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THE POWER OF CURIOSITY

HOW LINKING INQUISITIVENESS TO INNOVATION COULD HELP TO ADDRESS OUR ENERGY CHALLENGES

RSA SOCIAL BRAIN CENTRE

JUNE 2012

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About the Authors

Dr Jonathan Rowson, Director of the Social Brain Centre, is lead author of the report. The research, writing and editing was a collaborative process including significant contributions from Senior Researchers Jamie Young, Nathalie Spencer, Dr Emma Lindley and Research Assistant, Egidijus Gecius.

Acknowledgments

With many thanks to British Gas, Blue Rubicon, Sophie von Stumm, Steve Broome, Esther McCarthy, Matthew Taylor, Adam Lent, Rick Diamond and Guy Claxton.

The RSA Social Brain Centre

The RSA Social Brain Centre, which will be launched formally later this year, seeks to demonstrate why the emerging scientific account of human nature has practical relevance for our attempts to change our values, attitudes and behaviours. We endeavour to move beyond the 'rational actor model' that has dominated social and economic thought for decades. The early 21st century account suggests we are constituted by evolutionary biology, embedded in complex social networks, largely habitual creatures, highly sensitive to social and cultural norms and ultimately more rationalising than rational.

This emerging conception of human nature is radically different from the prevailing implicit view, but in public and private life many continue to act as if we had not learned anything useful about our brains, behaviour and biases in recent years. We therefore need to make prevailing theories of human nature more accurate through research, explicit through public dissemination and empowering through practical engagement. Through this ongoing process of thought and action, the Social Brain Centre seeks to support personal development and wellbeing, inform government policy, and improve social, financial, environmental and educational practice.

For further information about this report or the RSA Social Brain Centre please contact Jonathan.Rowson@rsa.org.uk

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Executive Summary

Almost every country in the world will face massive energy challenges over the next few decades. In the UK we are already faced with an energy 'trilemma' – three important goals that are pulling us in different directions. We need to aggressively reduce carbon emissions, while ensuring that a varied energy supply can reliably meet our energy needs, *and* we need to achieve this without exacerbating fuel poverty, by keeping energy bills at affordable levels.

In this context, we need fresh insight into energy supply, demand, and efficiency. The challenge is that innovative solutions will need to engage with the complex interplay of technology and behaviour, suggesting that the traditionally technology-led energy sector needs to become more curious about the foibles of human nature, and customers need to become more curious about their interaction with the energy technologies they rely on every day.

Unfortunately, most people are not particularly interested in their relationship to 'energy' as such, and a variety of attitude surveys suggest growing levels of 'green fatigue'. We may think about the issue of 'energy' when we notice our gas and electricity bills are getting higher, but our curiosity is rarely piqued while turning up the heating or leaving the lights on.

Perhaps if we better understand the nature of curiosity in general, we might find ways to cultivate curiosity about our shared energy needs, both in the energy industry and the population at large. If we can do that, it may help us spur the kinds of social and technical innovation that are now political, economic and ecological imperatives.

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Research and Findings

In late April 2012, British Gas commissioned the RSA's Social Brain Centre to write the following 'think piece' on curiosity.* This piece of work is part of a wider process to inform British Gas's sustainability-focussed *Generation Green* schools programme,** founded in 2008. British Gas now seeks to connect this educational programme to wider challenges relating to customer engagement with sustainability issues, and improving innovation in the energy sector. It was surmised that a reappraisal of 'curiosity' might be a promising way to begin to connect these separate but related concerns.

Given the exploratory nature of the brief, and the request for a rapid appraisal, our research was necessarily put together through a form of

* The Social Brain Centre was asked to elucidate the nature of curiosity, explore how curiosity might help solve future sustainability conundrums, examine the value of curiosity to innovation in Britain and the energy sector in particular, consider the role of schools in harnessing the power of curiosity, and investigate how modern technology could be changing the ways in which we are curious. We were also asked to help design a quiz on curiosity for the Generation Green website and British Gas's Facebook page.

** More than 10,000 schools are signed up to the programme, which offers teachers free sustainability teaching resources, and for every resource downloaded, an entry for the school into a termly prize draw for major sustainable technologies. These have included, for example, solar panels and insulation. 25 schools won prizes in the latest draw. See www.generationgreen.co.uk/

In the context of this conceptual ambiguity, we approached curiosity through the following working definition: a focussed or exploratory inquisitiveness that motivates us to connect what we don't know to what we do know

*bricolage** and can only offer promising ideas in need of further inquiry. Our research included a literature review on the concept of curiosity, particularly a critical examination of existing psychometric studies, which led us to design questions for a national survey on curiosity conducted by *YouGov*. We also conducted semi-structured interviews on the relevance of curiosity with senior figures working on innovation for British Gas, discussed how curiosity might be cultivated with experts in competency-based education, and explored how curiosity might help build exemplars of low carbon lifestyles.

Curiosity is a multi-dimensional concept with no single definition, and overlaps extensively with related concepts, including creativity, inquisitiveness and openness to experience. In the context of this conceptual ambiguity, we approached curiosity through the following working definition: *a focussed or exploratory inquisitiveness that motivates us to connect what we don't know to what we do know.*

How Might Curiosity Help Stimulate Innovation for Sustainability?

Curiosity is dually important for innovation, first in its link to creativity and divergent thinking, and second in its role as an intrinsic motivator to sustain interest in a given area. More specifically, we consider three applications in the energy sector:

- **Feedback:** In so far as customers are curious about their energy use, existing feedback devices do not adequately address it. People appear to be interested in feedback on very specific behaviours that is not revealed in current smart meters. We need to develop technologies that give more granular, salient and comparative feedback at the level where it impacts on habitual behaviour, not merely general feedback on energy use over an extended period of time.
- **Messaging:**
  - We need to actively create the information gaps that make people curious about – and therefore receptive to – new information.
  - We also need to build on what people already profess to care about and show interest in.
  - We need to make wider use of the experience of incongruity – the mismatch between different aspects of a message – thereby provoking people to engage more closely with the material to resolve the incongruity.
- **Habits:** The kinds of deep behaviour change we need to deal with environmental problems are at the level of habit, and changes in habit require that people become more curious about the power of their automatic systems and their behaviour more generally.

* The description that most closely captures our approach is 'bricolage', a term originally used by anthropologist Claude Levi-Strauss (1966). Bricolage refers to the tendency of people to solve problems or create products in an iterative, nonlinear, and fluid manner. The defining feature of a bricoleur (literally 'handyman' in French) is that he or she integrates various ideas and materials from diverse contexts that, on the surface, might appear unrelated and even inherently incompatible, and yet, when combined, represent novel ways of responding to and shaping social contexts.

