

# Where Science and Magic Meet: The Illusion of a “Science of Magic”

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Recent articles calling for a scientific study of magic have been the subject of widespread interest. This article considers the topic from a broader perspective and argues that to engage in a science of magic, in any meaningful sense, is misguided. It argues that those who have called for a scientific theory of magic have failed to explain either how or why such a theory might be constructed, that a shift of focus to a neuroscience of magic is simply unwarranted, and that a science of magic is itself an inherently unsound idea. It seeks to provide a more informed view of the relationship between science and magic and suggests a more appropriate way forward for scientists.

*Keywords:* magic, inattentional blindness, change blindness, deception

Scientific interest in magic has been aroused by two articles that have recently appeared in *Nature Reviews Neuroscience* and *Trends in Cognitive Science* (Kuhn, Amlani, & Rensink, 2008; Macknik et al., 2008) and that have led to extensive publicity in both popular science journals and the media more generally (e.g., Callaway, 2009; Fahey, 2009; Kim & Shams, 2009; Lehrer, 2009; Martinez-Conde & Macknik, 2008; Mitchum, 2009; Powell, 2008; Sanders, 2009). Given this recent publicity and the fact that it seems to be leading to new scientific interest, this may be an opportune moment to consider the topic from a wider perspective. This article argues that a science of magic, in any meaningful sense, is a misguided idea. It seeks to provide a more informed view of the relationship between science and magic and suggests a more appropriate way forward.

Psychological interest in magic is far from new. In 1897, Joseph Jastrow noted that there was “much to interest the student of science in the elaborate performances of the prestidigitateur and the illusionist” (Jastrow, 1897, p. 851). By then, he had already published articles on the psychology of magic that were based on experiments he had conducted with world famous conjurers, as had Alfred Binet (who had conducted his own experiments with conjurers in Paris); and Norman Triplett was on the point of writing a doctoral thesis on the psychology of conjuring, suggested and supervised by G. Stanley Hall and published shortly afterward in the *American Journal of Psychology* (Binet, 1894; Triplett, 1900). Indeed, for over a century, psychologists have periodically recognized the potential value in studying magic and have made several preliminary attempts to systematize the principles of magic with a view to establishing some sort of science of magic or deception (e.g., Binet, 1894; Ceillier, 1922; Dessoir, 1893; Hyman, 1989; Kelley, 1977; Kuhn et al., 2008; Lamont & Wiseman, 1999; Macknik et al., 2008; Nardi, 1984; Randal, 1982; Triplett, 1900; Wiseman, 1996). Nevertheless, despite regular calls for a proper scientific inquiry into magic, there has never been a sustained

program of research on the topic. To date, we have progressed no further than periodically noting our neglect of magic and claiming that there must be some value in studying it, making comparisons between some areas of magic and some recent experiments, then calling for further study with a view toward constructing a general scientific theory. The frequency with which this has happened suggests that our lack of progress is not the result of neglect but rather follows from the misguided idea that magic should be treated as a distinct subject of scientific inquiry.

This idea has not gone away. However, although the authors of both recent articles argue for a scientific study of magic, they suggest radically different approaches to understanding how magic tricks work, one group calling for a general psychological theory of magic (Kuhn et al., 2008), and the other calling for a neuroscience of magic, or *neuromagic* (Macknik et al., 2008; Martinez-Conde & Macknik, 2008). The latter authors have argued that “future studies of magic should be grounded in neuroscience,” and warrant this “shift in focus” by claiming that “the neuroscientific study of magic has already proved more productive . . . than previous attempts at psychological magic theory” (Macknik & Martinez-Conde, 2009, p. 241). In contrast, we argue that neither of these directions is warranted and that both lack evidential support and are inherently unsound. We suggest a third way forward that is more appropriate and has actually proven more productive than either.

