

Making Sense of Magic

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ABSTRACT

This paper discusses the sensemaking processes a spectator experiences when they are fooled intensely by a strong magic effect. The paper focuses on the precise ‘moment of magic’ – the point at which a spectator’s sensemaking process itself breaks down, and, for a moment, their understanding of reality fails. Factors that moderate the magnitude of this moment are identified, and implications for better utilizing such factors to create similar disruption of sensemaking in other domains are considered, including within the military, the arts and entertainment, and sport.

KEYWORDS

Sensemaking; Magic; Mental Models; Pattern-Matching; Tonic Immobility

INTRODUCTION

“Alice laughed: “There's no use trying,” she said; “one can't believe impossible things.” “I daresay you haven't had much practice,” said the Queen.” (Carroll, 1866, p. 100)

“Thus, at the peak moment, the ring rises and blows away their rapid intellectualizing and leaves them with an entirely non-cerebral event.” (Brown, 2001, p. 36)

In his 1998 show ‘David Blaine: Magic Man’, Blaine approaches a boy on the street, and begins to shuffle a deck of cards. He hands the deck to the boy, and asks him to cut it anywhere, and to then remove the top five cards at the location he cut to. The remainder of the deck is taken back by Blaine. Whilst turning to face away from the boy, Blaine instructs him to spread the cards he has just removed, to look at their faces, and mentally to select and think of just one card. The boy is then instructed to place the removed cards back into the middle of the deck, which is then discarded to Blaine’s side. The boy is told to place his hand on Blaine’s chest, approximately over his heart, and to name aloud his thought of card. The boy states that he is thinking of the four of hearts. Blaine then lifts his t-shirt to reveal a tattoo on his chest of a playing card, the four of hearts, in the precise location where the boy has just touched. The boy stands motionless and expressionless for a few seconds, staring at the tattoo. He mutters the words “Oh, man”, touches his chin, and continues to stare for several more seconds. He then turns away and stares downwards, slumping, shrugging and shaking his head in a repeated cycle that lasts about 15 seconds. The performance can be viewed at <https://youtu.be/FqlfrbbFRls?t=22s> (from 00:22 – 00:43). Similar reactions to Blaine’s performances can be seen at <https://youtu.be/N8Yhz4xDRM?t=1s> (from 00:01 – 00:43) and at <https://youtu.be/masWR2VMWZE?t=10m31s> (from 10:31 – 11:30).

Such reactions are typical when a spectator experiences a profound moment of strong magic. However, these reactions are perhaps the opposite of what one might expect to see when a spectator experiences something impossible (i.e. screaming, shouting, laughing, running away, or expressing disbelief or delight to nearby witnesses, etc). In his book ‘Strong Magic’ (Ortiz, 1994) the magician Darwin Ortiz differentiates ‘strong magic’ from other types of magic experience that are less impactful on the spectator. He suggests that most magic does not truly engage the spectator, leaves them bored and unentertained, makes them feel like they have been challenged or that they have a puzzle to solve, and potentially even leaves them feeling annoyed or upset (see also Fitzkee, 1943, p. 3; and Brown, 2001, p. 40). In contrast, ‘strong magic’ creates a profound, deep and meaningful experience for the spectator, leaving them to believe that they have genuinely taken part in something impossible for which they have no explanation. Such contrast is also reflected in the strong magic differentiation between *experiencing* a magic effect, versus merely *observing* a magic effect. Earl (2016, p. 4) suggests that in this moment “The spectator experiences a fracture in the grounded sense of consciousness or reality, and instead it is replaced by a disconnection from any sense of context or understanding. That is the magic moment: an empty space, a void of pure nothingness in which the spectator dissolves, losing any sense of who or what they are. This is the magic moment: no thoughts, feeling or action, complete nothingness.” It is the sensemaking activities involved in this experience of strong magic that provide the focus for this paper.

THE SCIENTIFIC STUDY OF MAGIC

The formal scientific study of magic as a basis for generating psychological insight has a long and rich history. Early psychological investigations of magic from the 1880s-1930s focused largely on how magicians employ sleight of hand to manipulate spectator attention, the mechanisms through which belief is shaped in both individuals and groups, how magicians' patter (the words they speak to describe, explain and guide the spectator through an effect), self-presentation and conviction support and amplify spectator belief. After a relative hiatus of interest in magic, the past 10-15 years has seen an incredible resurgence of interest in the scientific study of magic (see Tompkins, 2016) to explore a diverse range of psychological phenomena, including: the physiology and psychology of misdirection, change blindness, lower- and higher-level cognitive interactions, causal reasoning, insight, mental models, expectations, priming, choice and agency, temporality, belief, memory, learning, language, culture, expertise and ideology. This surge of psychological research using magic may, in part, be due to the public popularity of recent 'neuro-magic' research led by Macknik & Martinez-Conde (e.g. Macknik, Martinez-Conde, & Blakeslee, 2011), enhanced by the researchers' association with a number of big-name magicians. For a sample set of references relating to the scientific study of magic see Table 3.

Despite this extensive and rapidly growing body of research, one area that appears to have received little or no scientific attention is the moment of magic itself - the moment when a spectator's sensemaking is disrupted by experiencing something impossible. Often this moment is described in magic literature as the spectator experiencing a moment of *enchantment* (e.g. Curry, 1999; During, 2002, pp. 43-73; Anthony, 2010; Rolfe, 2015), *astonishment* (e.g. Harris, 1992), *wonder* (e.g. Ortiz, 2006, pp. 32-33; Henning, quoted in Randall, 2009; Elimelech, 2015), *amazement* (e.g. Lavand, quoted in Ortiz, 1994, p. 17; Elimelech, 2015), or *mystery* (e.g. Swiss, 2002). This paper, in agreement with Earl (2016, p. 4), argues that these descriptions more accurately refer to the emotions experienced in the moment *after* the moment of magic - that is, they describe the spectator's *reaction* to experiencing something impossible, and are not pertinent to the moment of magic itself. This paper presents an alternative view, that identifies the moment of magic as a profound disruption in sensemaking caused by an induced breakdown in pattern-matching, and an inhibition of the potential for recovery.