In addition, we report:

- **Curiosity can be cultivated in schools by:**
  - Teaching for the development of competencies and dispositions like curiosity as a goal of learning, rather than merely as a collateral benefit.
  - Encouraging forms of mental attention, including mindfulness, that make us more curious about things we previously hadn't noticed.
  - Promoting focal awareness and vital engagement i.e. giving people a chance to learn something in considerable depth
  - Experimenting with keeping learning outcomes open to make learning more exploratory
  - Encouraging reflexive awareness of students' own natures and learning patterns.
  - Remaining vigilant about the impact of screen-based technologies on different kinds of curiosity.
- **Survey results:**
  - There are variations in levels of curiosity throughout the UK. For instance, our research indicated that people in Wales were generally more curious than people in Scotland; that Cardiff is the most curious city of those we sampled, and York the least curious. These differences are statistically significant, but further studies would be needed to make sense of them.
  - Our survey showed, even though home energy use is likely to be a large component of personal environmental impact, people are more interested in the environmental impact of the products they buy than the impact of their homes.
  - While people generally believe that innovation will solve our energy challenges, they don't seem to think that changing their own behaviour is an important part of the solution.
  - Of all age groups, those over 55 were the most curious.

There is a coherent and compelling case that links curiosity to the challenge of creating sustainable patterns of energy supply and demand, and promoting energy efficiency

Implications

There is a coherent and compelling case that links curiosity to the challenge of creating sustainable patterns of energy supply and demand, and promoting energy efficiency. In the context of new technologies that allow us to find things out easily and quickly, the overarching challenge at an educational level is to support deeper forms of curiosity; those that arise from cultivating interest in the complexities of our own natures, embodied engagement with technical challenges, and cultivating expert curiosity through sustained commitment to a particular field or practice.

Introduction

> "Curiosity is the very basis of education, and if you tell me that curiosity killed the cat, I say only the cat died nobly." **Arnold Edinborough***

Enhancing human capability is at the heart of the RSA's modern mission. We seek to understand and improve the 'fit' between the world's pressing challenges and the human attributes needed to address them

We take many extraordinary things for granted. Clean running water, functional plug points, vanishing rubbish bags, warm white radiators, reliable car pedals, predictable light switches, safe gas hobs, and enormous metallic vehicles that somehow fly through the sky. We get used to such things, and learn how to live with them and through them. But is something lost when we cease to be curious about the things we rely on? In what ways might it help to be more curious, and what kinds of curiosity might currently be most needful?

Enhancing human capability is at the heart of the RSA's modern mission. We seek to understand and improve the 'fit' between the world's pressing challenges and the human attributes needed to address them. Different challenges require different kinds of capability, and this report focusses on an aspect of human capability – various forms of curiosity – that we believe might be particularly relevant to the complex and increasingly urgent challenge of creating a sustainable pattern of energy demand and supply for the 21st century and beyond. This work also stems from the Social Brain Centre's interest in attention as such, and how we respond skilfully to the growing demands on our attention.

Curiosity has been a major impetus behind scientific discovery and the advancement of civilization. Indeed, cultural psychologist[1] Jerome Bruner proposed that curiosity is so important that it "is essential to the survival not only of the individual but of the species", and neuroscientist Michael Gazzaniga specifically linked curiosity to the human evolutionary drive to survive and adapt. So where is curiosity when we need it now?

We devote a section to the literature on curiosity below, including its various forms and definitions, but the following encapsulates the role of this kind of conceptual advocacy more generally:

> "Concepts of human conduct operate much like tools for carrying out relationships. In this sense, the possibility of social change may be derived from new forms of intelligibility. The development of new languages of understanding augments the range of possible actions. As a language of unconscious motives was elaborated, so were new strategies of courtroom defence developed; as a vocabulary of intrinsic motives was enriched, so did we enrich our educational regimens; and as theories

* Arnold Edinborough was a longtime columnist on the arts for the Anglican Journal, founding president of the Council for Business and the Arts in Canada. Englishman, emigrated to Canada, died 2006

> of family systems were developed so did we expand our ways of treating individual pain." **Kenneth Gergen**[2]

Following from Gergen, perhaps if the language of curiosity became more engaging and relevant, pathways towards sustainable patterns of energy supply and demand might be uncovered. That is the purpose of what follows.

The Energy Challenge

> Only 50 years ago, most households were directly aware of the amount of energy they used from the weight of coal carried into the house. Today it flows in unseen through pipes and wires, and embedded in the multitude of products purchased, most of which are manufactured out of sight from consumers. The pervasive attitude that new energy infrastructure should not be seen may well be one of the reasons behind opposition to renewable energy installations. But a sustainable energy system will not be an invisible system. Reconnection of people with the energy system is a precondition for the low carbon transition. **Rebecca Willis & Nick Eyre, Green Alliance**[3]

You don't have to be any kind of eco-warrior to grasp that we are already struggling to supply energy in a viable way

A combination of high levels of economic growth in developing countries, the perceived imperative of economic growth in developed countries, and a rise in global population means that, short of a radical overhaul of the entire world economic and political system, the world's energy needs will continue to grow. Reliable estimates suggest that by 2050 we are likely to have nine billion living on the planet, 75% of whom will live in cities, using energy that will still be generated mostly (c60%) by fossil fuels. Research at the Stockholm resilience centre suggests we have already harmed the planet beyond repair in certain ways (biodiversity loss and disturbances to the nitrogen cycle) and, on our current trajectory, are likely to continue to do so to an increasingly damaging extent, particularly in relation to the effects of anthropogenic climate change.

The enormity of our energy challenge is driven by the simple fact that we are running out of planet. Given that we have already surpassed some safe planetary limits and are rapidly approaching others, you don't have to be any kind of eco-warrior to grasp that we are *already* struggling to supply energy in a viable way. In this context, while political (e.g. meaningful emissions targets) economic (e.g. viable carbon markets) and technological (e.g. more productive renewable energy) solutions are important, any progress on these fronts need to be supported by reductions in energy demand and improved energy efficiency. Moreover, as we argue below, these changes should not be viewed as additive, but as inextricably linked. We need technology to enhance society, but technological design relies on human insight.

The human response

Unfortunately, at a time when we most need people to be aware of the environmental impact of their behaviour, many are switching off and developing 'green fatigue'. The recent British Social Attitudes survey shows that we care less than we used to, and market research by energy companies

suggest that customers are increasingly motivated by price rather than planet.[4] Moreover, when asked what governments should do to improve environmental behaviour, people generally want either more information or for sustainable behaviour to be financially incentivised.[5] One interpretation of these findings is that people are not particularly motivated to change their ways, or make any significant adjustments to their lifestyles. Is it conceivable that making people more curious about the link between their behaviour and the scarcity of energy might help to change this?

Understanding Curiosity

> "Curiosity is not an only child; it is part of a family of terms used by writers, scientists, and everyday people making conversation to capture the essence of recognising, seeking out, and showing a preference for the new."
> **Todd Kashdan**[6]

Reconnection of people with the energy system is a pre-condition for the low carbon transition

–Rebecca Willis & Nick Eyre, Green Alliance'

Although most people intuitively know what it is to be curious, an exact definition of curiosity is difficult to pinpoint. In academic literature there is no agreed definition, and even in dictionaries it seems impossible to convey the meaning of curiosity with a single phrase. There is no canonical definition, curiosity is not a one-dimensional construct. Examining theoretical accounts of curiosity and various dimensions of the construct will therefore help us to better explore the links between curiosity and innovation, but for those interested in the historical roots and cultural references to the word, please see appendix 3.

