Coincidences: A Fundamental Consequence of Rational Cognition*

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Abstract

Believers tend to view the experience of coincidences as evidence for a variety of paranormal beliefs in mind and mysterious causal mechanisms out in the world. On the other hand, skeptics (e.g. most psychologists) tend to dismiss the psychological experience of coincidences as just yet one more demonstration of how irrational people can be. Irrationality in this context means an association between the experience of coincidences and biased cognition in terms of poor probabilistic reasoning and a propensity for paranormal beliefs. In this article, we present a third way: the rationalist perspective on the psychology of coincidence occurrence. We develop this new emphasis, including a new definition of coincidence, out of reviewing and synthesizing the extant literature on coincidences. We then propose a new three stage model to describe the psychological experience of coincidence, the 3C's model: 1. (C)o-incidence detection, 2. (C)ausal mechanism search 3. (C)oincidence versus cause judgment. The core principles in this model are that people use the same properties relevant for causal reasoning when detecting and evaluating events that are ultimately judged to be coincidental, and we describe how the model can account for the key prior research on coincidences. Crucially, rather than just being examples of irrationality, we argue that the experience of coincidences is a necessary consequence of rational causal learning mechanisms and provides a widely ignored approach to evaluating the mechanisms of causal reasoning.

Key Words: Coincidences, Pattern repetitions, Contingency learning, Causality, Induction

Coincidences: A Fundamental Consequence of Rational Cognition

1. General approaches to understanding coincidences

There are two basic views of the psychological experience and occurrence of coincidences that are fundamentally at odds with each other: The believer view, prevalent among members of the general public, is that coincidences are in fact evidence for various paranormal beliefs, held in the mind, and are induced by mysterious/hidden/paranormal causes, operating out in the world. The contrasting, skeptic view—prevalent among many scientists, particularly psychologists studying coincidences—is that the occurrence of coincidences, as psychologically experienced, is induced by noisy, chance occurrences out in the world which are then misconstrued via irrational cognitive biases into unfounded, possibly even paranormal beliefs in the mind.

The focus of this article is to argue that there is a third way of conceptualising coincidences, that is, from a rationalist perspective that their occurrence in terms of being a psychological experience is an inevitable consequence of the mind searching for causal structure in reality. We propose that a co-occurrence (as observed by a human) may end up being judged to be causal or it may be judged to be coincidental, but either way, both are dependent on the same inductive mechanisms. In essence this alternative position suggests that the occurrence of coincidences *as psychologically experienced* is integrally involved with a rational conception of the mind. More to the point, coincidences are psychological phenomena that occur as a result of how the mind perceives events. Most often, these events are perceived as meaningful. That is to say, they have personal direct relevance or consequences for us (i.e. meaningful psychologically and/or instrumentally), in both cases the events have causal impact because they can effect a change in us psychologically, but also can cause behavioral changes should we decided to act on the events.

Before we present this alternative perspective of coincidences, it is important to emphasize what this perspective is not claiming to do. It is *not* claiming to describe a third type of ontological causal mechanism operating out in the world that is in some way distinct from the normal causal mechanisms believed to operate in the world by most everyone and the paranormal causal mechanisms believed to operate by some. Rather it is intended to be a psychological theory describing the *experience* of coincidences and the resultant reasoning about them as they occur in mind. So when we make reference to "coincidence occurrence" or "coincidences" this should be generally taken to mean the *experience* of coincidence in the mind, thus emphasizing the psychological perspective.

To make the case for this alternative conceptualisation, in this article we review two aspects of psychological research on coincidences, the definitions, and the empirical studies of the phenomena. We evaluate the current research from the rationalist conceptualisation by proposing a new definition and theoretical framework. In addition, not only do we want to propose that coincidences reflect rational cognition, we claim that the psychology behind coincidences is another route to better understanding causal induction and the underlying coincidence detection mechanisms it is based on.

1.1 Coincidences: An Illustration

> To start with an example, consider the real case of identical twins separated at birth and living in different states in the US (Burger & Starbird, 2005). After being reunited 40 years later, the brothers shared a surprising number of attributes. Along with identical facial appearances (e.g., eye colour, hair colour), they drove the same make of car, chain-smoked the same brand of cigarettes, and preferred the same type of light beer. They both also remarried, and both initially married a Linda before then marrying a Betty. They also found out that they were audience members on the same night of the Tonight Show Starring Johnny Carson.

This example has many of the key aspects we develop into a new definition and theoretical framework for coincidences below in terms of the mechanisms for inferring causality. Some of the attributes shared by the twins can plausibly be explained as just chance regularities—for example if they drove a car manufacturer by Ford, smoked Marlboros, and drank Budweiser—especially as such individual attributes are common in the US population. Also divorce rates are high and the names of the women that they married are common, so chance can clearly explain individual shared attributes, though the overall combination of the attributions is still quite surprising. While admittedly the attributes listed here do not include the many features they did not share, the conjunction of many moderately probable features that they do share still seems relatively unlikely by chance and surprising, inviting causal explanation. Some kind of paranormal twin connectedness through psychic links is one possible causal mechanism, which could easily be contested (Blackmore, 1992). Shared genes are a more plausible causal explanation for some of the shared attributes, but it is difficult to extend this explanation to shared preferences for the same light entertainment show that they attended on the same night. This surprising coincidence is troubling in part because of its real world messiness in that the relative uniqueness of the events makes the assessment of the overall probabilities quite unclear at least in terms objective event frequencies. Also it seems likely that while these events are surprising to us, they are nowhere near as surprising and meaningful as they likely were to the brothers! In summary: on the one hand, the events seem quite unlikely just by chance, making "it's just chance" quite unsatisfactory, but this still seems a preferred explanation given that the available causal mechanisms do not fully or compellingly explain all the shared details.

The point to take from this illustration is that the process by which the mind detects pattern repetitions, and the way in which it evaluates them (i.e. cause or coincidence) is

based on processes that are used to detect and infer causality; a view currently shared by very few (but see Dessalles, 2008; Griffiths & Tenenbaum, 2007). The key point here and developed at length in this article is that coincidences need not be characterized *only* as evidence for biased probabilistic reasoning or paranormal belief, which is a common view taken by many researchers studying coincidences. The proposed rationalist conceptualizing that is presented here is that coincidences provide insights into studying the mind's induction mechanisms, i.e. contingency learning and causal reasoning.

1.2 Purpose and Plan

The purpose then of this article is to establish this alternative conceptualization of coincidences. To begin with, we situate the rationalist conceptualization within extant definitions of coincidences and use them to derive a new definition. We then review research on coincidences by organizing this section around empirical work examining psychological processes associated with coincidental experiences. We discuss how our conceptualization emphasizes some limitations in current research on coincidences, which then provides the platform for proposing our 3 C's Framework of Coincidences—1. Co-incidence detection, 2. Causality search and 3. Coincidence versus cause judgment. The framework is designed to provide an understanding of the process of detection and interpretation of coincidental events. In essence, we build on our conceptualisation in order to argue that while coincidental events do not have an underlying causal mechanism that jointly brings them about, they share similar properties to those used to detect actual causal mechanisms—temporal and spatial proximity, similarity, statistical regularity, and so forth—and so we suggest fruitful directions for future research. It is for this reason that understanding the basis by which people discriminate between coincidence and cause can help clarify the important properties of causal learning.

