, 2002; Turner, 2015).

Procedure

The experimenter/magician sat at one of Goldsmiths' cafeteria tables with the 4 cards already laid out in a row on the table. Participants were invited to sit facing the experimenter and signed the consent forms which also explained that the experiment was a study about decision-making and magic tricks.

The experimenter then proceeded to the Equivoque force, in which the forced card was always the same for all participants (i.e. the 3rd one from their left, always the 3 of Diamonds). First, the participants were asked to touch two cards. Depending on the cards the participant

touched, the experimenter either discarded them by taking them away or kept them by taking away the two other cards. Then, participants were asked to touch just one card. This time again, depending on the card that was touched, the experimenter either took it away or took the other one away, to assure that the forced card was the only one left (see Figure 4.1). These actions were done casually and in silence, without any comments. This ended up in 4 possible routes, with two consistent and two inconsistent ones that the experimenter took note of (see Figure 4.1). After only the forced card remained on the table, the experimenter slightly pushed it towards the participant while saying "OK so this is your card, don't look at it yet.", and asked them to answer the questions on the paper questionnaire.

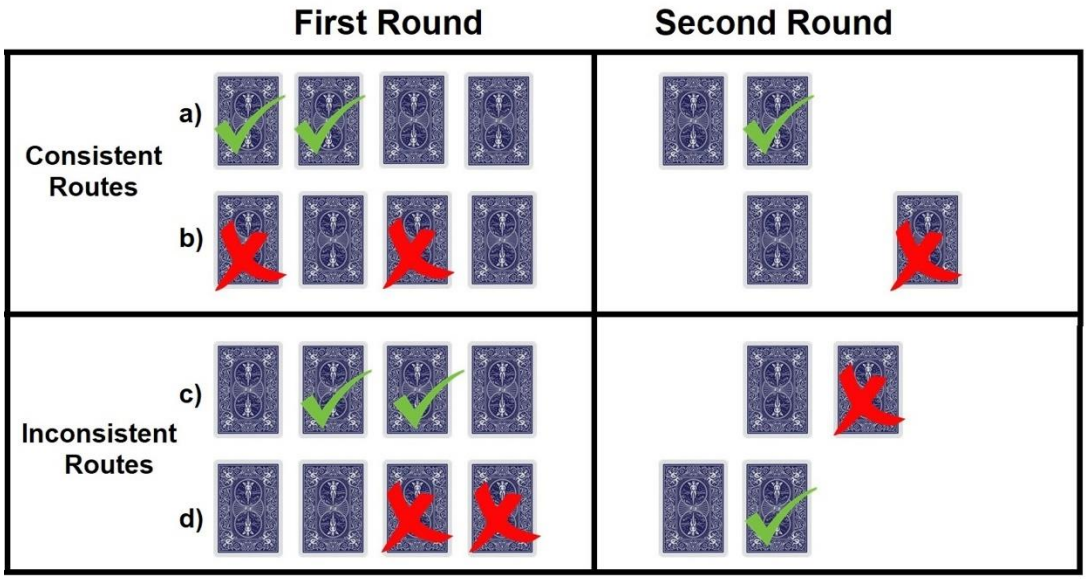

Figure 4.1. Consistency of the possible Equivoque routes regarding the two rounds (steps) of the trick. At first, participants are asked to touch two cards on the four presented. Depending on whether one of the two touched cards is the target one (here 2nd from the left, from the experimenter point of view), the experiment either kept (a and c) or discarded them (b and d). Then, when two cards are left (second round), participants are asked to touch just one card. Again, if the participant touches the target card (a and d) it was kept. If the other one was touched, the choice was therefore discarded (b and c).

First, participants were asked how free they felt about choosing the card they touched. We used this measure because it incorporates a key component of a successful forcing technique is that the spectator has to feel he or she is making free choices (Kuhn, Amlani, et al., 2008a; Pailhès & Kuhn, 2019, 2020b).

Second, and most importantly, participants were asked about how much impact they felt their choices had on the card they ended up with. We used this measure to assess participants' illusory sense of agency over the outcome of the card selection. Both questions were displayed with a scale from 0 (not at all) to 100 (extremely).

Before the debriefing, the experimenter revealed a prediction she had written down on a piece of paper (i.e. "You will choose the 3 of diamonds") and then asked the participants to look at their card (and not the other ones). This was an informal way to verify participants' sense of surprise when the magician successfully predicted their choice, and it provides an additional measure of whether they understood that their choice was forced. A more systematic measure of surprise was taken in our second experiment.

4.3.2. Results and Discussion

We excluded 4 participants from the analysis as the experimenter made some minor mistakes in the procedure, by miming a pushing or discarding gestures while asking participants to touch the cards.

Overall, participants felt a strong sense of freedom for touching the cards they wanted (M= 80.3, SD=26.4), and a moderate sense of control over the card they ended up with (M=53.1, SD= 35.2). When asked to justify their answer, participants typically reported that they did not feel a very strong sense of control because only 4 cards were displayed from the beginning and

they therefore could not have a large impact over the outcome (i.e. choosing one of the other 48 cards). We previously found similar ratings of sense of control (*M*=45) in experiments using the Criss-Cross force (Pailhès & Kuhn, 2020c) and for which participants did not understand they were manipulated. However, higher ratings were found in our research using the Position force technique (*M*=82, Pailhès & Kuhn, 2020a). Contrary to the Position force, both the Equivoque and the Criss-Cross are outcomes forces, in which the magician physically intervene during the trick. The Position force is a choice force, for which the magician simply asks the spectator to physically push a card among three others presented in a row. The force relies on the ease with which the forced card (third from participants' left) is the most easily reached by their dominant hand (most people being right-handed). Here, as in the Criss-Cross force, participants typically reported feeling moderately high levels of control over the outcome card. Even though they did not attribute it to the experimenter physically handling the selected cards (e.g. often reporting not being able to see the faces of the cards, being presented with a limited number of possibilities etc), we suggest it is possible that this factor unconsciously affected their ratings. It is common for people to confabulate the reasons for their thoughts and behaviours when they do not have access to the real ones (Johansson, Hall, Sikström, Tärning, & Lind, 2006a; Nisbett & Wilson, 1977), and this phenomenon might play a part in the present results.

Figure 4.2A shows participants' freedom ratings and their impact over their chosen card, as a function of whether the chosen path was consistent or not. We examined whether path consistency influenced participants ratings. Consistent routes were trials on which the experimenter consistently either kept or discarded the touched cards. Inconsistent routes were trials in which the experimenter inconsistently kept or discarded participants' choices. Fifty-four per cent of the participants experienced consistent routes and 46% experienced inconsistent routes. Mann-Whitney analyses showed that the consistency of the routes did not affect

participants' feelings of impact over the final card (W=1078, p=.503, r_{rb}= -0.08). However, contrary to our prediction participants reported significantly higher feelings of freedom over which card they chose for the inconsistent than consistent routes (W=1493, p=.015, r_{rb}=.276).

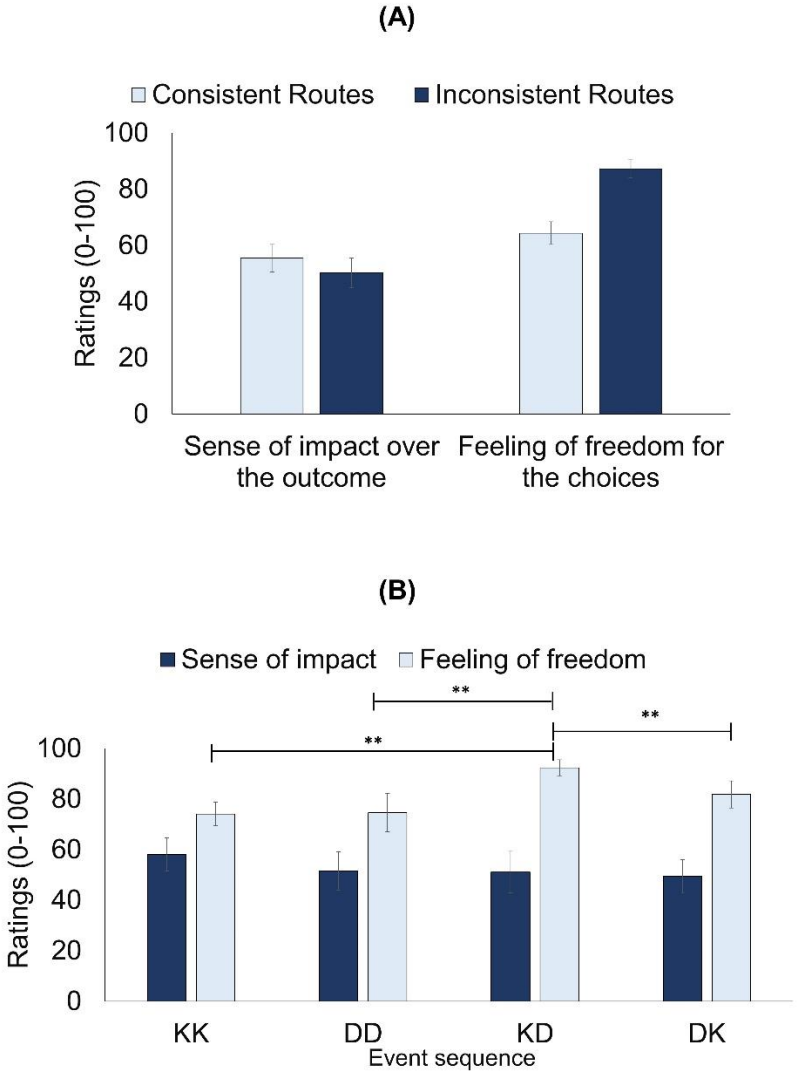

Figure 4.2. (A) Participants' sense of impact over the outcome forced card and their feeling of freedom for touching the cards they wanted according to (A) the consistency of the Equivoque routes and to (B) the specific event sequence they experienced. Their chosen cards were either first kept (K) or discarded (D) during the first and second rounds. Therefore, KK represents a route where participants' choices were kept for both rounds, DK represents a trial in which participants' choices were first discarded and then kept, etc. Error bars represent the standard errors of the mean.

We were surprised by these findings and therefore examined the different decision routes more closely by separating them into 4 conditions depending on whether the experimenter first kept (K) or discarded (D) the two touched cards in the first round, and then kept or discarded the touched card in the second round. We therefore had 2 consistent (KK and DD) and 2 inconsistent (KD and DK) possible routes (see figure 2B). With regards to people's sense of impact on the outcome of the chosen card, a Kruskal-Wallis test found no significant effect of the different routes on participants' sense of impact over the outcome card ($X^2(3, 97) = 0.98$, $p = .806$, $\eta^2 = .010$). However, there was a significant difference among the 4 different routes regarding participants' sense of freedom ($X^2(3, 97) = 8.68$, $p = .034$, $\eta^2 = .079$). More specifically, a deviation contrast analysis showed that one specific inconsistent route (KD) led participants to feel significantly freer for their choice, (t (97) 2.52, p =.013, d = .707).

None of the participants expressed that they understood they were forced and that they understood the trick. The typical reaction after the experimenter revealed the prediction was surprise, and if not, to look at all the other cards to check if they were all the same (they were all different). These first results suggest that the Equivoque is a very effective forcing technique providing participants with the illusion that they freely selected one item out of four when they are in fact completely manipulated and forced to have a predetermined card. We cannot find any explanations for why participants felt significantly freer in the path for which their choice was first kept and then discarded. We acknowledge that while it is one of the inconsistent paths, the sequencing of keep and then discard is unique in nature, considering the manual actions of keep and discard are not identical and might be perceived uniquely by the participant. As this result was unexpected, we investigated it further in our second experiment.

4.4. Experiment 2.

The previous study showed that the Equivoque force is highly effective at providing people with an illusory sense of control over the outcome of an event even if they have no control over it. Participants were surprisingly oblivious towards the inconsistency in the choice procedure. In the second experiment, we firstly aimed to replicate these results and we wanted to further investigate the quirky results with regards to participants higher freedom ratings for one specific route sequence (Keep – Discard).

Secondly, we examined whether the trick would lose its efficiency after being repeated twice in succession. One of the key rules in magic states that magic tricks that rely on the same method should never be repeated since this increase people's chances of discovering the secret method (Ekroll, De Bruyckere, Vanwezemael, & Wagemans, 2018; Kuhn, 2019). Indeed, much of the empirical research supports this view and tricks that rely on attentional misdirection (Kuhn & Tatler, 2005; Kuhn, Tatler, et al., 2008) are far less effective when viewed for the second time. Recent studies have systematically investigated the impact that repeated viewing has on magic tricks that rely on perceptual mechanisms that are typically impenetrable to top-down control, which show that they too are less effective when repeated (Svalebjørg, Øhrn, & Ekroll, in press). In the Moses illusion, the detection rates are higher under instructions that stress accuracy (Van Jaarsveld, Dijkstra, & Hermans, 1997). When participants are only required to monitor for distortions rather than answer the questions, more inconsistencies are detected (Kamas et al., 1996). Moreover, it has also been shown that people detect distortions more often when the sentences' focus is on critical terms (Bredart & Modolo, 1988). We predicted that as trials progressed, participants would have more opportunities to detect the inconsistencies and understand they were forced, therefore feeling less impact on the outcome card. We expected the feelings of freedom to remain the same, as participants were indeed always free to touch the cards they wanted.

Our third aim was to measure the degree of surprise participants experienced when the experimenter revealed her matching prediction. Magic tricks elicit a wide range of emotional responses, but at the centre of the experience lies a cognitive conflict between the things we believe to be possible and the things we experience (Kuhn, 2019; Lamont, 2017; Leddington, 2017; Leddington, 2016). Curiosity resulting from such incongruity is marked by acute feelings of surprise and confusion (Brod, Hasselhorn, & Bunge, 2018; D'Mello, Lehman, Pekrun, & Graesser, 2014). The reveal of the prediction card is not a particularly powerful magic trick, but experiment 1 and some of our previous work (Kuhn et al., 2020) has shown that these types of effects elicit some surprise and wonder. Measuring participants' surprise when the choice matched their prediction therefore provides a more implicit measure of participants' understanding of the force and of the fact that they had no control over the outcome card. We predicted that the degree to which participants experienced an illusory control over the outcome card would positively correlate with the degree of surprise regarding the prediction.

4.4.1. Method

Participants

50 participants (36 females) were recruited on the Goldsmiths University campus (Mean Age=25.3, *SD*= 11.07). Prior to the experiment, we ran a power calculation for a repeated-measures ANOVA, with α = 0.05, a medium effect size of .25, power of .80 and a small correlation among repeated measures of .15, as we expected participants' feelings of control to gradually reduce over the repetitions. The output of the calculation was a total sample size of 46 participants.

Procedure

The procedure was identical to the one we used in Experiment 1, except that we repeated the trick twice, therefore ending with three different trials of the Equivoque. The same measures of the feeling of freedom and sense of impact over the outcome were used after each trial. The same card (3rd from the participants' left, 3 of Diamonds) was forced for this experiment and each trial. Therefore, the participants ended up with the same card three times in a row, no matter which card they decided to touch. Participants were asked to answer the questions regarding their feeling of freedom and sense of impact without looking at the face of the card. At the end of the third trial, the experimenter revealed the written prediction ("You will choose the 3 of Diamonds") after the participants looked at their card. This time, a measure of their feeling of surprise about the matching prediction was taken (from 0 not surprised at all to 100 extremely surprised). We also asked participants if they had any idea about how the trick was done before completely debriefing them.

4.4.2. Results and Discussion

As in experiment 1, the feeling of freedom for choosing which card(s) they touch was high (*M*=82.8, *SD*=25.3), and the sense of impact over the outcome card moderate (*M*=53.9, *SD*=37.1). We therefore replicate the results found in Experiment 1. The feeling of surprise at the end of the 3rd trial was also moderate (*M*=53, *SD*=36.6). Previous research investigating the Position force technique showed that participants also experienced a moderate sense of wonder (*M*=5.5 on a scale from 1 to 10) regarding the magician's matching prediction. As we have previously suggested, these relatively low levels of ratings may rely on the fact that when presented with a magic trick, participants can assume that the magician will predict their choice under all circumstances (Kuhn et al., 2020).

Trials

A non-parametric Friedman test of differences among repeated measures showed that contrary to our predictions, participants' sense of impact over the outcome card did not differ among the trials ($X^2(2,98) = 1.53$, $p = .466$, see Figure 3A). Therefore, even after two repetitions of the trick, participants did not understand that they were forced to have the target card and that their choice had no impact on their outcome card. Some studies have investigated the effect of expertise on participants' oversight to semantic illusions (e.g. history graduates asked "In what US state were the forty-niners searching for oil?"). Results showed that expertise does not eliminate the illusion, even when errors were underlined or bolded (Cantor & Marsh, 2017). This suggests that even strong prior knowledge does not guarantee that we will notice inconsistencies and that we still often use adaptive heuristics and shortcuts. As the Equivoque seems to be related to such illusions, it is possible that the same type of shortcuts was used here, even when participants had prior knowledge of the procedure and experienced it three times in a row.