We uncovered three main theories about the nature of curiosity, how it comes about and why we feel it. The first, almost biological in nature, is that curiosity is **a human drive, much like hunger or thirst**, which is satisfied by the acquisition of knowledge. The drive theory helps to explain the seemingly paradoxical use of resources (such as time or effort) to gain knowledge or experiences; analogous to the resources used to satiate hunger.[7]

The second theory, more cognitive in nature, is that **curiosity is evoked by incongruity between something (an event, object, etc.) and a person's existing world view.** We try to make sense of the world around us, and when an expectation about the way the world works is violated, curiosity is piqued. In incongruity theories, the amount of curiosity induced peaks at intermediate levels of cognitive incongruity. When the violations are very minor, we accept them easily without much thought and are not very curious. At the other extreme, when violations to our existing expectations are enormous, we find these instances very difficult to process, and it has been suggested that in these cases the incongruity is ignored rather than piquing curiosity,[8] or that curiosity is superseded by fear.[9]

A third model, building on incongruity theories, but slightly more emotional in nature, frames **curiosity as the desire to close an information gap between a given reference point (some desired knowledge) and a person's existing information set.** This model proposed by George Loewenstein "interprets curiosity as a form of cognitively induced deprivation that arises from the perception of a gap in knowledge or understanding."[10]

This model varies from incongruity theory in that it also considers the mere absence of information as evoking curiosity. Curiosity, in this information-gap model, is piqued when a person begins to feel that gap, for instance when they are asked a question, or after learning about some sequence of events without knowing the conclusion. Storytellers and advertisers use this form of curiosity to keep people engaged in their message. Moreover, sometimes learning about a subject can spark curiosity. This is due to the shift in focus from what someone knows initially, to becoming increasingly aware of what they do *not* know once they have learned more about the topic.*

Similarly, Loewenstein posited that curiosity increases as the likelihood that the information or experience being sought will close the information gap. This is rather intuitive – it is easy to imagine being more curious about a titbit of information that will complete a puzzle than one which only partly answers the question. "Because curiosity reflects a desire to close information gaps, it is natural to assume that curiosity will be greater toward information that more nearly accomplishes this task."[11]

Tactile Curiosity

> "The world can only be grasped by action, not by contemplation ...The hand is the cutting edge of the mind." **Jacob Bronowski**

Curiosity, is piqued when a person begins to feel that gap, for instance when they are asked a question, or after learning about some sequence of events without knowing the conclusion

We became aware of a fourth theory that links curiosity to embodied cognition and our active handling of the environment. This theory is not explicit in the psychometric literature, but can be inferred from a variety of sources. This perspective is grounded in a view of human cognition as inherently embodied, and is something we offer up here as an original contribution to the field. To place it in context, we first need a brief overview of the model of cognition on which it builds.

According to Lakoff and Johnson the three main major findings of cognitive science from the last half century are that the mind is inherently embodied, thought is mostly unconscious and abstract concepts are largely metaphorical.** These 'findings' are inferred from empirical studies in artificial intelligence, cognitive neuroscience, cognitive psychology and linguistics. What seems most significant about them is that they challenge our assumptions about what the mind is, and does. In the western philosophical tradition, mind has typically been assumed to be some sort of conscious processor in the head, with a mysterious relationship to the brain, receiving input, via the senses, from an outside world that is 'given', and which functions primarily through a faculty of reason that operates best on a non-contextual, non-emotional basis.[12] Granted, this view is a

* There are noted exceptions to this theory of the positive relationship between curiosity and knowledge in a particular domain. First, the new information acquired can actually change the perceived size of the information set. In effect, when a person learns about a subject, he may also realize that the subject has greater breadth and depth than he had expected. Second, curiosity might not increase with knowledge if the knowledge acquired makes the solution or answer to the question too evident. "Curiosity…is likely to decline if one becomes extremely confident that one already knows the answer" (Loewenstein 1994, op. cit.)

** Of these three findings we focus on the first two, and make only occasional references to metaphor. See Lakoff, G., & Johnson, M. (1999). Philosophy in The Flesh. Basic Books.

The point is to get beyond asking what curiosity is, and ask instead where is it? The answer is that it may be as much in our hands as our minds. Indeed through working with our hands we get beyond some of the ways that our minds can limit our curiosity

caricature, but it feeds into our folk psychology and therefore influences assumptions about human capability and our chances of enhancing it.

Moreover, even when you realise that the mind is not just in the head* and that cognition is not just conscious,[13] it is hard to shake the view that cognition is primarily something representational, like a screen in the head, and that thought primarily involves our manipulation of the things on the screen. However, the view of mind emerging from cognitive science forces us to rethink the nature of perception, reason and emotion, and is therefore centrally relevant to our view of what curiosity may or may not involve.

The recent emphasis on the essentially embodied nature of cognition has grown out of the phenomenological tradition,[14] and the wider view of the relationship between mind and world is resonant with Gibson's ecological view of visual perception, in which objects are described as *affordances*.[15] The things we see are not perceived purely in sensory terms with colours and shapes etc, but in terms of what they are *for* – our opportunity to use or interact with them; so we see a door as a thing for opening, a chair as a thing to sit on etc. Our perceptual worlds are not comprised merely of objects that we passively imbibe, but of affordances that lead us to think and act in certain ways depending on what they mean for us. We have aims, and we direct our attention accordingly. We are, as Claxton recently put it,[16] 'always up to something'.

Moreover, Andy Clark suggests that:

> "Once mind is cast as controller of bodily action, layers upon layers of once-received wisdom fall away.... The rational deliberator turns out to be a well-camouflaged adaptive responder."[17]

Taking embodiment seriously has implications for curiosity. As Richard Sennett indicates in his writings on material consciousness:

> "This is the craftsman's proper conscious domain; all his or her efforts to do good quality work depend upon curiosity about the material at hand... I want to make a simple proposal about this engaged material consciousness: we become particularly interested in things we can change."[18]

The point is to get beyond asking *what* curiosity is, and ask instead *where* is it? The answer is that it may be as much in our hands as our minds. Indeed through working with our hands we get beyond some of the ways that our minds can limit our curiosity, as Crawford indicates:

> "The repairman has to begin each job by getting outside his own head and noticing things; he has to look carefully and listen to the ailing machine."[19]

* In Natural Born Cyborgs, Clark (See Clark., A. (2003). *Natural Born Cyborgs*, Oxford University Press.) argues that the growth of technology makes this increasingly true: "The mind is just less and less in the head." I have noticed that when I try to solve a computer-related problem for a friend it is so much easier when you can use the mouse and keyboard, because your understanding of how to solve the problem is not just in your head, but in what emerges from the coordination between your eyes, fingers, mouse and keyboard as you think about the problem. This kind of coordination can be thought of as 'mind'.