2. Definitions of Coincidences

We start by introducing the various prior definitions of coincidence as a motivation for a definition from the third way, rationalist perspective. Also, the kind of descriptions that theorists have used to refer to coincidences broadly reflects the ways in which coincidences have been studied, and so this provides a context for the literature which we review in the next section.

2.1 Definitions Emphasizing Low Probabilities

Some researchers have refrained from giving definitions of coincidences outside of referring to the laws of probability. The reason for this is that coincidences are classified as chance events and nothing more; so coincidences don't need additional psychological description. John Venn's (1866) *The Logic of Chance* exemplifies this point by suggesting that laws of probability are enough to explain away coincidental events, "...there can be no doubt that, however unlikely an event may be, if we (loosely speaking) vary the circumstances sufficiently, or if in other words, we keep on trying hard enough, we shall meet with such an event at last" (p. 274). By associating coincidences with unambiguous, low probabilities (e.g., double lottery winners, common birthdates, etc.), a bench mark is established by which people's reasoning about coincidences can be compared.

2.2 Definitions Emphasizing Connected Mental States

The similarity between this set of definitions and the previous set is that coincidences are low probability events which have no causal basis. For example, Henry (1993) proposes that "A coincidence experience may be defined as the occurrence of two (or more) odd, surprising, out-of-the-ordinary or personally meaningful events connected in the mind of the observer" (p. 97). The main difference between the two sets of definitions is that researchers in this camp don't tend to use examples of highly stylized forms of coincidences with unambiguously specified probabilities (e.g., lotteries, shared birthdates) in their studies.

Instead they focus on people's actual reported experiences of coincidences in order to generate definitions (Coleman & Beitman, 2009; Henry, 1993; Diaconis & Mosteller, 1989).

2.3 Definitions Emphasizing Causal Phenomena

Where this set of definitions departs from the previous, is that they focus on the link between coincidence and causality (Griffiths & Tenenbaum, 2007; Johnson, 1898; Mill, 1843). For instance, take Mill's (1843) description "The question is not whether the coincidence occurs often or seldom, but whether it occurs *more* often than chance will account for" (p. 314). This early description has been revived by Griffiths and Tenenbaum (2007). They argue that, "Coincidences arise when there is a conflict between the evidence an event provides for a theory and our prior beliefs about the plausibility of that theory. More precisely, a coincidence is an event that provides support for an alternative [possibly paranormal] to a current theory, but not enough support to convince us to accept that alternative" (p. 10). They go on to formalize this in a Bayesian probabilities framework of belief updating for hypotheses which we have used in part to develop our 3C's framework for coincidence (though there are also some key differences which we discuss in detail later). In brief, the Bayesian framework proposes that a given set of events might have a greater likelihood of their occurrence due to a potentially paranormal hypothesis compared to chance (as formalized in a likelihood ratio of the probabilities of the data due to the paranormal hypothesis and chance respectively). Note that unlike the skeptic view of coincidences we've characterized, this represents a genuine admission that the evidence in isolation (that is the likelihood ratio by itself) might reasonably constitute some evidence for a paranormal hypothesis. However, when this likelihood ratio is combined with prior beliefs against the paranormal hypothesis (as formalized in a priors ratio composed of the probability that the paranormal hypothesis is true divided by the probability that the chance hypothesis is true), these effectively cancel each other out resulting in an ambiguous posterior beliefs ratio in

which the probability of neither the causal/paranormal hypothesis nor chance hypothesis is substantially larger than the other. Overall, these definitions refer to an evaluation process that weighs up the events in terms of evidence based on probability judgments for and against chance and causality (an idea we'll come back to when proposing the 3C's model below).

2.4 Definitions Emphasizing Pattern Repetitions

The previous set of definitions is limited in one respect, which is that they don't consider the particular properties of the events themselves. Stephen Jay Gould (1988) hints at the significant impact that pattern detection has on psychology: "We think we see constellation[s] because the stars are dispersed at random in the heavens, and therefore clump in our sight. Our error lies not in the perception of pattern but in automatically imbuing pattern with meaning, especially with meaning that can bring us comfort, or dispel confusion" (p. 10). Not only is the detection of a pattern important in experiencing coincidences, it is the repetition of the pattern which is the key. That is to say, features of an event are subjectively judged to be relevant or salient to the observer, and a subsequent event containing features that are also judged to be subjectively similar to the first would constitute a coincidence (Santini & Jain, 1999).

Our own definition of coincidences builds on the previous descriptions that we have introduced here. The key details of past definitions that we consider to be important in the psychological processes associated with detecting and forming judgments about coincidences are: the repetition of two or more similar events/patterns, the likelihood of their co-occurrence by chance, and the co-occurrence likelihood as the output of a search for causal hypotheses. Thus we propose that *coincidences are surprising pattern repetitions that are observed to be unlikely by chance but are nonetheless ascribed to chance since the search for causal mechanisms has not produced anything more plausible than mere chance.*

2.2. What is Not a Coincidence?

The reader may rightly point out that there are many events that would fall under our definition, and so to clarify this conceptualization we also discuss examples that would not fit this definition. Coincidences tend to be surprising (Falk & MacGregor, 1983), but surprising events are not necessarily experienced as coincidental (e.g., an unexpected bang from a firecracker may induce surprise but not require further consideration about its cause). Coincidences are also fairly rare events, but rare events need not be coincidental (Griffiths & Tenenbaum, 2007). For example, pouring a jar of coins on the floor will produce a set of heads and tails with an extremely low probability, but the configuration of the coins won't induce perception of a coincidence unless there is an obvious surprising pattern repetition (e.g., all the coins being heads). Coincidences can be strongly tied to precise, if implausible, causal mechanisms (e.g., psychic link between twins), but often coincidences do not invoke any specific candidate causes. In fact, many of the examples of coincidences that we discuss later are complex and don't have obvious parapsychological causes.

So, given these points, let's now consider the example of shattering a plate in the kitchen and shortly thereafter hearing a loud bang from outside, and consider under what circumstances this would be a coincidence. This would not be a coincidence if the person dropping the plate was on an artillery range! Specifically, the base-rate of loud bangs on an artillery range is high. It would not be a coincidence if the person is extremely clumsy and routinely shatters plates (for the same reason of a high base-rate of occurrence). It would also not be a coincidence if the base-rates of both plate shattering and loud bangs are low, but there was an obvious causal mechanism. For instance if the order of events was reversed, i.e., if the bang from outside surprises the individual washing the plates and they jump and drop the plate shortly thereafter, then this would render the events as causal, rather than coincidence. Essentially a low probability pattern has to be observed to repeat corresponding to an even lower conjunctive probability that makes chance as an explanation seem

implausible but the co-occurrence is even less plausible via a causal mechanism, which leads to the judged events as a "coincidence".