## A Scientific Theory of Magic?

To seek a scientific theory of magic is a misguided endeavor. First, the potential for such a theory has been exaggerated by pointing to apparent similarities between recent scientific research and particular areas of conjuring theory but based on a misunderstanding of the latter. To take one example, in an attempt to link conjuring theory to recent psychological research, Kuhn et al. (2008) defined misdirection as “the direction of attention away from the method [how the trick is done],” and stated that “[m]any methods involve attentional capture, in which attention is pulled away by an irrelevant task,” citing in support recent experiments in which abrupt visual onsets distracted attention (p. 349). However, although distractions clearly divert attention, this has little to do with misdirection as discussed by magic theorists, who typically

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make explicit distinctions between crude distraction and effective misdirection (e.g., Lamont & Wiseman, 1999; Ortiz, 1994; Wonder & Minch, 1996). Although scientists may be interested in how attention can be distracted by irrelevant stimuli, magicians seek to direct attention without resorting to such crude distractions, as the audience should not be aware that their attention is being directed. Indeed, for spectators to fully appreciate a conjuring effect, their attention needs to be directed so that it is not distracted by irrelevant stimuli (e.g., someone passing nearby or another member of the audience returning to their seat). Studies in inattentive blindness, of course, have shown how observers can miss similarly irrelevant events within the visual field (e.g., Simons & Chabris, 1999), but such direction of attention is a part of the observation of any performance, indeed any event, on which observers are closely focused. In this sense, magic is no different from any live performance. Misdirection, however, is quite different. Far from distracting attention by an irrelevant task, such as an abrupt visual onset, misdirection in magic is concerned with directing attention away from the method by naturally directing attention toward what is most relevant to what the audience sees as the trick. To take the simplest of examples, by asking a spectator who has chosen a card to shuffle the deck and then commenting on how thoroughly the cards are being shuffled, the magician can naturally direct attention toward what is most relevant to what the audience see as the trick (that the chosen card is being lost in the shuffled deck) and, at the same time, away from the method (that the card is actually concealed in the magician's palm). It is precisely this relevance to the effect (what the audience sees as the trick) that allows attention to be directed naturally, and without awareness, because if the observer is naturally attending to what they see as most relevant to the event they are watching, they will not realize that they are, at the same time, being directed away from the method (Lamont & Wiseman, 1999; Wonder & Minch, 1996). To compare misdirection to crude distraction by abrupt visual onsets is a basic misunderstanding that exaggerates the link between misdirection and recent scientific research.

There are, of course, links between some forms of misdirection and some research that scientists have conducted. For example, magicians direct attention by looking in certain places at certain times, and Kuhn et al. (2008) understandably link this to recent research that shows how eye gaze leads to shifts in visual attention (p. 349). However, the use of gaze to direct attention is part of many forms of performance, it has been consciously used in theater for centuries, and it is a part of normal human interaction. The only difference in the way it is used by magicians is that by naturally directing attention to one place, they can execute the method in another place without it being seen. However, they direct attention in the same way even when it is not to conceal the method. To take the aforementioned example, the magician might direct attention toward the shuffling of the cards not to direct attention from the method but simply to reinforce the effect (i.e., that the card is truly lost in the deck), as the more convinced the audience is that the card is completely lost, the better the trick (e.g., Tamariz, 1988). In terms of attention direction, this is not so different from an actor (or salesperson) directing attention toward an area of the stage (or a product) and away from other irrelevant areas within the visual field of the audience. In short, how magicians direct attention is much the same as how anyone else might who seeks to focus attention in a certain place at a certain time, and

this is deliberate because the point of using natural direction of attention is that it prevents suspicion that covert action is taking place elsewhere. Thus, it is an exaggeration to make a particular connection between magic and recent scientific research into the effect of gaze, and the idea that a science of magic will provide particular insight into the relationship between eye gaze and attention is misguided.