This kind of perspective has a strong pedigree, but is most vividly expressed by Heidegger:

> "The nearest kind of association is not mere perceptual cognition, but, rather, a handling, using, and taking care of things which has its own kind of 'knowledge".[20]

More recently, Designer Tim Brown has highlighted the importance of encouraging physical playfulness and prototyping in creating new ideas:

> "The average Western first-grader spends as much as 50% of their play time taking part in construction play. Construction play is playful but also a powerful way to learn … David Kelley calls this behaviour, when it's carried out by designers, 'thinking with your hands' and it typically involves making multiple very low resolution models quickly, often by bring many found elements together. This behaviour is all about quickly getting something into the real world and having your thinking advanced as a result… The sad thing is although pre-schools are full of this kind of stuff, as kids go through the school system, it all gets taken away. They lose this stuff that facilitates this playful way of thinking, and by the time you get to the average work place, maybe the best construction tool we have might be the Post-it note. But by giving project teams permission to think with their hands, quite complex ideas can spring into life and go into execution much more easily."[21]

While our ideas on tactile curiosity are at an early stage of development, we are confident that there is reason to posit that, the curiosity that arises through handling things, as a distinct form of curiosity alongside the others we have considered. Table 1 features the four theories of curiosity considered.

By giving project teams permission to think with their hands, quite complex ideas can spring into life and go into execution much more easily

– Tim Brown

Table 1: Where Does Curiosity Come From?

Theory	Summary	Key Theorists
Drive	Curiosity is a human drive, comparable to hunger	Berlyne
Incongruity	Curiosity is evoked by incongruity between something (an event, object, etc.) and a person's existing world view	Hebb, Piaget, Hunt
Gap	Curiosity arises when someone becomes aware of a gap between his or her existing set of information and some other desired information	Loewenstein
Tactile	Curiosity arises from physical engagement with things we believe we might change	Sennett, Crawford, Heidegger

Four Dimensions of Curiosity

Numerous models have been proposed in the last half-century to unpack the various dimensions of curiosity, but one of the more enduring is that of Daniel Berlyne, considered a leading figure of modern curiosity

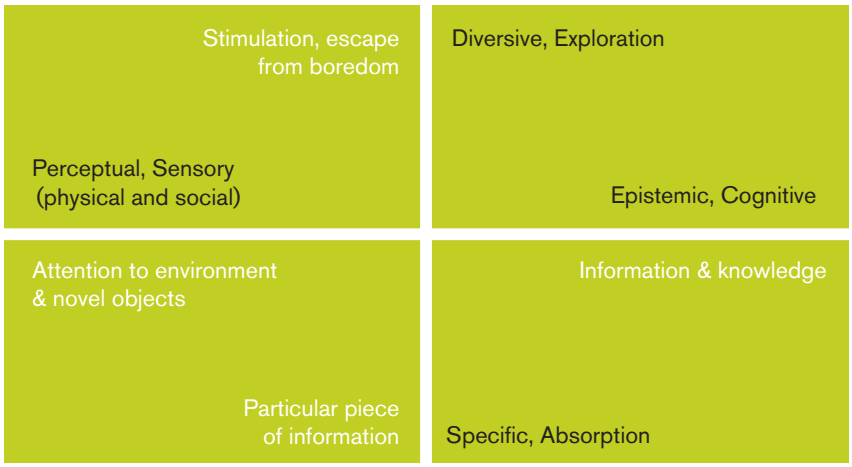
research. In his early work, Berlyne located curiosity along two dimensions, making a four-fold classification. While his work, and the field more generally, has moved on, we liked the simplicity of his four-fold model, and it is an open question whether subsequent models were improvements or merely changes.

On one axis lies **Epistemic curiosity,** which is the desire for information and knowledge, and **Perceptual curiosity**, which describes one's attention to novel objects in their immediate environment. The other axis runs from **Specific curiosity**, which is the desire for a particular piece of knowledge such as the final piece of a puzzle, to **Diversive curiosity**, which is less directed and would describe seeking stimulation to escape boredom or when ready to grow. It is important to grasp that these contrasts are not zero-sum, and one can grow in epistemic curiosity without losing perceptual curiosity, and, as we will show, it is possible, indeed desirable to have both convergent (specific curiosity) and divergent (diversive curiosity) thinking for innovative solutions to emerge.

While Berlyne's model from the 1950s and 1960s is widely accepted, other models have since been developed. Thomas Reio identifies three components of curiosity, named as: (i) **Cognitive** curiosity: 'the desire for information and knowledge', (ii) **Physical** and (iii) **Social Sensory** curiosity: 'the primary intent is to experience new thrills and sensations'.[22] Kashdan, Rose, and Finchman[23] distinguish between two factors of dispositional curiosity. On the one hand is **exploration,** where one seeks out novel or challenging situations, and on the other hand is **absorption**, where one becomes fully engaged in a situation. When taken together, it seems that the categorizations proposed by different experts sit comfortably together, as shown in Diagram 1. Mapped in such a way, it becomes easy to identify different "types" of curiosity as falling into each of the quadrants.

Cultivating curiosity is as much about creating the right kind of situations, contexts and environments as it is about creating the right kinds of thought patterns and habits

Diagram 1: Map of Different Dimensions of Curiosity



On the Perceptual side, curiosity is associated with sensation-seeking and is influenced by the environment. A *Perceptual-Diversive* type might be described as flighty – stimulated by many different environmental cues, with attention given to many of them. It is this type of curiosity that may motivate someone to wander through a park they've stumbled upon, taking

in new sights, sounds, smells and textures; it is exploratory rather than directed towards answering any particular question. A *Perceptual-Specific* type of curiosity might lead someone to want to know how a particular experience feels, for example taking a drug, or reaching for a hedgehog to learn what its quills (spikes) feel like. This type of curiosity is the desire for new sensations – sights, sounds, textures – directed towards answering a particular question ("I wonder what that hedgehog feels like?") and is often stimulated by the environment around us.

We argue below that greater curiosity is good for creativity and innovation, and that each of the four dimensions of curiosity – epistemic, perceptual, specific and diversive – are valuable ingredients of creative thinking

Epistemic curiosity is the urge to learn more or to acquire some information, and is more cognitive in nature. It is more about thinking than experiencing. *Epistemic-Diversive* curiosity is the desire for information or knowledge that is exploratory, and might describe the behaviour of someone when flicking through TV channels on a Sunday afternoon or when daydreaming about many different topics. Finally, an *Epistemic-Specific* type of curiosity is the desire for information or knowledge, directed towards answering a specific question, however deep that question may be. This type would be the curiosity that compels us to solve a Sudoku puzzle, or that motivates a PhD student to complete her research. Our national survey appeared to indicate that Epistemic curiosity was relatively (compared to other forms) low in the UK.