3. The Psychology of Coincidences, a Review

Thus far we have discussed the rationalist conceptualisation of coincidences in the context of the definitions that previous researchers have proposed. In order to show how far this conceptualization departs from the typical approach to understanding coincidences, it is important to also review studies of the psychology of coincidences. As mentioned before, the common approach to understanding the detection and judgment of coincidences is from the view of flawed cognition. We present typical illustrations of the biases that are associated with the detection and evaluation of coincidence, and we also review the connections that are drawn between experiencing coincidences and the propensity to believe in the paranormal. At the end of each section we evaluate the literature with respect to the rationalist conceptualisation of coincidences, and highlight some of the limitations in the empirical approaches taken.

3.1 Biases in Cognition

By focusing on unambiguous low probability events in which the probabilities can be specified, researchers have been able to show common errors in the way coincidences are interpreted. For instance, Hanley (1984, 1992) discusses a story in the New York Times in which a lottery winner received $3.9m in October 1985. The same lottery winner then won another lottery, and received $1.5m in February 1986. The likelihood of this occurring was estimated in the article as 1 in a trillion. Hanley suggested that this extraordinary estimate is based on asking: what is the likelihood of this *particular individual* winning the lottery twice having bought multiple tickets every week for several years and then winning another in succession? The right question to ask is: what are the odds of *anyone anywhere* winning the lottery having bought multiple tickets every week for several years and then winning another

in succession? Answering this question drops the odds from 1 in a trillion to 1 in a million. Hanley (1984) claimed that when people read about low probability events, they make erroneous judgments that ignore the probability of the events occurring to anyone while focusing on the associated probabilities after the fact that the events occurred to a particular individual.

This type of error has been demonstrated empirically using the Birthday Problem (DasGupta, 2005; Matthews & Stone, 1989; Schwarz, 2010). People are told that they are in a room full of people at a party, and they need to guess the number of people needed in the party for there to be a high probability of at least two individuals sharing the same birthday. People typically estimate that large numbers are needed, well over 100, when actually only 57 are needed for a 0.99 probability. This suggests that people under-appreciate events that are likely to happen to anyone within a group of people, and one reason why they might do this is because they tend to focus on probability estimates of the particular events occurring, rather than the probability of any such event occurring (Burger & Starbird, 2005; Diaconis & Mosteller, 1989; Mathews & Stones, 1989). This can be explained through an egocentric bias that influences the way people make probability estimates (Falk, 1989; Mathews & Stones, 1989). It is claimed to work in two ways: first, by elevating their own importance, the individual underestimates the likelihood of events in favor of making them seem unique, and second, by correspondingly inflating the likelihood of events that are experienced by others (Falk, 1989; Falk & MacGregor, 1983; Watt, 1991). In the birthday problem, the individual anchors the probability to their own birthdate, emphasizing their uniqueness, which means that they inflate the rarity of another member of the party sharing the same birthdate as them. In support of this, people have been shown to systematically judge self-experienced coincidences as more surprising and less likely than similar coincidences experienced by

others (Falk, 1989; Falk & Konold, 1997; Falk & MacGregor, 1983; Miller, Turnbull, & McFarland, 1989).

While the egocentric bias suggests there is a distortion in the probability estimates people make, which may increase the value and rarity of the coincidences personally experienced, it doesn't explain why there is a propensity to experience coincidences in the first place. To answer this, many have claimed that the fact that people experience coincidences tends to reflect an underlying problem with their probabilistic reasoning (Hanley, 1984, 1992; Mathews & Stones, 1989; Mock & Weisberg, 1992). Consequently, much has been made of the association between people's ability to solve classic decision making tasks and their reported frequency of coincidental experiences (Blagrove, French & Jones, 2006; Blackmore, 1997; Blackmore & Trosiancko, 1985; Brugger, Landis & Regard, 1990; Bressan, 2002; Brugger, Regard, Landis, Krebs, & Niederberger, 1994; Brugger, Regard, Landis, & Graves, 1995; Dagnall, Parker, & Munley, 2007; Musch & Ehrenberg, 2002; Watt, 1991). Blackmore (Blackmore, 1984; Blackmore, 1997; Blackmore & Trościanko, 1985; Mathews & Blackmore, 1995) has been a strong proponent of the view that poor probabilistic reasoning accounts for people's experience of coincidences. In fact, in support of this, there is evidence of negative correlations between poor performance on probabilistic judgment tasks, e.g., base rate neglect, expected value problems, sample size problems (See Dagnall, Parker, & Munley, 2007) for illustrations of these tasks) and tendencies to hold beliefs in the paranormal. Blackmore claims that poor probabilistic reasoning coupled with a misperception of chance events (Blackmore, 1992; Blackmore & Troscianko, 1985) in turn gives rise to beliefs in the paranormal which result in a tendency to experience coincidences (Blackmore, 1984; Glicksohn, 1990). Crucially, this view implies that the interpretation of coincidences is defective but does not imply that the process of experiencing the coincidence itself is necessarily defective. However, on the basis of a large

survey conducted by Blackmore (1997), the probability misjudgment theories were rejected on grounds that believers generated as accurate probability estimates as non-believers.

A more specific defect that has been associated with increases in the frequency of coincidences is the failure to generate random sequences (e.g., avoiding repetitions in coin tossing, or incorrectly judging repetitions in sequences as non-random) (Blackmore & Troscianko, 1985; Bressan, 2002; Brugger, et al, 1990; Brugger et al, 1994; Brugger, et al, 1995; Dagnall, et al, 2007). Brugger and colleagues (Brugger, et al, 1990; Brugger et al, 1994; Brugger, et al, 1995) claim that belief in the paranormal, including coincidental experiences, is symptomatic of a failure to appreciate properties of random sequences. That is, people misinterpret random sequences of events as meaningful and attribute a causal, though non-scientific, basis to them, e.g., fate, god, luck, psychic ability.

3.1.1 Limitations in understanding coincidences from the biased cognition perspective

The discussion so far has suggested that the detection and interpretation of coincidences as meaningful rare events goes hand in hand with a range of cognitive biases (Beitmans, 2009; Diaconis & Mosteller, 1989, Falk, 1981-1982; Hintzman, Asher & Stern, 1978; Watt, 1991). Biases might explain the tendency to misperceive low probability in favor of a personal perspective, but they do not explain other aspects of personal coincidental experiences, namely, that they aren't simply low probability events and that they form clusters of particular types of experiences (Diaconis & Mosteller, 1989; Lopes, 1991; Watt, 1991). An issue for the skeptic perspective is that there is no general framework that so far integrates the various demonstrations of biases in perception, judgment, reasoning and memory to account for the experience of coincidences. This is the motivation for our attempt to offer a potential way of conceptualising coincidences in terms of a stage model that takes into account the way in which causality and pattern repetitions inform the detection and then evaluation of coincidences. Moreover, the two most common features of the coincidences

that have been examined with respect to biases in cognition is that they are judged to be low probability events and that the events themselves are repeating patterns (Beitman, 2009; Diaconis & Mosteller, 1989; Falk, 1989; Falk & Konold, 1997; Falk & MacGregor, 1983; Fischoff & Beyth, 1975). By taking a different stance on the way coincidences are conceptualised, experimental work can focus on a broader range of phenomena than those with unambiguous probabilities typically shown to illustrate biased cognition, e.g., birthdays, lotteries, etc.

