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Abstract

In the absence of an objective contingency, psychological studies have shown that people nevertheless attribute outcomes to their own actions. Thus, by wrongly inferring control in chance situations people appear to hold false beliefs concerning their agency, and are said to succumb to an illusion of control (IoC). In the current article, we challenge traditional conceptualizations of the illusion by examining the thesis that the IoC reflects rational and adaptive decision making. Firstly, we propose that the IoC is a by-product of a rational uncertain judgment ("the likelihood that I have control over a particular outcome"). We adopt a Bayesian perspective to demonstrate that, given their past experience, people *should* be prone to ascribing skill to chance outcomes in certain situations where objectively control does not exist. Moreover, existing empirical evidence from the IoC literature is shown to support such an account. Secondly, from a decision-theoretic perspective, in many consequential situations, underestimating the chance of controlling a situation carries more costs than overestimating that chance. Thus, situations will arise in which people will incorrectly assign control to events in which outcomes result from chance, but the attribution is based on rational processes.

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The illusion of control: a Bayesian perspective

Adam J. L. Harris · Magda Osman

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Abstract In the absence of an objective contingency, psychological studies have shown that people nevertheless attribute outcomes to their own actions. Thus, by wrongly inferring control in chance situations people appear to hold false beliefs concerning their agency, and are said to succumb to an illusion of control (IoC). In the current article, we challenge traditional conceptualizations of the illusion by examining the thesis that the IoC reflects rational and adaptive decision making. Firstly, we propose that the IoC is a by-product of a rational uncertain judgment ("the likelihood that I have control over a particular outcome"). We adopt a Bayesian perspective to demonstrate that, given their past experience, people *should* be prone to ascribing skill to chance outcomes in certain situations where objectively control does not exist. Moreover, existing empirical evidence from the IoC literature is shown to support such an account. Secondly, from a decision-theoretic perspective, in many consequential situations, underestimating the chance of controlling a situation carries more costs than overestimating that chance. Thus, situations will arise in which people will incorrectly assign control to events in which outcomes result from chance, but the attribution is based on rational processes.

Keywords Bayesian · Illusion · Control

The Illusion of Control (IoC) indicates a perceived causal relationship between actions and outcomes in the absence of an objective contingency. Moreover, people not only

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attribute responsibility to desirable chance outcomes, but also undesirable ones (Biner et al. 2009; Langer 1975; Mirowsky and Ross 1990). In processing terms, this implies that we either encode an association between our actions and observed outcomes (when none exists), or incorrectly infer that through our actions we can influence a chance outcome. The prevailing opinion is that, while objectively there is zero contingency between actions and outcomes in some contexts (e.g., gambling scenarios, experimental settings), in most other contexts judging control is important from an adaptive perspective (Blanco et al. 2011) and may even be innate (Leotti et al. 2010). However, laboratory demonstrations of the IoC are taken as evidence that we make false attributions of causality, and maintain erroneous beliefs of control. In this article we propose that the IoC may be usefully situated within a Bayesian framework.

We follow a long tradition in assuming that rationality criteria should be based on information that is available to the agent. For example, if there are 20 red balls in an urn and 80 black balls, predicting that the next ball will be black is the rational decision regardless of the actual outcome. Participants are said to display the IoC if they perceive control in a situation where, objectively, there is none (i.e., the bias is evaluated on a privileged external standard). Here we assess the information available to the individuals who display the IoC. We argue that the IoC is a necessary by-product of a rational judgment (on standards of Bayesian probability and Decision Theory), given the statistics of the world in which we live.

In the present article, we do not purport to provide an exhaustive review of the IoC literature. Rather, we propose a framework which links IoC research to 'big' questions concerning the fundamental representational structure of the cognitive system (e.g., Chater et al. 2010, 2006), as well as 'big' issues concerning ways in which we reduce uncertainty. Firstly, we consider a Bayesian approach as a way of identifying in a principled manner what makes a situation controllable. The approach prescribes that, when making a judgment about the controllability of a situation, agents should combine the available evidence with their prior degree of belief. In support, there is evidence demonstrating that cues typically more representative of controllable than of uncontrollable tasks are reflected in judgments of control in laboratory based IoC tasks (e.g., Langer 1975; Langer and Rodin 1976). Moreover, we propose that people's prior degrees of belief should reflect the fact that most naturalistic scenarios are controllable.