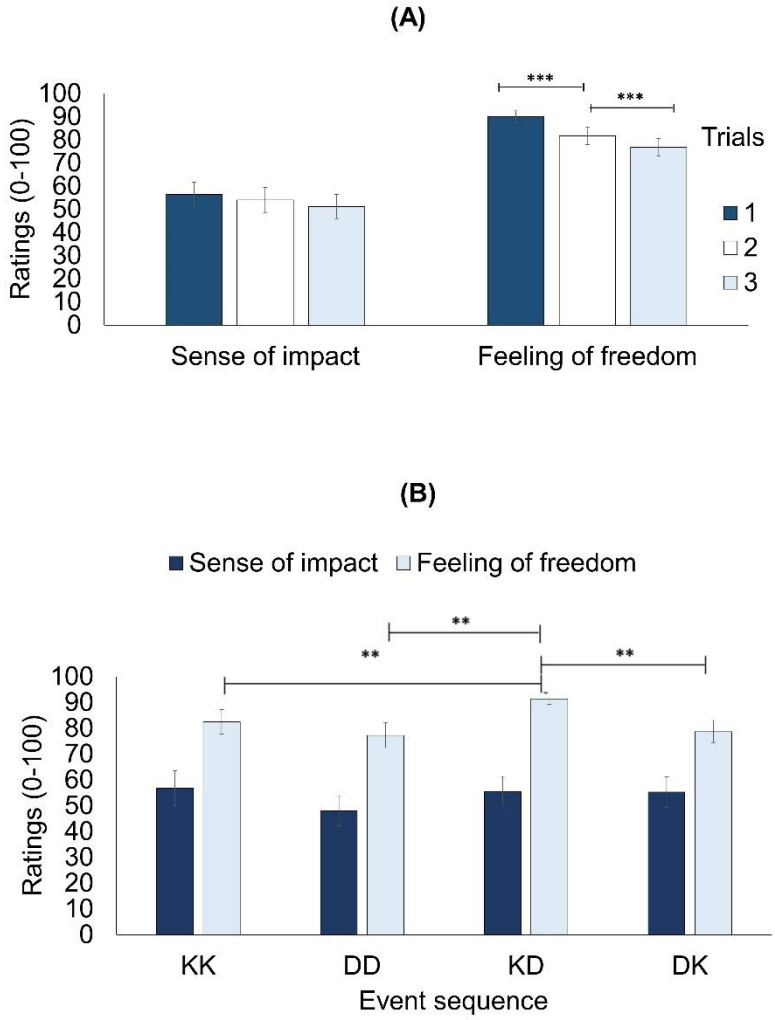

Figure 4.3. Participants' sense of impact over the outcome forced card and their feeling of freedom for touching the cards they wanted (A) among the 3 trials and (B) according to the specific route they experienced. Their chosen cards were either first kept (K) or discarded (D) during the first and second rounds. Error bars represent the standard errors of the mean.

Looking at participants' feelings of freedom, a Friedman test showed that they felt significantly different levels of freedom among the trials ($X2(2,98) = 18.8$, $p < .001$, Figure 4.3A). A polynomial linear contrast analysis confirmed that participants' feelings of freedom for their choice significantly decreased over the 3 trials ($t(50)$ 3.30, $p = .001$). A possible explanation is that even though participants did not explicitly understand the trick and the fact

that they were forced, they implicitly felt something outside their control was happening and leading them to end up with the same card.

Route consistency and event sequences

We then looked at the impact of the route consistency on participants' feelings of freedom and impact across all trials. Looking at the routes across the trials, 58% participants in trial 1, 48% in trial 2 and 46% in trial 3 experienced a consistent route. Figure 4.3B shows participants' ratings according to the event sequence they experienced. A Mann-Whitney test showed that whether the two rounds were consistent (M=51.7) or not (M=56.1) had no significant effect on participants' sense of impact over the outcome card (W=2961, p = .573, r_{rb} =.053). Likewise, participants' feelings of freedom for their choice did not significantly differ in consistent (M=79.6) or inconsistent (M=86.2) routes (W= 2968, p = .539, r_{rb} =.055).

Next, we took a closer look at the impact that the different decision routes had on our measures. Figure 4.3B shows the sense of freedom and impact ratings for each decision rout (final trial). A Kruskal-Wallis test (X^2(3, 50) = 9.94, p = .030, η^2= .051) and a deviation contrast analysis (t(50) 2.62, p = .010, d = .545) replicated the results from Experiment 1 in that participants felt significantly more free for their choice of cards in the inconsistent route first keeping the touched cards and then discarding the touched one. As in Experiment 1 however, the type of sequence had no significant effect on participants' sense of impact (X^2(3, 50) = 1.44, p = .697, η^2= .009). Something leads participants to retrospectively feel they were freer to choose which cards to touch when the experimenter first kept their choice and then discarded them. Even though in all possible event sequences participants were equally free to touch the cards of their choice, this particular sequence leads them to feel an illusory higher degree of freedom for their choice. Although these results were not expected in the first place, we

replicated them again. Therefore, this effect does not seem random. The experiment was conducted by a different person who was blind about the effect found in Experiment 1. We can therefore confidently say this is not due to the person performing the trick. It is possible, though we are simply speculating, that the act of keeping and discarding chosen items are inherently different, and participants might intuitively expect touched/chosen items to be subsequently kept, and different outcomes (e.g. one's choices being kept and discarded) following the same action (e.g. touching the items) might produce a greater feeling of freedom when asked to judge it.

Surprise

Finally, we looked at participants' degree of surprise after discovering the matching prediction and its correlation with their feelings of freedom and impact over the last trial. As predicted, there was a significant positive correlation between the degree of impact participants felt they had over the outcome card and the amount of surprise they reported regarding the prediction (r_s=.305, p = .031). No correlation was found between the feelings of freedom over the touched cards and the degree of surprise (r_s = .195 p = .175). These results confirm our prediction that when participants experienced an illusory sense of agency over the outcome card, they did not understand that their choice was pre-determined. The last trial's route consistency (W= 241, p = .171, $r_{rb=}$ -.226) and event sequence (H(2, 50) =2.01, p = .570) did not have an impact on participants' level of surprise.

This second experiment replicates findings from Experiment 1 and confirm that the Equivoque is a powerful technique to provide an illusory sense of agency over a predetermined outcome. Moreover, it shows that the force is still efficient after being repeated twice in succession. Participants' feeling of surprise provides a reliable implicit measure of participants'

understanding of the trick. Finally, and to our surprise, we replicated the results regarding participants' feelings of freedom in the keep/discard inconsistent route. Unfortunately, we cannot find any explanation for this strange effect, and it might be worth investigating further.

4.5. Experiment 3

Our third experiment had two aims. Firstly, we examined whether the Equivoque force is effective when participants make choices about items where they can have strong a priori preferences. The magic literature suggests that this force can be used with items other than playing cards (Jones, 1994; Turner, 2015), and we therefore expected participants to experience an illusory sense of agency over the outcome when choosing objects that have clearly different levels of value (i.e. holiday destinations).

Secondly, we examined whether the force can induce a preference change for the forced item. Previous research has shown that it is possible to induce a preference for an item when the person thinks they chose it (Coppin, Delplanque, Cayeux, Porcherot, & Sander, 2010; Rozin, Scott, & Dingley, 2011; Sharot, Martino, & Dolan, 2009; Sharot, Velasquez, & Dolan, 2010), and it has been suggested that mental process of making a choice changes someone's preferences (Jack W. Brehm, 1956). However, it is possible that the act of choosing simply reveals pre-existing preferences (M. K. Chen & Risen, 2010). Moreover, many of these previous experiments suffer from important methodological flaws, allowing participants' real preferences to guide their choices (M. K. Chen & Risen, 2010; Risen & Chen, 2010). To address this issue, some authors have invented procedures such as blind choice (Sharot, Velasquez, et al., 2010) or choice blindness paradigms (Johansson, Hall, Tärning, Sikström, & Chater, 2014) and have shown similar effects. Some of the research using choice blindness paradigms suggests that it is possible to induce a preference change for the switched item (Johansson, Hall,

& Chater, 2012; Johansson et al., 2014). Johansson and colleagues (2014) asked participants to choose which of a pair of faces they found the most attractive, and covertly switched the chosen face for the other. Participants then had to justify their alleged choice and rate both faces. Then, the authors included a second round of choices with the same face pairs (and no manipulation of the choices), as well as another stage of post-choice attractiveness rating of the faces. Participants tended to choose the initially rejected face more frequently in the second round and the perceived attractiveness increased when they were led to believed they chose it. In other words, when participants make a blind choice which cannot be guided by pre-existing preferences, they end up preferring the item they believe was their choice. The Equivoque force provides a tool to address previous criticism on preference change, as participants' preferences are not guiding by the outcome of the procedure. Moreover, the Equivoque relies on a much flexible procedure than typical choice blindness paradigms, which means it could potentially be easily implemented in context where people make choices that have real consequences (e.g. food or objects). Here, we investigate whether participants can be led to prefer a holiday destination because they think they chose it.

We predicted that the Equivoque can effectively force the choice of an imaginary holiday destination. Moreover, we predicted that participants would prefer the forced holiday destination when they experienced an illusion of choice, that is, in the Equivoque procedure rather than in a situation where the experimenter explicitly states they are forcing the participants to have the outcome item.

4.5.1. Method

Participants

84 participants (55 females) were recruited on the Goldsmiths University campus (Mean age= 24.1, SD=7.70). The sample was therefore similar to the two previous experiments.

We ran an a priori power analysis for a t-test with independent groups, a power of .80, $\alpha = 0.05$, and d=.55. We based the effect size on two main things. First, based on the two prior experiments, we expected a medium to strong effect of the Equivoque procedure on participants' sense of agency over their choice when compared to an explicit forced-choice procedure. Second, we suggest the Equivoque resembles a choice blindness paradigm which follows Risen and Chen's recommendations (Risen & Chen, 2010) and has shown medium to strong effect sizes on participants' induced preference change (Johansson et al., 2014). The output of the calculation was 84 participants.

Procedure

To investigate our hypotheses, we used 4 holiday destinations written on 4 blank pieces of paper (10x5cm). The destinations were chosen based on an online pilot study for which participants had to rate how much they liked each of 16 different holiday destinations on a scale from 0 to 100. We took the 4 destinations which had close mean results to avoid any bias in pre-existing preferences (Means from 71.5 to 76.2). As in previous experiments, the experimenter sat at a table in one of Goldsmiths' café with the 4 holiday destinations already on the table. These were always presented in the same order (Sydney, Bali, Paris, Mykonos) for each experimental group and participant, and Paris was always the forced destination.

Participants were randomly allocated to one of two experimental conditions (Equivoque vs. Explicit Force, see Figure 4.4). In the Equivoque, the experimenter stated, "Here are 4 holiday destinations", and then proceeded to the usual Equivoque procedure by asking participants to touch two of them, discarding or keeping their choice, and then asking to touch

one of the two which were kept on the table. At the end of the Equivoque procedure, as Paris was the last destination on the table, the experimenter slightly pushed it towards the participants while saying “OK, so here is your destination” and asked participants to answer the questions on the paper questionnaire.

In the Explicit Force condition, we tried to keep the event sequence as close as possible to the Equivoque, while making it obvious that participants ended up with Paris because the experimenter explicitly chose it for them. For this, the experimenter started by saying “Here are 4 holiday destinations. For this exercise, you are going to have Paris. Before I give it to you, could you please touch two destinations?”. The experimenter waited for the participants to touch two destinations, and then simply asked them to touch only one. Like this, participants made the same number of choices, but the Equivoque procedure was not implemented (keeping or discarding the choices to force one of them). In other words, the experimenter did not touch the choices made by the participants.

Participants were then asked to fill in the paper questionnaire. First, they were asked to rate how much they liked each of the 4 destinations, how free they felt about touching the destinations they wanted, and how much impact they felt these choices had on the final destination. Participants were also asked to state how much they agreed with the statement “I was the one choosing the final destination”. After filling in this first part, the experimenter asked participants to open the prediction which was on the table from the beginning and in which “You will choose Paris” was written. Participants then had to rate how surprised they were about this matching prediction. All the measures were taken on a scale from 0 to 100.

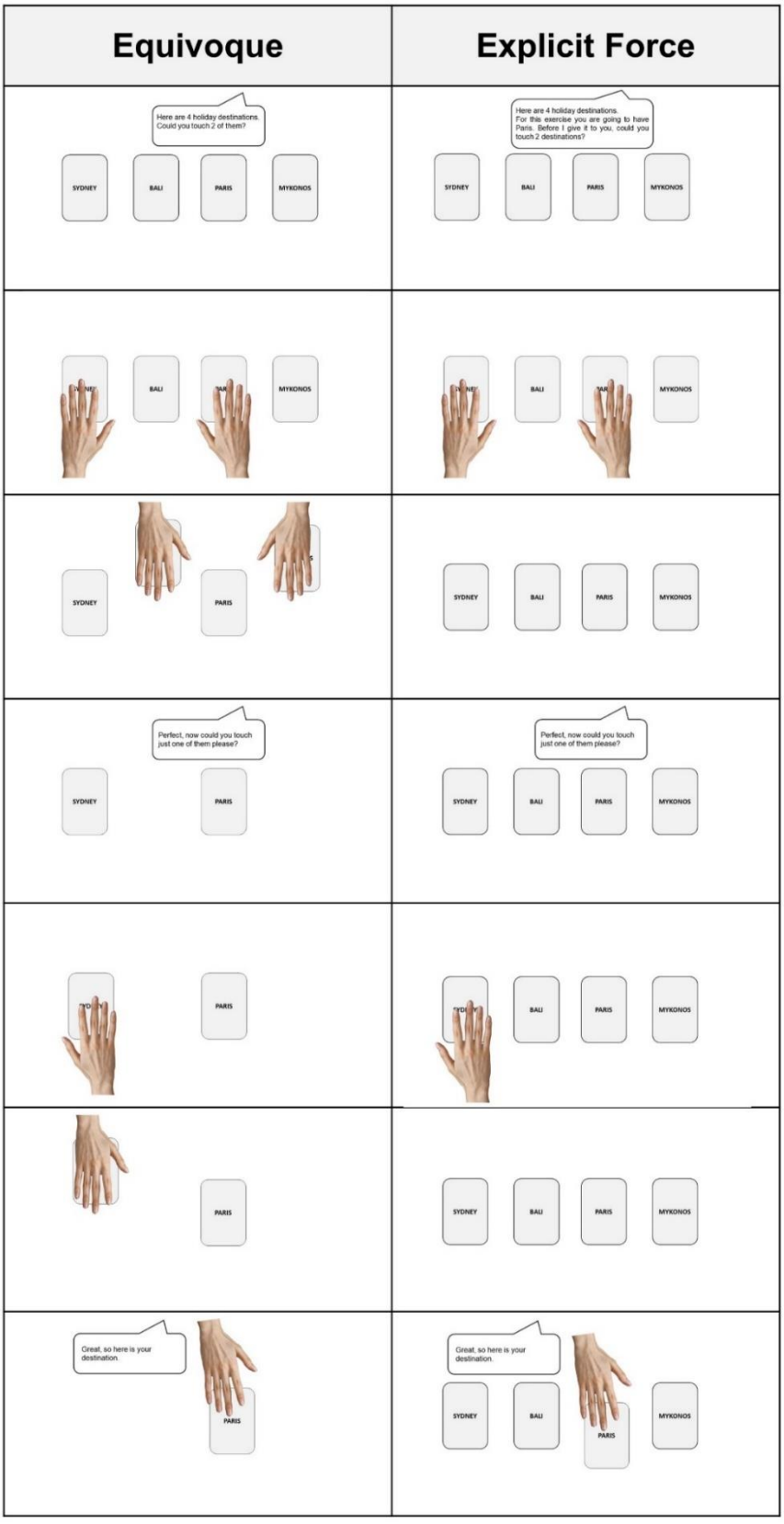

Figure 4.4. Equivoque and Explicit Force procedures representing the two experimental conditions.

4.5.2. Results and Discussion

Participants' overall feelings of freedom (*M*=81.4 *SD*=22.9), sense of impact (*M*=52.6, *SD*=33.5) and level of surprise (*M*=54, *SD*=39.1) were similar to those of experiments 1 and 2.

Equivoque Efficiency

Figure 4.5A shows the mean ratings as a function of whether the choice was forced, using the Equivoque or the explicit force. Participants felt significantly more impact over the outcome destination (*W*=1138, *p*=.010, r_{rb}= .293) and freer for touching the destinations they wanted (*W*=1210, *p*=.001, r_{rb}= .375) in the Equivoque procedure (*M* impact=61.8, *M* freedom=87.1) than in the Explicit Force condition (*M* impact=44.3, *M* freedom=76.1).

Likewise, they significantly agreed more with the statement "I was the one choosing the final destination" (*W*=1110, *p*=.019, r_{rb}= .262) and were more surprised by the matching prediction (*W*=1175, *p*=.004, r_{rb}=.336) with the Equivoque.

These results illustrate that the Equivoque force is also effective in situations where people have a priori preferences for an item. In other words, these results suggest that it is possible to make people feel they freely chose a specific holiday destination even though they were objectively manipulated toward it.