Another of the attempts to link conjuring theory to recent scientific research, also based on misunderstanding, may help to illustrate the degree to which such an approach is misguided. Both recent articles cite the well-known saying in magic that one should "never repeat a trick," and both link this to recent experiments in visual cognition in which observers spotted on a second viewing what they missed on the first (Kuhn et al., 2008; Macknik et al., 2008). Although the basic point is again valid, the idea that it relates to a "key rule" (Kuhn et al., 2008) or "principle" (Macknik et al., 2008) in magic is misleading. As one of the articles itself seems to recognize (Macknik et al., 2008), many magic tricks involve a repetition of effect (what the audience sees) but a change in method (how it is done). However, even this is not a rule or principle, because many magic tricks rely on the repetition of a method. For example, Alex Elmsley's "four card trick" (Minch, 1991) repeatedly uses the same method to produce different effects, and Tommy Tucker's "six card repeat" (Eastman, 1933) repeatedly uses the same method to produce the same effect. These are not esoteric examples but classic magic tricks that have been performed by countless magicians for decades. Indeed, depending on the context, the same method can be used repeatedly to produce the same effect in such a way that observers do not even spot the effect (we discuss this in more detail later). Perhaps more important to note, however, and again depending on the context, the same method can be used successfully to produce the same effect several times in such a way that even magicians who already know the method nevertheless fail to spot it (Edmondson, 2001). Furthermore, it is a common practice for magicians to deploy methods and misdirection techniques in ways that deceive fellow magicians who know but simply fail to recognize the particular techniques being used. This is possible because effective deception depends largely on exploiting the physical and psychological conditions of the performance situation, the latter including not only the knowledge of those present but also any assumptions they might have about what might be possible, practical, or likely in that particular context (Lamont & Wiseman, 1999). Thus, the advisability of repeating a trick (whether effect, method, or both)—indeed, the efficacy of any method or form of misdirection—depends on how and for whom it is applied in a particular situation. Relying on what superficially appear to be general rules or principles as a route to a scientific theory of magic is misguided.

Second, the purpose of a scientific theory of magic is far from clear. One suggestion has been that it might be of benefit to magicians (Kuhn et al., 2008), but it is difficult to see the obvious benefit. After all, the vast majority of psychological writings to date have been based almost entirely on what conjurers have written themselves. Even the most recent papers draw heavily on Lamont and Wiseman (1999), which was itself based on an extensive literature written by magicians. In any case, magicians have always displayed ample competence in drawing on scientific knowledge when necessary to create new types of misdirection and to improve methods (e.g., Dawes, 1979; Steinmeyer, 2003).

Indeed, even the early work on inattention blindness, which was not originally presented as relevant to conjuring, was rapidly applied by magicians to the creation of new tricks (Lamont & Wiseman, 2003). More recent experiments that were explicitly presented as a scientific study of magic, on the other hand, were dismissed by an influential conjuring journal as a “fascinating bit of scientific trivia, something we’ve all known through empirical evidence for 100 years” (Kaufmann, 2007, p. 11). New scientific knowledge might well be of interest to magicians, but they seem to be quite capable of recognizing what is beneficial to them and what is not.

It is surely the potential benefit to science that makes any science of magic worthwhile, but before any benefits can be gained, we must be clear on what we want to achieve. After all, although it has been agreed for over a century that psychologists may have something to learn from studying magic, it is quite another matter to suggest that we should construct a scientific theory of magic. In terms of scientific benefit, Kuhn et al. (2008) suggested that by “reducing all magic effects to a set of basic operations (such as physical and psychological misdirection),” we might discover “unknown perceptual or cognitive mechanisms” (p. 353). However, this too is a misunderstanding of conjuring theory. First, it confuses magic effects with methods, as any effect can be achieved by a variety of quite different methods. One classic text on conjuring theory (Fitzkee, 1945) provides dozens of methods for each effect, and each of these methods, when applied in practice, might use a variety of quite different forms of physical and psychological misdirection. These deeply complex methodological processes might provide psychologists with some insight into how deception works. Second, physical and psychological misdirection are far from being basic operations. On the contrary, they are general umbrella terms for a range of approaches that are categorized by terms that themselves cover countless more specific ways in which attention and suspicion may be directed in a particular context (depending on such matters as the nature of the effect, the style of the performer, the type of audience, the size and shape of the venue, and so forth). For example, one key approach within psychological misdirection is the “false solution,” in which suspicions are diverted by suggesting a method other than the real one, but this might be done in countless ways with varying degrees of subtlety, all of which would in turn involve other kinds of physical and psychological misdirection (Lamont & Wiseman, 1999; Tamariz, 1988). The difficulty of isolating misdirection from any other aspect of magic is such that magicians often cite Jean Hugard’s well-known quote: “Magic is misdirection and misdirection is magic” (Polidoro, 2007, p. 36). In short, if we seek to reduce magic to a list of basic operations, then we need to identify rather more basic elements, and if the purpose of a general theory is to discover unknown mechanisms through a process of reduction and exclusion, then we have yet to begin the process. Furthermore, if we consider the purpose and form of conjuring theory so far, we can see that an attempt to identify new mechanisms in this way is itself inherently flawed. The purpose of the many attempts by magicians to systematize what they do has not been to provide any sort of definitive list but simply to offer to magicians another way of understanding their craft. Indeed, there has never been a list that has not been challenged by others in the magic community who understand that there are various ways in which one might reduce the performance of magic (e.g., Lamont & Wiseman, 1999; Swiss,

