How Imagination Gives Rise To Knowledge

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A long and well-established philosophical tradition assigns the imagination a central role in the justification of our modal beliefs. Just as perceiving a state of affairs justifies us in believing that it is actual, imagining a state of affairs is thought to justify us in believing that it is possible.[1] This tradition has its fair share of opponents, and even among its adherents there is by no means a clear consensus about how and why imagination can play this justificatory role.[2] But there does seem to be widespread agreement about at least the following claim: Whatever justificatory power the imagination may have is limited to the modal sphere.[3] Outside of the domain of modal epistemology, the imagination is, as Brian O'Shaughnessy puts it, "out of the cognitive circuit." (O'Shaughnessy 2000, 345)

Our ordinary epistemic practices seem to support this philosophical conclusion, or what I will call *the charge of epistemic irrelevance* (CEI). Consider, for example, a doctor who diagnoses his patients not by running lab tests but by imagining what diseases he thinks they have.   This sounds like a malpractice suit waiting to happen. Or consider a trial in which the prosecution's star witness is not an eyewitness but rather a "mind's eye" witness: The lead detective has marshaled his case against the defendant not in the field but in his imagination. Surely the jury would not take long in their deliberations before delivering a verdict of not guilty.

Unless, perhaps, the detective in question were Sherlock Holmes. Holmes' crime-solving prowess owes directly to his ability to take the scant evidence available and somehow "see" in his imagination how everything fits together.[4] In case after case in the Conan Doyle

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[1] See, e.g., McGinn's claim that "imagination is the *means* by which we acquire modal knowledge; it functions to supply *reasons* for modal belief." (2004, 138)

[2] For an excellent introduction to some of these issues, see Gendler and Hawthorne (2001).

[3] I here set aside the trivial fact that an exercise of imagining may contribute to the justification of non-modal beliefs about that exercise of the imagining itself. My having imagined a purple cow contributes to the justification of my belief that I have imagined a purple cow. But my having milked a brown cow likewise contributes to the justification of my belief that I milked a brown cow. Just as the latter claim does not show that cow-milking has a role to play in epistemology, the former claim does not show that imagining has a role to play in epistemology.

[4] Holmes is not the only (fictional) detective to work this way. Nero Wolfe, who famously aims never to leave his brownstone for business purposes, leaves all the legwork to his assistant Archie Goodwin. Once Wolfe is in

oeuvre, Holmes retreats into his imagination to solve the case with which he's been presented. He is able to identify the perpetrator and to describe various heretofore unknown details about the crime itself. The conclusions that Holmes reaches inevitably turn out to be true; in fact, he himself refers to the imagination as the "mother of truth." (Conan Doyle 1953, 943) More importantly, the stories suggest that he is justified in believing them. As Holmes tells Watson, "If we go beyond facts, use our imagination as the criminal does, imagine what might have happened ... we usually find ourselves justified."[5] He also explicitly rejects the suggestion that what he is doing is guesswork. Rather, he describes his method as the "scientific use" of the imagination. (Conan Doyle 1953, 804)

In this paper, I will argue that the imagination can indeed be put to such a use, i.e., the imagination cannot be dismissed as epistemologically insignificant. Granted, Sherlock Holmes is a fictional character, but the imaginative method that he uses – or what he would call his "art of detection" – is not limited to the world of fiction. As we will see in what follows, there are a variety of situations – real situations – in which it is plausible to claim that the justification for a non-modal belief owes to an act of the imagination – that is, in which an imagining can justify our belief in a contingent claim about the world.[6] Contrary to the charge of epistemic irrelevance, the imagination is not entirely out of the cognitive circuit.

Of course, it's a tricky business to define exactly what imagining is, and I will not here attempt to offer an account of my own.[7] For the task at hand, however, no such account is needed, since the examples that I use in what follows fall squarely within our usual understanding of the term. For example, although philosophers disagree about whether all imaginings involve imagery, it is uncontroversial that at least some of them do, and any account of imagination will have to accommodate them.

My argument proceeds by first considering two real-life people with exceptional powers of visual imagination: Nikola Tesla, an electrical engineer who pioneered the development of alternating current technology, and Temple Grandin, an animal scientist whose innovative

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possession of the facts of the case, he retreats into an almost trancelike state, his lips pushing in and out. Thereafter, he inevitably solves the mystery before him.

[5] This quotation, which is from the film version of *The Hound of the Baskervilles*, seems to have been borrowed from *The Memoirs of Sherlock Holmes* where Conan Doyle writes "'See the value of imagination,' said Holmes. 'It is the one quality which Gregory lacks. We imagined what might have happened, acted upon the supposition, and find ourselves justified.'"

[6] I hereafter leave out the qualifier "non-modal." Moreover, in presenting my argument, I assume that we do sometimes have justified beliefs about the external world. In other words, I here set aside the worries of a skeptic who denies that we are ever justified in such beliefs. Thus, one useful way to construe the issue before us is by way of an analogy to perception. In at least some cases, perceiving a states of affairs *S* justifies (or contributes to the justification of) the belief that *P*. I want to show that, in at least some cases, imagining a state of affairs *S* can have the same justificatory power.

[7] But see my [citation withheld].

designs have revolutionized the handling of livestock. Both of these individuals explicitly credit their imaginative exercises as having played a critical role in their creative success. But how should that role be understood? As I argue, their imaginings served not merely as an impetus for new ideas but rather in a justificatory capacity with respect to those ideas.