SENSEMAKING ACTIVITY WHEN EXPERIENCING A MAGIC EFFECT

When a spectator experiences a magic effect, a range of psychological processes are utilized. First, attentional and sensory systems (primarily the spectator's eyes, ears, and sense of touch - although some effects also make use of smell and taste) are used to collect and track information about the stimuli that are present in the performance environment. Microcognitive processes perceive these stimuli as cues that inform the spectator's understanding about the features and actions that are present in the environment, including the objects that the magician is using and the actions that he or she is performing. In parallel, with this microcognitive activity, the spectator engages in a higher-level macrocognitive activity of dynamic 'Sensemaking' to generate meaning from their experience of these events (literally, to make sense of what is happening as they experience the effect). This higher-level process includes the activities of actively managing and directing attention, managing uncertainty, detecting anomalies, generating expectations, etc. (Klein, Ross, Moon, Klein, Hoffman, & Hollnagel, 2003).

Klein, Moon, and Hoffman (2006); and Klein, Philips, Rall, and Peluso (2007) suggest that people make sense of their experience through a process of pattern matching. Pattern-matching can be either a subconscious, or a conscious and deliberative activity that enables people to make sense of their world. Humans learn by mentally creating patterns (characteristic associations, or 'frames', which may comprise stories, maps, organizational diagrams, or scripts) among objects, properties, behaviors, and causes and effects (the 'data' perceived from the environment). Consequently, these patterns are stored as mental models, and are employed as templates against which to compare our perception of real world features. Our 'pattern library' is thus our experience. When we see characteristic collections of cues that together we *recognize*, this triggers activation of the relevant pattern, which creates meaning and tells us the set of expectations and actions that are appropriate for the situation at hand – a process known as 'Recognition Primed Decision Making' (Klein, Calderwood, & Clinton-Cirocco, 1986). The spectator's expectations about what will happen in the environment then in turn direct their attention and ongoing collection of additional environmental data. Frames therefore determine what counts as data (i.e. which data are noticed or searched for) whilst at the same time, the perceived data activate, shape or generate the frames themselves (we thus construct our frames based on previously experienced data relationships).

Table 3 - Psychological studies using magic as a basis

Research focus	Psychological studies using magic as a basis
Early research on human attention, perception and belief	Hodgson and Davy (1887); Jastrow (1888); Dessoir (1891, 1893); Binet (1894); Jastrow (1896); Triplett (1900); Carrington (1907); Rockwood (1919); Blodgett (1927); Hahne (1929); and Bernhard (1936)
Physiology and psychology of misdirection	Tatler and Kuhn (2007); Kuhn, Amlani, and Rensink (2008); Kuhn, Tatler, and Cole (2009); Kuhn and Findlay (2010); Hergovich, Gröbl, and Carbon (2011); Kuhn and Martinez (2011); Otero-Millan, Macknik, Robbins, and Martinez-Conde (2011); Demacheva, Ladouceur, Steinberg, Pogossova, and Raz (2012); Smith, Lamont, and Henderson (2012); Rieiro, Martinez-Conde, and Macknik (2013); Kuhn, Caffaratti, Teszka, and Rensink (2014); Rensink and Kuhn (2014); Tachibana and Kawabata (2014); Phillips, Natter, and Egan (2015); Tachibana and Gyoba (2015); Caffaratti, Navajas, Rey, and Quian Quiroga (2016); Hergovich and Oberfichtner (2016); Thomas and Didierjean (2016a, 2016b); Wiseman and Nakano (2016)
Neuro-psychology of attention and perception	Martinez-Conde and Macknik (2007); Macknik, King, Randi, Robbins, Teller, Thompson, and Martinez-Conde (2008); Martinez-Conde and Macknick (2008); Macknik and Martinez-Conde (2009); Macknik, Martinez-Conde, and Blakeslee (2011); Quiroga (2016)
Change blindness	Memmert (2010); Most (2010); Smith, Lamont, and Henderson (2012, 2013); Aardema, Johansson, Hall, Paradisis, Zidani, and Roberts (2014); Smith (2015); Lamont and Wiseman (n.d.)
Perception-cognition interactions	Thomas, Didierjean, Maquestiaux, and Gygax (2015); Ekroll and Wagemans (2016); Tompkins, Woods, and Aimola Davies (2016); Ekroll, Sayim, and Wagemans (2017)
Causal reasoning and insight	Subbotsky (1996); Subbotsky (1997, 2001); Parris, Kuhn, Mizon, Benattayallah, and Hodgson (2009); Faber (2012); Danek, Fraps, von Muller, Grothe, and Ollinger (2013, 2014); Hedne, Norman, and Metcalfe (2016); Smith, Dignum, and Sonenberg (2016); Williams and McOwan (2016); Shtulman and Morgan (2017)
Mental models	Landman (2013); Beth and Ekroll (2015); Griffiths (2015); Tompkins, Woods, and Aimola Davies (2016)
Expectations	Danek, Ollinger, Fraps, Grothe, and Flanagan (2015); Van de Cruys, Wagemans, and Ekroll (2015)
Priming	Trinkaus (1980); Mohr, Koutrakis, and Kuhn (2014)
Choice and agency	Shalom, de Sousa Serro, Giaconia, Martinez, Rieznik, and Sigman (2013); Olson, Amlani, Raz, and Rensink (2015)
Temporality	Thomas and Didierjean (2016c)
Belief	Williams and McOwan (2014); Leddington (2016); Olson, Landry, Appourchaux, and Raz (2016); Leddington (in press 2017)
Memory	Wilson and French (2014); Olson, Demacheva, and Raz (2015)
Learning	Curzon and McOwan (2008); Moss, Irons, and Boland (2016)
Language	Jones and Schweder (2003)
Culture	During (2002)
Expertise	Jones (2011); Rissanen, Palonen, Pitkänen, Kuhn, and Hakkarainen (2013); Rissanen, Pitkanen, Juvonen, Kuhn, and Hakkarainen (2014)
Ideology	Saville (2013)

The Data-Frame sensemaking model (Klein, Moon, & Hoffman, 2006) provides a description of how people generate an initial account to explain (i.e. make sense of) events they are experiencing; how they elaborate that explanation to account for new information they have acquired; how they question that explanation when they discover data that does not fit; how they may potentially defend their explanation in light of contradictory data; how they discover limitations or flaws in their understanding; and how they reframe (switch or adjust) their explanation to an account that better explains the circumstances. The core activity within the Data-Frame model is the parallel process of applying a frame to the data, and the data to the frame. The frame explains how the data relate to each other (in terms of how they form a meaningful pattern) and the frame guides the search for new data whilst also defining what actually counts as data. Therefore, sensemaking can be viewed as “not merely joining the dots or generating inferences, but also identifying what counts as a dot, and how to go about seeking new dots.” (Hutton, Klein, & Wiggins, 2008). Sensemaking activities within the Data-Frame model are depicted in Figure 2, and Figure 3 presents the same model with a magician’s goals for shaping a spectator’s sensemaking overlaid. The model identifies seven different forms of sensemaking, which are summarized and considered in terms of their relevance to magic in Table 4.