These dimensions of curiosity are not mutually exclusive, and a person will probably possess all four dimensions at various points in time, depending on all sorts of factors such as mood, environment, context, among others. But it might also be the case that, in general, a person identifies more closely with one particular type of curiosity. In the literature there is a debate concerning the extent to which curiosity is a 'trait', like part of one's character, or a 'state', something more fleeting and context specific. We recognise the value and importance of both of these perspectives, and do not feel it is necessary to subscribe to one over the other. Rather, we take the position that cultivating curiosity is as much about creating the right kind of situations, contexts and environments as it is about creating the right kinds of thought patterns and habits. In any case, we argue below that greater curiosity is good for creativity and innovation, and that each of the four dimensions of curiosity – epistemic, perceptual, specific and diversive – are valuable ingredients of creative thinking.

Curious Correlations

Since curiosity itself is difficult to define, its relationship to other attributes and emotions, which are also difficult to define, is contentious. With this caveat in mind, curiosity has been found to be negatively influenced by anxiety,[24] as well as fear. If curiosity evolved as a beneficial trait to motivate our ancestors to explore their environment and the world around them, fear may have been the counter-emotion to rein in that exploration in dangerous circumstances.[25]

Curiosity, a "knowledge emotion",[26] has been linked to other emotions, such as anger,[27] and a lack of curiosity has been observed among people who are depressed or suffer from Alzheimer's.[28] Curiosity has also been found to be a predictor of longevity. In a study by Swan and Carmelli (1996),[29] among older people, higher curiosity levels were correlated with a higher five-year survival rate. Some researchers even suggest that "diminished curiosity may be one of the earliest signs of

abnormal aging of the central nervous system"[30] as experienced with Alzheimer's disease.

Curiosity has also been linked to a range of other personal characteristics, such as loyalty, reliability, a sense of personal worth, and, perhaps unsurprisingly, tolerance for ambiguity

Curiosity has also been linked to a range of other personal characteristics, such as loyalty, reliability, a sense of personal worth, and, perhaps unsurprisingly, tolerance for ambiguity,[31] as well as active coping strategies.[32] The results of some studies suggest that curiosity is higher in men than in women, but in our survey we found no discernible difference, except that on one question on perceptual curiosity, women appeared to score more highly.[33]

Curiosity sustains our interest, and motivates us to inquire or explore. Intrinsic motivation is thought to be stimulated by curiosity; a pattern of interacting with the world that is developed in childhood and stays with us in adulthood, as Thomas Reio reported:

> "Reeve (1992) proposed an interesting model in which curiosity was the first step in the intrinsic motivation process. In his model, a child encounters an activity, and decides if it is novel or interesting. If so, his or her curiosity would be piqued and exploratory, investigatory, and manipulatory behaviors would be initiated. When the child finds these play-like activities reinforcing because they challenge his or her personal skills and competencies, or they afford a possibility for feedback on personal competence, the activity becomes an intrinsically motivated activity for that child."[34]

More generally, there appears to be a correlation between curiosity, creativity, and intelligence; and some studies have already explored this relationship.[35] Curiosity has been called the genesis of creativity, and, even controlling for intelligence, one study found that people who score highly on curiosity scales also score highly on creativity measures.[36] This particular set of correlating factors is particularly relevant for the topic of this paper.

Key components of innovation are creativity and intelligence, divergent and convergent thinking, and a concept described by Angela Duckworth as "grit" which requires sustained interest and intrinsic motivation to persist with effort.[37] As we have seen, curiosity is closely related to all of these components. The link between curiosity and innovation will be discussed in more detail below, but first these theoretical perspectives are used to inform some empirical measurements.

Curiosity in the UK

Survey

We drew on our understanding of curiosity measurement instruments, and the conceptual models that underlie them, to devise a six-item survey that assessed self-reported levels of curiosity (see appendix one for the full list of questions). In common with much of the literature since the 1950s, we used psychologist Daniel Berlyne's model as a basis for our survey which identifies four dimensions of curiosity: epistemic, perceptual, specific and diversive.

Various tools have since been developed to identify the presence of each of these dimensions (often running to forty or eighty items long) which we drew on to develop four items that tested each of the four dimensions of curiosity, and two to measure curiosity in general. These items were developed with some assistance from Sophie von Stumm, a curiosity researcher at Edinburgh University – although any errors or misjudgements are entirely the responsibility of the RSA researchers involved.

The results of our survey yielded a number of insights into the state of the UK's curiosity

These items were Likert questions, with seven-stage responses ranging from 1 (strongly agree), through 4 (neither agree nor disagree), to 7 (strongly disagree). To allow us to explore correlations between curiosity in itself, and curiosity about sustainable resource consumption, we also asked people whether they would be most curious about the environmental impact of the products they buy, the energy they consume, the food they eat or the journeys they make. The survey also included a question on ecological worldview, adapted from a recent national survey commissioned by Defra. The survey was conducted by YouGov between 16th and 18th May 2012 among a nationally representative sample of 2211 adults. The data from the survey was reviewed for notable findings, and more detailed analysis was conducted to identify statistical significance, including Mann-Whitney U tests and Kruskall-Wallis tests.*

Main Findings

The results of our survey yielded a number of insights into the state of the UK's curiosity. Perhaps most importantly: people seem to identify with the core concept, with respondents agreeing more than disagreeing that they exhibit curiosity. While our survey is not strictly comparable with

* For the majority of these tests (exceptions include the perceptual difference between men and women), the six Likert questions that related to curiosity were merged to give an overall curiosity index. We also individually grouped the seven options from 'strongly agree' to 'strongly disagree' to give a nominal curiosity index. For the most part, 95% confidence was considered statistically significant, however 90% confidence was accepted in some situations.

It is notable that London is at an approximately median position in our ranking of curiosity levels in cities, though it often comes first in ranks of the most creative or innovative cities in the UK

the results of other curiosity surveys, we did uncover some interesting differences that would be worth seeking to test with different question batteries or scales.

Curiosity was not evenly spread across different regions. While the mean level across the UK was 73%, average curiosity in Wales was 80%, and average curiosity in Scotland was 66%. With 90% confidence, this difference was found to be statistically significant (H=12.047, p=0.099). Participants were also asked for their nearest city, and further analysis was conducted to explore this. Cities were ranked for curiosity, with Cardiff at the head of the curiosity rankings, and York at the bottom.

It is not clear to us what could lie at the root of this regional difference in curiosity. Richard Florida's concept of the Creative Class[38] – the group of workers that includes scientists, researchers, educationalists, engineers and others that create innovative products – claims that cities require talent, tolerance and technological infrastructure to attract and retain creatives. These three Ts may provide a useful parallel for understanding why curiosity appears to be grouped as it is. Incidentally, it is notable that London is at an approximately median position in our ranking of curiosity levels in cities, though it often comes first in ranks of the most creative or innovative cities in the UK.[39] Regional differences may be caused by a combination of contagion, homophily and reporting biases. Future studies would be needed to further investigate the cause of the regional differences in curiosity.