2000). If a science of magic is to mean a scientific theory of how magic works, presumably it must begin by reducing conjuring knowledge in a coherent and systematic way. However, although there have been several systematic accounts of magic, there is no reason to regard one as self-evidently superior to, or more accurate than, another. With so many ways of reducing magic to more basic elements, it is hard to see how any unknown mechanisms might be discovered through a process of reduction and exclusion.

Another claim concerning how a science of magic might be useful has been that it could shed light on the study of persuasion and deception (e.g., Kuhn et al., 2008). However, although there may be some insight to be gained into these areas from specific techniques used by magicians, magic itself is fundamentally different from other kinds of deception in that it is uniquely open about its persuasive and deceptive aims. It is not, of course, open about its particular deceptive means, but it is based on the premise that audiences are aware that they are being deceived; most of the techniques used, not to mention the way in which they are used, recognize and regularly exploit this awareness. For example, the “false solution” referred to earlier, which is a fundamental approach to effective magic, relies on the assumption that audiences are, at some level, seeking to discover the method. Furthermore, although the performance of magic involves a range of other persuasive and deceptive techniques, all of them are deployed within a context in which techniques of persuasion and deception are not only expected but regularly made relevant. There is no reason to believe that those techniques unrelated to the unique context in which magic is performed are any different from those involved in other forms of persuasion and deception.

Indeed, it is notable that even scientists who have called for a general theory of magic have in fact done no more than suggest a few specific areas that might be of potential interest to both magicians and scientists. Although they claim that they seek to reduce magic to basic operations, even Kuhn et al. (2008) merely refer to general methods in magic (citing misdirection, illusion, and forcing) that are, in practice, extremely difficult to tease apart. For example, misdirection is an essential part of forcing (the control of spectator choice); to control the selection process, one must direct attention and suspicion in some way. Indeed, most of what Kuhn et al. have discussed in relation to forcing could equally apply to misdirection. It is not that these general methods are similar; rather, they are quite different in type. Indeed, they are less a scientific taxonomy than a Borgesian list and thus provide no more than some suggestions of themes that might be worth exploring. In short, even those who seek a scientific theory of magic have failed to explain either how or why such a theory might be constructed. On the contrary, what they have written confirms what history has shown so far: that the potential and purpose of a scientific theory of magic is simply unclear and that neither magic nor its apparent principles should be treated as distinct subjects of scientific inquiry.