One possible broader conception of the role that biases play is that detecting and interpreting particular kinds of low probability events serve an adaptive function (Falk, 1981-1982). The types of biases associated with the detection and interpretation of coincidences, in particular egocentrism, generally help to prioritize the effects on the individual's actions and perceptions of new events. This in turn is likely to facilitate the detection of genuine casual relations in the world through a mechanism that looks for frequent or complex pattern repetitions anchored around an individual's own actions and behaviors. By default, this mechanism will also detect pattern repetitions that invite a causal attribution but in the absence of any plausible mechanism, i.e., the occurrence of coincidences is inevitable if real causal mechanisms are to be detected. Consistent with the properties that we have based our definition on, the many illustrations of coincidental events appear to include: the repetition of two or more events/patterns, the improbability of their co-occurrence by chance, and the low co-occurrence likelihood in relation to causal hypotheses.

3.2 Paranormal Beliefs Perspectives

In the main, people tend to have many experiences of coincidences that are interesting but trivial and have little meaning for the individual experiencing them (Bressan, 2002; Falk, 1989; Watt, 1991). However, there is also a class of coincidences that seem meaningful and appear to have happened for a reason (Beitman, 2009; Henry, 1993; Inglis, 1990; Koestler,

1973; Tanous & Ardman, 1976). For example, there are a number of cases of religious practitioners praying on behalf of family members wishing their ill relative a quick recovery and days later the relative recovers, against all medical expectation (Inglis, 1990). There are also reported cases of psychics successfully aiding police investigations (Tanous & Ardman, 1976). Coincidences such as these have helped to maintain beliefs in many different forms of the paranormal (e.g., luck, telepathy, precognition, destiny/fate, astrology, divine/diabolic intervention), and it is worth noting that the individuals who believe these things do not consider these events coincidences.

The importance of meaningful rare events of the kind just described is that they are often used to challenge the dominant scientific, materialist account of reality (Jung, 1972; Jung & Pauli, 1955; Kammerer, 1919; Koestler, 1973). Although Kammerer (1919) was trained as a biologist, his discoveries of pattern repetitions in nature and his personal experience of coincidences led him to propose his concept of seriality (e.g., repeating temporal and spatial occurrences of meteorological events such as storms): "The repetition of the same or similar things and events in time and space which cannot be linked by a mutual causal factor" (1919, p. 36). Kammerer's Law of Series proposed that events that have similar features tend to follow a law of recurrence in which they cluster in time or space without an identifiable causal mechanism. Jung's (1972) Synchronicity principle also suggests that coincidences are examples of a larger framework with structured patterns of events that are the result of non-physical mechanisms. As theories, the main problem with both synchronicity and seriality is that they ignore the possibility that coincidences are a psychological phenomenon and focus instead on the premise that coincidences are examples of actual but hidden structures in the world.

Psychological research has reported a strong association between believing in the paranormal and experiencing coincidences, particularly the frequency with which they are

experienced (Brugger et al., 1990; Coleman, Beitman & Celebi, 2009; Dudley, 2000; Houran & Lange, 1996; Glicksohn, 1990; Tobacyk, 1995a, 1995b; Tobacyk & Milford, 1983). But why might this association exist? Both Kammerer and Jung raise an important point with respect to coincidences, which is that as wide ranging as coincidental events are, at their core, the key properties that appear to be surprising and important are that they are improbable repeating patterns of similar events. Relatedly, Bressan (2002) discussed that observing patterns and uncovering the underlying causes of those patterns suggests an adaptive mechanism that seeks to explain new phenomena. But, for some, explanations of new phenomena that are based in the paranormal simply reflect a lower threshold for making causal attributions for rare random events, a point shared by Brugger (1997); this proposal is also in line with Griffiths and Tenenbaum's (2007) Bayesian belief updating approach to understanding coincidences. By lowering the threshold for explaining a new pair of events, not only are people more likely to experience coincidences frequently, but they are also quicker to attribute paranormal causal explanations for them (Beitman, 2009; Bressan, 2002; Whitson, & Galinsky, 2008). But a positive consequence of this low threshold is that these individuals are also potentially less likely to miss new but real causal structures than the skeptics. Again, as with research on biases in the detection and evaluation of coincidences, work on the link between coincidence and the paranormal shows that the core features of coincidences are consistent with our definition, which focuses on: the repetition of two or more events/patterns, the low likelihood of their co-occurrence by chance, but the even lower likelihood of the co-occurrence in relation to causal hypotheses.

In addition, Blagrove et al. (2006) argued that people with beliefs in the paranormal tend to connect unrelated events that appear to be repeating patterns through non-physical mechanisms because they connect broad categories of phenomena according to highly inclusive sets of explanations, e.g., the supernatural (Blackmore, 1997; Bressan, 2002). If the

membership criteria are vague, or if the threshold for explanation is especially low because the causal mechanism is underspecified, then this increases susceptibility to detecting patterns in meaningless, noisy environments (French & Wilson, 2007; Wiseman & Smith, 2002). What this implies is that the frequent detection of coincidences is indicative of the range of possible pattern repetitions that the mind is willing/able to observe. In order for the pattern matching mechanism to flag a coincidence, an individual must be tuned to various kinds of pattern repetitions occurring.

3.2.1. Paranormal Experiences

Another common area in which to examine experiences of coincidences is in the context of psi phenomena, which are prototypical examples of coincidental experiences (Inglis, 1990). Psi phenomena refer to "anomalous processes of information or energy transfer such as telepathy or extrasensory perception that are currently unexplained in terms of known physical or biological mechanisms" (Bem & Honorton, 1994, p. 4). The most common method used to investigate extra-sensory perception (ESP) is the Ganzfeld method which involves a participant (the sender) located in one room in which they observe a picture or video clip (the target) and attempt to "send" details of the picture to another participant (the receiver) who is located in another room and instructed to describe the thoughts entering their head. The receiver is then presented with four different pictures/videos, one of which is the target, thus setting the possibility of selecting the target by chance alone at 25%. Thus the pattern repetition here is the perceived target appearing in the mind of the sender and appearing in the mind of the receiver. Bem and Honorton's (1994) meta-analysis of Ganzfeld studies reported above chance detection (35% hit rate) and, therefore, evidence for extra sensory perception (ESP). However, Milton and Wiseman's (1999) meta-analysis of Ganzfeld studies, including Bem and Honorton's study, led them to draw different

conclusions. They claimed that the detection rates are at chance levels, and that the methodology as yet does not generate reliable results.