Following judgments as to the likelihood that a situation is controllable, the next step is to decide whether to act as though the situation is controllable or uncontrollable. We propose Decision Theory as the framework within which such a decision should be made. The decision will thus be influenced by the utilities associated with misclassifications of controllable events as uncontrollable ('misses'/the 'illusion of chaos') and uncontrollable events as controllable ('false positives'/the IoC). We propose that asymmetries in the utilities associated with these different errors further enhance the likelihood for an objectively uncontrollable situation to be rationally, although wrongly (from an objective perspective), classified as controllable (the IoC).

1 Bayesian rationality

The main sources of evidence for the IoC have originated from artificial environments (e.g., Psychology Laboratories, Casinos), which have been deliberately constructed

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so as to give rise to an illusory perception of control. The first argument we make is that participants in IoC experiments optimally use the evidence available to them when making judgments of the controllability of a situation. Thus, the IoC is a result of rational Bayesian updating. Psychological experiments investigating the IoC are unusual in that the conditions imply control when, objectively, control is absent.

Within the Bayesian framework, degrees of belief are represented as single event probabilities (or distributions over these probabilities). Here we propose that people have a degree of belief in the truth of the hypothesis 'Outcome X is controllable'. Bayes' Theorem prescribes how people should update their degree of belief in a hypothesis (e.g., that an outcome is under their control) upon receipt of a piece of evidence:

$$P(h|e) = \frac{P(h)P(e|h)}{P(e)}$$

Thus, a person's posterior degree of belief in the hypothesis, given a piece of evidence, $P(h|e)$, is a function of their degree of belief in the hypothesis before receiving evidence (the *prior*), $P(h)$, the likelihood of the evidence given the truth of the hypothesis, $P(e|h)$, and the base rate of the evidence, regardless of the truth status of the hypothesis, $P(e)$. The main support for our proposal, that the IoC is a result of such rational belief updating, comes from the evidence people appear to use to make inferences about controllability in IoC studies. In the remainder of this article, we provide evidence in support of our first argument, that the IoC results from rational belief updating, by considering the role of evidence (e.g., cues to controllability). Secondly, we discuss the limited available evidence concerning the role of priors, and propose this as a fruitful direction for further research. Finally, we outline the decision theoretic framework within which we locate our account.

2 The role of evidence

Langer (1975) claimed that people conflate chance- and skill-based situations because choice and active-involvement in a chance based task were the critical factors that generated the IoC. We consider this popular interpretation of the IoC from the point of view that the conflation between chance and skill is not erroneous, rather people are inferring cues to skill from IoC tasks (i.e., updating their degree of belief that a task is controllable from the supporting evidence), and basing their actions on this. From a Bayesian perspective this is a rational basis for judging control.

2.1 Choice and skill

From early demonstrations of the IoC and associated work on control (e.g., Langer 1975; Langer and Rodin 1976), to recent studies on choice and gambling (Martinez et al. 2009), having a choice within a task has been shown to increase perceptions of control. The relationship between choice-behaviors and the IoC has therefore been a popular basis for understanding the illusion. To gain insight into this relationship,

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we turn to situations which involve choice and chance, such as gambling scenarios (e.g., a roulette player can *choose* to bet on red or black, but this does not change her probability of winning [*chance*]). Gambling scenarios, or variations of them, have dominated IoC research. The rationale being that people's underlying motivation is to act in ways that will increase their success in achieving desirable outcomes. The probability of desirable outcomes will increase as a result of choice in skill-based tasks. In chance-based situations we therefore tend to make a misattribution that we can influence the outcomes when there is some choice in the tasks used. We know that there are several factors associated with gambling contexts which help to heighten our perception of agency over future outcomes (Burger 1986; Langer 1975; Langer and Roth 1975). For instance, they are often interactive which means that not only are our choices incentivized, but we are invested in the game because we directly act in it and can become familiar with it. Clearly it is wrong to hold beliefs of agency in zero contingency contexts, but it may not necessarily be irrational.

As outlined in the 'Bayesian Rationality' section above, to inform our judgment, we should combine our prior with the evidence at our disposal. The cues (e.g., choice and familiarity) that typically result in a greater likelihood of the IoC can be considered as items of evidence (Langer 1975), and thus our belief in the controllability of the situation *should* increase. For instance, amongst many of the factors that help improve our skill in performing cognitive and motor tasks (e.g., playing the piano, flying a plane, operating the latest mobile phone handset) is building up familiarity with the task through extensive practice (e.g., Ericsson and Lehmann 1996). When providing participants with repeated choices in IoC tasks, it is therefore no surprise that people are willing to attribute rewarding outcomes to their own agency, because the task conditions provide evidence that skill can influence the outcome (Langer 1975).