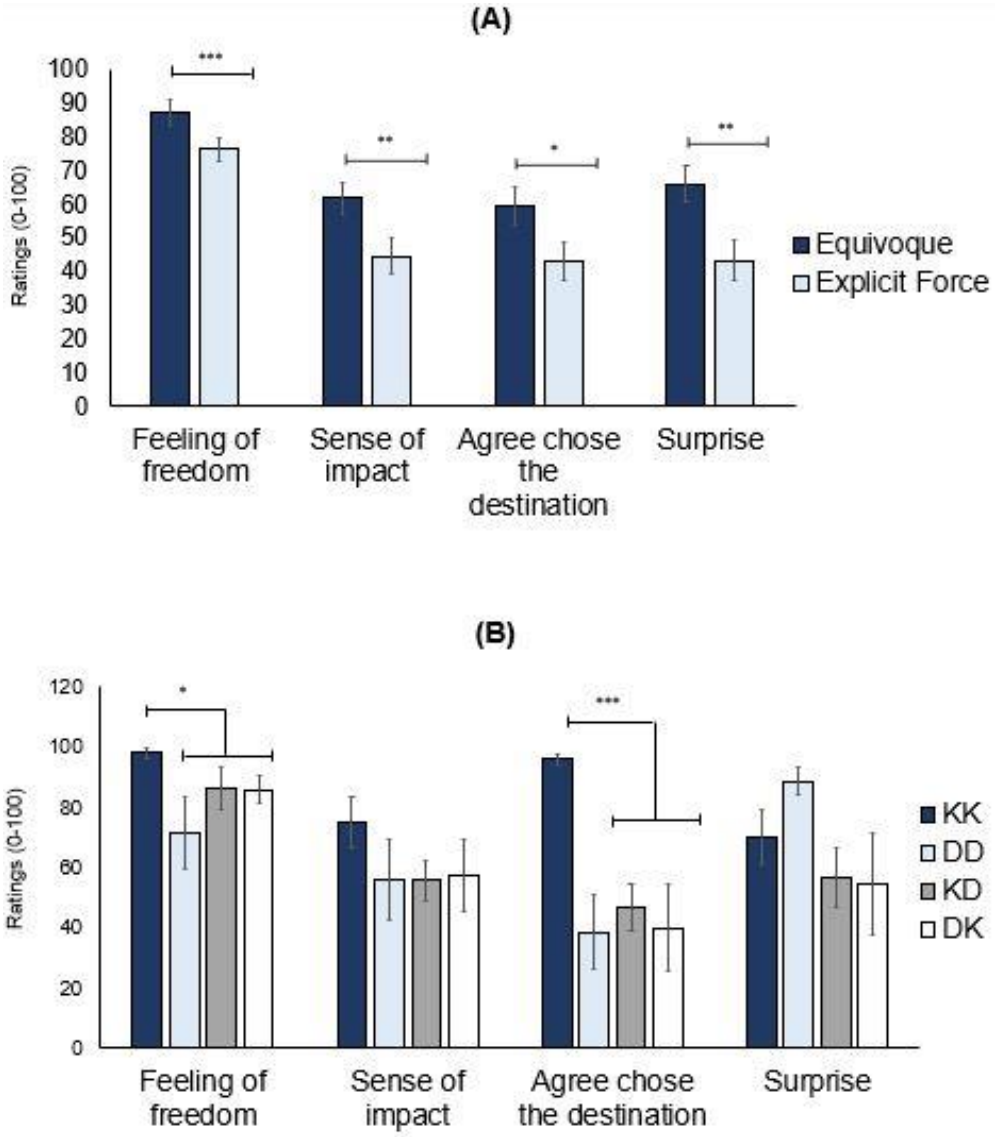

Figure 4.5. (A) Mean ratings of participants feeling of freedom to touch the destinations of their choice, sense of impact over the final destination, agreement that they were the ones choosing the destination, and surprise regarding the matching prediction according to the experimental conditions. Bars display standard errors of the means. Figure (B) represents the means according to the event sequence in the Equivoque condition. Bars display standard errors of the mean. * $p<.05$; ** $p<.01$; *** $p<.001$.

Route consistency and event sequence

Next, we looked at participants in the Equivoque condition only, and the impact of route consistency and specific event sequence on participants' ratings (Figure 4.5B). With the

Equivoque, 47.5% of participants experienced a consistent route and 52.5% an inconsistent one. Mann-Whitney test shows that route consistency did not have a significant effect on participants' feelings of freedom for their choice (W=185, p = .677, r_{rb}= -.073), sense of impact over the final destination (W=142, p=.123, r_{rb}=-.286) or surprise over the matching prediction (W=169, p = .059, r_{rb}=-.348). However, consistency had a significant impact on how much people agreed they were the ones choosing the destination (W=96, p = .005, r_{rb}=-.519), with people experiencing a consistent route feeling they were the ones choosing the destination more than participants experiencing inconsistent routes (Means= 74.7 vs 44.9). Looking closer at the event sequences, Kruskal-Wallis tests followed by deviation contrast analyses showed that participants felt freer for touching the destinations they wanted (X^2 (3, 84) = 9.95, p = .019, η^2=.148 and t(84) 2.11, p = .042) and that they were the ones choosing the outcome destination (X^2 (3, 84) = 20.62, p < .001, η^2=.474 and t(84) 5.66, p < .001) significantly more when their choices were kept in both rounds (KK event sequence, Figure 4.5B). This makes sense as it is possible that participants who experienced an event sequence in which their choices were kept in both rounds are participants who consciously chose the forced destination by themselves (i.e. touching the destination in both rounds). However, no significant effect of the event sequence was found for participants' sense of impact over the final destination (H (3, 84) = 4.37 p = .224, η^2=.089) or amount of surprise (H (3, 84) = 4.60, p = .203, η^2=.125).

Surprise

Next, we looked at participants' levels of surprise regarding the matching prediction "You will choose Paris". Overall, Spearman correlations show that the more participants felt their choices had an impact on the final destination, the greater was the amount of surprise regarding the matching prediction (r_s =.299, p = .003). Likewise, the more participants felt that they were the

ones choosing the destination, the more surprised they were (r_s =.358, p < .001). However, as predicted, the feeling of freedom over which destination to touch did not correlate with participants' surprise (r_s =-.078, p = .759).

Looking at participants in the Equivoque condition only, there was no correlation between their sense of impact (r_s =.048, p = .770), feeling of freedom (r_s =.055, p = .736), or feeling that they were the ones choosing the destination (r_s =.122, p = .452) and their amount of surprise. It was common for participants to try to rationalize what just happen regarding the matching prediction in this condition. When asked to explain their low ratings of surprise even when they felt they were the ones controlling the final choice, participants typically reported that the experimenter probably knew Paris was the most commonly chosen destination, or that Paris was obviously the best one, or the geographically closest one, so they assumed it was the reason for the successful prediction.

Induced choice preference

Finally, we examined whether the Equivoque induced a preference towards the forced destination (i.e. Paris, see Figure 4.6). Looking at the destinations' rating participants reported preferring Bali (*M*=74.5, *SD*=26.5) and then Paris (*M*=69.9, *SD*=23.1), Sydney (*M*=61.8, *SD*=25.2) and Mykonos (*M*=59.7, *SD*=28.2). We ran a 2x4 Kruskal-Wallis test to investigate the differences in ratings across the different destinations and experimental conditions. The destinations were rated significantly differently (H (3) = 17.5, p < .001, η^2= .047).

Contrary to our prediction, participants slightly preferred Paris in the Explicit Force condition (*M*=71.6, *SD*= 21.9) than in the Equivoque one (*M*=67.9, *SD*=24.6) (H (1) = .002, *p* = .965. η^2 = .000).

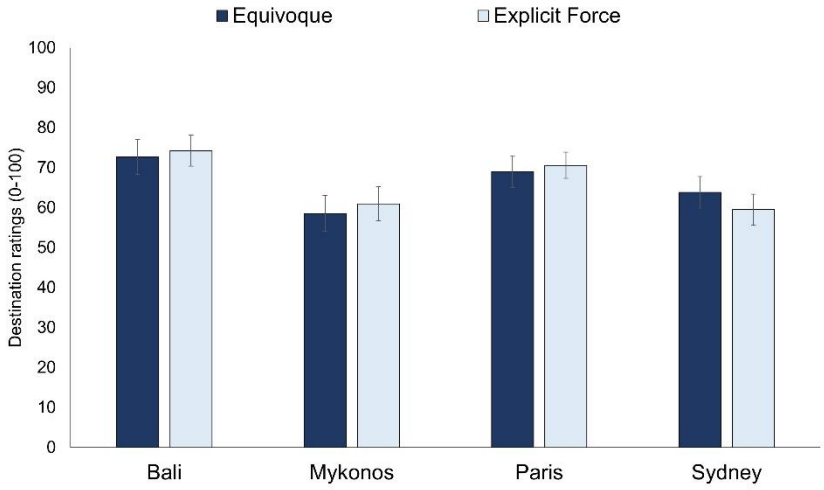

Figure 4.6. Participants' ratings of how much they like the destinations according to the experimental conditions. Bars display standard errors of the means.

Looking at participants in the Equivoque condition only, Spearman correlation shows that the more participants felt they were the ones choosing the destination, the more they preferred the forced destination over the others (r_s =.497, *p* = .001). However, when omitting the participants who chose Paris in both rounds of the Equivoque (KK event sequence, who are therefore highly likely to have a pre-existing preference for it), the correlation disappears (r_s =.319, *p* = .105). These results suggest that the induced choice preference effect might be smaller than what is reported in the literature (Coppin et al., 2010; Coppin, Delplanque, Porcherot, Cayeux, & Sander, 2012; Harmon-Jones & Harmon-Jones, 2002; Imada & Kitayama, 2010; Kimel, Grossmann, & Kitayama, 2012; Lee & Schwarz, 2010; Sharot et al., 2009; Sharot, Shiner, & Dolan, 2010), or based on methodological limitations allowing for pre-existing preferences to guide participants' choices. Indeed, some authors already pointed out

that free-choice paradigms used to investigate preference change rather created an artificial spreading of alternatives than a true reflection of preference change (Risen & Chen, 2010). Moreover, a meta-analysis (Izuma & Murayama, 2013) showed that the big effect sizes found in most papers drop when the issues are addressed and recommendations are followed.

It is worth noting that of the 44 participants in the Explicit Force condition, 11 did not remember that the experimenter told them that they were going to have Paris, and they were really surprised about the prediction (*M*=91.4, *SD*=8.09). They also agreed that they chose the destination to a greater extent than the participants in the Equivoque condition (*M*=64.1 vs 59.1). We carried out an additional analysis that excluded these participants - all the results remained the same, with even stronger effect sizes. We were however rather baffled that in such explicit conditions, participants could completely forget the experimenter instructions and ended up thinking they chose the force destination by themselves. Moreover, only one of them ended up the second round by touching Paris. The fact that participants ended up with the forced destination next to them on the table (as the experimenter pushed it towards them and asked them to take it) combined with reading the prediction "You will choose Paris" may have produced a form of suggestion and misinformation leading people to misremember the sequence of event.

It has already been shown that more suggestible participants (i.e. perceiving a key bending when it was stationary) were also significantly more likely than others to omit that the performer verbally suggested it (i.e. "The key is still bending")(Wiseman & Greening, 2005). This effect could be interpreted in several ways. It is possible that the participants who did not remember the experimenter's instructions simply did not attend to this piece of information (i.e. "You will have Paris"). It is also possible that the situation combining reading the prediction and having the forced destination close to them exerted some sort of misleading information, having an impact on participants' memory of the event. This second interpretation seems more

likely, as even if participants did not attend the experimenter's instructions, we would still have to explain why they think they chose the destination themselves. We suggest that this effect could be worth investigating further in future research, as this could have important practical implications, especially linked in eyewitness testimonies and other judiciary situations such as criminal identifications. These results are also very closely linked to choice blindness effects, during which participants fail to see the mismatch between their choice and the outcome of this choice (Hall & Johansson, 2008; Hall et al., 2010). For example, it has been shown that it is possible to covertly change participants' political attitude responses on a survey and make them accept and endorse this altered political score (Hall et al., 2013).

4.6. General Discussion

This paper describes three studies that explored a magician forcing technique called the Equivoque. In all experiments, participants were forced to end up with a target item (i.e. playing card or holiday destination) while the trick's procedure led them to feel they freely chose this item themselves. Our results show that participants experienced an illusory sense of agency over the outcome (their chosen item) even though their actions had no impact on it. Regardless of whether the experimenter was consistent or not with participants' choices (i.e. whether the choices were always kept/discarded or not), participants felt that their decisions had the same amount of impact on the outcome they got.

Our findings support previous results showing a dissociation between our subjective sense of control and the objective one (Gauchou, Rensink, & Fels, 2012; Haggard, Martin, Taylor-Clarke, Jeannerod, & Franck, 2003; Olson et al., 2015). This past research shows that at times we may feel that we are not in control of our own actions when in fact we are (Hon, Poh, & Soon, 2013; Olson et al., 2016; Terhune & Hedman, 2017). Likewise, we may fail to

understand that we are not the ones controlling external circumstances (Aarts et al., 2005; Sato & Yasuda, 2005; Tobias-Webb et al., 2017). Our results also dovetail findings from choice blindness findings, which show that people often fail to recall a choice immediately after having made that choice. However, in choice blindness paradigms, elaborate covert deceptive procedures are used to conceal a switch between participants' choice and the changed outcome (Hall & Johansson, 2008; Hall et al., 2010; Johansson et al., 2008). In the Equivoque procedure, the deception is fully visible and yet participants still believe they chose the outcome. Our results have important theoretical and practical implications. For example, we have implemented the Equivoque procedure in an online game and shown that gamers can feel in control of the story presented to them when they are not (Kumari, Deterding, & Kuhn, 2018; Kumari, Deterding, Pailhès, & Kuhn, in preparation). More worryingly, this type of deception could potentially be exploited in other decision-making processes such as in consumer behaviours and politics (Hall et al., 2010, 2013).

Similarly to the Moses Illusion (Erickson & Mattson, 1981), people fail to notice inconsistencies in their environment. In this illusion, participants often fail to notice contradictions with stored knowledge, and many errors are overlooked. In the Equivoque, participants also failed to notice the discrepancies between what the experimenter did with their chosen items. If participants noticed this discrepancy, they should understand that they were not controlling the outcome item. This cognitive failure led participants to experience an illusory sense of agency over the outcome of their action. People's failures to catch semantic errors can result from a type of knowledge neglect (Bottoms et al., 2010; Bredart & Modolo, 1988), and we suggest that the Equivoque force relies on a form of 'event neglect' in which people fail to catch inconsistencies in their environment. Since the procedure is performed fluently no attention is drawn to the inconsistent actions, the experimenter's incoherencies are easily overlooked.

One of the golden rules in magic is not to repeat the same trick with the same method (Ekroll et al., 2018). Experiment 2 showed that the Equivoque remains effective after being repeated twice, which suggests that the procedure is very robust. However, across the two first experiments, participants reported moderate feelings of impact over the outcome card (Exp 1 *M*=53.5, Exp 2 *M*=61.8). It was common for participants in the first two experiments to explain these ratings by stating that since only a few items were presented there was limited choice. Others claimed that since the choices were meaningless (because cards were used and there were 'no stakes') their actions had little consequence. In the final experiment participants were asked to choose an item for which people have genuine preferences, and indeed we observed higher ratings. It is important to note that even though the ratings were moderate, during debriefings when asked whether they knew how the prediction had been achieved, very few participants expressed that they understood the procedure (none in experiments 1 and 2).

Our third experiment assessed whether the Equivoque can force a choice for which people have pre-existing preferences (i.e. holiday destinations). Our results showed that participants could be led to believe they chose Paris as their destination even when this outcome was forced. These results illustrate that the Equivoque is not limited to playing cards, but can be applied to other items. This last experiment also investigated whether the Equivoque could induce a preference for the forced item. Previous studies have shown that people tend to prefer an item over others if they believe they chose it (Coppin et al., 2010; Johansson et al., 2012; Sharot et al., 2009). Our participants did not prefer the forced holiday destination compared to when they were explicitly given that item. Even though there was a significant correlation between how much participants felt they were the ones choosing the destination and their amount of preference for it, this correlation was weaker and not statistically significant once we removed participants who were likely to have had a pre-existing preference for the forced outcome (i.e. touching it in each round of the procedure). This caveat is important in the

contexts of some of the past literature on induced choice preference. Risen and Chen (2010) already pointed out important methodological flaws in these past paradigms, and argued that the evidence for this effect was insufficient and unreliable. However, most studies continued using the traditional free-choice paradigm without addressing these methodological limitations, and a meta-analysis (Izuma & Murayama, 2013) casts more doubt on these findings. Two points therefore seem important to note here. Firstly, our study, using the Equivoque procedure, provides a way to investigate the effect by addressing some of the previous methodological criticism: the task does not reflect participants' preference, as the same item is always forced by the experimenter. With this in mind, our results do not provide any evidence for an induced preference over the final item, which adds to the suggestions that the real effect size is smaller than what was previously reported (Izuma & Murayama, 2013). Our results do however, conflict Johansson et al. (2013) who used a choice blindness procedure to show moderate to strong effect sizes of the induced choice preference. Although there are similarities between our paradigms, there are two important differences that my account for this discrepancy. Firstly, choice blindness paradigms are by nature about preferences. Participants are not required to only choose one item among several, but make a choice that is based on their preference (e.g. faces attraction, political opinions, taste preferences…). As participants rate the switched item, they erroneously believe it is an item they preferred in the first place. This erroneous belief might account for the preference change effect in this type of paradigm. Secondly, the induced preference may have resulted from asking participants to justify their 'choice'. Johansson and colleagues asked participants to justify their alleged choice (i.e. the firstly rejected item switched for the chosen one) before asking them to rate it. Therefore, it is possible that elaborating a confabulation about a choice induce a cognitive dissonance (Jack W. Brehm, 1956) itself leading to an induced preference for the item. In our study, participants

were not asked to justify their alleged choice, and this might have been why we failed to see an induced choice preference for the forced item.