Even if the experimental techniques are sound and there are a sufficient number of trials to uncover an ESP effect, some claim there is still a potential error made in the way evidence is interpreted (Diaconis & Mosteller, 1989; Griffiths & Tenenbaum, 2007; Mathews & Stones, 1989). A potential mistake when making inferences from rare phenomena is confusing the probability of the data given the hypothesis, p(d|h), with the probability of the hypothesis given the data, p(h|d) (Wagenmakers, Wetzels, Borsboom & van der Maas, 2011). This is problematic scientifically, especially if the phenomena is estimated to be unlikely to begin with (e.g., ESP). But, this is also problematic in day-to-day reasoning about the pattern repetitions people experience in the world. Crucially, the argument that Wagenmakers et al. (2011) make concerning the study of extraordinary phenomena, and which applies to personal interpretation of coincidental experiences (Griffiths & Tenenbaum, 2007), is that the prior probability people have of a particular phenomenon, be it psi or any other paranormal belief, should moderate the interpretation of the evidence that is used as convincing support of it. So from the Griffiths & Tenenbaum (2007) Bayesian perspective on coincidences, while current data might plausibly support a paranormal explanation for a given set of events, this could reasonably be outweighed when combined with a prior belief against paranormal hypotheses (based on prior exposure to a lot of evidence against them). But even setting aside these complicated statistical arguments, the bottom line seems to be that there are as yet no psi effects which are robust enough as to be widely replicable by anyone who rigorously chooses to do so.

3.2.2 Limitations in understanding coincidences from the paranormal beliefs perspective

One potential problem with research uncovering associations between beliefs in the paranormal and the frequency of coincidental experiences is that items used in the measurement of paranormal beliefs also refer to experiences that are coincidental (Blackmore, 1997; Blackmore & Trosiancko, 1985; Bressan, 2002; Henry 1993; Inglis, 1990). Therefore, finding an association between paranormal beliefs and experiences of coincidences may not be all that surprising. Answering the paranormal belief inventory is likely to bias/prime people's recall of the kinds of coincidental experiences people have had over their lifetime. Another issue with this research approach is that while the range of experiences of coincidences that are examined is broader than those which researchers on biased cognition focus on, the key problem is the same. The focus of the type of coincidences is still narrow, and only concerns those that have a potential paranormal explanation.

This leads to a more fundamental point which concerns the two basic views of coincidences, believers versus skeptics, that we described at the start, which is that "coincidence" is relative to a particular perspective. If an individual were to explain a pair of events as an example of psychic phenomenon (e.g., dreaming about a plane crashing and avoiding taking a flight which crashes) then for that individual a causal attribution is made and the events constitute an example of a paranormal experience, not in fact an example of a coincidence. Therefore, this presents a point of contention because a skeptic would class the same events as coincidental, because a paranormal based explanation for the events is just not a scientifically plausible causal explanation, and that changes the status of events from to causal to coincidental, *for them*.

The key point is that neither perspective places much emphasis on what coincidences indicate about the mind's mechanisms for causal induction. In attempting to understand the psychological processes that underpin the detection and evaluation of coincidences, an alternative conceptualization is needed in order to avoid the problems of emphasis arising

from the believer versus skeptic perspective. For this reason, the rationalist conceptualization that we propose considers the mechanisms that enable the detection of low probability pattern repetitions, and the processes that make a judgment of cause or coincidence.

4 Theoretical Perspectives on Coincidences

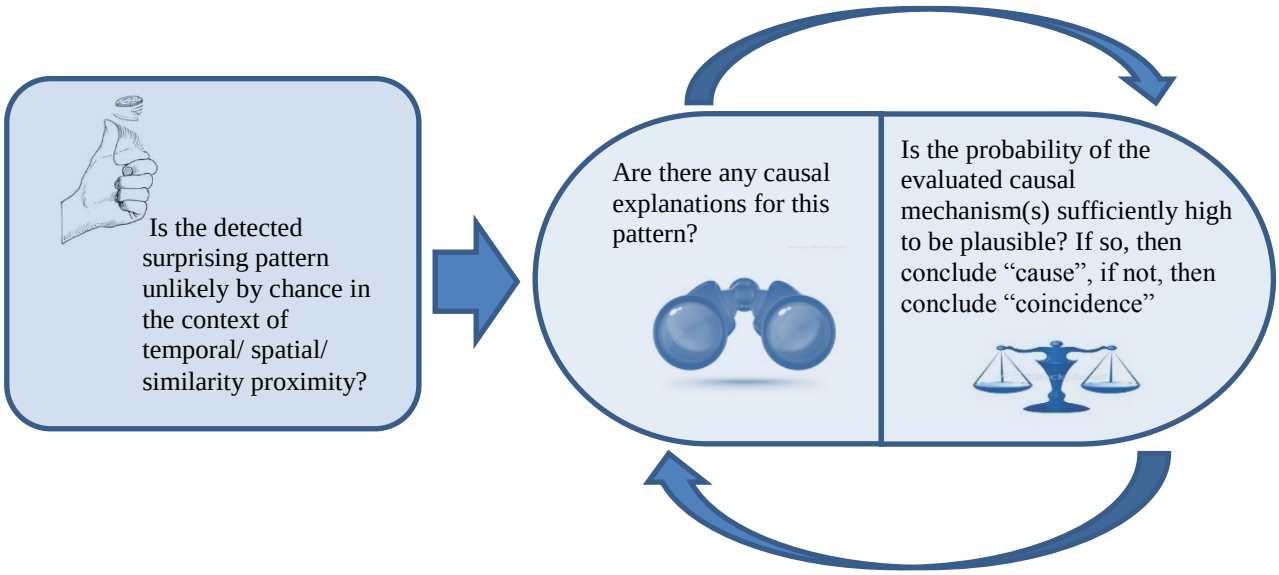
In this final section we present a psychological framework for coincidences (the 3 C's Framework for Coincidences) which follows directly from the definition and perspective we developed above. Specifically, it focuses on the detection and evaluation of coincidences in the context of causal induction mechanisms. Here too, we situate our proposals within previous frameworks that concern phenomena related to coincidences.

4.1 The 3 C's Framework for Coincidences

Implied in our definition is the view that coincidence and causality are flip sides of the same co-variance detection coin and are thus implicated in causal induction mechanisms as suggested, in part, by Griffiths and Tenenbaum (2007). We propose that the experience of coincidences is an unavoidable part of a rational inductive reasoning process that involves three stages, with the last two stages potentially cycling, as summarized in Figure 1. Hence, our 3 C's Framework of Coincidences: Stage 1 Co-incidence detection, Stage 2 Causality search, Stage 3 Coincidence versus Causality evaluation.