2.2 Active involvement

The proposal that participants use evidence from the task to make judgments about the controllability of the scenario is not a new argument, nor does it imply a Bayesian explanation. Matute's (1996; see also, Blanco et al. 2011) framing of the IoC within an associative learning approach specifies the role of active involvement in the IoC in terms of the probability of responding (interacting with the task), $P(R)$. On this account, the IoC is largely driven by the frequency of occasions on which an individual acts in an environment. Differences in the number of times a response is made leads to differences in the data/evidence that is obtained, consequently the IoC can arise in simulations of a standard associative learning model, such as the Rescorla-Wagner model (Matute et al. 2007). In order to most accurately perceive the degree of contingency between an action and an outcome, an agent should only make an action on half the available trials, so as to understand the number of times in which the outcome occurs in the absence of the action, as well as in the presence of the action. As the frequency of responding increases, so will the exposure to spurious associations between actions and positive outcomes; because responses appear to be reinforced this will further increase the probability of responding in the future (Blanco et al. 2011). Blanco et al. (2011) task, a variant of Alloy and Abramson (1982) learned helplessness study,

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involved the presentation of 50 fictitious medical case notes from patients with the same rare disease. Participants had to decide whether they would administer medicine (by pressing a button) or not (not pressing a button). They then received feedback on the status of the patient ("well", "still ill") but crucially there was zero contingency between the choice to medicate and the patient's status of health. As the number of responses (button presses) increased, so too did the estimates of success in generating a positive outcome (IoC), regardless of the actual, objective, contingency.

Work in the associative learning domain suggests that evidence (i.e. outcomes associated with repeated actions) influences the degree to which people succumb to the IoC. Critically, however, the way in which evidence is experienced (i.e. through active involvement) is, on an associative account, crucial to generating the IoC. However, choice appears to influence the IoC above and beyond repeated active response in chance based situations, for example the IoC can arise from a single exposure to a choice event (Langer 1975; Martinez et al. 2009). In this case the IoC is not dependent on multiple experiences of action-outcome associations. The associative account rests on demonstrations of the IoC in situations in which people have repeated exposure to probable reinforcers or repeated active involvement in a chance based situation. This account, however, is clearly limited given the range of conditions in which the IoC phenomena has been reported. The Bayesian account is proposed as a unifying framework within which all instances of the IoC can be understood.

In addition to highlighting the role of evidence, the Bayesian account also stipulates that evidence should be combined with *priors,* a consideration that cannot be incorporated within an associative learning account.

3 Priors

Recall our earlier example of an urn filled with 20 red balls and 80 black balls. By extension, if, over the course of your lifetime, you have had many exposures to urns and the sizeable majority contained a preponderance of black balls, then before drawing any balls from the new urn your prior expectation will be that there are more black balls than red balls. We propose that over the course of a person's lifetime, most people perceive more situations that are controllable than situations that are uncontrollable. Consequently, upon entering an experimental situation, especially one with cues that are reminiscent of controllable situations (e.g., skill, choice, active involvement), your expectation (i.e., prior) is that this is more likely to be a situation that is controllable than one that is uncontrollable ($P[controllable] > .5$).

Despite empirical evidence for the IoC, to date there are no dedicated investigations of how prior experience influences judgments of control. Such studies need to explore the differences in people's expectancies (priors) for different types of contingency in different experimental situations. Only by considering all possible contingency relationships can the role of priors be completely understood, because some situations will invoke prior beliefs of a positive contingency, others a negative contingency, and still others, no contingency. To explore the role of priors, a focused empirical research program would therefore systematically manipulate priors, before presenting participants with a situation in which either a positive, negative or no contingency exists.

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Without such focused and controlled research, interpretations of previous results that might be perceived as indirectly investigating this issue are speculative. Nevertheless, in this section we aim to highlight the key role that priors are presumed to play in the IoC, and present a possible fruitful line of research on the IoC that could be explored.

To make sense of findings from the IoC literature Mirowsky and Ross (1990) have also suggested a role for the priors that people bring to an experimental situation from their life experience. The effect that they focus on is the commonly reported finding that the IoC is observed less in depressed individuals than in non-depressed individuals (e.g., Alloy and Abramson 1979).