Finally, experiment 3 also provided unexpected and surprising results. In the Explicit Force condition, the experimenter explicitly stated that she was going to give them the target destination in the end ("You will have Paris"), and yet 25% of the participants forgot this statement. Moreover, these participants were genuinely surprised when the experimenter revealed the prediction about their "choice". In this condition, participants' manual touching actions had literally no impact on the outcome, and yet they erroneously believed they had chosen the item. Our memory is highly malleable (Loftus, 2005), and previous studies have demonstrated that misleading post-event information can affect people's memories (Loftus & Hoffman, 1989; Wright & Loftus, 1998). It is possible that a conjunction of choice blindness (i.e. our participants failing to see the difference between *their* choice and the forced outcome they had) and misinformation effect (i.e. "You will choose Paris" written prediction) impacted our participants' memory of the events, leading them to think they chose the target destination in the first place. Others have shown that merging choice blindness paradigm and the misinformation effect can affect eyewitnesses' recollections of an event (Stille et al., 2017), and create memory distortions (Pärnamets et al., 2015). Our results dovetail these findings and suggest the same results can be created with participants' memory of what they chose.

To conclude, we show that Equivoque force provides people the illusion of choice, when in reality their action had no impact on the outcome. Participants were oblivious to inconsistencies in decision paths, even when the procedure was repeated several times. Our paper shows that this forcing principle is not limited to playing cards, but can be applied to situations in which people chose items for which they have pre-existing preferences. These findings open up the possibility of applying this principle to areas where it is desirable to provide people the illusion of choice (e.g. gaming). The Equivoque force demonstrates the ease

by which we can experience an illusory sense of agency over the outcome of our actions, and highlights a surprising blindness over semantic inconsistencies in event sequences.

Decision Forces

This section focuses on Decision forces, which are techniques in which the magician tries to directly influence the spectator's choice. These techniques are known to be riskier than the Outcome forces (Jones, 1994). Here, I present two Decision forces relying on the spectators' psychological biases. Chapter 5 presents scientific investigation of the Position force which uses strategic physical positioning of cards. Finally, Chapter 6 presents an investigation of the Mental Priming force, relying on subtle conversational gestures to prime a specific card in the spectator's mind.

5. Subtly encouraging more deliberate decisions: Using a forcing technique and population stereotype to investigate free will.

5.1. Abstract

Magicians' forcing techniques allow them to covertly influence spectators' choices. We used a type of force (Position Force) to investigate whether explicitly informing people that they are making a decision results in more deliberate decisions. The magician placed four face-down cards on the table in a horizontal row, after which the spectator was asked to select a card by pushing it forward. According to magicians and position effects literature, people should be more likely to choose a card in the third position from their left, because it can be easily reached. We manipulated whether participants were reminded that they were making a decision (explicit choice) or not (implicit choice) when asked to select one of the cards. Two experiments confirmed the efficiency of the Position Force — 52% of participants chose the target card. Explicitly informing participants of the decision impairs the success of the force, leading to a more deliberate choice. A range of awareness measures illustrates that participants were unaware of their stereotypical behaviours. Participants who chose the target card significantly underestimated the number of people who would have chosen the same card, and felt as free as the participants who chose another card. Finally, we tested an embodied-cognition idea, but our data suggest that different ways of holding an object do not affect the level of self-control they have over their actions. Results are discussed in terms of theoretical implications regarding free will, Wegner's apparent mental causation, choice blindness and reachability effects.

5.2. Introduction

We like the feeling of being in control of our thoughts and our actions, and yet many of our behaviours are systematically influenced by external and internal factors (Ariely, 2008; Bargh & Chartrand, 1999; Bargh, Chen, & Burrows, 1996; Loewenstein, 1996). Likewise, our thoughts are often less unique than we intuitively believe them to be, and research on population stereotypes illustrates that most people will choose or think about similar things or objects when asked to make a decision (French, 1992; Grimmer & White, 1986; Marks & Kammann, 1980). Understanding the external factors that influence our behaviours may help individuals make more informed and freer choices (Appourchaux, 2014).

Baumeister suggested that free will is predominantly associated with cognitive processes involving conscious and controlled activity (i.e. System 2), rather than the nonconscious and automatic processes associated with System 1 (Baer, Kaufman, & Baumeister, 2008; Kahneman et al., 2002). Accordingly, a more useful view of free will is to think in terms of autoregulation and self-control mechanisms, a perspective that allows us to take advantage of the parameters influencing our thoughts and actions during our day to day lives. Magicians are masters at deception and creating the illusion of conscious will, and they use a wide range of forcing techniques, to give spectators the illusion that they freely, and consciously chose a card, which in reality is predetermined by the conjurer (Kuhn, Amlani, et al., 2008b). This paper uses a forcing technique to investigate whether explicitly informing people that they are making a decision leads to a more deliberate decision.

Forcing Techniques

Forcing refers to conjuring techniques which allow magicians to covertly influence a spectator's choice or its outcome. These techniques are often used to create the illusion of precognition or mind reading and magicians have extensive real-world experience in manipulating the decisions people make. Back in 1894, Alfred Binet investigated magicians' deceptive craft scientifically, and he observed that conjurers exploit spectators' "laziness" without them becoming aware of it (Binet, 1894). In other words, conjurers intuitively try to manipulate the spectator into using more automatic cognitive processes, which are easily exploited to trick the mind. He further noted that magicians often use circumstantial influences to push a person to act in a predictable way. Nowadays, we refer to these processes as automatic behaviours, which often rely on heuristics, or a System 1 type of thinking (Kahneman, 2011; Kahneman et al., 2002). By observing conjurers performing tricks, Binet noted that if you are presented with three different objects, one alongside the other, most people choose the middle one. He also points out that this is probably due to the ease by which people execute certain grasping actions. Likewise, he noted that when people are presented with a sheet of paper that has been divided into 16 equal size squares, and they are asked to draw a dot into one of them, most people will choose the middle squares. As he writes, "there is therefore a kind of attraction exerted by the centre of the figure. Probably also because they provide more convenience to the hand." (Binet, 1894, p.150/151). Magicians frequently exploit these types of cognitive heuristics and population stereotypes to force a decision (Annemann, 1933; Banachek, 2002; Jones, 1994). Magicians' real-world experience and expertise in performing these tricks for large audiences have allowed them to identify psychological factors that enhance the possibility of the spectator selecting the forced item.

Several other papers have investigated forces that rely on different techniques and it is likely that spectators simply choose the easiest option. The "Classic Force" relies on the timing

in which the magician is handling the deck of cards while asking the spectator to pick a card (Shalom et al., 2013). Shalom et al. showed that most people pick the card which is subtly handled by the magician who physically restricts the choice. Olson et al., (2015) investigated the "Visual Riffle Force" in which spectators are asked to visually select a card when the magician flips through the deck in front of their eyes — most spectators choose the card which is the most visually salient. Both forces have high success rates and showed that participants felt free even when they chose the target card.

Magicians have developed a large assortment of forcing techniques that rely on a wide range of cognitive processes (Pailhès & Kuhn, 2019). In this paper, we examine a forcing technique that relies on population stereotypes: the Position Force. This technique is based on the observation that people's choices for random objects are influenced by the object's physical position. According to the magic literature, people will be inclined to select the card that is the easiest to reach in the row (Banachek, 2002; Binet, 1894). This force is most commonly used with 5 playing cards (Banachek, 2002), but we decided to investigate the force with 4 cards to compare the results to forcing from our research program: here, the magician places four cards on the table in a horizontal row, after which the spectator is asked to select a card, by physically touching it. Results from an online survey on 91 magicians showed that most of them (68%) think that when we present four cards in a row on a table to spectators, the majority will choose the third card from their left. Their mean estimation of the percentage of people who would choose this target card was 57% of the spectators (*SD*=15.9). Indeed, a recently published study from our laboratory using the Position Force found that 60% of the participants select the third card from their left while feeling free for their choice and underestimating the proportion of people who would select the same card (Kuhn et al., 2020).

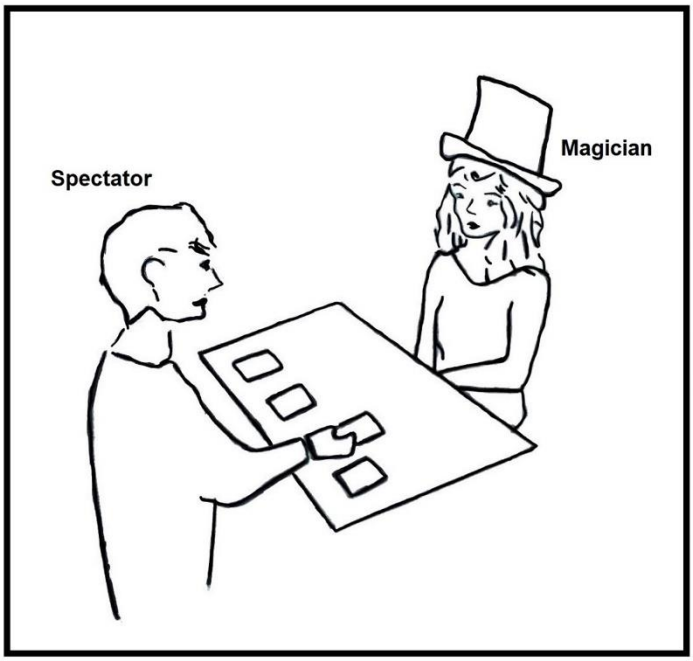

Figure 5.1. Representation of the Position Force. The spectator/participant selects the third card from his left by pushing it towards the magician/experimenter.

Moreover, research in other domains suggests that people's choices are influenced by the physical positioning of an object.

Position effects

Nisbett and Wilson showed in 1977 that when presented with four identical pairs of stockings, people tend to prefer the far-right one (Nisbett & Wilson, 1977). Nowadays, consumer psychology (Chae & Hoegg, 2013) and nudge techniques (Dayan & Bar-Hillel, 2011) often rely on manipulating an object's physical positioning with the intention of influencing people's behaviour and choices. For example, people are more likely to choose an item, such as food (Kim, Hwang, Park, Lee, & Park, 2019), if it is positioned in a specific location, and this can be used to lead people towards healthier choices (Bucher et al., 2016). There are however some discrepancies about the exact way in which positioning affect people's choices, with studies

showing both edge advantage and aversion. Bar-Hillel suggests that these inconsistencies result from different choice characteristics, such as whether it is interactive or not (Bar-Hillel, 2015). Accordingly, a choice is interactive when the payoff for someone's decision is affected by another interested person. For example, in a game such as Rock, Paper, Scissors, each player's choice payoff is determined by the joint choices of both players. A further factor involves the amount of cognitive processing a choice requires to figure it out. Situations in which all items are evidently identical (such as the back of playing cards) fall into the category of choices that neither require processing nor interaction. In this case, we observe that people present an edge aversion rather than edge advantage (Bar-Hillel, 2015).

Indeed, when presented with a selection of similar options, or identical items, individuals tend to choose items located in the middle position rather than the those located at the edges (Christenfeld, 1995). This effect has been found with a range of items. For example, participants prefer middle items and avoid items located at the extremes when choosing among a row of arbitrary symbols, a toilet paper roll within a stall, a bathroom stall, and when picking products from shelves in supermarkets. The principle ruling these effects is thought to be based on a minimal mental effort (Christenfeld, 1995; Shaw, Bergen, Brown, & Gallagher, 2000). Indeed, research showed that when participants are asked to choose between similar highlighters, survey papers, or seats, they reliably prefer the middle items (Shaw et al., 2000). Bar-Hillel (2015) notes that in such situations, it is not necessarily mental effort, but also physical one which is at play. The author further suggests that in these type of tasks, middle items are more reachable than those at the ends, because they are closer to the participants. Indeed, her principle of *reachability* dovetails this idea in that when all things are equal, people prefer objects that can be reached more easily. Accordingly, when people are presented with a horizontal physical display, their choice will be biased by this reachability principle, which might explain why they favour central items.

This behaviour, using a principle of least effort, is linked to dual-system theories of cognition (Chaiken, Liberman, & Eagly, 1989; S. Chen, Duckworth, & Chaiken, 1999; Evans & Stanovich, 2013; Kahneman, 2011; Kahneman et al., 2001; Petty & Cacioppo, 1986) which argue that most of the time we use automatic, rapid, stereotyped responses rather than controlled ones (Tomlin, Rand, Ludvig, & Cohen, 2015). Research on the psychology of the self suggests that one of the most important human characteristics is the ability to modify our responses and therefore remove ourselves from effects of situational stimuli (Baumeister & Heatherton, 1996). It has been shown that self-control requires attention and effort (Baumeister, 2002; Baumeister & Heatherton, 1996; Hagger, Wood, Stiff, & Chatzisarantis, 2010) and that one of the main functions of our reflective system is to control thoughts and actions suggested by our automatic, impulsive system (Kahneman, 2011). Our System 1 (automatic type of thinking) is associated with greater use of diverse biases and heuristics, rather than our deliberative, reflective processes (Kahneman et al., 2002). Therefore, encouraging people to reflect before making a decision is expected to lead to lesser use of impulsive behaviours. Although there is some research examining the psychological factors that activate our automatic type of thinking (e.g. cognitive load and time pressure, Baumeister & Heatherton, 1996; Hwang, 1994; Vohs & Heatherton, 2000), less is known about how to activate more deliberate decisions.

This paper seeks to document the Position Force, investigating its success rate and how free participants feel even when they are influenced by the trick. At the same time, we seek to investigate whether it is possible to encourage participants to make more deliberate choices, impairing the success of the force. In Experiment 1 we examine whether a simple change in phrasing, making the choice explicit, can lead to this effect.

5.3. Experiment 1

Experiment 1 aimed to empirically examine how effective the Position Force is in terms of forcing participants to choose a target card, and to investigate whether the nature of the choice affects the extent to which participants choose the predicted item. Participants were either asked to simply push a card toward the experimenter (implicit choice), or they were explicitly asked to choose a card before the physical selection (explicit choice). Previous research shows that deliberative decision-making can be induced by simply framing tasks as decisions rather than intuitive reactions (Small, Loewenstein, & Slovic, 2013; Zhong, 2011). For example, participants were asked to "decide" rather than "to feel" to induce a deliberative decision (Zhong, 2007). Deliberative decisions are thought to lead to less reliance on heuristics and impulsive, automatic behaviours (Boureau, Sokol-Hessner, & Daw, 2015; Kahneman & Frederick, 2002; Stanovich & West 2000). We therefore predicted that participants would be less likely to choose the target card (i.e. card that could be reached more easily) when they were encouraged to deliberately think about the choice (i.e. explicit choice) rather than when they made the selection implicitly. In line with previous research on the reachability bias (Bar-Hillel, 2015a; Bar-Hillel, Peer, & Acquisti, 2014), we predicted that the force would only work for participants who used their right hand to reach for the card, and thus it should be more effective for right-handed participants.

Our second objective was to examine the extent to which participants were aware of the force. To our knowledge, none of the previous studies on position effects and reachability has done this (though see Kuhn et al., 2020). Two key elements make a force successful: participants must select the target object, and this selection must feel free. Therefore, we assessed how free people felt about their choice and their awareness about the bias itself. Since the Position Force is commonly used in the context of a magic performance, we predicted that

participants should feel free about their selection and that they are unaware of this behavioural bias.

5.3.1. Method

Participants

100 participants (50 females, 50 males) between 18 and 60 years old (*M*=29.71, *SD*=11.65) recruited on Goldsmiths University campus took part in the experiment. Goldsmiths Psychology Department provided ethical approval for the two experiments. Before the experiment and to maximize the power of our results, we ran an a priori power analysis for a Chi-Squared test with w =.30 (moderate effect size), α = .05, and a power of 0.8. The output required 88 participants and the chosen effect size was based on prior results using the Position Force (Kuhn et al., 2020). We confirm that for both experiments, we report all measures, conditions and data exclusions.

Procedure

The experimenter/magician sat at one of Goldsmiths' cafeteria table with the 4 cards already on the table, all spaced by approximately 5 cm, and positioned on the table in a way which made the row as symmetrical as possible. Participants sat to face the experimenter. Participants were randomly allocated to one of the two selection types (implicit choice or explicit choice) and consent forms presenting the experiment as a study about magic tricks and decision making were signed. In the implicit choice condition, participants were asked to "push a card toward [the experimenter]". The procedure for the explicit choice condition was identical with the exception that they were instructed to "choose a card, and then push it toward [her]".

The experimenter then noted the chosen card and the hand with which the participant pushed the card. The participants were then asked to complete a questionnaire which asked them 1) how free they felt about their choice (from 0, not free at all to 100 completely free) 2) the percentage of people they thought would have chosen the same card as them 3) the Dutch Handedness Questionnaire (van Strien, 2003).