Stage 1) detection of a surprising pattern repetition, a Co-incidence (pronounced co-inCIDence as in to coincide) that seems unlikely by chance alone or an obvious causal mechanism, Stage 2) Causality search for possible explanations of the detected co-incidence, Stage 3) Coincidence versus Cause evaluation; if the probability of some causal explanation is now high, in particular relative to the probability due to chance, then surprise is eliminated and the co-incidence is evaluated as Cause. On the other hand, if no plausible causal explanations are generated (i.e., the combined probability of all causal explanations is low), then either the search for plausible causal mechanisms continues in an attempt to reduce the

surprisingness of the co-incidence (Stage 2 repeats), or Stage 3 terminates with a judgment of Coincidence (pronounced in the standard way coINcidence) given the lack of a plausible causal mechanism. However, surprise remains relatively high because further evaluation has still left the apparent probability of the events due to chance as fairly low even though the coincidence judgment has nonetheless ascribed them to chance given that cause is even less plausible. So, in line with the definition we propose, coincidences are surprising pattern repetitions that are observed to be unlikely by chance but are nonetheless ascribed to chance since the search for causal mechanisms has not generated any plausible ones.



Stage 1: Co-incidence Detection Stage 2: Causality Search Stage 3: Coincidence or Cause?

Figure 1. The 3 C's Framework for Coincidences

Our proposal has aspects in common with Griffiths and Tenenbaum's (2007) Bayesian framework of causal induction, though some differences as well. Coincidences are pattern repetitions ("anomalies") that are reasonably low-probability due to chance and invoke a search for causal explanation. Here we refer to anomalies as (Kittler et al., 2014): A situation in which an observer is faced with a new experience, in which some or all of the

current models that the observer has, initially fail to accommodate. The evaluation of the evidence for possible causal mechanisms is considered in relation to chance, thus arriving at causality versus coincidence judgment. A potential difference is that we are proposing multiple stages of processing in terms of an initial detection stage and a cycling search stage and a coincidence versus cause judgment stage rather than simply a final judgment.

Further, to be able to specify a formal Bayesian framework, Griffiths and Tenenbaum (2007) used experiments in which it was possible to precisely articulate alternative hypotheses (so as to be able to specify prior belief probabilities for them as well as calculate unambiguous probabilities of the observed events given each hypothesis respectively). One question that is raised from this perspective is whether a completely specified set of alternative hypotheses are required when evaluating pattern repetitions?

Our answer to this question is not necessarily. In fact, what is often overlooked in research concerning inferences about coincidences is the frequent lack of any clearly articulable causal explanation, however implausible. Most people don't necessarily or immediately posit a paranormal explanation when chance doesn't seem to be a sufficient explanation for a combination of rare similar events (Bressan, 2002; Blagrove et al, 2006; Inglis, 1990; Koestler, 1973; Watt, 1991). And they don't necessarily treat coincidences as meaningful simply because they correspond to an obvious but implausible paranormal explanation, but may rather accept that there simply is no casual explanation (Bressan, 2002; Blagrove et al., 2006; Inglis, 1990). In classification systems of coincidences that have been developed, there are categories which include coincidental experiences that people have reported which are simply repetitious events that are rare and that aren't associated with the paranormal (e.g., Henry's (1993) spontaneous perception in time and spontaneous perception in space). Moreover, people can accurately judge coincidences as chance events, but that doesn't prevent them from detecting these events as coincidences in the first place or from

trying to generate causal explanations for them (Bressan, 2002; Falk, 1989; Falk & Konold, 1997; Falk & MacGregor, 1983). For instance, take the famous coincidence of the similarities between John F. Kennedy and Abraham Lincoln: They were elected to congress in similar years (1946, 1846 respectively), and then elected as presidents 100 years apart (1960, 1860 respectively), their assassins were born 100 years apart, and their Presidential successors were born 100 years apart, etc. The many listed components of this rare pattern repetition invite a causal explanation, but most accept that this is just a fairly remarkable list of rare but chance pattern repetitions sampled also from the many attributes that they might have shared but didn't. Importantly, this coincidence doesn't necessarily arise from a conflict between a single, obvious causal account and chance. It may simply be that an abstract sense of causality conflicts with chance when incredible coincidences occur such as the one described above. For example, suppose that the Lincoln-Kennedy similarities included both losing the middle fingers of their left hands from the second joint in hunting accidents when seven years old, both having failed novelist uncles named Ebenezer who worked as baker's assistants, both born on the same day of the year, both born to fathers who were decorated army sergeants, both struck by lightning at 16, etc. At some point even though the exact probability of these repeating patterns cannot be unambiguously specified, it becomes so obviously small as to demand a causal explanation, we return to this point in the final section of this discussion.

In sum, prior research suggests that when people consider their own personal experiences of coincidences they don't always have a precise specification of alternative hypotheses. So, it is not clear that these are required. In other words, there need not be a precisely specified, possibly parapsychological explanation with a clearly low prior probability for the judgment of coincidence. It may be sufficient to articulate, that unable to think of any plausible alternatives, the overall probability of any causal mechanism is low,

without necessarily specifying them all or being able to individually specify their probabilities. In the section that follows, we now describe the psychological processes embodied in the stages of our model in the detection and evaluation of coincidental experiences.

4.1.1 Stage 1 Co-incidence detection

We argue that a critical feature of coincidences is that they are surprising low probability pattern repetitions without immediately obvious causal explanations. Pattern detection mechanisms are alerted to many new experiences of low probability events and are closely tied to mechanisms for learning and novelty detection. Exactly which patterns are detectable is tied to the richness of the conceptual apparatus of the detector. But in short a pattern is anything that results in "There's that thing. Oh! There it is again!" Novelty is simply an event that is judged to be unexpected within the context of the situation in which it arises. Pattern detection mechanisms are known to be sensitive to novelty in two basic ways—contrast and change, which has long been established in visual processing (Mareschal, & Johnson, 2002; Marr, 1982). In other words, the salient novel event is notable because it pops out from the background of highly probable events experienced within a given context. For instance, a man wearing a green outfit and an oversized green hat would contrast quite highly with the other customers of a London pub on any other day other than Saint Patrick's day given that the probability is generally very low that people wear green outfits and also frequent London pubs.

Once experienced, a novel event's representation is stored according to several associated features that include temporal, spatial aspects, and the perceptual/contextual/semantic features. This contrasts with the *Kinds* view proposed by researchers such as Falk (1989), which suggest that rather than decomposing the details, people have a configural representation that enables the observed events to be assigned to a

general category of ‘unlikely kinds’. In other words, the *Kinds* view assumes that people do not abstract specific temporal or spatial properties from the events they judge to be coincidental, they simply represent the whole event as coincidental. Returning to our green suit example, now imagine that you see the green suited man with an oversized green hat in pub X in London on Monday, and again in pub Y in London the following week on Monday. In this example the representation would be *green suited men in pubs*, rather than the specific temporal (e.g. I’ve seen the same man on two different Mondays), spatial (e.g. I’ve seen the same man in two different pubs in London), and semantic features (e.g. I’ve seen the same man wearing exactly the same odd clothes in two different places and it isn’t Saint Patrick’s day yet). As discussed by Griffiths and Tenenbaum (2007), there are various limitations with the *Kinds* position, because it is unclear how a kind should be specified, and the same events can be re-described in various different ways to appeal to different unlikely kinds.