### A Science of Neuromagic?

Although a more focused approach to studying magic is clearly advisable, the call for a shift toward a neuroscience of magic is unwarranted. As noted earlier, Macknik and Martinez-Conde (2009) have argued that “future studies of magic should be grounded in neuroscience,” warranting a shift in focus by claiming

that “the neuroscientific study of magic has already been more productive . . . than previous attempts at psychological theory” (p. 241). First, what neuroscience may offer to the understanding of magic—indeed, what Macknik and Martinez-Conde themselves admit—is the possibility of understanding more about the perception of magic. This restricts the inquiry to a study of the neural response of spectators, not the performance of magic itself, which remains a social phenomenon that relies on physical and psychological techniques. Thus, although a more focused approach may indeed be more fruitful, this particular focus ignores what magicians actually do. Second, although they are correct in claiming that neuroscientific interest in magic is new—indeed, given that magic is now being studied by many disciplines within the academy, it is long overdue—it is so new that it has yet to demonstrate its value. Indeed, as of this writing, the first empirical study of magic that is neuroscientific rather than psychological has only just been published and, as expected, is simply a study of neural responses to magic tricks (Parris, Kuhn, Mizon, Benattayallah, & Hodgson, 2009). Furthermore, this article makes no reference whatsoever to a neuroscience of magic, instead framing its findings in terms of belief, a point to which we return shortly. Meanwhile, however, it is important to remember that the call for a neuroscience of magic itself was based on no more than a conference in which some extremely knowledgeable magicians were invited to explain to neuroscientists how magic works (Macknik et al., 2008). It is easy to forget, after the widely publicized claims about the potential benefits of a new science of neuromagic, that these claims were based on no evidence whatsoever. Thus, the extent of dissemination and the claim that neuromagic has already been more productive than previous attempts at psychological theory are difficult to understand.

Again, this is not to say that such research is unworthy of our attention or that any studies that follow will not lead to greater understanding of cognitive and neural processes. If it is to do so, however, we need to be clearer about what we currently know and what it is we want to achieve (Lamont & Henderson, 2009). If we are simply looking for the neural bases of basic psychological processes in cognition and perception (e.g., those related to phenomena such as inattention blindness, change blindness, persuasion, deception, or belief), then we do not need to look to magic for testable neural hypotheses. Indeed, neuroscientific work on these and related topics are well underway (e.g., Beck, Muggleton, Walsh, & Lavie, 2006; Beck, Rees, Frith, & Lavie, 2001; Fernandez-Duque, Grossi, Thornton, & Neville, 2003; Huettel, Guzeldere, & McCarthy, 2001; Klucharev, Smidts, & Fernández, 2008; Pourtois, De Preto, Hauert, Vuilleumier, 2006; Turatto, Angrilli, Mazza, Umiltà, & Driver, 2002). Also, by presenting the scientific study of magic as an attempt to understand how magic tricks work, we risk missing a rather obvious point. Magicians not only understand how magic tricks work but also demonstrate the adequacy of their understanding in every performance (which, it might be said, has a rate of successful replication that few psychologists and neuroscientists manage to achieve). However, what any experienced magician also understands is that the performance of magic involves an endless range of physical and psychological techniques, the particulars of which continue to grow, and the general categories of which are, and always have been, disputed. However we attempt to understand magic performance, it remains a social phenomenon that is located within, and depends on, the particular

circumstances of the performance environment. Within this complex social context, specific psychological and neurological processes are at play, but there is currently no reason to believe that such processes are any different from those that have already been identified, or might be identified, in terms of attention, awareness, persuasion, deception, belief, and so forth.

### From a “Science of Magic” to Science

There is, however, a more focused and productive way forward, if we can resist the temptation to talk about a science of magic and instead recognize that magic is simply another resource from which scientists can draw. This approach will require us to focus on the difficult process of not only fully understanding particular areas of conjuring knowledge but also translating relevant knowledge into ways that advance scientific understanding. Rather than attempting yet another systematic classification of conjuring knowledge, or simply claiming that a neuroscientific approach is somehow more fruitful, we need to recognize that the aims of magic and science are radically different and that advancing scientific knowledge may mean a radical transformation of conjuring techniques so that what we want to learn about cognition, rather than magic, is paramount. The practical implications of this can perhaps be seen most clearly by considering the most obvious link between magic and current psychological research, namely, the area of change/inattention blindness. At a superficial level, both conjurers and psychologists are interested in how observers might miss potentially noticeable events. However, psychologists researching change blindness have focused on how a significant change in the scene is not noticed from one moment to the next, whereas magicians are primarily concerned with how to maximize the perception of a change in the scene (the more vivid the vanish, appearance, or transformation of an object, the better the trick). Similarly, psychologists researching inattention blindness have been concerned with how noticeable events within the scene are missed while observers are focused on an irrelevant task, whereas magicians have been primarily concerned with how to direct attention so that an audience notices a change (e.g., a vanish, appearance, or transformation) but does not think they have been distracted by an irrelevant task (the more convinced the audience is that they have not been distracted, the better the trick). These are clearly related interests, but the primary interests are different and roughly analogous to what magicians refer to as effect and method. Roughly speaking, whereas magicians are interested in maximizing the effect while making the method invisible, psychologists have focused on effects that are not seen while the method is visible. Without recognizing this fundamental difference, it is difficult to gain more from a scientific study of magic than further illustrations of what we already know; for example, that observers will miss noticeable events if their attention is directed elsewhere in the scene.