5.3.2. Results and Discussion

Efficiency of the Force and main manipulation

The first analysis aimed to assess the efficiency of the Position Force and the impact of the nature of the choice on participants' selection. Figure 2 shows the percentages of participants who chose each of the four cards as a function of the nature of the choice and the hand that was used to make the selection. Eighteen per cent of participants used their left hand, compared to 82% who used their right hand. Overall, 55% of the participants chose the target card, which was the most chosen card, significantly more than chance (i.e. 25%) (X^2 (1, N=200) 18.75, p <.001, φ=.293). This result very closely matches the mean of magicians' estimates (57%).

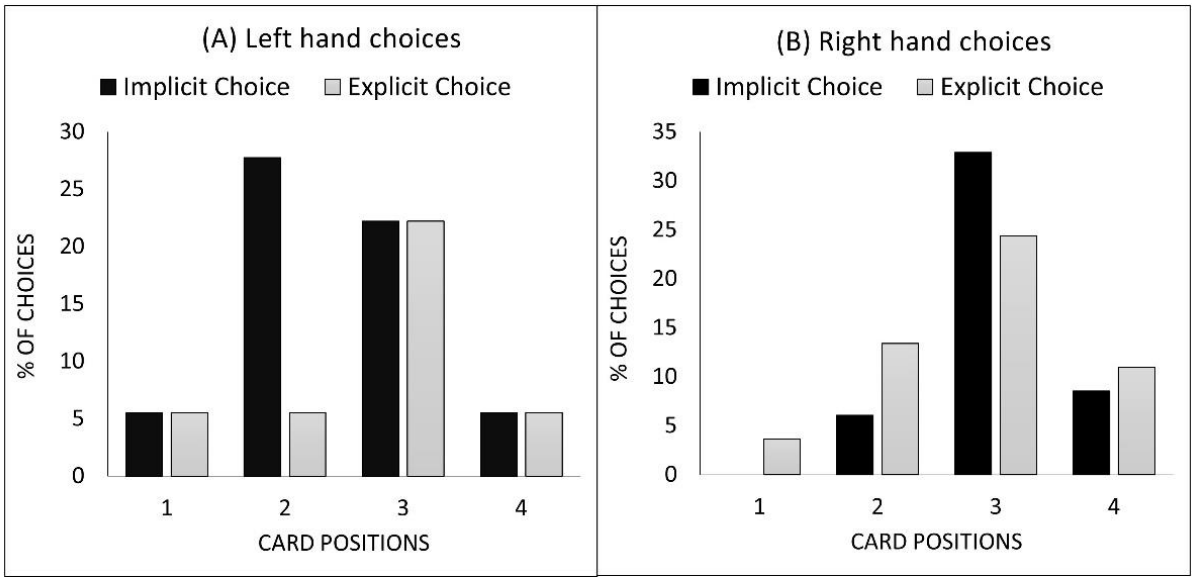

Figure 5.2. Percentages of choices as a function of the experimental conditions and the hand used to make the selection. (A) shows the choices made by participants who used their left hand to push the card, (B) for those who used their right hand. Position 1 is the first card from the left of the participants.

A visual inspection of the graphs illustrates a systematic difference in selections as a function of the hand used to make the selection[*]. Although the graph highlights clear differences in the success of the force as a function of hand selection, the difference did not reach statistical significance (X^2 (3, N=100) 3.95, p=.27, φ=.195). However, since only 18% of the participants used their left hand it is likely that non-significant difference is due to a lack of power. As we expected the force to work only when people used their right hand, we focused the rest of the analyses for the right-handed selection only. Participants in the implicit choice condition were significantly more likely to choose the target card than those in the explicit choice condition (X^2 (1, 82) 4.32, p=.038, φ=.224). This suggests that as we predicted, people tend to act in a more deliberate way when they are reminding that they are making a decision.

[*] Participants who used their right hand to had a significantly higher handedness score (H(1) = 12.67, p<.001), which illustrates that the selection as typically made with the dominant hand.

Awareness of the force.

Our next analysis examines the impact that the nature of the choice (explicit vs. implicit) and the choice itself (forced or not) has on people's feeling about how free the choice was. Kruskal-Wallis tests show that neither the choice of card nor the selection method had an impact on participants' feeling of freedom for their choice (H(1) = 1.77, *p*=.18 and H(1) = 0.17, *p*=.68, see Figure 5.3). This shows that participants are unaware of their bias, as well as a dissociation between their behaviour and their conscious introspection.

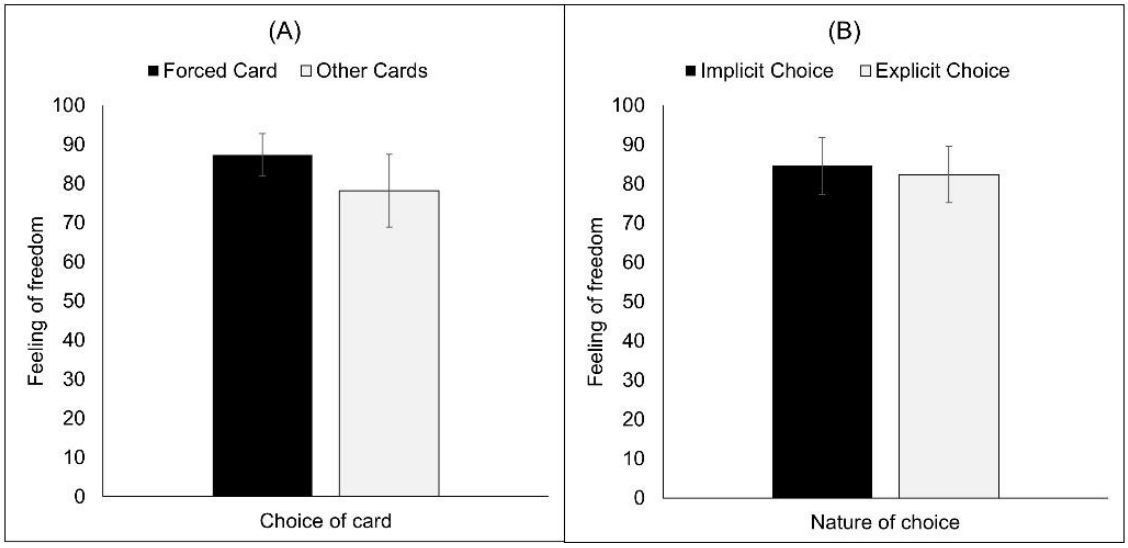

Figure 5.3. Mean feelings of freedom as a function of whether participants chose the target card or not (A) and of the experimental manipulation (B). Bars show 95% confidence intervals.

Next, we examined participants' metaknowledge of the bias by examining their estimates for the percentage of people who would choose the same card. Kruskal-Wallis test shows that whatever card the participants chose, they did not give different estimations of the percentage of people who would choose the same card as they did (H(3)2.46, *p*=.48). Interestingly, participants who chose the target card underestimate the fact that they used a population stereotype, and the other participants overestimate the number of times their card

would be chosen (see Figure 5.4). This shows again an important dissociation, this time between participants' behaviour and their evaluation of others'.

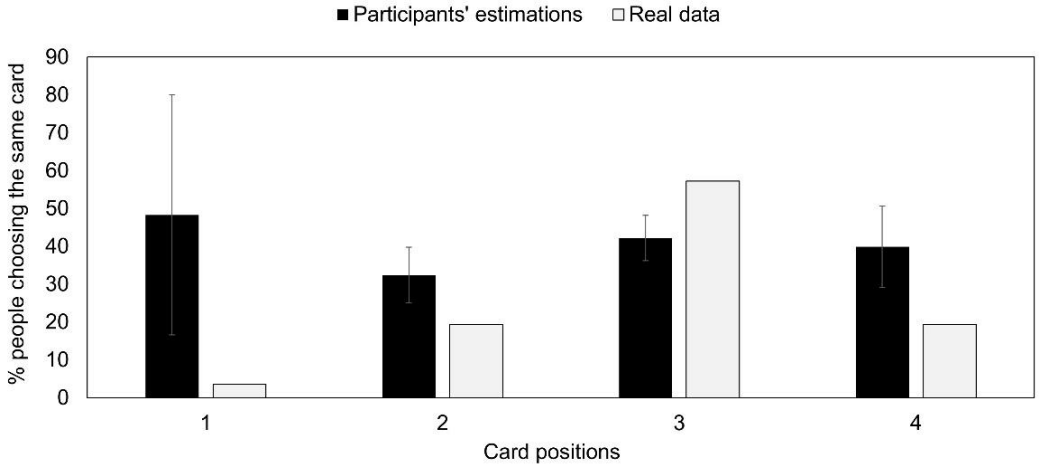

Figure 5.4. Participants' estimations of the percentage of people who would have chosen the same card as they did, and the real data from our experiment. 95% confidence interval bars are displayed for participants' estimations.

These results suggest that the Position Force is effective – a large proportion of our participants chose the target card, while not being aware of their bias. This confirms Wegner's theory (Wegner, 2002), showing that people tend not to have access to the real causes of their behaviours, which are often unconsciously rooted. Here, most participants' decision seems to have been guided by the position of the card while they underestimated the number of people who would have made the same decision. A simple change in phrasing negatively impacted the success of the Force. This suggests that participants rely less on automatic/impulsive biases when asked to choose before acting. Handedness also plays a role in this force — the force only worked when people used their right hand. The results confirm previous literature about reachability and edge aversion when presented items are identical, as participants favoured items which were easier to reach according to the hand their used while avoiding the cards at the ends of the row.

5.4. Experiment 2

The second experiment aimed to replicate the results from Experiment 1 and confirm whether explicitly informing people about the choice before their selection would impair people's stereotypical behaviour. This time, rather than letting people use their preferred hand, we forced them to use their right hand by restricting the use of their left hand. We used this experiment to test a controversial idea in embodied cognition which suggests that the nature in which they are asked to hold an object influences the level of self-control they have over their actions. This idea is based on the observation that people may clench their fists, tense their muscles or grit their teeth when firming willpower, and argues that such actions could also help us firm willpower and consequently improve self-control (Hung & Labroo, 2010; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Past research on embodied cognition shows that participants' self-control is enhanced when they firmly grasp an object while making a choice (Hung & Labroo, 2011; Niedenthal et al., 2005). The explanation behind these findings is that our memories would be composed of multimodal experiences, which also spread throughout our body. One consequence of this would therefore be that bodily actions accompanying thoughts could generate the associated cognitions and influence our behaviours (Briñol & Petty, 2003; Cacioppo, Priester, & Berntson, 1993). If true, it predicts that participants would experience greater self-control, therefore choosing the target card less often when they were asked to firmly grasp a glue stick rather than simply hold it. Finally, we decided to investigate participants' sense of freedom more thoroughly, using Thompson's 3 components of a free choice (Thompson, Locander, & Pollio, 1990): being deliberate, in control, and free from restriction.

5.4.1. Method

Participants

100 participants (59 females, 40 males, 1 non-binary) between 18 and 65 years old (*M*=30.19, *SD*=11.73) recruited on Goldsmiths University campus took part in the experiment.

Procedure

The experiment took place at the same venue, with the same setting at Goldsmiths University, where the participants were recruited. This time, every participant was asked to hold a glue stick in their left hand. The experimenter either asked them (while doing the gesture herself) to simply hold the glue stick in their open palm or to firmly grasp it between their fingers and their palm.

As in Experiment 1, participants were randomly allocated to one of the selection conditions and either asked to "choose a card and then push it towards [the experimenter]" (explicit choice), or to "push a card towards [the experimenter]" (implicit choice). Participants were then asked to put the glue stick down and answer the paper questionnaire. The questionnaire was composed of 0-100 scale questions about their feeling of freedom ("How free did you feel for your choice?"), its 3 components ("How restricted did you feel for your choice?" "How impulsive/deliberate did you feel in making your choice?" and "How much control did you feel you had over your choice of card?"), as well as two measures about how firmly and tightly they felt their hand while making the choice to ensure they did tense their muscles more in the self-control condition. Finally, their writing hand, gender and age were also recorded.

5.4.2. Results and Discussion

Efficiency of the Force and main manipulations

Our first analysis tested the efficiency of the Position Force and our two main manipulations. Figure 5 shows the percentages of participants who chose each of the four cards as a function of the two experimental manipulations.

Overall, 48/100 chose the target card, which was the most frequently chosen one. Comparing our results to a random distribution (25% choice per card), a Chi-Squared showed that our participants chose the target card significantly more often than the others (X^2 (1, 200) 11.41, p <.001, φ=.232).

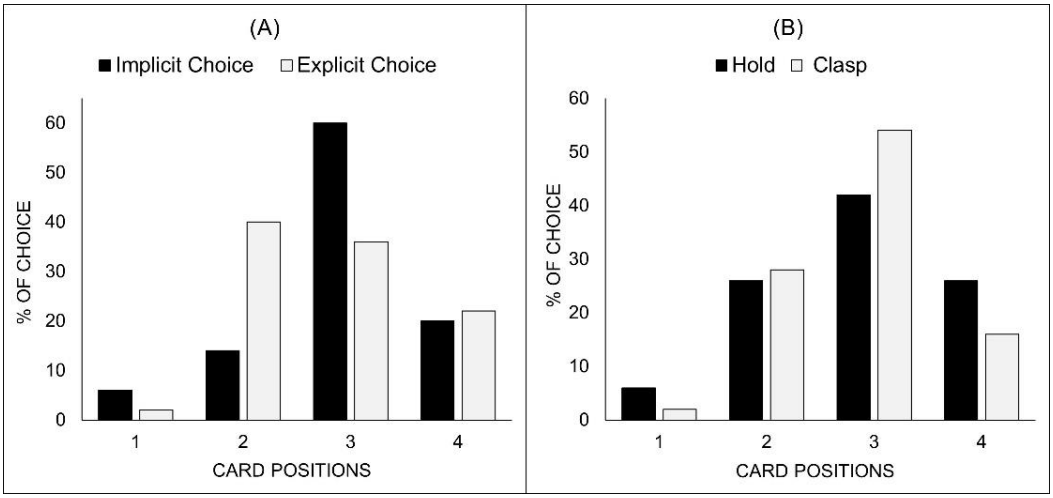

Figure 5.5. Percentages of choice for each card depending on the choice conditions (A) and embodied self-control condition (B). Position 1 is the first card from the left of the participants.

Regarding the experimental conditions, participants chose the target card significantly less often in the explicit choice condition than in the implicit choice condition (36% vs 60% of choices, X^2 (1, 100) 5.77, p=.016, φ=.234). This confirms that when participants are forced to use their right hand to make their choice, and therefore when the most convenient card to choose is indeed the forced one, the phrasing of the choice does have an impact on whether or not participants use a stereotypical answer. It appears that simply using the sentence "choose a card, and then push it towards me" rather than just "push a card towards me" subtly make the choice

more salient and explicit, therefore activating a more deliberative process in participants' decision. However, no significant difference was found regarding the effect of embodied self-control (X^2 (1, 100) 1.44, p=0.23, φ=.119) even though participants did feel their hand muscles were significantly tighter (W=1954, p<.001) and firmer (W=1980, p <.001) when they were asked to firmly grasp the glue stick rather than simply hold it. Several explanations seem possible in regard of these null results. First, studies using this type of procedure have suggested that firmly clasping an object could enhance self-regulation and control (e.g. withstand pain, overcome food temptation, consume unpleasant medicines etc.). But we cannot rule out the possibility that this does not apply to the current specific situation. It is also possible that the present study does not necessitate participants to use their self-control to choose a card other than the forced one, and therefore an enhanced self-control would not affect the results. However, embodied cognition theories have also suffered from important criticism regarding their grounding in theoretical background, and several papers have put in doubt the validity of research on the subject (Caramazza, Anzellotti, Strnad, & Lingnau, 2014; Goldinger, Papesh, Barnhart, Hansen, & Hout, 2016; Mahon & Caramazza, 2008) or lack of replication (e.g. Chabris, Heck, Mandart, Benjamin, & Simons, 2019). It has been pointed out that within most experiments on embodied cognition the expected behaviours tended to be overarching ones (e.g. completing a task), and our study was probably looking for a more specific outcome (Goldinger et al., 2016).

Feeling of freedom

First, regarding the overall general sense of freedom, participants felt significantly freer in the explicit choice condition than in the implicit one (W=1540, p=.034, r_{pb}=.232, see Figure 6). No significant difference was found for the embodied self-control variable (W= 1330, p=.56, r_{pb}=.064). Taking a closer look at the components of the feeling of freedom (Figure 6),

participants felt significantly more free from restrictions when the choice was explicit (M=80.06) rather than implicit (M=66.52, H(1) = 6.63, p=.01). No other significant result was found regarding either the self-control variable or the other components of freedom (i.e. the feeling of control and deliberation).

The mean of the feelings of control, restriction and deliberation was correlated with the general feeling of freedom (r_S= .619, p<.001, see Table 5.1). However, the feeling of deliberation did not seem to correlate with those of control, restriction, and general freedom. A calculation of Cronbach's alpha appeared to be only .34 for the three items but went up to .60 if the item of the feeling of deliberation was removed. It then appears that contrary to Thompson's definition (1990), the feeling of deliberation is not a reliable component of people's general feeling of freedom.