Importantly, my overall line of argument does not depend on the fact that these individuals – like the fictional Sherlock Holmes – are unusually gifted imaginers. I thus go on to consider our more ordinary imaginative exercises to show how in at least some cases they too can play a justificatory role. I by no means want to claim that *all* imaginings, or even *most* imaginings, can do this. The imaginings of a jealous husband do not themselves justify his belief that his spouse is cheating on him; the imaginings of a paranoid politician do not themselves justify his belief that the enemy is harboring weapons of mass destruction. But, as I will suggest in the final section of the paper, the sorts of cases in which imagining plays an epistemic role can be easily distinguished from the sorts of cases in which it does not. In particular, I offer an account of imagining that I call *imagining under constraints* that provides the framework for making this distinction.[8]

First, however, it will be helpful to have a clearer sense before us of what exactly the charge of epistemic irrelevance amounts to, as well as to clarify the challenge that one faces in trying to acquit the imagination of this charge. It is to these tasks that I now turn.

1. The Charge of Epistemic Irrelevance

In some respects, the challenge that faces us in responding to this charge may not seem very demanding at all. After all, many of the world's creative geniuses are widely recognized as having special powers of imagination, and it is commonly assumed that their remarkable discoveries owe at least in part to their imaginative powers. For example, Michael Farraday's ability to visually imagine unseeable "lines of force" led to his revolutionary developments in electromagnetism. (West 2009, 45) Similarly, at the age of sixteen, Albert Einstein famously imagined what it would be like to ride alongside a light beam, and this is just one of many acts of imagination standardly mentioned as central to his incredible scientific success. In the acclaimed biography *Einstein: His Life and Universe*, Isaacson credits the fact that Einstein was able "to make conceptual leaps that eluded more traditional thinkers" to his uncanny ability to visually imagine the reality behind mathematical equations. (Isaacson 2007, 93; see also 7ff) Given these examples, it seems obvious that imagination has an important role to play in our acquisition of knowledge.

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[8] I am indebted to [name withheld] for this terminology.

Unfortunately, however, the role that the imagination plays in these kinds of examples does not help us combat the charge of epistemic irrelevance. The problem is not that the imaginative acts in question were merely incidental to the scientific discoveries in question – let's grant for the sake of argument that they played an indispensable role in the respective creative processes. Rather, the problem is that the role looks to be the wrong sort – the role played by the imagination in these sorts of examples is compatible with the kind of epistemic irrelevance that proponents of the CEI have in mind. To see this, consider another famous example of an innovative scientific discovery: Friedrich von Kekulé's identification of the ring structure of the benzene molecule. According to Kekulé, his discovery owed to a dream he had in which snakes were devouring their own tails.[9] Kekulé's dream images of snakes clearly played an important role in *prompting* his scientific discovery, but they in no way contributed to the justification of his belief that benzene molecules had a ringlike structure. The role played by the imaginative acts of Einstein and Farraday in their scientific discoveries seems plausibly construed as akin to the role played by Kekulé's dream in his scientific discovery. While these imaginative acts serve to generate new ideas, they do not themselves serve to justify them. Thus, although examples like these show that the imagination can play an important role in problem solving and/or the creative process – thereby leading to new knowledge – they do not make clear that the imagination can play a *justifying* role in these processes, and this is what proponents of the CEI are concerned to deny.

Similar considerations suggest that we cannot combat CEI by way of mundane cases in which an imaginative exercise prompts new thoughts or jogs our memory in such a way that we reach new conclusions. We may call upon our visual imagination when confronted with certain questions – How many windows are on the north side of your house? What shape are a beagle's ears? – but in these cases, the justification for our new beliefs owes not to the imaginative exercises themselves but to the past perceptions on which they are based.[10] Likewise, we often use the imagination to help us represent various options when we are reasoning about what to believe. (See McGinn 2004, 142) In representing these beliefs, however, the imagination does not itself provide us with any reasons to believe them. Thus, while these sorts of cases suggest that the imagination can help us gain knowledge about the world, they do not show that it does so in any sort of justificatory capacity.

None of these cases, then, yet establishes that imagination has the kind of epistemic relevance that proponents of CEI deny. But there is one more potential source of support of

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[9] For a discussion of Kekulé's dream, see West (2009, 236-7).

[10] Kosslyn 1995 provides a list of questions of this kind. As McGinn notes, when confronted with these sorts of questions, we may not be able to answer them easily without forming mental images, and so "there is some kind of cognitive enhancement occasioned by the image; something is learned." (McGinn 2004, 19-20) But this kind of cognitive enhancement does not equate to justification.

opposition to CEI that is worth considering, namely, Kant's account of the productive imagination and the role that it plays in perception. As Strawson explains, on the Kantian view:

> the actual occurrent perception of an enduring object as an object of a certain kind, or as a particular object of that kind is, as it were, soaked with, or animated by, or infused with—the metaphors are *à choix*—the thought of other past or possible perceptions of the same object. (Strawson 1970, 41)

Since it is the role of the imagination to produce these "nonactual" perceptions of the object, the imagination is, as Kant says in the Transcendental Deduction, "a necessary ingredient of perception." (Kant A120)

On this Kantian view, then, the imagination seems to have the kind of epistemic relevance at issue in CEI. Given that perceptions serve to justify beliefs, a view which holds that imagination is constitutively involved in perception would seem to entail that the imagination serves to justify our beliefs. However, here the imagination has its epistemic relevance only derivatively – it is not imagination *qua* imagination that plays a justificatory role, but only imagination *qua* participant in the act of perception. The Kantian view does nothing to show that imaginative exercises have any justificatory power in their own right.