However, by drawing on certain areas of conjuring knowledge, but by ignoring the fundamental aims of conjuring in favor of what is of primary interest to psychologists, we can gain new insight into psychological processes. For example, by attempting to direct attention toward the method of a trick, we can see how robust attention direction can be, so that powerful yet irrelevant stimuli fail to attract attention. Indeed, we have recently conducted experiments in our laboratory in which observers of a card trick failed

to spot the method, which was in full view, even when abrupt visual onsets were used to direct attention toward it. Similarly, by performing a transformation effect in such a way that it is not noticed, we can see that observers can fail to notice an object change within a dynamic scene even when they are attending to the object as it changes. For example, in other recent experiments we have conducted, observers failed to spot the transformation of one coin into another despite continually attending to the coin throughout the viewing. Neither attempting to direct attention toward the method nor performing an effect that is not noticed is an approach that any magician would take, but both can provide new insight into psychological processes. Furthermore, insofar as these were magic tricks, in the sense that a transformation of objects did occur, they were performed in a way that involved an unrelated task sufficient to distract viewers from the method of one and the effect of the other. This, as we noted earlier, has little to do with misdirection as discussed by magicians but rather is a translation of particular conjuring techniques into an experimental context that focuses on what is of primary interest to psychology.

Perhaps when we realize that we would benefit more from focusing on how certain specific aspects of magic might be used in the advance of scientific understanding, rather than on attempting to understand magic from a scientific perspective, we might finally cease to talk of a science of magic. After all, it is the case that scientists have long drawn upon specific conjuring knowledge and deployed it creatively with a specific purpose in the interests of psychological research (e.g., Besterman, 1932; Hodgson & Davey, 1894; Johansson, Hall, Sikstrom, & Olsson, 2005; Johansson, Hall, Sikstrom, Tarning, & Lind, 2006; Jones & Russell, 1980; Wiseman & Greening, 2005; Wiseman & Lamont, 1996; Wiseman & Morris, 1995). Such an approach has been genuinely productive because, rather than being misdirected by calls for a science of magic, it has simply taken specific techniques from magic to conduct scientific research. It is this approach that, we argue, will continue to be the most productive. Indeed, this approach is by no means incompatible with some of what has been argued by Kuhn et al. (2008) and Macknik et al. (2008), as they have both explicitly stated that this should be done. There is, however, nothing whatsoever new about this; it depends on focused understanding and application, and it does not amount to a science of magic in any meaningful sense. The recent heightened interest in magic is only as a result of the grander call for a science of magic and the claim that it may provide significant scientific and practical benefits. We have argued that this wider endeavor, whether defined as a quest for a scientific theory of magic or as a neuroscientific investigation of spectator's brains during magic, is simply unwarranted. What we can do, of course, is continue to draw upon specific techniques from magic (or anywhere else for that matter) in the interest of advancing scientific understanding. However, that is not a science of magic; it is science. To call for a science of magic is a form of misdirection, in that it directs attention toward what is not real and away from what will provide insight into what is actually occurring. The science of magic is, in that very real sense, an illusion.

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Received June 23, 2009

Revision received July 2, 2009

Accepted July 3, 2009 ■

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