Note that the spectator’s sensemaking will often begin to be influenced by a magician before the spectator is aware that the effect has begun. For example, the way in which the magician approaches the spectator, introduces themselves, frames their capabilities, introduces and sets-up the effect, removes items from their person, and invites the spectator to begin to participate, all serve to suggest a frame of meaning, and influence the spectator’s sensemaking before the effect *appears* to have begun; yet all such activities may in fact be intrinsic to both the method and to the effect itself. Note also that during this phase the magician may be performing a range of ‘secret moves’ or *sleights*, which are hidden from the spectator through both covert manipulation, and as a result of the spectator’s attention not yet having been engaged and directed towards the effect. Later, when the spectator attempts to recall the sequence of events leading up to the moment of magic, their recall will begin at the point in

time when they activated their attention - i.e. at a point *after* the secret moves had been performed. From that point on, the spectator's Data-Frame matching process will therefore be operating on the basis of incomplete data.

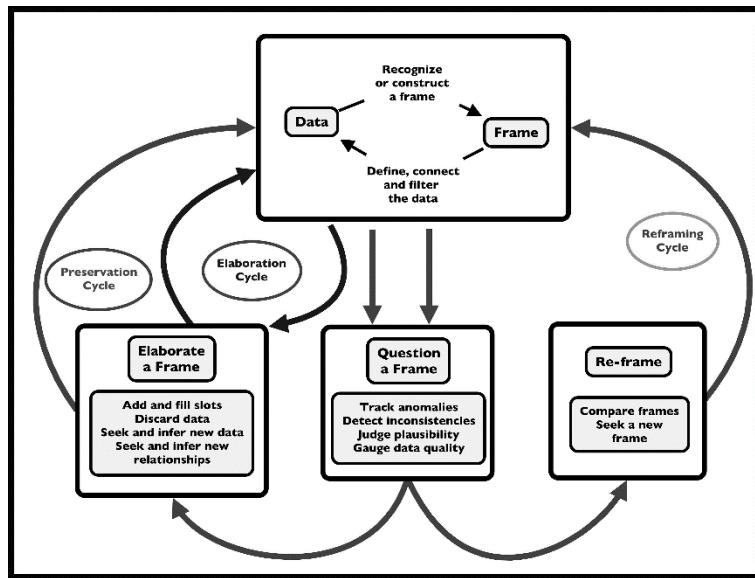


Figure 2 - The Data-Frame model of sensemaking (Klein, Moon, & Hoffman, 2006)

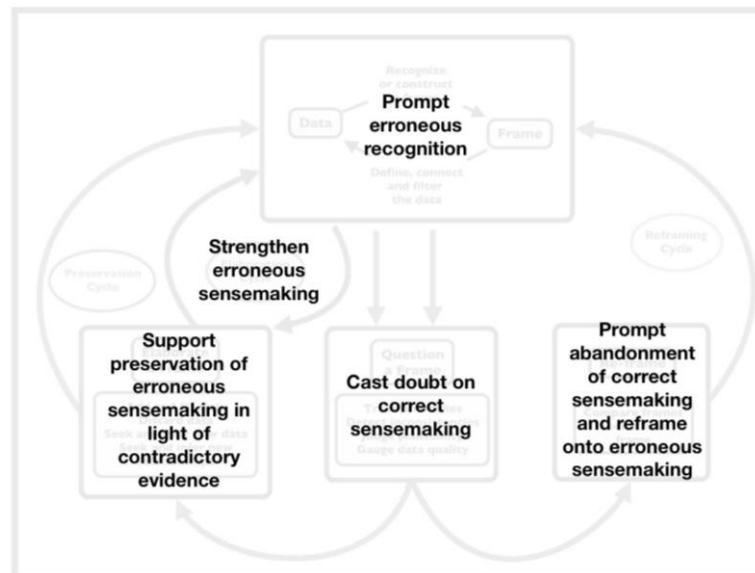


Figure 3 - The Data-Frame model of sensemaking overlaid with magician's deception goals (adapted from Klein, Moon, & Hoffman, 2006)

Within the primary matching loop of the Data-Frame model, the spectator applies frames about the physical world, objects, and actions, to make sense of what they are observing, directed and informed by the magician's patter, movements, and own attention. Such patter may draw the spectator's attention towards features that are salient to the sensemaking that the magician wishes to provoke, and draw attention away from (i.e. misdirect from) noticing features associated with the methods underpinning the effect. Actions are interpreted in terms of the spectator's general experience about how the world works, and how the objects employed by the magician work. However, this recognitional process (including associations, attributions and assumptions) is open to exploitation. For example, when a deck of cards is shuffled we know that the order is changed into an unknown sequence. However the magician may be performing a highly convincing false shuffle that retains the order of the deck, that visually is virtually indistinguishable (particularly by non-magicians) from the real thing. The magician may also be presenting false cues to the spectator to shape directly their erroneous pattern recognition and sensemaking process. For example, if magician and spectator are sat at a table, the magician might at one point appear to transfer a coin from the right hand to the left. Subsequently, after a little time has passed, he will slowly open his left hand to show that the coin has disappeared. The spectator now suspects that the coin must really still be retained in the magician's right hand, which he notices now appears to be a little stiff and unnatural (these are false cues presented by the magician). In fact, the coin was ditched from the magician's right hand into his lap whilst

the spectator was focusing on the magician's left hand revealing itself to be empty. The fact that the spectator's attention is now directed intently onto the magician's empty (but apparently, coin-retaining) right hand creates the perfect opportunity for the magician to use his left hand to secretly steal the ditched coin back from his lap. Note that throughout this effect, the magician will be directing *his own* attention to the hand where he wants the spectator to look, as this form of social cueing is powerfully seductive.