It's this claim that I aim to defend in what follows, and it's this claim that is denied by the proponents of CEI. But now that we've clarified what's meant by the charge that the imagination lacks epistemic relevance (and, in what follows, whenever I use the terms "epistemic relevance" or "epistemic irrelevance," they should be understood in the sense intended by CEI) we can get a better sense of what we're faced with in trying to respond to this charge.

CEI is often presumed to be obvious, obvious, so obvious that philosophers often simply presuppose it without bothering to present any argument for it. For example, philosophers working on the epistemology of perception typically take it as their starting point that imaginings, like desires and hopes, are not sources of justification – as Markie puts it, "They have no epistemic status."[11] But reasons can indeed be given in support of CEI, and the philosophical case in support of it owes primarily to the work of Sartre and Wittgenstein. In their respective discussions of the imagination, each of these two philosophers attempts to show that our imaginative exercises have several basic features that prevent them from contributing to our knowledge of the world. Although these features are inter-related, I would suggest that we can distinguish three different claims about the imagination – each of which distinguishes it from perception – that assume central importance in the argument for its epistemic irrelevance:

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[11] Markie (2005, 348). See also Heumer (2001, 98).

1) Imagining is typically under our voluntary control. Although we may close or cover our eyes, we do not generally have control over what we perceive in the way that we generally have control over what we imagine. As Wittgenstein succinctly puts the point: "It is just because imaging is subject to the will that it does not instruct us about the external world." (1948/1980, §80)[12] Hume's claim in the *Treatise* that nowhere are we more free than in our imagination also seems relevant here.

2) Imagining is not world-sensitive – its content is determined by the imaginer, not by the world. An act of imagining is, as Wittgenstein puts it, a "creative act." (1948/1980, §111) Thus, while changes to the objects that we're seeing cause changes to our perceptions of them, they need not cause any changes to our imaginings about them. An act of imagining typically fails to track changes in the worldly objects with which it is concerned and can diverge dramatically from the actual facts about them.[13] Moreover, as Brewer notes, the fact that the imaginings are our own creations means that an imagining "succeeds in being *of a particular thing*, if it does so, only because this particularity is derived from the subject's attendant beliefs and imaginative intentions, rather than from the world." (Brewer 1999, 226)

3) Imagining is uninformative – an act of imagining can provide us with no new information. As Sartre claims, "nothing can be learned from an image that is not already known." (1948, 12) Since on his view "it is impossible to find in the image anything more than what was put into it," we can conclude that "the image teaches nothing." (1948, 146-7)[14] Wittgenstein seems to be after a similar point when he notes that we are not surprised by the content of our imaginings. (Zettel §632)

Any attempt to establish the epistemic relevance of the imagination must grapple with these three claims. For each one, we seem to have two options: We might deny that imagination really has the feature in question, or we might deny that the feature in question prevents the imagination from being epistemically relevant. My strategy in what follows will proceed primarily by way of the second of these options. As I will argue, once we properly understand what these three features of imagining really involve, we will see that they present no reason to deny the epistemic relevance of the imagination.

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[12] See also O'Shaugnessy (2000, 359), McGinn (2004, 12-17, 131-2).
[13] See also McGinn (2004, 132)
[14] See also McGinn (2004, 18).

2. Extraordinary Imaginers

Now that we have a clearer sense of why, and in what sense, the imagination has been charged with epistemic irrelevance, I can begin to rebut this charge. To make my case against CEI – that is, to show that the imagination can play a role the justification of our beliefs – it will be helpful to look at some specific examples in more detail. In this section I focus on two individuals, Nikola Tesla and Temple Grandin, both of whom are particularly gifted imaginers. Although the degree of their imaginative talents is highly unusual , they should not be taken as singular in this regard; there are countless other people endowed with special powers of imagination that could equally well serve my purposes.[15] Moreover, as my discussion will show, what's important to me about Tesla and Grandin is not the depth of their imaginative talent, but the use to which they put that talent.[16]

a. Nikola Tesla

Born in 1856 in what was then Austria-Hungary, Nikola Tesla found himself from a very early age to have remarkable powers of visualization. This was initially less a blessing than a curse:

> When a word was spoken, the image of the object designated would present itself so vividly to my vision that I could not tell whether what I saw was real or not. If I had witnessed a funeral, or perhaps come close to some animal while on a hunting trip, then inevitably in the stillness of night a vivid picture of the scene would thrust itself before my eyes and persist, despite all my efforts to banish it. (Tesla 1921)

In an attempt to rid himself of these "tormenting appearances," Tesla taught himself to refocus his mind on some remembered scene that was more tranquil. Eventually, he began instead to imagine scenes that he had never previously witnessed, and in the process he trained himself to make the imagined scenes extremely sharp and vivid.

At the age of seventeen, while studying electrical engineering, Tesla discovered that his imaginative training could be put to use in the process of invention. As he describes it, "I observed to my delight that I could visualize with the greatest facility. I needed no models, drawings or experiments. I could picture them all as real in my mind." (Tesla 1919, 4) Tesla went on to develop the alternating current technology in widespread use around the world

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[15] See West 2009 for numerous other examples.