Table 5.1. Spearman Correlations with the three components of freedom, their mean and the general sense of freedom.

Table 1. Spearman Correlations with the three components of freedom, their mean, and the general sense of freedom.

	1.	2.	3.	4.	5.
1. Deliberation	—				
2. Control	0.069	—			
3. Restriction	0.074	0.537***	—		
4. *M* 1,2,3	0.623***	0.690***	0.704***	—	
5. General freedom	0.137	0.525***	0.684***	0.619***	—

Note. The item for the feeling of restriction was reverse (On a scale from 0 to 100, 100 was completely free from restrictions). *** p<.001

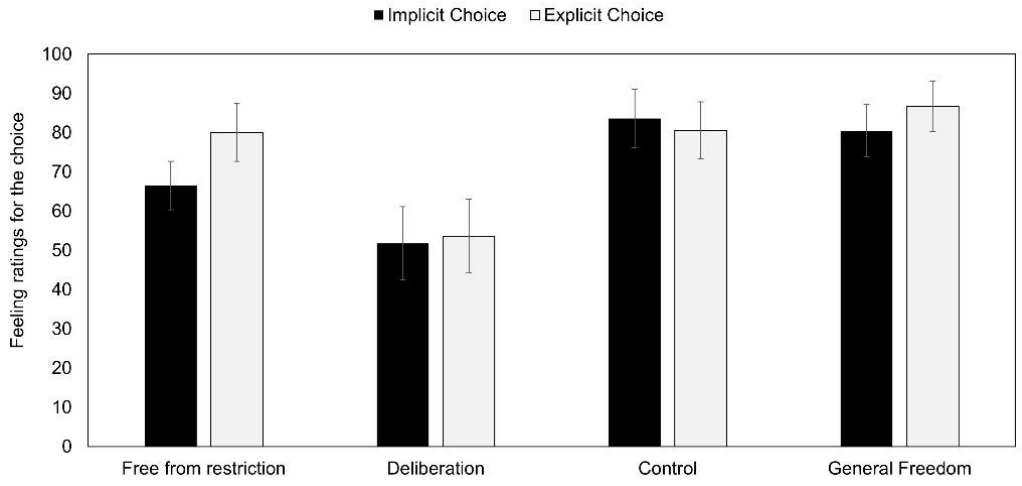

Figure 5.6. General feeling of freedom and its components as a function of the experimental conditions. Bars are 95% confidence intervals for each condition.

Finally, we looked at how the feeling of freedom and its components were linked to participants' choice of card. Results of the logistic regression indicated that there was no significant association between participants' feeling of freedom, restriction, control and their choice of cards ($X^2(95) = 4.93$, $p=.295$). However, the feeling of deliberation was significantly associated with the participants' choices ($p=.045$). Indeed, the more participants felt their decision was deliberate, the more likely they were to choose another card than the forced one. During debriefings, participants who did not choose the target card typically reported first thinking about taking it and then changing their mind for another card.

In summary, this experiment replicated experiment 1, showing that most participants tend to choose the target card and that the Position Force is extremely effective. We confirmed that the nature of the choice has an impact on whether they choose the target card or make a more deliberate choice and go for another one.

Moreover, the more participants felt their choice was deliberate, the less likely they were to choose the target card. Also, participants felt less restricted and more generally free when they were asked to "choose" a card (explicit choice) rather than simply "push" it (implicit choice). However, the embodied self-control variable did not show to have any impact on any measure.

5.5. General Discussion

This paper sought to document the Position Force, as well as investigate whether it was possible to lead people to act more deliberately when making a simple decision. For this, we used a subtle change in the phrasing of the choice, making it either explicit or implicit (Experiment 1 & 2), as well as a controversial idea in embodied cognition (Experiment 2).

Position Force's efficiency and choice variable

Both experiments confirmed that the Position Force is efficient, and replicate previous results (Kuhn, Pailhès & Lan; 2020), with an overall 52% of participants choosing the target card (the third one from participants' left). These results closely match the mean of magicians' estimates (57%) and demonstrate that magicians' intuition about the effectiveness of the force is pretty accurate and precise. Our results further show that a position effect influences people's choice, and they clearly illustrate an edge aversion effect, which dovetails previous findings that have used identical items (Bar-Hillel, 2015; Christenfeld, 1995). It is interesting to note that some other related forcing techniques might rely on this principle as well. Dai Vernon's five cards force is thought to rely on reverse psychology and five cards are placed in a horizontal row with the target card located 4th from the left. In this force, 5 cards are carefully chosen, namely the King of Hearts, 7 of Clubs, Ace of Diamonds, 4 of Hearts and 9 of Diamonds (from left to

right). The spectator is primed to be suspicious as the magician insists the selection must be a free choice and points out that the Ace is in the middle and the 7 is the only black card. These statements are thought to eliminate these two cards as they were mentioned. The two last cards are situated at the end of the row, and the King is the only picture card which is suggested to make it suspicious. As stated by Banachek (2002), the 4 of Hearts is more likely to be chosen as it is not at the end of the spread and is in the fourth position. It would be interesting to investigate whether this force truly relies on reverse psychology, or simply on the position of the card — again seemingly the most reachable one.

The two experiments also showed that asking participants to make an explicit decision impairs the success of the Force. When participants were asked to choose a card and then push it rather than simply push it, they chose the target card less often. These results suggest that the subtle change in the presentation of the choice resulted in less automatic, and more deliberate choices. Therefore, it seems that making a choice explicit leads to a less automatic, impulsive decision: a more deliberate one.

Awareness of the bias

Experiment 1 investigated participants' awareness of their bias, asking them to estimate what percentage of people would have chosen the same card as they did in the same situation. The results show that participants' choice of card had no impact on their estimation. Across the four different types of choices (the four cards), participants estimated that between 33 and 43% of other people would choose the same card as theirs. Participants who chose the target card underestimated the fact that their choice was a population stereotype, their mean estimation being 40%, compared to the 55% of participants who chose the identical item. However, participants who did not choose the target card, gave overestimations of the frequency of other

people's choices. The mean of their estimations across the three cards was 38% compared 15% who chose these cards. This adds to previous literature in choice blindness and highlights a dissociation between our behaviour and our conscious introspection (Hall & Johansson, 2008; Hall et al., 2010, 2013; McLaughlin & Somerville, 2013). As Wegner noted, the actual causal paths of an action are not present in the person's consciousness, and the experience of conscious will arises as we infer this path from our thought to our action (Wegner, 2002). According to his theory, we unconsciously decide upon an outcome, and if this decision coincides with our conscious intention, we experience having made this choice independent of the unconscious processing. This phenomenon appears to be what happened in the implicit choice condition: most participants used an automatic behaviour influenced by external factors (position and reachability effects), but were not consciously aware of these influenced, underestimating the number of people who would have chosen the same card as they did.

Feeling of freedom

We also measured participants' general sense of freedom for their choice (Experiment 1 & 2) as well as its three components (Experiment 2) according to Thompson's definition (Thompson et al., 1990). Participants' feelings of deliberation, restriction, and control for their choice were measured, alongside their general feeling of freedom. Regarding the general sense of freedom across both experiments, participants' choice of card did not have any significant impact. This shows that whether people were influenced by the force or not, they felt the same degree of freedom for their choice. As Binet already noted (Binet, 1894), "each individual placed in certain conditions, and thinking to be acting freely, is, in reality, behaving in the same way as other individuals, and what they have in common is automatic activity" (p.151). This adds to previous results regarding people's awareness of their bias, and support the choice blindness literature, showing that people tend to be blind to the reasons for their choice (Hall & Johansson,

2008; Hall et al., 2010; Johansson, Hall, Sikström, Tärning, & Lind, 2006b; Rieznik et al., 2017).

However, participants felt their choice was more deliberate when they did not choose the target card. The feeling of deliberation was the only component which was not correlated with the general sense of freedom or its other two components. During the debriefing, participants who did not choose the target card typically reported first thinking about taking it and then changing their mind for another one. This suggests that people can be aware of their metacognition about their choice, while still being blind to why they are acting in the way they do.

Towards freer choices?

Our results highlight important new pathways to explore the nature of free will. If people can become aware of their metacognition about their decisions, they can inhibit their initial impulsive and automatic behaviour and decide not to act upon them. Baumeister, notes that one needs to go through an inner process of choosing for free will to be relevant. He describes how the role of free will would be to alter the flow of our behaviour, and how "the capacity for rational thought and decision-making lies atop an irrational, impulsive beast, and so it only sometimes can alter the cause of action that that impulsive beast will take" (p.71).

Dovetailing this idea, our results suggest that we should refocus the debate on determinism vs. free will and frame the latter in terms of degrees. Baumeister linked free will and dual-process theories of human mental functioning by pointing out that free will could be mainly associated with what is called System 2, or the cognitive processes involving conscious and controlled activity rather than the nonconscious and automatic one associated with System 1 (2002). Investigating freedom in terms of autoregulation and self-control might help us find

ways to conquer these degrees of freedom of choice. Such empirical findings may help us understand the mechanisms that underpin our reasoning and help us make more deliberate choices, rather than simply acting on habits and automatic behaviours. This research may help us find concrete and practical ways to enhance our deliberate and rational cognitive processes. Our paper suggests that simply making people more aware that they are making a decision could be one efficient solution.

6. Influencing choices with conversational primes: How a magic trick unconsciously influences card choices.

6.1. Abstract

Past research demonstrates that unconscious primes can affect people's decisions. However, these free choice priming paradigms present participants with very few alternatives. Magicians' forcing techniques provide a powerful tool to investigate how natural implicit primes can unconsciously influence decisions with multiple alternatives. We used video and live performances of the Mental Priming Force. This technique uses subtle non-verbal and verbal conversational primes to influence spectators to choose the three of Diamonds. Our results show that a large number of participants chose the target card while reporting feeling free and in control of their choice. Even when they were influenced by the primes, participants typically failed to give the reason for their choice. These results show that naturally embedding primes within a person's speech and gestures effectively influenced people's decision making. This raises the possibility that this form of mind control could be used to effectively manipulate other mental processes.

6.2. Introduction

The question of how unconscious processes influence our thoughts and behaviours remains amongst the most controversial topics in psychology (DeCoster & Claypool, 2004; Lucas, 2000; Newell & Shanks, 2014; Van den Bussche, Van den Noortgate, & Reynvoet,

2009). Various studies have shown how visual primes can facilitate the processing of related targets (Dehaene et al., 1998; Kentridge, Heywood, & Weiskrantz, 1999; Ocampo, 2015; Rusconi, Priftis, Rusconi, & Umiltà, 2006). Vicary's fabricated subliminal advertising study caused much controversy and skepticism, but more recent research suggests that unconsciously presented primes can influence the choices people make (Mattler & Palmer, 2012; Ocampo, 2015; Parkinson & Haggard, 2014). However, to this day, these free choice paradigms present participants with very few alternatives (typically only two or three), and we do not know their impact on decisions with a large number of options. Moreover, most reliable unconscious priming paradigms rely on tightly controlled stimulus presentation parameters, which restricts this type of research to highly controlled laboratory environments (Cetnarski, Betella, Prins, Kouider, & Verschure, 2014). The extent to which these results generalize to more ecologically valid contexts is unclear.

Magic tricks provide a valuable tool to investigate psychological processes within a highly natural environment (Kuhn, Amlani, et al., 2008a). Most magic principles rely on tightly structured action and language scripts, which allows researchers to investigate psychological processes (e.g. priming, attention, perception) under controlled, yet realistic conditions (Kuhn & Teszka, 2016). Forcing refers to conjuring techniques that allow magicians to covertly influence a spectator's choice (Kuhn, Amlani, et al., 2008b), and they provide unique tools to investigate how primes unconsciously influence people's decisions when there is a broad range of alternatives (i.e. 52 playing cards). Many of these forces are commonly used within a magic performance context, but only a few have been empirically investigated (Kuhn et al., 2020; Olson et al., 2015; Shalom et al., 2013). In this paper, we examine a forcing technique that relies on subtle conversational non-verbal and verbal primes: the Mental Priming Force. This force was created by British illusionist Derren Brown (Brown, 2002) and uses subtle verbal and non-verbal primes to influence the spectator to think about the three of Diamonds (see Figure 6.1).

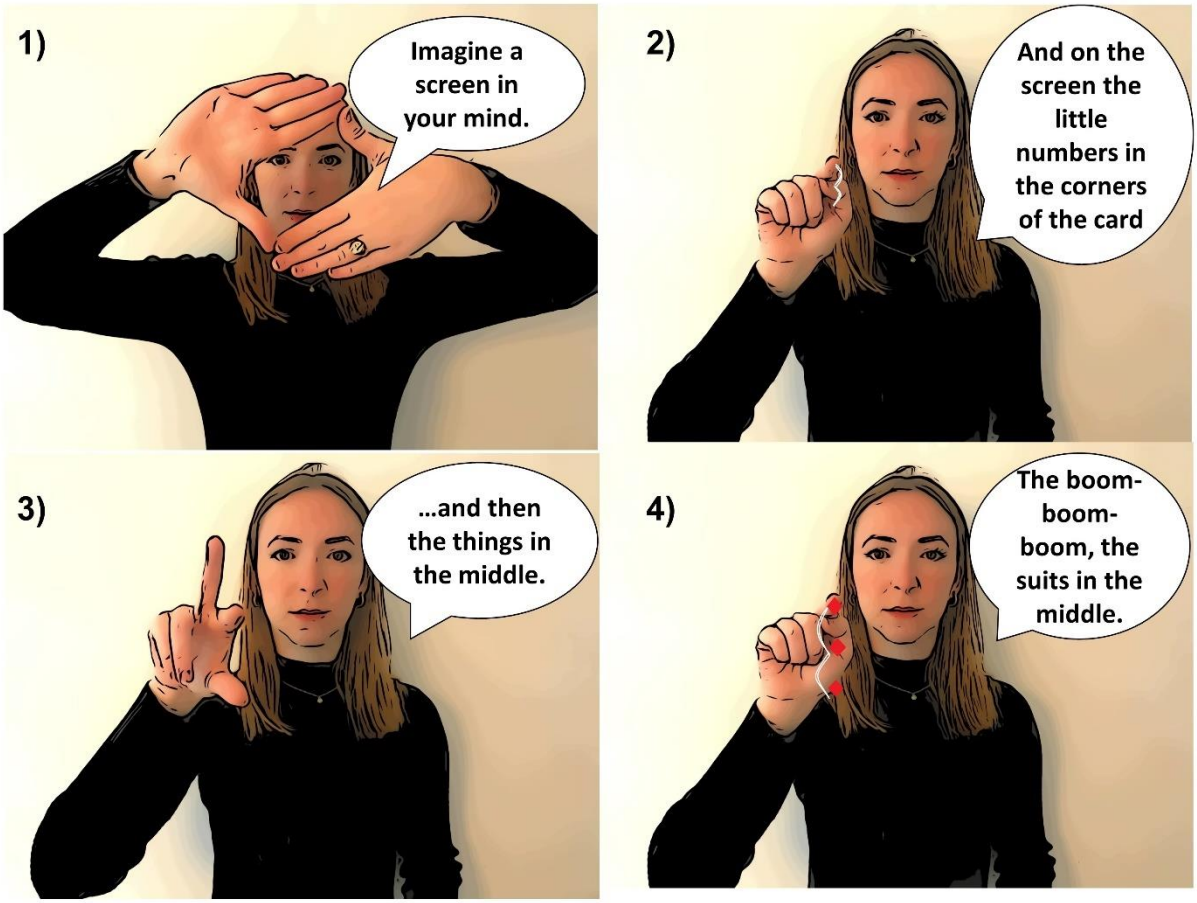

Figure 6.1. Examples of gestures priming the Diamond suit (1) and the number three (2). For the diamond, the magician performs the gesture displayed in (1) while asking the participant to imagine a screen in their mind. Then, the performer does the pointing gesture shown in (2,3,4) while asking the spectator to imagine the symbols in the centre of the card.

The magician asks a spectator to think of a card that the magician will 'transmit' to him or her, whilst using gestures and keywords to bias the card that comes to mind (see Appendix, Mental Priming force script). This technique, contrary to typical free choice paradigms, does not mask the primes to people's conscious awareness but subtly integrates them in the performance.

Anecdotal evidence suggests that this form of priming is effective, but it has never been studied scientifically before – nor do we know to what extent observers are consciously aware of the primes. The Mental Priming Force could shed light on how subtle conversational primes

can influence people's choices amongst a broad range of alternatives. More specifically, this technique allows us to investigate whether relatively abstract primes can unconsciously influence people's mental processes.

Firstly, we aimed to investigate whether abstract gestures can unconsciously influence a person's decision when they are provided with a wide range of alternatives. We predicted people should be more likely to choose the three of Diamonds (target card) and that most participants would not be aware of the influence of the primes. Secondly, we examined whether the force relied on the nature of the interaction. Most conjuring forces rely on real social interactions and are thought to work better when some sort of 'rapport'/relationship is established between the magician and the spectator (Brown, 2002; Turner, 2015). Indeed, previous empirical forcing studies have found smaller success rates with computer-presented tricks (Olson et al., 2015; Shalom et al., 2013) than when they are performed live. We therefore presented the force in two ways: video and live. We predicted that the force would be more effective in a live performance than on video.