Four of the six questions in our survey were intended to detect levels of the different dimensions of curiosity identified by Berlyne. The results were analysed to see whether any dimensions were more common than others. A Friedman test was used to compare participants' response across these four questions, showing that of the four dimensions of curiosity, 'Epistemic' scored the lowest and 'Specific' the highest. Because we only used one question for each dimension of curiosity, the interpretation of the low epistemic score should be made with caution. While it may be that the nation, on average, exhibits lower epistemic curiosity (i.e. relatively uncurious to know new information) it might also be the case that the particular question used to elicit this dimension of curiosity was inadequate.

We found no significant difference when testing curiosity across different genders. However further Kruskall-Wallis analysis of curiosity type by gender showed one significant difference. This was that women tended to be more perceptually curiosity than men (H=7.81, p=0.005). This finding is consonant with previous research on attention in men and women, such as that used by advertisers to target adverts at each gender. For example, men are supposed to be 'selective processors', who look for very salient information, while women are 'comprehensive processors', who like to synthesise a wide variety of information before making a judgement.[40]

Further exploration of the data indicated a number of other statistically significant differences between groups, with Over 55s scoring as

more curious than other age ranges* (this could be less to with age per se, but rather down to the particular characteristics of the people in that specific generation), people classified as ABC1 are more curious than C2DE (this could be related to years in formal education) and that retired and widowed people are more curious than people in other working or marital situations.

It seems unlikely that it is simply that people with more time on their hands that exhibit higher curiosity, if only because the unemployed are generally less curious than those in work, but it might be a function of how one's prior experience assists in the what and how we pay attention to things. Perhaps those people with more life experience are more aware of curiosity-inducing information-gaps due to a broader knowledge base? If curiosity is linked to longevity, as mentioned in 'curious correlations' above, could it even be that the more curious partner in a marriage tends to outlive the other? These conjectures are to stimulate thought only; further research would be needed to suggest a cause of these particular survey findings.

Arguably our centralised energy system has alienated people from the source of the power that makes lights flick on at a switch

Environmental Attitudes

In addition to items that measured curiosity, our survey also asked people which aspect, in terms of their personal environmental impact, they were most curious about. The results showed that respondents were most curious about the impact of the products they buy, followed by the energy they used in the home, and the food that they eat, with people less curious about the impact of the journeys they make. Even though the largest component of each individual's carbon footprint was likely to be the energy they use in the home, this wasn't the item that most sparked curiosity. This suggests (reinforced by a quotation in a following section) that the government, environmental NGOs, and energy suppliers like British Gas still have a way to go, before energy in the home is considered sufficiently interesting to drive curiosity among residents.

Finally, we asked people a question about ecological worldview adapted from a 2007 Defra survey on public attitudes towards the environment, in which people select one of a series of statements that represent a broad spectrum of views. The most popular (by some way) was that 'Humans are capable of finding ways to overcome the world's environmental problems', approximately similar to results from five years ago. It could be said that their faith in this innovation is largely faith in other people's ability to innovate. Arguably our centralised energy system has alienated people from the source of the power that makes lights flick on at a switch, perhaps in the similar way that makes urban-dwellers less confident and knowledgeable about the natural environment. The current shift from centralised power stations to a network of community-owned micro-generation could give people the curiosity and confidence to tinker with such systems, directing their curiosity towards low-carbon energy innovation.

* A contradictory finding was mentioned in Swan and Carmelli (1996), citing work by (Giambra, Camp, and Grodsky 1992): "Research in humans identifies a decline with age in some components of curiosity". P.449

The Link Between Curiosity and Innovation

> "If we were encouraged to be curious, we would stand a better chance of survival" **Mark Haw**[41]

Innovation has become an enduring buzzword for our uncertain and complex times, and leaders in the private and public sector voted creativity their most important capability to navigate this volatile environment.[42] But what do we mean by creativity and innovation, why are they relevant, and what do they have to do with curiosity?

Creativity involves the conception of new ideas, while innovation executes them, scaling them from rough prototype or small-scale pilot to become a widespread solution. The challenges of the 21st century require both social and technological innovation

Why Social and Technological Innovation Need Each Other

Researchers generally agree that creativity is the "ability to produce work that is both novel and appropriate [or useful]",[43] while innovation is "the successful implementation of creative ideas within an organization".[44] Creativity involves the conception of new ideas, while innovation executes them, scaling them from rough prototype or small-scale pilot to become a widespread solution.

The challenges of the 21st century require both social and technological innovation. Though the means of innovation often involve new technology, novel solutions delivered without technology may be no less innovative. However a technology-centric bias does appear to be a feature of the energy industry, in which much of the innovation relates to 'smarter' grids, meters and homes.

> "I see a lot of presentations that suggest a huge amount of curiosity, but I often see it as very industry-led and very technology-led: 'How can I make this widget a bit better and save an extra 1%'. Whereas I see less curiosity about a customer; how they're going to use the widget and interact with it, and that can often be the downfall of the widget. You might have the best widget in the world, but if you haven't answered some of those customer needs, and the customer doesn't get it – it ain't going to take off!" **Daniel Taylor, Head of Innovation, British Gas**

Although the term 'innovation' has traditionally had strong connotations with solely profit-making ends in the private sector, it also refers to novel ways of achieving social ends across all sectors. The *Stanford Social Innovation Review* defines social innovation as:

> "A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals"[45]

Although the term 'innovation' has traditionally had strong connotations with solely profit-making ends in the private sector, it also refers to novel ways of achieving social ends across all sectors

Some of the most effective innovations combine technological interventions with a thorough understanding of the social factors involved. In 2006, global brand Nike created Nike+, a 'product service system' that allows runners to track their fitness through wearable technology and an online social network. During the first two years of Nike+, Nike's share of the US running shoe market jumped from 48 to 61%.[46]

In another interview, Rick Diamond, Staff Scientist at the Lawrence Berkeley National Laboratory in California informed us that California installed over 14 million smart meters in the homes and businesses in the state at huge cost, but early impressions are that very few consumers look at these meters or change their behaviour as a result. Rick Diamond argued that a big challenge is to connect feedback information with the kinds of routine actions that may have small energy savings that don't typically show up on a smart meter, even to those who look.

He also suggested that in his experience among those people who appear to be curious about how their actions affect their energy use, there is rarely available information to satiate that curiosity because the gap between cause and effect is too great. Attempts to reduce this gap, for instance with home energy displays, have been attempted by large companies including Google and Microsoft, but both were dropped for reasons that are still unclear – though it is possible that a lack of curiosity in the information they would have offered was one reason.