[16] Even in this regard, Tesla and Grandin are by no means peerless. To give just one other example, A. R. Luria presents a detailed case study of a man, S., whose imagination "allowed him to solve, with an ease that was truly enviable, certain practical problems that others would have to reason through at length. These he solved quite simply, by means of his inner vision." (Luria 1968, 98)

today, and the many inventions for which he is responsible include high-voltage electrical coils, long-distance electrical transmissions lines, hydroelectric generators, bladeless turbine engines, X-ray tubes, and various radio-controlled devices.

Of interest to us, however, are not the inventions themselves but rather the creative process underlying their development. In Tesla's view, many inventors proceed far too quickly to physical construction. This rush to build inevitably causes one to get caught up in details at the expense of the underlying principles at work. His own method, which he takes to be "more expeditious and efficient," is strikingly different:

> Before I put a sketch on paper, the whole idea is worked out mentally. In my mind, I change the construction, make improvements, and even operate the device. Without ever having drawn a sketch, I can give the measurement of all parts to workmen, and when completed these parts will fit, just as certainly as though I had made accurate drawings. (Tesla 1921)

Moreover, Tesla claims that it is "absolutely immaterial" to him whether he mentally runs the machine in his mind or whether he physically runs it in his shop: "There is no difference whatever, the results are the same." (Tesla 1919) As he reports:

> The inventions I have conceived in this way, have always worked. In thirty years there has not been a single exception. My first electric motor, the vacuum tube wireless light, my turbine engine, and many other devices have all been developed in exactly the same way. (Tesla 1921)

b. Temple Grandin

Although Temple Grandin was introduced to the world by Oliver Sacks in the titular essay from his collection, *An Anthropologist on Mars*, she has recently become a celebrity of sorts because of the Emmy-award winning HBO biopic about her life (in which she was sympathetically portrayed by Claire Danes). Over the past several decades, Grandin has significantly improved the welfare of animals throughout the world by revolutionizing the design of livestock-handling facilities. Approximately half of the cattle in North American meat plants are now handled in systems that she designed. Grandin's accomplishments are especially noteworthy in light of the fact that she has autism – though it is also undoubtedly true that her autism has in many ways contributed to her success by gifting her with extraordinary powers of visualization. As Grandin herself notes, "One of the most profound

mysteries of autism has been the remarkable ability of most autistic people to excel at visual spatial skills while performing so poorly at verbal skills." (Grandin 1995, 19-20)[17]

Grandin characterizes herself as thinking in pictures, with words being a "second language" to her: "I translate both spoken and written words into full-color movies, complete with sound, which run like a VCR tape in my head." (Grandin 1995, 19) When she was a child, she assumed that everyone thought this way, and it was only when she got to college that she began to realize that her visualization skills were quite different from, and far superior to, the people around her. She credits these skills with enabling her to understand the animals that she works with and to translate that understanding into a design solution; as she notes, "Visual thinking has enabled me to build entire systems in my imagination." (Grandin 1995, 19)

Grandin, who explicitly compares her mode of thinking to Tesla's, describes her design process in terms very similar to his:

> Now, in my work, before I attempt any construction, I test-run the equipment in my imagination. I visualize my designs being used in every possible situation, with different sizes and breeds of cattle and in different weather conditions. Doing this enables me to correct mistakes prior to construction. (Grandin 1995, 20-21)[18]

Although many 21st century designers use three-dimensional computer simulation programs, Grandin claims that she has no need for any such "fancy graphics program ... I can do it better and faster in my head." (Grandin 1995, 21)

One of Grandin's early design successes came in 1978 when she developed an innovative dip vat design for a cattle-handling facility in Arizona. A dip vat, which is filled with pesticide to rid animals of parasites, is a long narrow pool-like structure in which cattle are completely immersed while proceeding through it single file. Prior to Grandin's designs, cows would often panic both when approaching the dip vat and when exiting it. By taking a "cow's eye view" of the situation, Grandin diagnosed the problems with the existing structures and was able to create an alternative in which the cows would calmly enter and exit the equipment voluntarily, without any use of force. Her design process, however, took place entirely in her mind: "I started running three-dimensional visual simulations in my imagination. I

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[17] Interestingly, Tesla also was probably somewhere on the autism spectrum. In addition to having strong sensory aversions, he had many other unusual habits and compulsions. As a child he would count his steps while walking and could not enjoy his meals unless he "calculated the cubical contents of soup plates, coffee cups and pieces of food." Moreover, he always did repeated actions in numbers that were multiples of three. (Tesla 1919) For discussion of the connection between autism and visual ability, see West 2009.

[18] For the comparison to Tesla, see Grandin (1995, 26).

experimented with different entrance designs and made the cattle walk through them in my imagination. These images merged to form the final design." (Grandin 1995, 23)

Because Grandin's design for the dip vat entry was so different from the one traditionally used, it was greeted with skepticism by many of the livestock handlers. In fact, these workers were so convinced that her design would prove unworkable that they initially implemented various modifications behind her back. Unfortunately, these modifications led to the drowning death of two cattle, and once Grandin discovered them, she insisted that the entry be converted to her original specification. As she reports, the workers "were flabbergasted when they saw that the ramp now worked perfectly." (Grandin 1995, 23-24).