Table 4 – Sensemaking activities when observing a magic effect

Sensemaking activity	Explanation from Klein et al. (2007)	Sensemaking activity when experiencing a magic effect
Sensemaking attempts to connect data and a frame	The specific frame a person uses depends on the data or information that are available; and on the person's goals, the repertoire of the person's frames, and the person's stance (e.g., current workload, fatigue level, and commitment to an activity).	In a magic performance, the spectator's data and frames will relate to: the performance <i>context</i> (e.g. a performance on stage; a performance in the street, etc); the <i>magician</i> (how they are dressed, their demeanor; how they speak, etc); the <i>effect introduction</i> and set-up (e.g. a demonstration of mind reading; a card trick, etc); the <i>objects</i> used (e.g. coins, cards, clipboards, etc); the <i>magician's actions</i> (e.g. shuffling a deck, writing a prediction, etc); and the <i>spectator's actions</i> (e.g. thinking of a friend's name; selecting a card, etc). Frames will also be informed by the spectator's pre-existing familiarity with magic.
Elaborating the frame	As more is learned about the environment, people will extend and elaborate the frame they are using, but will not seek to replace it as long as no surprises or anomalies emerge. They add more details, fill in slots, and so forth.	The spectator's frame will be elaborated as they observe the effect progressing. For example, the magician may shuffle a deck of cards, have the spectator select a card, loose the card back in the deck, and then produce an envelope from their pocket. Each action and manipulation of the objects serves to elaborate the spectator's sensemaking frame, advancing their understanding, and giving rise to new expectations.
Questioning the frame	Questioning begins when we are surprised - when we have to consider data that are inconsistent with the frame we are using. This is a different activity than elaborating the frame. (Lanir, 1991) has used the term "fundamental surprise" to describe situations in which we realize we may have to replace a frame on which we had been depending. He contrasted this with situational surprise, in which we merely need to adjust details in the frame we are using.	Throughout the magic performance, the spectator may question and adjust their frame. For example, when the magician produces an envelope from their pocket during a card trick, the spectator may expect their previously vanished card to be revealed within the envelope. However, when they rip open the envelope to find a small padlock key, their (situational) surprise and violation of expectations will result in a revision of their frame for making sense of what is happening. Note that whilst the moment of magic itself encompasses profound surprise, many smaller surprises within the effect may lead up to this moment.
Preserving the frame	We typically preserve a frame by explaining away the data that do not match the frame. Sometimes, we are well-advised to discard unreliable or transient data. But when the inconsistent data are indicators that the explanation may be faulty, it is a mistake to ignore and discard these data. Related to fixation.	When observing a magic performance, the spectator may have been led by the magician to suspect certain methods to be used to achieve the effect. This expectation can then be exploited by the magician to divert the spectator's attention away from the real method, and, (should the spectator catch any of the real method) encourage them to dismiss or explain away their observation in favor of the stronger frame.
Comparing multiple frames	We sometimes need to deliberately compare different frames to judge what is going on. This may entail holding onto one frame, whilst concurrently elaborating a second, opposing frame.	Throughout the observation of a magic effect, the spectator may hypothesize as to what they believe is 'really' happening (as opposed to what the magician suggests is happening). This will involve holding onto the magician's framing of events, whilst concurrently generating and evaluating alternative frames that might account better for the data in respect of suspected trickery (which may itself, in fact, be prompted by the magician!).
Reframing	In reframing, we are not simply accumulating inconsistencies and contrary evidence. We need the replacement frame to guide the way we search for and define cues, and we need these cues to suggest the replacement frame. Both processes happen simultaneously.	Should the spectator decide that they are not 'buying' the magician's suggested frame for making sense of their actions, the spectator may decide to reframe events based on their reasoning as to what is 'really' happening. The new frame will better account for their suspicions, postulated methods being used by the magician, and expectations regards the outcome of the effect. A new frame may, for example, be based on an apparently analogous magic effect the spectator has experienced before; or could potentially be anchored around a known or suspected property of the objects being used, etc.
Seeking a frame	We may deliberately try to find a frame when confronted with data that just do not make sense, or when a frame is questioned and is obviously inadequate. Sometimes, we can replace one frame with another, but at other times we have to try to find or construct a frame. We may look for analogies and also search for more data in order to find anchors that can be used to construct a new frame. People can assemble data elements as anchors in the process of building an explanation.	At various points whilst experiencing a magic effect, the spectator may seek to construct a new frame that better explains the collected data up to that point, that reflects hypotheses about what is 'really' happening, that incorporates suspicions about any secret methods employed, and that includes the spectator's expectations about how the effect may end. For example, having experienced (a) their selected card being mixed back into the deck; and (b) the envelop produced by the magician turning-out not to hold their card, but a key; the spectator may now construct a new frame based on an expectation that their card will be found in a locked container of some kind. When a safe-box is produced later in the effect, this supports and further strengthens the new frame.

Note that at no point does the spectator make sense of the secret methods by which the effect is achieved, as these will be invisible to the spectator, even though they may be occurring in front of their eyes. Such secret methods can be made invisible through a range of strategies, for example: the magician may block such actions from being viewed by turning their body so that their hand momentarily cannot be seen; the actions may be embedded within natural action that provides cover – for example, ditching a coin in a jacket pocket when reaching for a pen; the spectator may not attend to the secret action as their attention has been directed elsewhere (i.e. they have been misdirected), for example, the magician looks at their right hand whilst their left ditches the coin in their pocket; or the spectator sees but does not register the action, as the actions are not task-relevant (i.e. the spectator has been rendered inattentionally blind to noticing those actions), for example, the magician may ask the spectator to count the number of red-faced (hearts and diamonds) cards as a pile is dealt onto the table, leading them to not notice that several duplicates of a particular card are present in the pile being dealt.