How Curiosity Links to Innovation

Scores of studies have investigated how to encourage creativity and innovation in businesses, public services and communities, but could curiosity add a new dimension? The current state of knowledge in the fields of curiosity and creativity strongly supports a link, with some reviews of the literature concluding that curiosity marks the beginning of a creative process,[47] with others going so far as to say that curiosity is synonymous with creativity.[48]

Their assertions are reinforced by several studies that show a strong correlation between curiosity and creativity; psychometric tests show that individuals who score highly for curiosity also score highly for creativity. One study[49] measured children on the *Children's Reactive Curiosity Scale*, noting high correlations with J. P. Guilford's *Unusual Uses Test* – a test of divergent thinking. E. Paul Torrance, developer of the *Torrance Test of Creative Thinking*, noted that students who scored highly for curiosity also scored more highly for creativity than others of the same intelligence.[50] Other studies showed significant correlations between self-rated measures of curiosity and the *Remote Associates Test* of creativity.[51]

One of the reasons behind this close link between curiosity and creativity might be due to curiosity's ability to stimulate both divergent and convergent thinking. In *The Nature of Human Intelligence*, psychologist J.P. Guilford identified the presence of both convergent and divergent thinking in response to a given problem. Divergent thinking draws on

different fields of enquiry to produce many answers to a problem, such as 'find uses for a paperclip', whereas convergent thinking is the production of the one best answer to a problem. Creativity involves both convergent and divergent thinking. It seems intuitive to us that Specific curiosity is linked with convergent thinking, whereas Diversive curiosity is linked with divergent thinking.

The overall innovation process could be summarised as including periods of sensory curiosity that provoke explorations of an environment and divergent thinking, followed by periods of cognitive curiosity that test new ideas for practicality, before selecting, piloting and scaling-up those expected to solve a particular problem

Creativity researchers and practitioners emphasise the importance of using cycles of both types of thinking to generate (divergent) and select (convergent) innovative ideas. For example, the widely-used *Creative Problem Solving* process from the Creative Education Foundation (founded by Alex Osborn, the inventor of brainstorming) involves several such sequential stages; from Idea Finding to Solution Finding. Likewise among Edward de Bono's popular *Six Thinking Hats* tool is both a green hat (divergent) for putting forward new ideas, and a black hat (convergent) to consider the risks of such ideas.

Curiosity is therefore closely related with, if not the cause of, creativity. The overall innovation process could be summarised as including periods of sensory curiosity that provoke explorations of an environment and divergent thinking, followed by periods of cognitive curiosity that test new ideas for practicality, before selecting, piloting and scaling-up those expected to solve a particular problem.

One innovator who put his curiosity into practice is Paul Preistman. He conceived of the idea for the Water Pebble after his curiosity about the energy needed to heat a shower was piqued by a hotel sign.[52] The hotel urged users to be conscientious and "please use water sparingly", which spurred Preistman to ask himself: what was a practical way to do this? The Water Pebble is a device which can be placed by the drain of a shower. It monitors the duration and temperature of a shower and displays a green, amber, or red light to signal to the shower user when he should turn the tap off.

Preistman's process of design helps to illustrate the link between curiosity and innovation discussed in this section. We have argued that curiosity can be the catalyst of innovation, and more precisely, that social and technological innovation are inextricably linked and should be mutually reinforcing.

Energy: Feedback, Communication and Habits

Perspectives on the Need for Innovation in the Energy Sector

The challenges facing the energy sector, including climate change, peak oil and fuel poverty, provide a stiff test for innovation in the 21st Century.

> "There's what we call the energy trilemma; three great forces for change, but pulling in different directions. First of all you've got our commitment from the government around climate change, so we must reduce fossil fuel generation but this will need more investment in renewable and possibly nuclear generation. The second one is that we've got to keep the lights on which becomes more complex and costly with renewables as it's less predictable and controllable. The third part of the trilemma is trying to manage the bills that you and I are faced with, in the context of the first two parts of the trilemma, in recent years we've seen bills rise higher than the rate of inflation and bills are hurting people." **Daniel Taylor, Head of Innovation, British Gas**

Unfortunately, however, this remarkable energy-saving technology has side-effects. Some humans call turning the thermostat down a lifestyle change, and are not happy with it

– David Mackay

David Mackay, chief scientific advisor to the Department for Energy and Climate Change, clearly illustrates the need for innovation in the energy sector that combines technology and social change. While leaky houses can be made more energy efficient through double glazing and insulation of lofts and wall-cavities, changing behaviours is also essential:

> "The thermostat (accompanied by woolly jumpers) is hard to beat, when it comes to value-for-money technology. You turn it down, and your building uses less energy. Magic! In Britain, for every degree that you turn the thermostat down, the heat loss decreases by about 10%. Turning the thermostat down from 20 °C to 15 °C would nearly halve the heat loss. Thanks to incidental heat gains by the building, the savings in heating power will be even bigger than these reductions in heat loss. *Unfortunately, however, this remarkable energy-saving technology has side-effects. Some humans call turning the thermostat down a lifestyle change, and are not happy with it.*"[53] [emphasis ours]

Social innovation is also required elsewhere in the energy sector. Experts working in transport note that social innovation could potentially lead to more immediate lower-carbon outcomes than technology alone. While new low-carbon technologies require long periods of

research and development, low-carbon *behaviours* could be enacted today, and the danger of allowing emissions to accumulate is reduced:

> "…the best achievable reduction in carbon emissions as a result of technology alone could mean that by 2050 annual [car, van and motorbike] emissions would be reduced by 80%. However such reductions would not happen quickly enough to limit the accumulation of carbon in the atmosphere and so global temperature rises. Changes to travel behaviour would therefore be necessary in addition to technology change because they could be implemented early and so have an impact on cumulative emissions."[54] **Dr Steve Skippon, Principal Scientist, Shell Global Solutions**

Curiosity, Innovation and Feedback Mechanisms

Jon Kimber, Managing Director, British Gas New Energy, indicates that one of the obstacles to motivating behaviour change is lack of interest in energy use:

> "How interesting is energy to consumers? Many people like myself can still remember power cuts in the 70s; then you really did value energy because you knew what it was like to be without it – but for many people now that's a distant memory. They take it for granted that energy is there, it's plentiful, you flick a switch and the light comes on, and you don't have to worry about it. As an 'interest item' for consumers, it's very low interest. I think the question for me is 'can we make it more interesting for consumers?'" **Jon Kimber, Managing Director, British Gas New Energy**

He also shared their experience of interventions that enhance curiosity:

> "It is now very common to see solar panels on customers' roofs – FIT subsidies encouraged house builders to invest in solar panels – and now people are more familiar with this technology. They'll soon be more familiar with heat pumps, smart meters, biomass and other technologies that are evolving. This kind of visibility will add to curiosity among consumers. We're on the verge of something quite interesting in the relationship between energy companies and their consumers."

> "Already with electricity monitors, customers are becoming more aware of the energy they use in the home; the fact that the kettle uses three times as much as the microwave ... the more we can provide data that is of use and that people can act upon, the more they're likely to take notice and become more curious, wanting more information on how they can save energy."

One is rarely sure exactly how much energy is being saved by which set of actions. This problem, in our view, represents a clear challenge to the energy industry to try to solve

As the Government and energy companies prepare to roll out 'smart meters' across the UK, a number of suppliers are designing hand-held energy displays and apps for smartphones and tablets. Perhaps the challenge for businesses in this field is how to make energy information salient, compelling and persuasive. For example, George Monbiot highlights a study of households which showed that fitting cookers with electricity meters reduced the energy used for cooking by an average of

15%.* Could feedback that specifically aims to encourage more curiosity about a home's energy system be a fertile direction for designers? Indeed, Rick Diamond's perspective highlights the depth of the challenge. The question consumers are generally curious about, he said, is: "If they make a change for energy efficiency, did it have an effect?" The challenge is that it is not currently easy to show that at the micro-level, so one is rarely sure exactly how much energy is being saved by which set of actions. This problem, in our view, represents a clear challenge to the energy industry to try to solve.