Having imagined her new dip vat design, Grandin believed that it would work. She believed this before she saw the new dip vat in action, in fact, she believed it before the dip vat was even built. She was confident in this belief. And, although she does not say so explicitly, I think that it's pretty clear from her own account that she would take herself to be justified in this belief. The same is true for Tesla. Should we accept this characterization of their epistemic states? Answering this question will be the task of the next section.

3. Generation vs. Justification

Consider some particular claims that Grandin might plausibly have believed after engaging in her imaginings, such as:

>   *Dip vats built to these specifications are more effective than currently existing dip vats.*

>   *An entry built to these specifications makes things easier on the cows than the entry on currently existing dip vats.*

>   *Cows entering a dip vat built to these specifications don't panic.*

Although the proponent of CEI will happily grant that these beliefs were *generated* by Grandin's imaginative acts, CEI implies that the beliefs were not *justified* by them. The CEI proponent thus has two options: deny that these beliefs are justified at all, or accept that they are justified but deny that the justification stems from the imagination. To my mind, neither of these options seems plausible. Let's consider each in turn.

Option One: The beliefs are not justified.

Fast forward a bit from the time of Grandin's imaginings to the time that the first dip vat is built according to the specifications of her new design. At this time, the owner of the cattle-handling facility watches hundreds of cows walking in single file, entering the dip vat, and

remaining calm and peaceful. I assume that there would be no question that at this point, absent defeaters, the owner would be justified in believing the above claims. Perceptual experience of actual cows using the dip vat without panicking justifies his belief that cows using a dip vat like this don't panic.

But must he have had the direct perceptual experience of the cows in order for his belief to be justified? Surely not. Had he been watching a live camera feed of the cattle procession from his office, his belief in the effectiveness of the new dip vat – again, absent defeaters – would equally have been justified. Likewise if he had been watching the camera feed on a tape delay. He doesn't actually have to be out there in the muck in order to be justified in this belief.

Now let's suppose that after Grandin had produced her new design specifications, but before the dip vats were actually built, the owner had asked his design firm to run some three-dimensional computer simulations. With the sort of "fancy graphic programs" that Grandin dismissively mentions, the design firm presents the owner with a detailed simulation of cows using a dip vat with the new design. The simulation shows the cows entering peacefully and being appropriately immersed in the pesticide. It is a highly detailed, multi-view simulation, and the program has been completely reliable in the past. Is watching this sort of simulation sufficient to justify the owner's belief?

Here I have the strong intuition that it is – or at least, that it can be, assuming that it is suitably reliable, etc. In support of this intuition, it is worth noting that computer simulations have become ubiquitous in both science and social science, and they are generally considered to be a critical part of the scientific enterprise. To give just a few examples:

- In 1992, the United States entered into a unilateral moratorium on nuclear weapons testing. The justification for our expectations that these weapons work thus owes entirely to advanced computer simulations that have been run.
- Computer simulations were used to predict how the oil from the spill in the Gulf of Mexico would spread, and decision about how to focus clean-up efforts were based on those predictions.
- Investment banks, venture capitalists, and private equity firms use computer simulations to appraise the potential of companies and stocks.

In 2009, a panel consisting of scientists from many fields (including physicists, chemists, biologists, neuroscientists, and aeronautics engineers) issued a comprehensive report on the current state of the art of simulation-based science and engineering [SBE&S]. Such simulations, according to this report, are currently "guiding wise decisionmaking" in a vast number of different areas:

> SBE&S is changing the way disease is treated, the way surgery is performed and patients
> are rehabilitated, and the way we understand the brain; changing the way materials and
> components are designed, developed and used in all industrial sectors; and aiding in the
> recovery of untapped oil, the discovery and utilization of new energy sources, and the
> way we design sustainable infrastructures. (Glotzer et al, 2009, ii)

For our present purposes, the panel's overall assessment of SBE&S – that it "today has reached a level of predictive capability that it now firmly complements the traditional pillars of theory and experimentation/ observation"(Glotzer et al, 2009, ii) – is particularly noteworthy.

Importantly, in many if not all of these cases, the simulations serve not only to generate new hypotheses but to test hypotheses that have already been developed. Moreover, the simulations are explicitly claimed to improve our understanding of the various phenomena being simulated. In other words, simulations are playing a vital justificatory role in current scientific research. If this is right, then the question naturally arises: Why can we become justified in our beliefs by running simulations on computers but not by running simulations in our heads – especially if, like Tesla and Grandin, one is especially adept at imaginative simulation? Once we accept that computer simulations can provide us with justification for beliefs, it becomes very hard to deny that imaginative simulations can do so as well.

What feature of the computer simulation might give it the justificatory power that the imaginative simulations allegedly lack? The proponent of CEI cannot advert to the reliability of the computer simulation, since the imaginative simulations might well be equally reliable – recall Tesla's assertion that, over his 30 year career, his inventions always worked exactly as predicted by his imaginative simulations. Even if, in most ordinary cases, a computer is able to carry out far more complex simulations than a human imaginer, there is certainly no reason in principle why this must always be the case, or why it would matter.

In the absence of a principled reason for distinguishing computer simulations from imaginative simulations – and I will return to this issue in Section 4 – the proponent of CEI is in something of a bind. She might try to deny that the beliefs formed on the basis of computer simulations are justified, but that, to my mind, is a rather hard bullet to bite. Alternately, she might take a different tack altogether, which leads us to the second of the two options we delineated above.

Option Two: The beliefs are justified, but the justification does not stem from the imagination.