We recruited 90 participants (62 women) who were randomly allocated to the video or live performance groups. After watching the performance, participants were asked to write down the card they chose, and rate on a scale from 0 to 100 how free and in control they felt about this choice. Two reasons guided these measures. Firstly, participants' feeling of freedom is one of the key elements of a successful forcing technique (Jones, 1994; Kuhn et al., 2020; Olson et al., 2015). If the magician manages to force a card but this person feels constraint and not free for their choice, the trick does no longer work. Secondly, we used these measures as an indirect way to assess participants' awareness of how they were manipulated. We expected that if participants understood that the experimenter tried to influence their choice, we would see these feelings of freedom and control drop. Indeed, previous papers investigating forcing techniques (Olson et al., 2015; Shalom et al., 2013) used measures of the feeling of freedom to

investigate participants' ability to identify whether their choices were made freely or forced by external parameters (here, the primes). The Mental Priming Force primes two separate features – number (three) and suit (Diamonds). For the purpose of our hypothesis, we considered the main target card to be the three of Diamonds. In the second instance, we focused on the number (three) and suit features (Diamonds). After completing the questions, participants were asked whether they knew why they chose that card and if so, they were asked to explain. The last question asked if they noticed any of the performer's gestures and if yes, to write them down. These measures followed a funnelling procedure, which provided an indirect way of assessing participants' ability to identify whether their choice was forced by external parameters (i.e. the primes).

6.3. Results

Figure 6.2 shows the percentages of participants who chose each of the cards. Overall, 17.8% of the participants chose the three of Diamonds, 38.9% chose a three (all suits combined) and 33.3% chose a Diamond (all numbers combined). The three of Diamonds was the most commonly chosen card, closely followed by the three of Hearts. To carry out statistical analyses, we compared these results to a condition in which participants were asked to choose a card after watching a video of the same performer and script without using any specific prime (0 out of 23 named the three of Diamonds, see Appendix) as well as to a random distribution (i.e. 52 different playing cards). Our participants chose the three of Diamonds significantly more often than the video without prime (X^2 (1, N=113) 4.76, p=.029, φ =.201) and a random distribution (X^2 (1, N=142) 7.861, p=.005, φ =.229). In the same way, participants chose a three significantly more often than the video without prime (X^2 (1, N=113) 1.58, p=.006, φ =.251) and a random distribution (X^2 (1, N=142) 16.1, p<.001, φ =.319). Moreover, norming data by Olson et al. (Olson et al., 2012) shows that the three of Diamonds is not commonly named.

However, the Diamond alone did not have any significant effect compared to the video without prime (X^2 (1, N=113) 0.44, p=.506, φ =.062) as well as to a random distribution (X^2 (1, N=142) 1.08, p=.298, φ =.087).[*]

1

[*] Our participants chose a card of red colour significantly more often than the random distribution (X^2 (1, N=142) 7.07, p=.008, φ =.218) but not than the video without prime (X^2 (1, N=113) 1.12, p=.289, φ =.099). Moreover, in addition to the main analyses and as the script of the force asked participants to imagine the "numbers" on the card, we ran analyses comparing our results to a distribution of 40 cards, excluding all the picture cards. When considering the correct distribution to be 40 cards and treating participants who chose a picture card as N/A (not following the instructions), the same results regarding the three of Diamonds, three, Diamond suit and colour red are found.

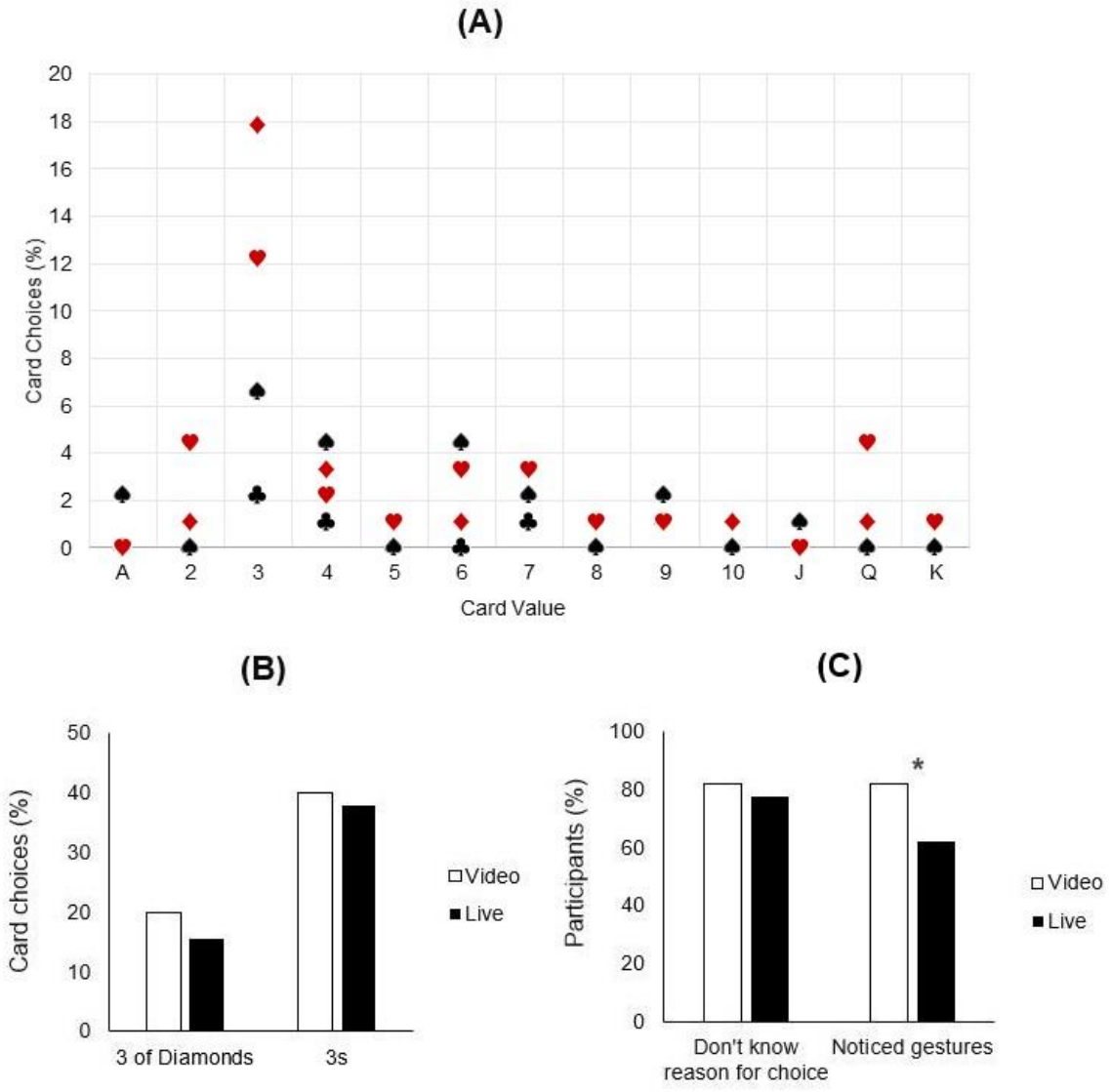

Figure 6.2. (A) shows participants' choice of cards across both general conditions. (B) shows the results regarding the target card and features according to the experimental conditions. (C) displays participants' reports on whether they knew the reason for their choice and noticed the experimenter's gestures according to the experimental conditions.

Next, we examined whether the force relied on real social interaction (Figure 6.2). Contrary to our prediction, participants did not choose the target cards significantly more often during the live performance compared to the video one (X^2 (1, N=90) 0.30, p=.581, φ =.058 for the three of Diamonds, X^2 (1, N=90) 0.05, p=.829, φ =.023 for the three).

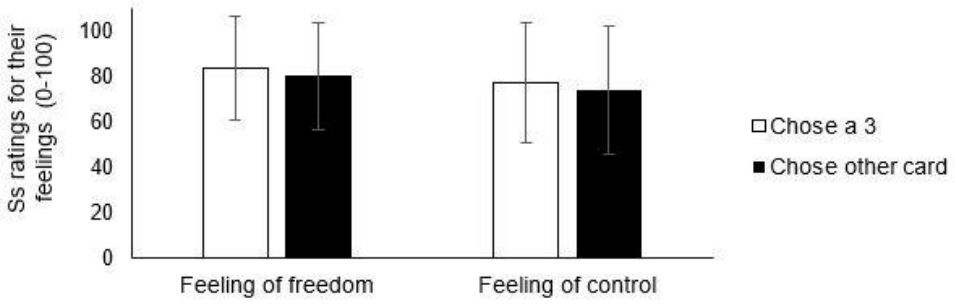

Figure 6.3. **Feelings of freedom and control over the choice of card as a function of participants' choice.** Errors bars indicate standard deviations of the means.

Looking at participants' conscious awareness of the force, the nature of the performance did not affect participants' feelings of freedom (*M*Video=83.1 vs *M*Live= 79.7, *W*= 1019, p=.963, r_{pb}=.006) or control over their choice (*M*Video= 73.9 vs *M*Live=76.4 *W*=1141, p=.291, r_{pb}=.126). More importantly, whether participants chose a three of Diamonds (*M*=83.5) or not (*M*=80) had no significant impact on their feelings of freedom (*W*= 599, p=.943, r_{pb}=.012). In the same way, whether participants chose a three of Diamonds (*M*=.77.1) or not (*M*=73.9) had no impact on their feelings of control over their thought of card (*W*=630, p=.6845, r_{pb}=.064). The results remained the same looking at whether participants chose a three or another card (see Figure 6.3).

Figure 6.4. Percentages of participants who declared knowing the reason for their choice and noticing some gestures of the experimenter as a function of their choice of card.

Finally, out of the 16 participants (18%) who chose the three of Diamonds, only 3 (19%) stated that they knew the reason for their choice. This was not significantly different from the participants who chose any other card (X^2(1, N=90) 0.02, p=.89, φ =.015). Likewise, out of the 35 participants (19%) who chose a three, only 7 (20%) claimed they knew the reason for their choice, and this result was not significantly different from the participants who chose any other card (X^2 (1, N=90) 0.000, p=1.00, φ =.000 see Figure 6.4).

Looking closer at the qualitative data, out of the 7 participants who chose a three and stated they knew why, only 3 provided explanations that were related to the performer's gestures. The 4 remaining participants came up with confabulations (e.g. "I always seem to count in 3s, and diamond because I hate jewellery"), or said they chose it "randomly". Participants who chose other cards and said they knew why, gave various explanations (e.g. favourite number).

Overall, 72.2% of the participants stated they detected at least some of the performer's gestures, but gesture detection was independent of whether they chose the three of Diamonds or another card (X^2 (1, N=90) 0.79, p=.374, φ =.093). The same was true for those naming the number three (X^2 (1, N=90) 0.02, p=.893, φ =.014). Among all the participants declaring they saw gestures, none of them recollected all the priming gestures, and they typically provided rather vague answers (e.g. saying they saw pointing to the locations of the card's features). Nineteen out of 65 participants talked about a rectangle/screen/diamond shape the experimenter gesticulated with both hands. Participants did not declare knowing the reason of their choice more often in one of the two conditions (X^2 (1, N=90) 0.278, p=.598 φ =.055, see Figure 2). However, they declared noticing gestures significantly more often for the video performance rather than for the live one (X^2 (1, N=90) 4.49, p=.034, φ =.218, see Figure 6.2).

6.4. Discussion

Our results illustrate that the Mental Priming Force significantly influenced participants' choice among a large number of alternatives, and it works just as effectively when presented on video compared to when it is performed by a real person. Eighteen percent of our participants chose the target card, and most were oblivious to the force itself. Indeed, even though the force resulted in a nine-fold increase chance of participants choosing the three of Diamonds, participants reported that their choice was free and that they were in control of it. Investigating the way implicit cues unconsciously influence people's thoughts provides important insights into the nature of human cognition. However, in the last decade, many priming studies have been at the centre of the replication crisis (Harris, Coburn, Rohrer, & Pashler, 2013; Pashler & Wangenmakers, 2012; Shanks et al., 2013), and the difficulty to replicate a number of well-known effects has raised much skepticism about priming more generally. At this point, we would like to note that we have investigated the Mental Priming Force several times and with large sample sizes, and always found it to be effective (see Appendix). For example, another unrelated study involving 240 participants showed that 15.4% of participants chose the three of Diamonds (most frequently chosen card) and 33.8% chose a card with the number three.

Naturally embedding primes within a person's speech and gestures effectively influenced people's decision making. Despite the primes being fully visible (and audible) participants were unaware that the primes may have influenced their decisions. Our results dovetail findings from choice blindness literature, which illustrates that people often do not know the real reason for their choice (Hall et al., 2010; Johansson et al., 2008, 2006b; Nisbett & Wilson, 1977).

We believe that most forcing principles can be applied to decision-making processes that are not restricted to playing cards. For example, research from our lab shows that some psychological principles applied to card forces generalize to contexts where people have stronger preferences (e.g. holiday destinations, (Pailhès, Kumari, et al., 2020)), or the outcome of a computer game. With regards to the Mental Priming Force, others have shown that misinformation from gestures can also influence eyewitnesses' memory reports (Gurney, Ellis, & Vardon-Hynard, 2016; Gurney, Pine, & Wiseman, 2013) and that gestures could prime words (Yap, So, Melvin Yap, Tan, & Teoh, 2011). Despite their implicit nature, these nonverbal cues can influence both memory and decision-making processes in contexts outside the magic performance.

Our study shares some of the characteristics of previous research on social psychological priming and embodied effects, which have been heavily criticized and found hard to replicate (Chabris et al., 2019; Durgin et al., 2009; Hutchison & Loomis, 2006; Lynott et al., 2014): our primes were naturally embedded within the context of the experiment. However, the cognitive mechanisms that are being activated seem to differ. As Newell and Shanks (Newell & Shanks, 2014) point out, standard priming effects such as lexical and repetition priming rely on well-established cognitive mechanisms, but it is often difficult to explain embodied priming effects on theoretical grounds. We appreciate that further research is required to help understand the cognitive mechanism that underpins the Mental Priming Force, but we believe that it relies on semantic priming. Several studies have shown that people process specific gestures semantically (Chui, Lee, Yeh, & Chao, 2018; Lim et al., 2009; Özyürek, 2014) and it is likely that they evoke similar semantic activation that is found for words or pictures (Wu & Coulson, 2011). We therefore suggest that the Mental Priming Force relies on gestures and speech segments evoking simple semantic activation that make the number 3 and diamond shape more accessible.

The Mental Priming force is less reliable than most other forcing principles (Kuhn et al., 2020; Olson et al., 2015; Pailhès & Kuhn, 2020c, 2020b; Shalom et al., 2013), and it is rarely used by magicians. Nevertheless, it was surprisingly effective. Although magicians often rely on more powerful tricks, they always have a 'way out' for tricks relying on small probabilities of success rate like this one. Most conjuring techniques are very reliable, and we have investigated a wide range of forcing techniques (Kuhn et al., 2020; Pailhès & Kuhn, 2020c, 2020b; Pailhès, Kumari, et al., 2020) that are far more reliable than the Mental Priming Force. However, as we mentioned, previous findings have for example shown that gestural misinformation (i.e. subtle hand gestures) can influence an eyewitness testimony and implant false memories about objects that are associated with the gesture (i.e. a specific jewellery such as a bracelet or ring) (Gurney et al., 2013), and that words (e.g. bird) could be primed through iconic gestures (e.g., a pair of hands flapping)(Yap et al., 2011). Our results, using the force, add to these findings and confirm that forcing techniques provide a reliable way of studying diverse mental processes (Rensink & Kuhn, 2015). Moreover, our results, linked to these findings, raise the possibility that this form of mind control could be used to effectively manipulate other mental processes such as memory and word retrieval.

7. General Discussion

7.1. Summary of the main findings

Magicians have developed a wide range of powerful forcing techniques that rely on different psychological principles. This thesis pioneers the scientific research on forcing and it provides a new theoretical construct of forcing as well as several empirical investigations that uncover some of the psychological mechanisms that underpin these different forces. Throughout the thesis, I have identified some of the key principles that magicians' forces exploit and presented the first scientific investigations of four different forcing techniques.

In Chapter 2, I provided a theoretical psychologically-based taxonomy of forcing that allows us to identify the key psychological processes that underpin these forces. This classification distinguishes two main types of forcing: Outcome forces and Decision forces.

The third chapter investigated the Criss-Cross force, in which the magician exploits the spectator's illusory sense of agency over an outcome card that is completely controlled by the performer. Our results showed that an attribute substitution error, rather than misdirection, explains why people fail to understand that their actions have no impact on the outcome they get. In Chapter 4, I present studies of the Magician's choice forcing technique. Here we exploited semantic ambiguities and people's failure to notice inconsistencies in the event sequence which ensure that participants ended up with our pre-determined outcome without being aware of this. Across all experiments, participants were oblivious to inconsistencies in the procedure that was used to guide their decisions, and experienced illusory agency over their actions' outcome.