Mirowsky and Ross (1990) examined the effects of individuals' judgments of responsibility for good/bad events, and good/bad outcomes. Non-depressed individuals gave high ratings of control over all four types of events and outcomes, whereas depressed individuals judged all four types of events as out of their control. These differences were explained on the basis of the locus of control (LoC). When the LoC is judged to be internal, it is associated with other aspects of behavior that indicate high levels of control (e.g., motivation, goal-directed thinking, ambition). When the LoC is judged to be external, in other words external factors are thought to influence outcomes (e.g., luck, fate, chance, powerful others, unpredictable complex mechanisms), judgments of control are lower for *all* events, controllable and uncontrollable. This explanation has since been supported by findings from Stadelhofen et al. (2009), who examined the relationship between LoC and depression in patients with pathological gambling problems. In addition, those scoring high in desire for control, a scale that examines the extent to which individuals are motivated to control outcomes in their environment (Burger and Cooper 1979), tended to make higher attribution judgments of negative as well as positive outcomes, as compared to those scoring low on the scale (Burger and Hemans 1988). Mirowsky and Ross argued that actually the real probabilities of a win or a loss of a simple laboratory task is not what determines the IoC. Rather, it is the prior beliefs of the probabilities of wins and losses that people bring with them to the lab. Depressed participants may have had prior beliefs that the probabilities of desirable and undesirable events occurring under their control were low. Contrast this with non-depressed participants that may have come in with a belief that there was a higher probability of desirable events occurring under their control compared with undesirable events. From a Bayesian perspective, the different attributions of control by depressed and non-depressed participants are thus rationally motivated. They reflect prior beliefs that have received support over the lifetime of experiences, and inform judgments of the controllability of novel situations.

As stressed above, further research is required to precisely determine the role of priors. Given, however, the potential for the Bayesian approach to provide a unifying framework for existing demonstrations of the IoC, we believe there are great gains associated with such an empirical program. It is clear to us that a conflation of skill and chance based situations can result in an increased likelihood of people demonstrating an IoC (e.g., Langer 1975). Likewise, in repeated choice tasks an associative learning account (e.g., Matute et al. 2007) provides a good account of the data, and could well be the best explanation for the data in such contexts. Moreover, associations between active involvement and frequent positively reinforced outcomes can be explained using a control heuristic in which people's judgments of control

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are informed by the perceived connection between their own action and the desired outcome, and their intention to achieve the outcome (Thompson et al. 1998). Rather than a critique of existing accounts, our intention has been to demonstrate that no extant account is able to explain all manifestations of the IoC observed in the literature. The Bayesian framework would appear to be a suitable candidate for providing such an overarching framework, and furthermore would link IoC research to a broad literature investigating the probabilistic nature of cognition (see e.g., Chater & Oaksford, 2008; Chater et al. 2006, 2010; Griffiths et al. 2010).

4 Combining priors and evidence: an empirical example

Ladouceur and Sevigny (2005) investigated the effect of a 'stopping device' on the IoC in a video lottery task divided into two phases. In Phase 1, participants were simply told to hit the 'play' button and then to watch as the reels settled on certain symbols. When asked, no participants reported that it was 'possible to influence the symbols after having pressed play', that 'there was a method for controlling the outcome', that 'skill could contribute to winning', or that 'there were strategies that could enable one to increase winning chances'. In Phase 2, participants were told that, if they desired, they could stop the reels by pressing anywhere on the computer screen. In this phase participants were more likely to answer the above questions in the affirmative, and in a follow up experiment participants who were given a stopping device played the game significantly longer than participants not provided with a stopping device.

The responses of these participants appear entirely rational. Under conditions in which there are no obvious cues indicating control, participants correctly report that there is no potential to control the outcome, whereas when there are obvious cues (i.e. a stopping device), participants give answers that are perfectly consistent with (erroneously) perceiving that it is *possible* to influence the outcome, and consistent with this, they behave accordingly, by playing for longer. Participants might know that they are, as of yet, unable to influence the outcome, but the evidence from the task suggests that it is controllable in principle. Perhaps if they practice for longer they can achieve control over the outcome. After all, many everyday tasks might at first appear uncontrollable, but we subsequently learn to control them (control over our own bladder is one of the earliest examples). In this study, participants used the evidence in the task and their past experience with the need to 'learn' controllability to infer that a currently uncontrollable task might, nevertheless, be controllable in the future.

5 Controllable or uncontrollable?

Bayes' Theorem alone cannot determine those situations in which one should act as though a scenario is controllable. Whether or not to act in such a way is a binary choice, whilst Bayes' Theorem's output is a probabilistic degree of belief. A binary output from a ratio scale requires the setting of some threshold value. Decision Theory prescribes that this output reflects both degrees of belief (probabilities) and the utility (subjective goodness or badness) of different possible outcomes. In any

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Table 1 The four possible outcomes of decisions based upon the controllability of a situation

		State of the world controllable	Uncontrollable
Act as though the world is…	Controllable	*Hit*	*False positive (Illusion of Control)*
	Uncontrollable	*Miss (Illusion of Chaos)*	*Correct rejection*

situation, there are two possible states of the world: The situation is controllable or the situation is not controllable. Similarly, one can act as though the world is controllable or uncontrollable. Thus, there are four potential outcomes (see Table 1).