At this point, the proponent of CEI might retract her insistence that Grandin's beliefs are unjustified. Granting that beliefs based on imaginative simulations, and acts of imagining more generally, are justified, she might instead deny that the justification stems from the imaginative

acts themselves. Imaginings might generate beliefs, but they don't justify them – rather, the beliefs are justified by our prior beliefs and/or perceptual experiences. Norton, for example, forcefully pursues this strategy with respect to the epistemic relevance of thought experiments. On his view, if we were to take at face value the suggestion that we could learn about the world just by engaging in imagined thought experiments, we would have to believe that thought experiments proceed by way of "epistemic magic." (Norton 2002, 1) But, he claims, that would be a mistake. Thought experiments don't work by way of epistemic magic; rather, they work just as arguments do: "All thought experiments can be reconstructed as arguments based on tacit or explicit assumptions. Belief in the outcome-conclusion of the thought experiment is justified only insofar as the reconstructed argument can justify the conclusion." (Norton 1996, 339)

Here again, however, the analogy between imaginative simulation and computer simulation will put pressure on the position taken by the proponent of CEI. The computer simulation and the imaginative simulation seem to work via the same kind of epistemic "magic." So if the imaginative simulation is simply a tacit argument, then it looks like the computer simulation must be as well. But this suggestion seems implausible.

To see why, let's return to the owner of the cattle-handling facility. Suppose that he's been around cattle all of his life. He's seen how they behave in different sorts of situations. He's seen them balk at doing some of the things that handlers have wanted them to do, and he's seen them passively accede to others. He's seen many different dip vat designs. He's seen detailed blueprints of the new design that Grandin has proposed. Let's stipulate, then, that he has all the beliefs that are embedded in the programming of the computer simulation. But without some understanding of how cows react to a design with these new specifications those prior beliefs alone seem insufficient to justify a belief in the design's adequacy (or inadequacy). It is not just that those beliefs are insufficient to *generate* the belief. We might suppose – perhaps because he's fond of Grandin – that even before running the computer simulation he's already formed the belief that her design will work. It's that he needs some way of bringing those prior beliefs to bear in the current situation; he needs some way of taking what Grandin calls a "cow's eye view" of the situation. It's precisely this epistemic work that the computer simulation does for him.

Likewise, it's precisely this epistemic work that the imaginative simulation does for Grandin. And just as it's not plausible to view the computer simulation as a tacit argument, it is not plausible to view the imaginative simulation as a tacit argument. We thus can reject the

suggestion that Grandin's prior beliefs themselves do all the epistemic work in justifying her beliefs about the efficacy of the new design. [19]

Ultimately, however, perhaps there's an even easier way to show why this suggestion from the proponent of CEI should be rejected. For insofar as Grandin's imaginative simulation could be charged with epistemic irrelevance in this way, it also looks like many of our perceptions could likewise be charged with epistemic irrelevance. Suppose that Grandin did not engage in her imaginative simulation and that she didn't herself develop the specifications for a dip vat with this new design – instead, it was designed and built by one of her rivals. Normally, we would think her seeing her rival's new design in action would contribute to the justification of her belief in its efficacy. But on the line currently being pursued by the proponent of CEI, that can't be right. Given that she has the prior beliefs that she does, her seeing the design in action is epistemically irrelevant to the justification of her belief in its efficacy. And this seems absurd. The fact that someone has a vast store of prior knowledge about cows does not mean that they couldn't learn something from seeing the device in action.[20] And likewise, the fact that one has all of this prior knowledge does not mean that one couldn't learn anything from imagining the device in action.

4. Ordinary Imaginers and Imagining Under Constraints

The discussion of the previous section – and our consideration of the imaginative exercises of Tesla and Grandin – supports the claim that the imagination should be cleared of the charge of epistemic irrelevance. But this might seem to be a very narrow result. Most of us don't come even close to having the powers of imagination that these two extraordinary individuals have. We cannot run complex simulations in our imagination, we cannot imaginatively "see" how a new invention can work, we cannot take a cow's eye view of a situation. Thus, although the previous section has suggested that there might be unusual cases where the imagination has epistemic relevance, for all that we've said thus far it remains possible (perhaps even likely) that those cases are rare. In fact, they might even seem to be so rare that it would still be plausible to suppose that, as a general matter, the imagination

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[19] In arguing that thought experiments are not arguments, Sorensen invokes what he calls *the parity thesis:* thought experiments are arguments if and only if experiments are arguments. As Sorensen notes, "With determination and ingenuity, you can make a thought experiment look like an argument. But determination and ingenuity will also put you in a position to make executed experiments look like arguments. Hence, I doubt that the objector can shoulder his burden of proof by showing that thought experiments are enthymemes in a way that ordinary experiments are not." (1992, 214) One way to construe my argument in the text is as offering a similar parity thesis for computer simulations and imaginative simulations.

[20] Stock makes a similar point: "We would not, after all, deny that one could learn from visual perceptions about the nature of an object, simply on the ground that the information thereby acquired might also have been acquired via non-perceptually derived inference." (2006, 186)

remains out of the cognitive circuit. An important question thus remains unanswered: Does our reflection on extraordinary imaginers really show us anything about ordinary imaginers? This question relates to another question that remains unanswered by the discussion of the previous section. For although that discussion suggests that the imagination does indeed have epistemic relevance, it remains unclear *how* this relevance can be achieved. Given the claims of Wittgenstein and Sartre that imagining is voluntary, not world-sensitive, and uninformative, as we discussed above in Section 2, it is not yet clear why the imagination would be able to play the epistemic role that I have suggested that it does in fact play. In this final section of the paper, I aim to answer both of these questions by providing a rough framework – what I call *imagining under constraints* – that distinguishes the cases in which imagining has epistemic relevance from the cases in which it does not.