In the second section, Chapter 5 presented the Position force, a force that relies on strategic physical positioning of items. We manipulated whether participants were reminded

that they were making a decision or not when asked to select one of four cards. Two experiments confirmed the efficiency of the force – 52% participants chose the target card and were unaware of their stereotypical behaviours. Finally, Chapter 6 investigated the Mental Priming force. We used video and live performance of this force, which relies on subtle non-verbal and verbal conversational primes to influence spectators to choose the three of Diamonds. Our results show that many participants chose the target card while reporting feeling free and in control of their choice.

The present work offers a starting point into a new area of the science of magic, and it demonstrates how forcing techniques can be studied to investigate illusory agency and freedom over choices and their outcomes. I will now examine some of the theoretical and practical implications as well as some general limitations.

7.2. Theoretical implications

Investigating magicians' forces can allow psychologists to uncover the cognitive mechanisms that underpin decision-making and illusory agency and freedom of choice. In Chapter 1, I argued that forcing techniques can either produce a feeling of freedom for choices which are objectively manipulated (Decision forces) or a sense of agency over outcomes entirely controlled by the magician (Outcome forces). In these two cases, a wide range of psychological principles seem to be involved – from priming mechanisms, visual saliency to ambiguity blindness or memory errors. Studying these forces allows psychologists to shed light on external and internal factors that guide our decision-making processes. For instance, in Chapter 5 (Pailhès & Kuhn, 2020b), we illustrated that subtle changes in the framing of a decision task (i.e. "choose" vs "push a card") can have a significant impact on the type of decision-making processes that are used (i.e. deliberate vs more automatic decisions). Chapter 6 uncovered an

innovative way of priming, which revealed that mental choices can be influenced by subtle conversational gestures and key words (Pailhès & Kuhn, 2020a).

Likewise, studying magicians' forces can shed a light on what makes us believe that we are free and in control when we are not. Findings from the Criss-cross force (Chapter 3) suggest that complex and unfamiliar event sequences may result in people using attribute substitution, making them fall victim of illusory agency over the outcome of the trick (Pailhès & Kuhn, 2020c). Finally, Chapter 4 examined the Magician's Choice forcing technique in which people become blind to inconsistencies in their environment, allowing them to feel a high degree of control over an outcome which was entirely predetermined (Pailhès, Kumari, et al., 2020).

Our studies show that it is easy to influence people's decision or the outcome of these decisions without their awareness. Overall, the forcing techniques investigated in this thesis are highly reliable and successful in that they control the outcome of a selection process while people feel free and in control for the choice they made. Our results using Decision forces show that people are often unaware of their bias and of the external factors (e.g. gestures or physical position of the items) that influence their decisions. Although the forces had a significant impact on people's mental and physical decisions, participants underestimated the fact that their choice were influenced by population stereotype (Chapter 5) and typically reported not knowing the reason for their choice (Chapter 6).

Results on Outcome forces show that these principles might be even more powerful than what the magic literature and common magicians' knowledge suggests. Indeed, Chapter 3 showed that the Criss-cross force is extremely effective even without misdirection. Moreover, Chapter 4 showed that the equivoque force remains effective after being repeated twice and when there are inconsistencies in the experimenter's actions.

Overall, studying these forces provide new insight into decision-making processes (e.g. primed through conversational gestures and keywords, influenced by reachability or the nature of the choice), helping us understand the very nature of human beings. Studying forcing techniques can help us understand the cognitive mechanisms that underpin decision-making that guide our choices, and what makes us believe that we are in control of our actions. These techniques provide an opportunity to help us understand what makes one action feel 'freer' than another (e.g. inconsistency of the action outcome, see Chapter 4). Most of the past research on free will and agency has focused on simple physical actions (e.g., when to press a button). The study of forcing allows us to examine these questions in more natural contexts, and in situations in which there are lots of choice alternatives. Many of these principles have been thoroughly tested in the real world (i.e., magic performances), but they can be easily implemented in more controlled laboratory experiments that allow us to examine the cognitive factors that result in illusory feelings of freedom and agency over our behaviour and thoughts. These principles also provide reliable tools to influence people's choice outcome, providing illusory sense of agency over an outcome item even though participants' actions and choices had no impact on it.

7.3. Practical implications

The scientific study of magicians' forces, and the examination of their psychological mechanisms also hold several practical implications. One of key objectives of the science of magic involves applying magic principles to the contexts outside the magic performance (Kuhn, 2019), and forcing principles can be applied to many decision-making contexts. Decision forces resembles many of the principles adopted in the nudge approach (Thaler & Sustein, 2008). Nudges are ways in which choice architects modify the environment to enhance the likelihood that one option (e.g. taking the stairs) will be taken rather than an others (e.g. taking the

elevator). Magicians have a wide range of decision forces at their disposal, which all aim to enhance the probability that one card or item will be selected among a lot of different options. Investigating these techniques might provide new ways to encourage healthier, and better decisions. Using physical strategic positioning of items (Missbach & König, 2016; Nakakima, Kurokawa, & Masutani, 2016), visual saliency (Wilson, Buckley, Buckley, & Bogomolova, 2016) or even reactance (Sinha & Foscht, 2016), scientists can find exciting and novel approaches to influence decisions to enhance well-being.

Forcing techniques might also be implemented outside the laboratory in entertainment industry. For instance, it has already been suggested that game designers should study magic and use forces to provide to the gamers a sense of agency and freedom of choice during the story they in fact do not control that much (Kumari, Deterding, & Kuhn, 2018). More specifically, I have been involved in a project that implemented the findings from Chapter 4 on the Magician's choice technique into a computer game (Kumari et al., in preparation). Interactive TV shows or theatre, requiring the audience to be involved in the show and to make decisions might also benefit from forcing techniques.

Finally, throughout my PhD thesis, I have disseminated my findings at academic and non-academic conferences, and many of my research findings have been discussed in the popular press (Pailhès, 2021). The topic of forcing illustrates the ease by our mind can be influenced and this provides a powerful way to raise ethical issues about manipulating human thoughts and behaviour. Magic, especially forcing techniques, provide an original and exciting way of communicating serious and important subjects such as illusory freedom of choice to the wider public.

7.4. Limitations

The science of magic has not been without its critics, some who question the possibility of reducing complex magic performances into isolated magic principles (Lamont & Henderson, 2009), as well as the general notion of developing taxonomies of magic (Lamont, 2015). I am optimistic that a scientific study of magic is not only possible, but also a worthwhile endeavour. That said, this approach is not without limitations. The first limitation is that magic tricks are usually performed in the context of a magic show and in which the magician establishes a particular connection with their spectators or audience (Brown, 2002; Ortiz, 1995). Our experimental context did not allow for such connections to develop, nor was it ever our intention to do so. However, the rather sparse context in which our experiments were conducted might have impacted the success of the techniques as well as participants' reports of their feelings of freedom and agency. It might be a good thing for future research to implement forcing techniques in the context of a magic show to investigate the role of the situation in the success of such methods. Indeed, other research on forcing suggests that context can influence how people experience a magic performance, and different success rates can be found between a naturalistic context (i.e. live performance in the street) and a computer-based magic trick (Olson et al., 2015). It is therefore possible that the techniques investigated in my thesis will have a different success rate when they are presented in a context of a whole magic performance. Moreover, as both the magic literature and scientific research suggest, the order in which different tricks are presented impact how they are perceived (Bestue, Martínez, Gomez-Marin, Gea, & Camí, 2020; Tamariz, 2019). As the main aim of this thesis was to identify the psychological mechanisms that underpin the forces, it was however necessary to adopt such a reductionist approach with our experiments.

Secondly, there has been much debate about the most appropriate way in which people's sense of agency should be measured (Dewey & Knoblich, 2014; Moore, 2016; Saito, Takahata,

Murai, & Takahashi, 2015) and explicit measures of participants' sense of agency over the outcomes of the trick have their limits. People's ability to distinguish between their own and others' actions and their report of how much control they feel over an outcome are not entirely equivalent. In most of our experiments, we asked participants to rate how much control they felt over the outcome card rather than if they agreed the outcome was controlled by their actions rather than the experimenter's. This was intentional, as we did not want to take the risk of making participants suspicious about who controlled their outcome choice if they did not suspect anything by themselves in the first place. More implicit ways to measure agency might be good to use, such as the measures we use about participants' level of surprise regarding the experimenter's prediction, which correlated with participants' feelings of agency over the outcome of the trick (see Chapter 4).

The experience of agency can be experimentally manipulated and measured in a variety of ways (Moore, 2016) and it has recently been argued that the standard use of the notion of a sense of agency is ambiguous, possibly referring to four different possible constructs (Grünbaum & Christensen, 2020). Grunbaum and Christensen have built a 2-by-2 construct of sense of agency, in which this experience is divided based on whether the focus is put on the phenomenal character or the ability of agency, and whether the bodily or external sense of agency is measured. In our cases, experiments on forcing focused on what the authors named Constructs 3 (*phenomenal character of agency* and over *external events*) and 4 (agency as an *ability* and over *external events*). Indeed, in all our experiments we asked participants how much control they felt over the outcome of the trick (Construct 3, feeling of control) and we sometimes asked if participants agreed with statements such as "I was the one choosing the outcome destination" (Chapter 4), therefore measuring people's ability to distinguish between events caused in some other way (Construct 4). Future experiments might need to differentiate between these two constructs and use both types of measures as it is important for participants

to feel in control over the outcome of the trick as well as judge that they were the ones controlling it.

7.5. Future directions

The present thesis has helped advance our theoretical understanding of what forcing is through a psychologically-based taxonomy, and has identified some key psychological processes used in forcing. However, it is important to note that this classification can be improved. Our classification is not complete, and as our understanding of forcing advances, aspects of this taxonomy will change. Likewise, alternative taxonomies are of course possible, and we encourage future research to develop them.

This thesis has presented scientific investigations of four different types of forcing principles, and many forcing techniques – as well as the psychological processes underpinning their success – still need to be investigated. For instance, our taxonomy proposes that an error in perceptual inference explains the success of a Hindu force. However, we have not scientifically investigated these techniques, and it is possible that our hypotheses would not be confirmed. As we have seen in Chapter 3, both the magic literature and magician's intuition about the psychological mechanisms underpinning a force might be erroneous, and these factors might not play any role in the success of the techniques we have discussed. Moreover, Cole has argued that magicians frequently mislead the public about the psychological principles they use to manipulate what we perceive and the decisions we make (Cole, 2020). Accordingly, the method of forcing rarely includes an attempt to influence a spectator as it is claimed, and caution is urged in the use of forcing.

Moreover, it might be interesting for future research to investigate individual factors that influence the success of the forces. Importantly, decision forces simply enhance the

probability that a spectator will choose one alternative over the other, and it is possible that some people are more strongly affected by these techniques than others. The magic literature often emphasizes that the performer should select a "responsive spectator" and that external factors might impact the success rate of such technique. These parameters seem worth exploring in the future (e.g. needs for cognition, locus of control, hypnotic suggestibility). Likewise, to gain a deeper understanding of what modulates peoples' sense of agency over their choice, future research using forcing could examine individual factors that could be involved in this process. For instance, hypnosis offers a well-established means to alter people's sense of control over their thoughts and actions (Walsh et al., 2015), and hypnotic states can increase compliance to indirect and direct suggestions (Stone & Lundy, 1985). It has recently been suggested that highly suggestible individuals have reduced awareness that their control is being manipulated (Terhune & Hedman, 2017)[1], and thus we predict that hypnotisability will correlate with people's illusory sense of control in the magician's force. Moreover, transliminality, defined as "a hypersensitivity to psychological material originating in (a) the unconscious, and/or (b) the external environment" (Thalbourne & Maltby, 2008, p.1618) is correlated with schizotypal personality and schizophrenia (Thalbourne, 1998), which are related to abnormal sense of agency. In regard of Wegner's (2002b) conception of our illusion of free will (putting our unconscious thoughts triggered by external factors, rather than our conscious experience of will, as the real causes of our thoughts and actions), we could predict that becoming aware of unconscious thoughts (i.e., being high in transliminality) could affect peoples' sense of agency for their choice.

Moreover, I have studied five different external factors that could impact participants' sense of agency and freedom over their choice, as well as the success rate of the different forces (i.e., time delay and attentional misdirection in Chapter 3, route consistency in Chapter 4, nature of the choice in Chapter 5 and nature of the performance in Chapter 6). Other external factors

might have an important impact on the forces' effectiveness. For instance, magicians frequently put individuals under stress, to prevent them from reflecting on their actions, and this principle might tell us about the sense of free will in general. In regard of dual-process theories such as the Heuristic-Systematic Model-(Chaiken et al., 1989), we can expect that putting individuals under a high-cognitive load can prevent them from reflecting on their decision, and modulate their sense of agency. Moreover, Mohr, Koutrakis and Kuhn have shown that the interpretation of a magic trick can be modulated by the way we frame it (Mohr et al., 2014). Likewise, Subbotsky has shown that people are more likely to accept an unknown scientifically plausible explanation than a magical one, even though they do not understand the true cause of the effect (Subbotsky, 2001). Similarly, we could predict that the nature of the external force (magical influence vs. scientific) will influence participants' feeling of free will and sense of agency for their choice. This thesis provides valuable insights into the nature of forcing and opens lots of avenues for future research.

7.6. Conclusion

Across the studies presented in this thesis, we have repeatedly shown how magicians' forcing techniques provide reliable and powerful ways to investigate people's illusory sense of agency and freedom of choice over choices and their outcomes. These studies have pioneered the scientific study of forcing, and they have advanced our understanding of the processes of influence. Moreover, this thesis has paved the way for innovative methods to investigate matters of agency, freedom of choice and influence.

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Appendix

Chapter 6 supplementary material

Material and method

Participants

90 participants (62 women) between 18 and 60 years old (*M*=22.7, *SD*=7.38) recruited on Goldsmiths University campus took part in the experiment. Goldsmiths Psychology Department provided ethical approval for the experiments.

Procedure

The experimenter/magician sat at one of Goldsmiths' cafeteria table. Participants were randomly attributed to one of the two experimental conditions – video or live performance. They sat facing the experimenter and signed the consent form presenting the experiment as a study on magic tricks and decision-making. Then, they were asked to read the instructions on the paper form stating that the experimenter was going to ask them to follow instructions and visualize and imagine some things (see supplementary material for more details). Depending on what condition they were in, they then either watched the video performance on the laptop with headphones (Sony ZX310), or the live performance of the experimenter. At the end of the performance, they had to fill in the paper questionnaire. Participants had to write which card they chose, and how free and in control they felt for their choice on a scale from 0 to 100. Then, they were asked whether they knew the reason for their choice and explain it if they answered yes. The last question asked if they noticed any gestures the experimenter did during the performance. This time again, they had to write down which gestures they saw if they answered yes.

The Mental Priming Force

The mental force was carried out according to the Brown's method (2000). Firstly, to influence the spectator to think about a red card, the magician asks the participant to imagine that she's trying to mentally transmits the identity of a playing card, and asks to first "make the colour bright and vivid". This is intended to implicitly prime the observer to think of a red, rather than a black card. Then for the suits, the observer is asked to imagine a screen while miming a diamond shape with two hands (see Figure 1), which is intended to prime the observer to think of a diamond.

To prime the number three, the spectator is asked to imagine the "little numbers low down in the corner of the card and in the top" while the performer quickly draws little 3s in the air on the imaginary card with the index finger. The magician then finishes the force while asking the spectator to imagine the "things in the middle of the card, the boom-boom-boom, the suits", while pointing at three imaginary symbols (Figure 1). The force is performed relatively quickly and only lasts around 15 seconds, and if successful should prime the observer to think of the 3 of Diamonds. We realised a video of the force for the video performance condition, which is available below..

Video performances:

Mental Priming Force performance: https://youtu.be/_XrlDAruNfU

Performance without prime: https://youtu.be/jXZjMS-gBYM

Mental Priming force script

"I'm going to try to transmit to you the identity of this card [holding up the card with the back facing the spectator]. Don't try to guess what it is, but just wait until you get. Make the colour bright and vivid. Imagine a screen [diamond gesture with both hands facing the spectator] in your mind, and on this screen, the little numbers low at the bottom of the card [draws a ' 3 ' in the air with the index finger in the imaginary corners of the card], in the corners, and at the top , and then the things in the middle [right hand raised with three fingers pointing at the imaginary symbols], in the centre of the card. The boom-boom-boom [pointing each imaginary symbol for each ' boom ' with the index finger], the symbols in the middle of the card. Did you get it?"

Supplemental experiments results

Comparison to video performance without prime

The statistical analyses presented in the present paper compared the Mental Priming Force performances to a video of the same performer and script without any prime. This analysis was based on results from a previous experiment: we used 3 different videos of the Mental Priming Force: the basic Mental Priming Force, the same performance without the non-verbal primes (using only the verbal ones), and the performance without any prime. The present paper compared the overall proportion of participants choosing the target cards (three of Diamonds and threes) without any primes. Of the 23 participants who watched the video, none chose the three of Diamonds and 2 chose a three.

Replicability of the Mental Priming Force with large sample size

In an unrelated experiment (unpublished), we used the Mental Priming Force live performance on 240 participants. Overall, 15.4% (37) of participants chose the 3 of Diamonds, which was the most chosen card. Cards with the number 3 were also frequently chosen 33.8% (81). For the purpose of this study, we did not take systematic measures of participants' awareness of the reason for their choice. However, the experimenter showed her prediction when the chosen card was a hit, and participants were typically very surprised about it.

Figure list

Table list