Throughout the performance of the effect, the spectator may also seek actively to avoid being fooled. They might become hypervigilant, seeking to notice everything that is happening before them, to catch every detail and miss nothing. They may seek deliberately to not be misdirected, trying instead to fixate on observing the magician's hands at all times. And they may try to anticipate what will happen next, to inform their attentional and sensemaking strategy to keep one step ahead of the magician. At the same time, the magician will seek actively to control the spectator's observation and collection process in line with the frame he is seeking to promote, for example, using conspicuity to attract the spectator's attention; creating expectations through repetition and portrayal of causality, so that the spectator directs their own attention to where the magician wants; and he may deliberately portray both real and false patterns that shape the spectator's sensemaking, including the spectator's attempts to second-guess what is really happening. Patter will also play a key role in influencing the spectator's attention, pattern activation, and expectations – for example, asking the spectator a question will make them momentarily make eye contact with the magician, taking attention away from his hands (and enabling a secret move to go undetected). False cues may be generated or pre-planted to suggest incorrect methods by which the effect is achieved, or to set-up false assumptions or expectations. Secret moves may also be employed, with any detectable signatures being attenuated, hidden or obfuscated from the spectator. And in a performance of strong magic, the spectator's pattern recognition and well-founded expectations will, at some point, be profoundly violated to create an intense and impactful moment of magic.

THE MOMENT OF MAGIC

“Regarding each moment in a magic effect, the audience says, ‘Yes, that was fair.’ ‘Yes, that was fair.’ ‘Yes, that was fair.’ And then the moment of magic occurs and the audience says, ‘Wow! What happened here?’”
(Burger, 2003, p. 196)

“Attention, if sudden and close, graduates into surprise; and this into astonishment; and this into stupefied amazement.” (Darwin, 1873, p. 278)

At some point during the performance of a magic effect, usually at the end, a ‘moment of magic’ occurs. If the magician's performance has been weak and unengaging, this moment may elicit a neutral, barely perceptible response from the spectator, and potentially even a negative response. However, if the magic has been ‘strong’ and the moment curated effectively, the spectator's response may be profound.

The moment of magic is created through a combination of surprise, sudden violation of strongly founded expectations, disruption of pattern matching, and a lack of available sensemaking ‘recovery cues’ which serves to prolong the moment. So whilst the moment of magic relies upon surprise (defined by Willis (2002, p. 1660) as “a highly transient reaction to a sudden and unexpected event.”) within the context of magic many other processes occur that intensify the experience beyond mere surprise. The phases a spectator passes through when experiencing a moment of magic correspond with the four stages of surprise described by Luna and Renninger (2015, pp. 5-6). This framework suggests that people who are surprised transition through the phases of Freeze, Find, Shift and Share, key features of which are identified in Figure 4. Note that whilst the moment of magic relates to Luna and Renninger's Freeze phase, subsequent phases serve to amplify impact of this moment on the spectator's overall experience of the effect. Each stage will now be considered in relation to the moment of magic and associated sensemaking activities.

A sensemaking account of the Freeze phase in magic

Tomkins (1963) describes surprise as a “resetting” state because, for a fraction of a second, the mind is cleared of thought. The momentary interruption of thought and action is related to the basic adaptive function of facilitating rapid evaluation and response to sudden changes. Luna and Renninger (2015) suggest that “Surprise is the neuropsychological equivalent of a pause button. It makes us stop what we're doing, hijacks our attention, and forces us to pay attention.” Such physiological ‘freezing’, which is evident in both performance clips of Blaine,

has been studied in the laboratory by Luna (2013) who asked study participants to observe a short video whilst concurrently making a circulating motion in the air with their finger. Unknown to the participants, the video contained a sudden and unexpected event. On witnessing this event, participants could be seen momentarily stopping circulating with their finger, starting again when they emotionally expressed surprise (a clip from this study can be viewed at <https://youtu.be/6JrbL4gBg-c?t=45s>, from 0:45 – 1:12). This phenomenon has also been labelled as “Attentional Blink” (e.g. Shapiro, Raymond, & Arnell, 1997; Biggs, Cain, Clark, Darling, & Mitroff, 2013; Cialdini, 2016, p. 29); as a “Pattern Interrupt” (e.g. Luna & Renninger, 2015, pp. 123-126; Cialdini, 2016, pp. 76-79) and as a type of “Instantaneous induction” (e.g. McGill, 1996, pp. 224-227)

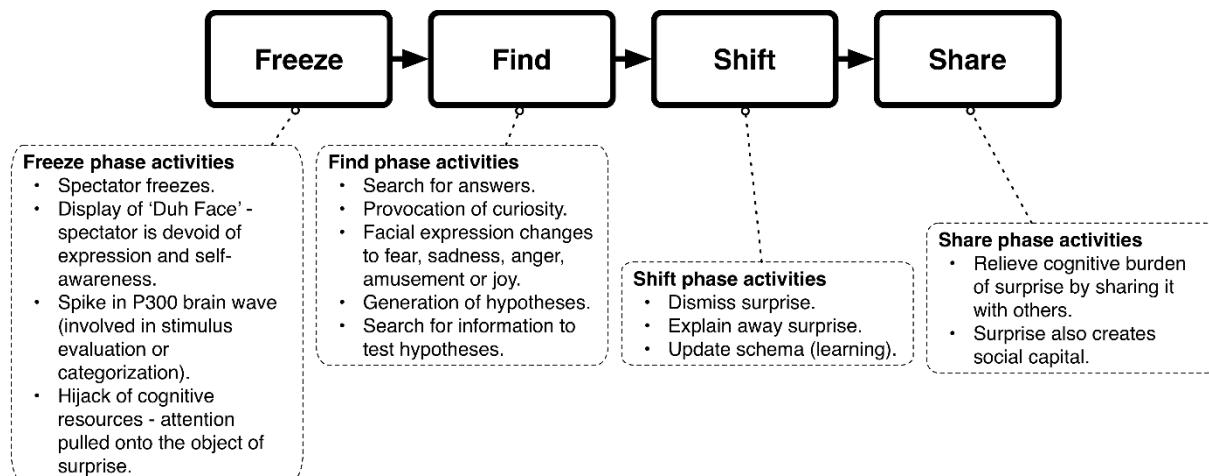


Figure 4 – The four phases of surprise (adapted from Luna & Renninger, 2015)