We propose that for the novel experience to constitute a coincidence, the key properties of the novel event must be that they are rare, they repeat and there is not a compelling causal explanation and as such is surprising. For instance buying a round of drinks in which the total cost is £11.11 might appear somewhat rare because it is an odd total cost because the 1 repeats. However, when going to pay for the round, you notice that the amount of money in your wallet exactly matches the amount due down to the penny, £11.11. Once the representation of the novel event is triggered again (i.e. when you go to pay the number 1111 re-presents itself to you), this activates the search for causal mechanisms (e.g., what’s the connection between the cost of the round which contains a repeating pattern, and the repeating pattern presenting itself in the exact change that I have?). The judged coincidentality is based on the conjunctive probability that the novel pattern initially detected repeats (e.g., the numeral 1 occurs repeatedly in the cost of the round and in the exact change available) but is not explained by a habitually expected causal mechanism like the lights

coming on after flipping the switch. This, along with spatio-temporal proximity of the events, is the trigger for a search for possible causal explanations.

4.1.2 Stages 2 and 3: Search for possible causal explanations ↔ causality vs. coincidence decision

When a coincidence seems improbable due to chance or an obvious causal mechanism, a memory search for causal explanations gets initiated. Memory searches are assumed to continue if no plausible hypotheses have currently been retrieved, or if the plausibility of the hypotheses already retrieved from memory is lower than chance (Gettys & Fisher, 1979). More specifically, we refer to a recent model proposed by Dougherty, Thomas and Lange (2010) that connects hypothesis testing to hypothesis generation and memory retrieval. Once a set of features initiates a search in memory for candidate hypotheses, the set of hypotheses that could be considered may end up being intractable. The HyGene (Hypothesis Generation) model tackles this problem by suggesting that the range of hypotheses generated is constrained by the available data that the individual is considering at the time (Thomas, Dougherty, Sprenger, & Harbison, 2008). By thinking about the semantic, perceptual and contextual features of the pattern repetition, this acts as a retrieval cue for hypotheses from semantic and associative memory (Dougherty et al, 2010).

The sub-set of hypotheses that are then generated is in fact the space of possibilities which become the focus of consideration. The total possible number of hypotheses that are under consideration at any one time is constrained by working memory (Dougherty et al, 2010). The consideration of the hypotheses is based on an evaluative process which occurs in stage 3, and involves a comparison of the probability of the hypotheses against chance (similar to the Griffiths and Tenenbaum, 2007, Bayesian framework). We propose that the search in memory for a candidate hypothesis to account for the pattern repetition is highly recursive. In other words, the search may eventually generate a potential hypothesis, once it

is evaluated in stage 3 it may eventually be rejected, and so the search for another hypothesis from memory will be generated. If the overall sense of causal improbability is still low, the search may continue and/or new data (i.e., new features of the coincidence) may be elicited and used in further searches.

If we return to the round-of-drinks example, the improbability of the cost of the round of drinks having both a repeating numeral (e.g. £11.11) and exactly matching the available change is obvious, that sort of thing doesn't normally happen by some habitualized causal mechanism (stage 1), so triggers a search for causal explanations (stage 2) based on the surprise generated in stage 1. Such explanations might include the possibility that the cost of drinks somehow conformed to the available money, for example, the cost might actually have been £11.50, but then the bar tender said they'd just take the available change because they were in a good mood. If a plausible causal mechanism is found then surprise is eliminated at stage 3 which would terminate with the judgment "Cause." If not, ongoing surprise can result in continuing the stage 2 search for causal mechanisms and further stage 3 cause versus chance evaluations until one wins, either because a plausible mechanism is found or because the probability by chance is small but not too small to be an unacceptable explanation. However, if eventually stage 2 is exhausted in terms of not producing more candidate mechanisms, then at stage 3 a decision based on the available evidence is invoked. So the stage 3 output is either "Coincidence" if the probability of the chance explanation isn't too small or "Coincidence?!" and an implied unknown causal mechanism if the probability of the chance explanation is still unacceptably small.

4.2 A real world example of the 3 C's Framework of Coincidences

A famous criminal case that illustrates these 3 stages is that of Nurse Lucia B. The reason we have chosen this example is that it is a relatively high profile real world example of a seemingly rare pattern. It is an example of events that do not have easily specifiable

probabilities, and which do not lend themselves to a paranormal explanation. More importantly, the example demonstrates the cognitive processes that would have likely been involved when identifying and evaluating the pattern repetition. Finally, it also illustrates that this kind of induction process has consequences in the real world. As mentioned by others (Griffiths and Tenenbaum, 2007), the processes implicated in the evaluation of cause and coincidence had led to major discoveries, but also to serious errors in judgment.

In 2003, Nurse Lucia B was convicted of seven murders (poisoning) and three attempted murders of patients in three different hospitals. Nurses working in the most recent employment of Lucia became suspicious when 9 patients needed resuscitation and died on her shifts (stage 1, coincidence detection, leading to stage 2, search for causal explanations). Authorities initially estimated the odds of this many resuscitations occurring on the same nurse's shift at 1 in 7 billion, an estimate which was later reduced to 1 in 342 million, still extremely low.

Given the estimate, the criminal investigation began, based on the assumption that the odds were so low that the events were due to chance that they had to have a causal basis (stage 3, cause chosen over coincidence). The search for an explanation clearly stopped because a highly plausible causal explanation was found. However, the conviction was later overturned with the uncovering of new evidence, and statistical analyses revealed that the odds of the same nurse being present at 9 resuscitations in 3 hospitals were actually as high as 1 in 44. The events were indeed found to be coincidental, and Nurse Lucia was exonerated in 2010 (stage 2, new information downgraded the causal evidence, so stage 3 resulted in a decision of coincidence over cause).

A very similar case to Nurse B which is still currently being investigated involves a nurse in Scotland that was convicted in 2008 of murdering 4 elderly patients. The controversy here, just as with Nurse B, is whether in fact the death of the four patients is a coincidence,

rather than the result of murder (BBC, 2014). There are many legal cases in which there have been miscarriages of justice because the initial estimates of the events occurring by chance (e.g., finding traces of evidence on the victim and the suspect) are considered too low for that to be a plausible explanation but then go on to be reversed because the plausibility of chance gets re-evaluated. Typically, the coincidences that people experience are not of this extreme low probability, or as consequential, and typically, in most day to day coincidental experiences the search for causal explanations not likely to be exhaustive because the events aren't considered important.

5. The 3 C's Framework of Coincidences and Key findings from Prior Research on Coincidences

Our review of the literature on coincidences (above) indicates that there are three key findings:

1. Biased judgments. Peoples' evaluation of coincidences has been shown to be influenced by a variety of judgment biases, especially in terms of probability estimation, and notably the egocentric bias in which people tend to give higher estimates of rarity and surprise to personally experienced coincidences as compared to those experienced by others.
2. Paranormal beliefs. There is an association between beliefs in the paranormal and the frequency with which coincidences are experienced.
3. Individual differences in educational background, IQ, gender, and occupation are not reliable predictors of the frequency with which coincidences are experienced.