Individuals with extraordinary powers of imagination are often described as creative, and it is tempting to understand this creativity as a certain kind of freedom from the constraints of the ordinary world: It's by casting off the shackles of reality that innovative discoveries arise.[21] In some cases, this understanding of creative genius may well be the correct one. But when we're focused not on the generation of innovative new ideas but on their justification, this way of thinking about imaginative creativity gets things precisely backward. When it comes to the epistemic relevance of the imagination, what's most important about the imaginative capacities of extraordinary imaginers like Tesla and Grandin is not their extraordinary ability to let their imagination run wild, but rather their extraordinary ability to keep their imagination under control.

One of the reasons that imagining is thought to lack epistemic relevance is that acts of imagining are under the imaginer's own volition. Since imagining, unlike perceiving, is subject to the will, I can imagine all kinds of things that don't exist. Whether or not I can perceive purple cows depends on facts about the world. Whether or not I can imagine purple cows depends on facts about my will. In fact, philosophers have taken it to be so obvious that this feature of imagining renders it epistemically irrelevant that few have even bothered to argue for it -- recall, for example Wittgenstein's simple remark that "It is just because imaging is subject to the will that it does not instruct us about the external world." (1948/1980 §80) O'Shaughnessy is one of very few philosophers to have made the argument explicit:

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[21] Consider, for example, Gaut's analysis of the connection between imagination and creativity: "Imagination is free from commitments to what is the case and to particular actions.... As such, imagination is peculiarly suited – suited of its nature – to be the vehicle for active creativity, since one can try out different views and approaches by imagining them, without being committed either to the truth of the claims or to acting on one's imaginings. Imagination allows one to be playful, to play with different hypotheses, and to play with different ways of making objects." (Gaut, 160-1)

All imaginings arise from the subject's mind in such a way that the constraint of Reality is necessarily inoperative, whether through substituting one's will for Reality or through confusing 'subjective Reality' with Reality itself. The fact that the mind acts here, not as a representative of Reality but in direct opposition, guarantees that imaginings must be cognitively void. (2000, 359)[22]

But given our above discussion of Tesla and Grandin, I think we can see where O'Shaughnessy's argument goes wrong. When Tesla imagined the bladeless turbine, he was trying to get things right. Likewise, when Grandin imagined cows walking through the new dip vat, she was trying to get things right. In these imaginative exercises , they took themselves to be working within "the constraint of Reality"— in fact, it was critical to the success of their inventions that they do so. In short, *contra* O'Shaughnessy, the fact that imagining is subject to the will does not mean that the imaginer's mind acts "in direct opposition" with reality.

A similar point allows us to better understand the second feature of imagining, namely, that it is not world-sensitive. By their very nature, perception and belief are world-sensitive. As the point is often put, belief has truth as its *constitutive aim*. The contrast is then drawn with imagining, which does not have truth as its constitutive aim, and this is then taken to show that imagining cannot inform us about the world. But this inference is a mistake. Although imagining may not have the truth as its *constitutive* aim, that does not mean it never has the truth as its aim at all – that it is somehow constitutively divorced from the truth. Rather, an act of imagining can have the truth as a non-constitutive aim. Thus, although imagining is not world-sensitive *by its nature*, it would be a mistake to assume that this means that imagining must be completely world-insenstive.

It is precisely this mistake, I think, that underlies CEI. Consider for example the following passage from McGinn:

When I am in the business of investigating the world, I adopt an attitude of evidential sensitivity, and my beliefs are formed accordingly; but not so when I am merely imagining. Here I am indifferent to how things actually are. ... Perception and belief purport to get things right, so they involve sensitivity to evidence; but forming images and imagining-that do not purport to depict how things really are. (2004, 132)

Parallel considerations to those we invoked above in response to O'Shaughnessy will apply here in response to McGinn. In perceiving, I can't be indifferent to how things are; in imagining, I

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[22] McGinn raises similar considerations: "Belief is a commitment to truth, and the truth cannot be willed into being. But imagining is not a commitment to truth, even possible truth, so there is no obstacle to willing it..." (2004, 132)

can. But the fact that imagining is not by its nature required to aim at depicting things how they actually are does not mean that it must always lack this aim completely.

In sum, once we properly understand what it means for imagining to be subject to the will and to lack world-sensitivity, we see that its having these features does not support the charge of epistemic irrelevance. What about the third feature of imagining that we outlined above, namely, the claim that it is uninformative? Here we must take a slightly different tack and simply deny that imagining has the feature in question. Although Sartre is right to claim that an imagining contains nothing more "than what was put into it," this fact does not have the consequence of uninformativeness that he took it to have. This point should already be familiar to us from our discussion of computer simulations above. A computer simulation contains only the facts that are put into it, but it can nonetheless provide us with information about the world. That this point generalizes to imaginative simulations should not be surprising, especially since we can see applications of it in so many different domains. A computer programmer can be provided with new information by the outputs of her program, even though the program contains nothing but what she put in it.[23] A baker can be provided with new information once she tastes her newly-baked cake, even though the cake contains nothing but what she put in it. An artist can be provided with new information once she sees her artistic composition, even though the artwork contains nothing but what she put in it. So too can an imaginer be provided with new information by an imagining that contains nothing but what she put in it.