This physiological freezing phenomenon is consistent with the phenomenon of ‘Tonic Immobility’, which has been studied in animals since the 1600s (see Völgyesi & Klumbies, 1966) - later emerging as a field colloquially, (and perhaps unhelpfully) referred to as ‘animal hypnosis’ (Crozier, 1923; Gallup & Maser, 1977). Tonic immobility is a temporary behavioral state of motor inhibition thought to occur in response to situations involving intense shock or fear (literally, being ‘scared stiff’). Nash, Gallup, and Czech (1976) identified that Tonic Immobility presents as a stuporous catatonic-like immobility with muscular hyper- or hypo-tonicity, odd postures, suppression of vocalization, intermittent eye closure, Parkinsonian-like tremors, and reduced responsiveness to external stimulation. Physiological correlates have been found to include decreases in heart rate and body temperature, increased respiration rate, and altered electro-encephalograph patterns. Because of the potential for tremor, eye closure, occasional head turns and vocalizations, the behavior cannot be described as absolute immobility, however, there is clearly a profound state of response inhibition. Studies have indicated that the state may last from fractions of a second to over several hours, and the phenomenon has been identified in scores of different species including insects, crustaceans, fish, amphibians, reptiles, birds, mammals and primates (Gallup & Maser, 1977). However, Abrams, Nicholas Carleton, Taylor, and Asmundson (2009) suggest that most research effort to date has been directed towards studying the phenomenon in animals, with relatively little attention having been paid to the phenomenon in humans.

Ratner’s Defensive Distance Hypothesis (Ratner, 1967) suggests that tonic immobility has evolved to provide a last line of survival under conditions of predation, such immobility reducing the likelihood of further attacks, minimizing visual cues to the predator, and increasing the probability of predator boredom or distraction (in animals, the process of playing dead is known as ‘thanatosis’). As the distance between predator and prey decreases, Ratner suggests that the prey moves through the stages of freezing, attempted flight, struggle with the predator, and lastly tonic immobility. Gallup and Maser (1977) have tested this hypothesis experimentally, showing that the duration of freezing is indeed affected by predation distance; specifically, the proximity the predator’s eyes alone (when the eyes are hidden or removed from a stuffed predator, its proximity no longer moderates freeze duration). It is interesting to note that during the moment of magic, various magicians have developed an approach of staring intently at the spectator whilst themselves remaining totally motionless and silent (for example, Blaine can be seen doing this in all the examples referenced earlier, and the effect is especially pronounced in his performance at: <https://youtu.be/rCskKEhaKhY?t=1h4m21s>, from 1:04:21 – 1:07:58). It is suggested that this behavior on the part of the magician also serves to minimize the cues available to the spectator that might help them recover their sensemaking – thereby serving to further prolong the moment of magic.

Luna and Renninger (2015, pp. 5-6) state that during the Freeze phase, the spectator will usually for a few moments exhibit (what the authors refer to as) the ‘Duh Face’, wherein the face itself becomes frozen, blank, and devoid of expression. This account is at odds with traditional views on the facial expressions associated with surprise (e.g. Darwin, 1873, pp. 278-309) which describe features such as widened eyes, raised eyebrows, and open mouth. However, such expressions only arise later whilst searching for meaning, which Luna & Renninger define as the

‘Find’ phase. As a corollary, work by Schützwohl and Reisenzein (2012) found that common stereotypes about facial reactions to surprise were evident in just 5% of the participants that experienced intense surprise and novelty in their experiments.

The types of sensemaking described in the Data-Frame model help link together Luna & Renninger’s Freeze and Find phases, in terms of an ongoing data-frame matching activity that becomes radically disrupted by the sudden presence of data that fundamentally does not fit the current operating frame and associated expectations – a form of ‘fundamental surprise’ (Lanir, 1991) that requires the existing frame to be replaced. The intensity of the Freeze phase depends on the degree of surprise, and the degree of surprise itself depends on the degree of frame discrepancy. Another factor that may effect the duration of this phase is culture. Choi and Nisbett (2000) tested the hypothesis that East Asians, because of their purported ‘holistic reasoning’, take contradiction and inconsistency for granted and consequently are less likely than Americans to experience surprise. Their studies suggest that Koreans display less surprise than Americans when a target’s behavior contradicts their expectations, even when contradiction is created in highly explicit ways.

Following a momentary period of paralysis, the spectator’s sensemaking then moves into a process of seeking a new frame, and a new explanation for their experience, corresponding with the ‘Find’ phase in Luna & Renninger’s model. The Freeze phase may be transitioned into the Find phase in response to a reactivation of sensemaking (potentially based on the identification of a ‘recovery cue’ obtained from recall or from the external environment), dynamic internal physiological events, or from environmental events and associated new data.

A sensemaking account of the Find phase in magic

Following the initial phase of freezing, the spectator will likely attempt to recall and reconstruct the sequence of activities leading to the moment of magic, seeking an alternative frame to make sense of what they have experienced. This activity may involve formulating questions or hypotheses, necessitating the comparison of multiple frames. Early theories of surprise, including Darwin’s (Darwin, 1873), argued that surprise is predominantly a basic emotion, a viewpoint supported by others such as Ekman and Friesen (1971). More recent theories have used the potential for surprise to be positive or negative to develop a more cognitive view of surprise that casts it as a process of “making sense of surprising events”. Foster and Keane (2015) advance the view that the essence of sensemaking following surprise is explanation; specifically, that people’s perception of surprise is a metacognitive estimate of the cognitive work involved in explaining an abnormal event; and therefore, the degree of surprise is determined by how difficult the event is to explain. Experimentally, Foster and Keane have shown that the difficulty of explaining a surprising outcome is the best predictor for people’s perceptions of the surprisingness of an event.

To the spectator, all the data necessary for understanding what is happening appears to exist in the present moment, in front of them within the context of the effect performance (note that they are unaware of the other data that has been deliberately hidden from them, relating to the secret moves or gimmicked objects employed). Thus, when the moment of magic occurs and their understanding of the current data fails, the *only* place to begin looking for an explanation is in their recall of the past sequence of events (i.e. memory). However, memory involves ‘attention in the past’, and the magician has already manipulated the attention of the spectator - therefore memory is a compromised resource for supporting the spectator’s recovery of sensemaking. The spectator has been carefully guided through the process of the effect, therefore their data and frames have been subtly created and managed by the magician. Memory is the only major resource available to potentially unravel the effect, and humans generally have misplaced faith in the validity of their own memory. Memory is by nature a distortion of reality, an approximation of real events. Magicians know this and intentionally manipulate this resource, counting on spectators to over-rely on their ability to correctly recall events.