We consider each of these in relation to the proposed 3C's framework.

Our purpose is not to dismiss the research on biases in general and probability judgments in particular as wrong or unimportant. Indeed, the 3C's framework predicts outcome judgment biases will occur to the extent that the various component probability

judgments are biased. So for example if the egocentric bias is fundamentally the result of biased probability judgment then that is not specifically a problem for the framework. Also to the extent that this framework overlaps with the Griffith's and Tenenbaum's (2007) Bayesian framework then it can predict that even accurate probability judgments about the immediate events can lead to paranormal conclusions in the presence of prior paranormal beliefs. So associations between coincidence occurrence and paranormal beliefs as a result of biased probabilities also don't seem particularly problematic. Crucially, what is important to highlight is that the 3C's framework can predict these key effects as a result of the processing stages, separate from or potentially even without biases being present in the input probabilities.

5. 1 Egocentric Bias

Consider the application of the 3 C's processing framework to two comparable coincidences one of which is mine and one of which is yours. If the events weren't surprising in terms of a high initial probability by chance and/or an obvious causal mechanism, then both of us wouldn't make it beyond stage 1 and it is very unlikely either of us would even think a coincidence had occurred. However to the extent that the events are surprising, in terms of a low apparent probability by chance and no habitually applicable causal mechanism, they both initiate stage 2, the search for plausible causal mechanisms. If either of us finds one, then stage 3 terminates "Cause". However if we've both exhausted stage 2 and haven't found any plausible causal mechanisms then the events survives in our own minds as "Coincidence!" So at any given moment in time such a coincidence has survived a fairly extensive and maybe even exhaustive search process thus making it quite surprising. Also we both may be inclined to tell other people "This surprising thing happened...." so in turn we're also both likely to hear about other peoples' "surprising coincidences" as well. But an apparent egocentric bias can occur between my own and other peoples' i.e. your coincidences

because my coincidence has survived and maybe even exhausted stage 2 and is still pretty surprising at the end of stage 3. But while your coincidence may still be surprising to you at the end of stage 3, I haven't even completed stage 2 for it yet; i.e. I'm still searching. Further there's a substantial chance that my different causal search space results in at least a semi-plausible mechanism for your coincidence that you've missed. In essence, two minds are better than one. So now my coincidence is more surprising that yours as mine has survived a selection process in terms of my search and that of the other people I've told and is still a "surprising coincidence" while at the same time my additional search for yours may downgrade it to being just a "somewhat surprising coincidence" or at best leave it the same. In short, the search and selection process through these stages can produce an apparent egocentric bias even if the component input probabilities are unbiased. A paradoxical prediction from this search selection process is that forced termination of causal search early before it is exhausted should result in *higher* judged probability of *some* as yet unspecified causal mechanism compared to a search which is allowed to run its full course.

Another potential reason for the egocentric bias is related to the meaningfulness of the coincidence for the protagonist who experienced it. In terms of the 3C's framework, meaningfulness is closely tied to the importance of personally relevant causal mechanisms especially in terms of usefulness. All else being equal, it is generally more important for me to detect potential causes impinging on me than those you report as impinging on you. So to the extent that surprise is adaptive, my coincidences should be both more surprising and more meaningful to me than yours, even if my assessment of the relevant probabilities for both is unbiased.

5.2 Beliefs in the paranormal

The message concerning the association between poor probabilistic reasoning and frequency of experiencing coincidences is not clearly established, but there does appear to be

convergence in the literature on the association between beliefs in the paranormal and frequency of experiencing coincidences. Our framework would account for this effect in the similar way as with egocentric bias, which is the impact of beliefs is likely to influence stages 2 and 3 of the 3 C's framework. It's important to emphasize that there are two perspectives in this context, that of the person who experienced the coincidence and that of the researcher studying coincidences. From the perspective of the person experiencing the coincidence, belief in the paranormal means that stage 2 produces a reasonably plausible causal mechanism quickly and stage 3 terminates with the judgment "paranormal CAUSE!". Such an individual sees paranormal causation everywhere and consequently may miss more mundane normal causes when they're actually occurring. However, from the perspective of the researcher who doesn't believe in the paranormal, the person has actually experienced and is thus reporting a "coincidence." But if the individual doesn't believe in the paranormal, then they are more likely to do a protracted stage 2 search for a normal causal mechanism. And because they're searching longer and harder, they're more likely to find one and terminate stage 3 by deciding "Cause" and not report the events as a coincidence at all. So again a selection process operating while moving through these three stages can explain the correlation between paranormal beliefs and the number of coincidences experienced separate from whether the component input probabilities are biased or not. A test of this hypothesis would involve believers and non-believers (in the paranormal) taking part in a diary study in which they keep a record of their coincidental experiences, estimates of their likelihood, and descriptions of possible explanations for each of them. We would predict that there would be fewer causal explanations and higher estimates of the rarity of the coincidences experienced for those that believe in the paranormal as compared to non-believers.

5.3 Individual Differences

Large scale surveys examining individual differences tend to suggest that the frequency of experiencing coincidences is not predicted by IQ, age, gender, occupation, and educational background. At least greater age, IQ and education background would all seem likely to correspond to a richer conceptual apparatus and a greater potential to detect surprising co-incidences in stage 1. However this is potentially offset by correspondingly rich causal search spaces, so there is a greater chance of finding at least semi-plausible causal mechanisms in stage 2 and thus resulting in less surprising and ultimately fewer "coincidences". However, this is likely, in turn, to be partly offset in the sense that the fewer events which survive this harsher selection process are likely to be *more* surprising. So overall search and selection results in offsetting tendencies in terms of coincidence occurrence but in the context of the prediction that the conceptual spaces of older, those that are better educated and also have higher IQ's should result in fewer but more surprising coincidences.

6. A final thought: Coincidences and the problem of induction

We have argued that coincidence and causality are different sides of the same covariance detection coin, and for this reason we have proposed that coincidences provide an extremely useful alternative perspective on the mechanisms of causal induction. Studying coincidences is crucial, not only because they give a new perspective on the pattern repetitions the mind is prepared to detect in the first place but also because they correspond to an assessment of limitations in using past events to predict future events, because no plausible causal explanation has been found. That is, concepts which correspond to potential causal knowledge of the world and can provide inductive justification for thinking that a pattern will repeat in the future are called projectable (i.e. they allow the mind to reasonably project the past into the future) while concepts that don't are nonprojectable (Goodman, 1955). If coincidences are pattern repetitions ascribed to chance and not to underlying causal

structure then, we argue, coincidences can be usefully viewed as nonprojectable concepts and vice versa. While this conceptualization does not solve the philosophical problem of induction, examining coincidences gives a unique perspective both on the philosophical problem and on how the mind practically deals with causal induction.

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