Correct classifications of the world as controllable or uncontrollable (hits and correct rejections) are associated with positive utility, whilst incorrect classifications of the world (false positives and misses) are associated with negative utility. If the positive utility associated with a hit equals the positive utility associated with a correct rejection and the negative utilities associated with false positives and misses match, then the threshold for deciding that a situation is controllable or uncontrollable is: $P(controllable) = .5$. As soon as there is an asymmetry in the utilities, however, then the threshold moves from .5. Thus, if one perceives higher costs with a miss than with a false positive, the threshold will be less than .5, increasing the likelihood of acting as though a situation is controllable.

6 The London riots

Between August 6th and August 8th, 2011, London experienced its worst rioting for over thirty years. Rioters felt untouchable, and law-abiding citizens lamented that the situation appeared out of the control of police or government. Given scenes of grossly outnumbered police forced to stand by and watch the rioters, along with the lack of arrests at the time, and the sheer scale of the criminality, the evidence available pointed to an uncontrollable situation. On August 9th, the British Prime Minister, David Cameron, stated "…people should be in no doubt that we will do everything necessary to restore order to Britain's streets and to make them safe for the law-abiding…" Despite the available evidence at the time, this situation *did* prove to be controllable, and police were able to contain the situation. This example shows the benefits of perceiving a potential for control over a situation (sometimes in the absence of strong evidence for controllability).

If viewed in decision theoretic terms, there is a huge cost attached to signaling to the UK population that the events surrounding the riots provide sufficient evidence of an uncontrollable situation. Therefore, if wrongly judged to be uncontrollable, then no additional preventive action will be taken, and so further rioting and chaos ensues. In other words, it seems as though the costs associated with perceiving a controllable situation to be uncontrollable (illusion of chaos) will often be greater than those associated with perceiving an uncontrollable situation to be controllable (illusion of control). Consequently, in addition to often being in possession of priors and evidence indicative of a controllable situation, it might also be considered rational to set the

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threshold for acting as though a situation is controllable at less than .5, further exaggerating the likelihood of erroneously, but rationally, classifying an uncontrollable situation as controllable (as in IoC tasks).

Scheibehenne et al. (2011) highlighted a similar asymmetry related to the expectation for positive recency (the "Hot Hand Fallacy") in prediction tasks. Expecting or perceiving a pattern erroneously in such tasks cannot harm one, as performance cannot be better than chance. However, not spotting a correct pattern prevents an agent from being able to capitalise on the predictiveness of the environment.

Matute and colleagues (e.g., Matute 1996; Matute et al. 2007) make a similar point to the one advanced in this section, recognising that to obtain a desired outcome it is likely to be beneficial to continue to act (rather than be passive, and see if you obtain the outcome anyway). However, on Matute and colleagues' account, this is seen as a precursor to the IoC, which then occurs because participants act continuously to obtain the outcome and thus cannot learn that the outcome would also have occurred in the absence of their action. On our account, participants alter their threshold for deciding that a situation should be classified as controllable or uncontrollable, having already made a judgment of the likely controllability of the situation.

The present account of the IoC also exists within a broader framework outlined in McKay and Dennett (2009). They claim that there is a functional role in acting on misbeliefs that are based on reliable generalizations (e.g. men's general perception of women's sexual interests in them) that can be anomalous in particular situations (e.g. a woman doesn't share this intent). The trade-off between the overall accuracy of beliefs and their inaccuracy in certain situations comes from an asymmetry between the benefits (i.e. fitness) and costs (i.e. decreased fitness) of actions. Similarly, the IoC is a candidate for what they would classify as a (mis)belief that is an adaptive by-product of a cognitive system.

7 Conclusion

The British Prime Minister's announcement at the time of the riots illustrates the need to be seen as being 'in control.' Moreover, it is an illustration of the profound impact that perceived control has in affecting real world outcomes. We have argued here that the IoC is not a product of biased, motivated reasoning, but can be seen as a product of a rational Bayesian reasoning process. By reviewing the IoC literature we argue that forming judgments of control generally involves marshaling relevant evidence, which is combined via Bayesian methods of inference with prior beliefs that people bring to laboratory settings. Furthermore, in making a binary judgment as to whether to act as though a situation is controllable or not, people operate under the assumption that overestimating control in uncontrollable environments is advantageous to underestimating control in controllable environments.

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