The Data-Frame model is also predicated upon the utilization of expert knowledge, familiarity (based on our stored experiential pattern library), and feature recognition to enable sense to be made of a given situation. In the context of a magic effect, most spectators are novices in that they do not have experience of, familiarity with, or expertise in, the performance of magic effects. They do not know about the secret methods by which magicians achieve their effects (which are deliberately kept outside of public awareness); and they have little or no experience even of having previously observed the impossible feats they have just witnessed. To have the expertise necessary for recognizing the patterns underlying the achievement of a magic effect, the spectator needs to have experience (that goes beyond knowledge alone) of effect design, sleights, apparatus, performance, and spectator impact. The interaction between a magician and spectator is thus founded upon a fundamental mismatch in levels of domain experience. Thus, any expertise in magic will reduce significantly the intensity of any surprise, and thus the intensity of the moment of magic (Alberdi, Sleeman, & Korpi, 2000; Foster & Keane, 2015). Even a partial explanation that a spectator can generate will serve to reduce the intensity of the moment (Foster & Keane, 2015).

Foster and Keane (2015) propose that any factor that acts to increase the cognitive work in explaining a surprising event results in higher levels of surprise. Additional factors that increase a spectator’s cognitive load when

experiencing a magic effect include: the spectator’s lack of scientific and psychological knowledge, their lack of conjuring knowledge, their inability to assess the plausibility of potential methods employed by the magician (e.g. the actual method may be dismissed from consideration as a result of it being perceived as too simple or too complex), the spectator misremembering, and finally, the magician using deliberate strategies to misdirect the spectator’s recall and reconstruction, such as having laid-out false cues, and recapping events in a deliberately misleading or suggestive way (see Lamont & Wiseman, 2005, pp. 82-101). This means that not only does the spectator not know *where* to look, or *what* to look for to construct meaning regards how a magic effect has been achieved, but also that if they do detect something meaningful, they are unlikely to recognize *why* it is important.

In addition, when the magician stares at the spectator following the moment of magic, this may serve not only to reduce any potential ‘recovery cues’ transmitted by the magician, but also to seduce and fixate the spectator’s attention away from the environment and any associated objects in-play, thereby reducing and constraining their search for other meaningful cues. The magician may also take deliberate action to help frame the spectator’s search and sensemaking process following the reveal - for example, Fitzkee suggests that it is the magician’s job to use “words, actions and implications” to ‘interpret’ and add meaning to the spectator’s experience of the magic effect (Fitzkee, 1945, pp. 35-37). Similarly, Brown suggests that the purest experience of magic is simply ‘confusion’, and that the job of the magician is not just to invoke confusion, but subsequently to ascribe meaning to it (Brown, 2001, pp. 39-44).

It is also worth noting that some research suggests that individuals are likely to experience greater surprise when participating in a magic effect as an individual, than when experiencing magic in a group. In a group setting, the collective will have wider experience from which to draw, have more cognitive resources available, can gather and analyze in parallel more data, and can reach a collaborative consensus of post-effect explanation. In addition, if a spectator is selected by a magician from a group to be the focus of the effect, the other group members may serve to provide distractions, and act as points of reference for the spectator to ‘check-in’ with as the effect progresses. These are all factors that are likely reduce the spectator’s surprise (see Tachibana & Kawabata, 2014; Foster & Keane, 2015).

Finally, the Find phase involves the spectator experiencing an emotional reaction to their experience of surprise, which may be fear, anger, amusement or joy. Such emotions are usually telegraphed externally via facial expressions and verbal utterances, and are usually (and as suggested in this paper, erroneously) associated with occurring *at* the moment of magic, as opposed to being a later reaction *to* the moment of magic.

A sensemaking account of the Shift phase in magic

Luna and Renninger (2015) suggest that, having acquired new data via a search process, the spectator may dismiss or ignore the cause of the surprise as irrelevant (“I know it’s impossible to bite coins in half and then restore them by blowing, so I figure that was just silly and not worth any further consideration.”). They may develop an explanation for the effect, which may be correct or incorrect (“I know that teeth aren’t strong enough to bite coins, so that guy must be wearing a special gum-shield that he removed when I wasn’t looking”). Or they may update their schema to account for their experience (“I know most people can’t bite and restore coins, but based on this experience I figure people with strange powers maybe can.”) In the Data-Frame model, these activities follow-on from questioning the frame and seeking a frame, and correspond broadly with the sensemaking activities of preserving the frame, reframing, and elaborating the frame. And as cited earlier, any factor that serves to increase the cognitive work involved in these reasoning processes will likely increase the intensity of the moment of magic (Foster & Keane, 2015).

A sensemaking account of the Share phase in magic

Surprise creates a cognitive burden (Söderlund, 1998) as it is difficult to keep an emotionally and cognitively intense experience to ourselves. Surprise also arms us with social capital, enabling us to share an interesting story about our experience with others. Research demonstrates that the more significant the surprise, the sooner and more frequently we share it (Rimé, Philippot, Boca, & Mesquita, 1992). Repetition of a story also increases retention, and in the case of a magical experience that story is already atypical (Munnich, Ranney, & Song, 2007; Adler, 2008; Foster & Keane, 2015; Schomaker & Meeter, 2015). Repeated telling also increases the likelihood of distortion and confabulation, exaggerating and amplifying the power of a recalled effect. After performing a strong magic effect to an individual selected from a group (for example, in a street magic setting) it is common to see the selected spectator socially unloading and sharing their experience, seeking validation and experiential normalization, checking-in with other group members to compare their personal experiences of the effect.

A magician can readily capitalize on these short-term and longer-term effects, using spectators’ exaggerated personal testimony to increase public perceptions about their powers, and to feed the rumor and publicity mill to seed expectations about the power of their act relative to other magicians, and thereby gain greater bookings.

IMPLICATIONS OF THE DATA-FRAME MODEL FOR AMPLIFYING THE MOMENT OF MAGIC

A sensemaking data-frame analysis of the moment of magic helps identify a range of strategies that serve to moderate the intensity of the spectator's experience of a magic effect. Table 5 summarizes these, classified into strategies employed ahead of effect execution, those employed during effect execution, and those employed after effect execution. To maximize the intensity and duration of the moment of magic, it is suggested that multiple strategies should be exploited across all phases.