I thus reject the claim that imagining is uninformative. And although it is true that imagining is both subject to the will and not world-sensitive, these claims are no bar to its epistemic relevance. Despite its long philosophical pedigree, CEI – the charge of epistemic irrelevance – is simply false.

Of course, in rejecting CEI, I by no means want to claim that all imaginings have epistemic relevance. I thus owe an explanation of how we can distinguish the imaginings that do have epistemic relevance from those that do not. Fortunately, having clarified the features of the imagination in our discussion above, we are now well positioned to provide at least a rough framework for drawing the distinction. We are also now well positioned to see how our reflection on extraordinary imaginers is relevant to the case of ordinary imaginers.

Although both Tesla and Grandin are unusually adept at visual imagining – their ability to create, maintain, and manipulate finely detailed images exceeds what most of us are able to do -- the imaginative exercises in which they engage are not in themselves that unusual. Consider

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[23] This can be true even when the program's algorithms are completely deterministic, i.e., they contain no randomizing elements.

a skilled mechanic who imaginatively runs an engine in her mind in order to figure out what is wrong with it, or an interior designer who imaginatively entertains different furniture arrangements in an effort to decide which will be the best use of the space.   And consider also all sorts of everyday decisions that we need to make, when we don't have the time, or energy, or the ability to try out all the different alternatives: Which shoes would look better with this outfit? Would my kids be able to handle seeing *The Wizard of Oz*, or would the Wicked Witch be too scary for them? Which office should I pick in the new building – the one with the better view, or the one in the quieter location? Was my colleague's email meant to be as nasty as it came across, or was he just clueless about how it would be received?

In each of these situations, we might naturally use imaginative simulations to help answer the question posed. I imagine myself first in one pair of shoes, and then the other, and I can thereby "see" that the second pair works better with the outfit. I imagine sitting with my kids on the couch as the Wicked Witch first appears on screen, I imagine them hearing the witch's cackle as she taunts Dorothy, and as I figure out what their reactions are going to be, I come to realize that they're not quite ready to watch that movie. I imagine myself sitting in the office with the gorgeous view of the snow-capped mountains, but hearing loud student cell-phone conversations in the hall, and I discover from the deep well of irritation brimming inside me that the quiet is more important to me than scenic beauty. And as I imagine being in my colleague's position, having his characteristic lack of social grace, and knowing only what he knows about the current situation, I conclude that there's no reason to suppose that he had any nasty intentions when his email was sent.

In all of these cases, my imaginings are subject to my will, and the imaginings contain nothing but what I put into them. Yet in each case they propel me to reach a conclusion that I had not previously believed. Must we see these new conclusions as no better than guesses? That seems to me implausible. When we engage in these kinds of imaginative simulations, if things have gone right, we will typically take ourselves to be justified in the conclusions that we reach. We take ourselves to be justified in our beliefs about which shoes to wear. We take ourselves to be justified in our decisions to bar our children from watching the movie. We take ourselves to be justified in believing that the quieter office would be the better choice. And we take care ourselves to be justified in letting our colleagues off the hook for ill-advised emails.

I don't think we're wrong to do so. All of these cases have something important in common: In each of them, I am aiming to get things right. I have various beliefs about the world – about what color the shoes are, about what sorts of things have scared my children in the past, about the typical volume of students' voices in the hallway, and about my colleague's mental states. These beliefs about the world infuse my imaginings. In doing so, they act as constraints on my imagination, just as pre-programmed variables set constraints on computer

simulations. When I set myself these imaginative projects, I don't take myself to be completely free. In fact, I don't take myself to be free at all. My imagining is not governed by the world as it is before my eyes right now, as it is when I am perceiving. But that does not mean that it is not governed by the world.

I might not always be good at setting the right constraints, and I might not always be good at abiding by the constraints that have been set. It's in these respects that Tesla and Grandin are so good at engaging in imaginative exercises. When they set themselves an imaginative project, the images that they produce stay true to their intentions. Mine may not. I might embellish the beauty of the mountain or the volume of the student's voices. But when I do set the right constraints, and when I am good at abiding by them, my imagining can be as epistemically relevant to my project as their imaginings are to theirs.

What I've said here gives us just a very rough framework for when and how the imagination justifies our beliefs, and developing this framework in complete detail is the project for another paper. The main project of this paper, however, was the more modest one of showing us that such a framework deserves development, i.e., that any full account of the sources of epistemic justification cannot ignore the imagination.

My discussion of imagining under constraints thus brings us back to the fictional detective with whom we began: Sherlock Holmes, who refers to his own method of detection as the *scientific use* of the imagination. There are indeed many different uses to which the imagination can be put, but when we constrain our imaginings to fit the facts of the world as we know them, we are using an epistemic procedure that is much more akin to scientific experimentation than it is to mere flights of fancy. Although our imaginative experimentation will not be foolproof, neither is scientific experimentation. But in both cases, when we proceed cautiously, the beliefs that we arrive at will, as Holmes tells Watson, usually be justified. Thus, that we should reject the charge of epistemic irrelevance – that the imagination is, after all, part of the cognitive circuit – is, as Holmes might also say, simply "elementary my dear Watson, elementary."

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