These strategies are potentially exploitable systematically by magicians to help shape the design of both their effects and their performance to maximize spectator impact – in other words, to make their magic stronger. It is suggested that such strategies are also potentially available to planners, designers and practitioners in other domains that wish to create similar experiences for their audience. For example, fiction writers could supplement narrative development using these strategies to amplify reader immersion, impact and entertainment (e.g. Bae & Young, 2008). Military deception planners could utilize the strategies to increase the degree of surprise that their operations achieve (e.g. Whaley, 2007). Sports team could exploit such strategies to support the design of deceptive plays that create surprise against their competitors on the sports-field (e.g. Pfleegor & Roesenberg, 2013). Advertisers could develop adverts based on these strategies to support enhanced brand recognition and retention within their target audience (e.g. Alden, Mukherjee, & Hoyer, 2000). And industrial designers might employ these strategies to design objects that surprise, confound and delight users in relation to their outward appearance; that operate in unexpected or magical ways; or that support the user in unexpectedly helpful ways they never envisaged (e.g. Ramírez, 2014).

CONCLUSIONS

'Strong magic' provokes a profound, deep and meaningful reaction in a spectator, leaving them to believe that they have genuinely experienced something impossible for which they have no explanation. Whilst the moment of magic is often described as a moment of enchantment, astonishment, wonder or amazement, in agreement with Earl (2016, p. 4) it is suggested that these are in fact emotional reactions that occur *after* the moment of magic itself. The moment of magic is characterized by a profound disruption in the spectator's sensemaking resulting from a breakdown in pattern matching, coupled with an induced inability to recover. This results in the spectator experiencing a moment of temporary physiological and psychological paralysis, before they then try to recover and generate meaning from mental replays of their apparently impossible experience. Fundamental to enabling the moment of magic is a mismatch between the magician's and the spectator's levels of expertise. A range of strategies for amplifying the moment of magic have been identified, that could have utility for creating and amplifying this moment within both a magic performance, and within a range of other domains and applications.

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Table 5 – Key strategies for amplifying the moment of magic

Factors before the effect	Factors during the effect	Factors after the effect
<ul style="list-style-type: none"> • Perform for individuals in preference to groups. • Select individuals that have no knowledge of magic. • Perform in an environment that does not create expectations of magic - for example, street magic contexts may serve to amplify surprise, as there is no pre-existing performance context that serves to inform expectations of encountering the impossible. • Use objects and actions that are familiar to the spectator, to reduce within and post-effect attention, examination, searching and critical analysis. • Consider carefully how you frame and signal your own abilities through demeanor, dress, voice, introduction, patter, actions, and objects used. Bear in mind that these will also inform the spectator's post-effect sensemaking and attempt to explain their experience. • Convey confidence, self-belief, and absolute conviction in the effect, so that contextual credibility and sincerity are telegraphed to the spectator. • Employ secret moves ahead of the spectator being aware that the effect has started, before their attention towards your actions has been activated. • Note that cultural studies of surprise suggest that more intense surprise may be experienced by Western spectators than by East Asian spectators. 	<ul style="list-style-type: none"> • Clearly frame the (apparent) start of the effect to the spectator, so that their subsequent recall of events commences at the wrong point. Wherever possible, secret moves should occur prior to this moment, to minimize within-effect anomalies. • Make the flow of the effect easy to follow. Use plain language, and clear, easily discernable, and natural movements (which may differ from popular beliefs about what is 'natural' - see Whaley (2013)). • Use the simplest means possible to achieve the effect. Minimize the use of props, phases, gimmicks, and sleights, and any anomalies they create. • Create a strong, grounded and reinforced base frame by portraying easy to recognize cues that support clear, unambiguous, and easily discernable pattern recognition. • Strengthen the base frame through apparently independent or coincidental confirmation and reinforcement of the desired pattern. • Minimize distractions and other irrelevant sources of conspicuity or interest. • Perform only natural manipulations of objects. If you must perform an unnatural manipulation, it should be physically, and preferably psychologically invisible. • Do not use objects, object properties or object functions in unusual ways, unless this is intended solely to be the moment of magic. • Telegraph purpose, motivation and justification behind your actions. • Reduce discrepancies in the patterns you are portraying to enable easier recognition. Make cue sequences and cue cluster easily discernable (although see also below). • Do not give the spectator the entire pattern 'on a plate'. Present pattern fragments, and make them invest effort to build a complete, absolutely certain, and yet absolutely wrong understanding about what is happening. • Present convincers in a natural and justified manner, with appropriate time delay. • Divorce method from effect. Eliminate potential cues that may anchor post-effect explanatory sensemaking. The fewer cues that are available to the spectator for subsequent analysis, the better. • Attenuate, mask or obfuscate anomalies created through the use secret methods or gimmicks employed. • Where necessary, present false cues about potential methods to misdirect the spectator away from real methods, but ensure that these are subsequently cancelled-out to eliminate potential sources of explanation later. • Create, reinforce and amplify expectations through repetition, conditioning, and the portrayal of obvious causality. • Invest effort and genuine belief in your actions and their effects (i.e. Method Act). • Seek to maximize and amplify schema discrepancy by violating strong expectations, breaking or defying causality, defying physics, jarring with well-established pattern frames, and portraying actions and states that have no natural explanation. • Make the actions and states associated with the moment of magic as far removed from proceeding actions and states as possible. 	<ul style="list-style-type: none"> • Stand still and stare intently and silently into the spectator's eyes, to prolong the duration of tonic immobility, and to minimize any unintentional recovery cues that may trigger a search for meaning. • When the spectator's tonic immobility is broken, use language and movement that is congruent with the effect they have experienced. • Do not break character, change demeanor, or make references to anything outside the frame of the effect, as this may serve to accelerate the spectator's initiation of explanatory sensemaking. • Do not correct the spectator misremembering, exaggerating or confabulating details about the effect. Your specificity about any details will reduce the opportunity for future exaggeration by the spectator. • Do not correct the spectator's attribution of any impossible powers to you, or seek to amplify this yourself. Leave them to do the work for you. • Encourage the spectator to share their experience with others, to (post-hoc) amplify the intensity of the moment of magic, to increase possible confabulation and exaggeration, and to act as publicity.

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