Knowledge that might otherwise appear irrelevant or discomforting can be experienced as pertinent and personal when it arises naturally from looking at the commitments and attachments that are implicit in what people already profess to care about

Curiosity and Innovation in Environmental Communication: Mind the Gap

Environmental messaging is by no means a virgin field. Major environmental groups like Greenpeace or WWF, and government departments like Defra and DECC are very aware that changing attitudes and behaviours is about much more than giving people information, no matter how impressive that information seems.

It is widely known, for instance, that it matters who the messenger is, that it matters that the message seems salient to that person's daily concerns, that people have a finite pool of worry and will tend to ignore or dispute negative messages, and that messages that tell stories and connect on an emotional level tend to work better than simple facts.[55] Moreover, from our desk-based research into environmental messaging, it seems that there is already also some recognition of the role of piquing curiosity.

Environmental messaging regularly connects at the level of incongruity, for instance by showing orang-utans changing light bulbs and asking: if you won't change your light bulbs, who will? Or showing polar bears sleeping rough in cardboard boxes and saying that climate change will make many homeless. However, we found much less evidence of messaging that showed an appreciation for curiosity that was not related to incongruity. We address the role that encouraging tactile curiosity might have in changing environmental attitudes and behaviours in our educational recommendations below, so for now we focus on the importance of creating the right environment for an appetite for knowledge (drive theory) and a gap in information (gap theory) in which messages might make a deeper impression.

The degree to which one can manufacture a drive is an open question. But arguably one can create an environment where such a drive is stimulated, and, in the case of the climate crisis, it is important that this is one in which people feel compelled to continue their knowledge-seeking beyond their initial question. In other words, we need to create the conditions conducive to not only stimulating an appetite for knowledge, but also maintaining and extending such an appetite. Some insight has been offered by Lord Smith while speaking recently at the RSA.[56] He reminded the audience that environmental concerns in public life will constantly change depending on whatever else is happening but it will never become a central concern unless there is "a broad public sense that these issues are fundamentally important". He argued that one strategy to create this sense of importance is to link to "the enormous public attachment to the idea of place, to the

* See Monbiot, G. (2006) Heat.

immediate environment that envelopes and sustains our own everyday life." People are passionate about their local river, or parks, or wildlife, and "harnessing that passion for a bigger picture is an idea of tremendous power turning the truly local into the global." He mentioned that RSPB and The National Trust have far more members each than all the political parties put together and that success is attributed to this capacity to connect small local concerns with bigger political ones:

> "They take a tiny thing, a dipper, say, and they tell you 'if you are interested in this dipper, you need to understand about the habitat it lives in, which it needs for its survival. You need to understand about the water quality and about the fate of our hedgerows and the patterns of agriculture. You need to understand about the planning system and how it protects valuable landscape. You need to understand about the pressures of development, and urban expansion, and industrial growth. You need to understand about how the crucial decisions are taken by business, by local government, by national government, by European institutions. And you need to understand about the impact of climate change and what causes it. And you need then to understand about the faltering international discussion and negotiations and how we must press for more and quicker action.
>
> And before you know what's happened, you have been taken on a journey of understanding from something incredibly small and tiny, and vulnerable, a dipper. And you've reached into a hazy understanding of the global and national political forces that shape the future of our environment and the dipper's environment. These things are all interconnected. If we can help people and policy makers to understand these interconnections and to cherish them, we can make real progress."

One important implication of the gap theory is to tell people that we need to open gaps before we close them. Our tendency is to tell people facts. First, though, they must realise they need these facts

– Chip and Dan Heath

Identifying the precise mechanics for achieving this is beyond the scope of this paper, but whatever approaches may be employed, we are confident that they must be grounded in an appreciation for what people are actually curious about. In addition, finding ways to pique that curiosity will be pivotal – our working definition of curiosity attempts to incorporate these factors, by highlighting the desire to connect what is known with what is unknown. Knowledge that might otherwise appear irrelevant or discomforting can be experienced as pertinent and personal when it arises naturally from looking at the commitments and attachments that are implicit in what people already profess to care about.*

While making use of the drive theory of curiosity amounts to fostering an *appetite* for new knowledge based on what people care about, using the gap theory of curiosity is more about highlighting gaps in knowledge such that people feel obliged to start seeking out the relevant information by asking themselves the right questions.

* That said, we shouldn't think that promoting environmental behaviour by appealing to materialist values is necessarily a good idea. For a robust challenge to this, see the Common Cause Report – see http://valuesandframes.org/

> "One important implication of the gap theory is to tell people that we need to open gaps before we close them. Our tendency is to tell people facts. First, though, they must realise they need these facts. The trick to convincing people that they need our message, according to Lowenstein, is to first highlight some specific knowledge that they're missing. We can pose a question or puzzle that confronts people with a gap in their knowledge. We can point out that someone else knows something they don't. We can present them with situations that have unknown resolutions. We can challenge them to predict an outcome… To make our communications more effective, we need to shift our thinking from 'What information do I want to convey?' to 'What questions do I want my audience to ask?'"[57]

Information has to do more than communicate the scientific evidence. It also has to create a climate of deliberations in which no group perceives that accepting any piece of evidence is akin to betrayal of their cultural group

– Dan Kahan

This point is potentially quite profound, because while factual information is always interpreted through values and social norms, questions may be generated more directly out of individual curiosity. A recent study reported in *Nature Climate Change* sought to test two hypotheses, one that attributed the enduring political controversy on climate change in the USA *to* the public's limited ability to comprehend science, and the second, to opposing sets of cultural values.

Dan Kahan, a Professor of Psychology at Yale says the findings supported the second hypothesis and not the first. "In effect," Kahan said, "ordinary members of the public credit or dismiss scientific information on disputed issues based on whether the information strengthens or weakens their ties to others who share their values. At least among ordinary members of the public, individuals with higher science comprehension are even better at fitting the evidence to their group commitments." In other words, it is not about your level of education or your understanding of science, but about your sense of loyalty to the groups you identify with. Kahan added the profound point that:

> "Information has to do more than communicate the scientific evidence. It also has to create a climate of deliberations in which no group perceives that accepting any piece of evidence is akin to betrayal of their cultural group."[58]

The kind of curiosity called for here seems to be quite advanced. It is a curiosity into our own biases and a willingness to be curious about the thought processes of people we often assume to be simply wrong. Such sophisticated forms of curiosity are rare, and depend upon a prior interest in human behaviour more generally, which is a central concern of the RSA Social Brain Centre.

Curiosity and Innovation in Behaviour Change:

The fashionable expression, 'behaviour change' obscures the huge variety of forms of behaviour, who exactly is doing the changing, and different ways in which behaviour can be changed. Some environmental behaviour changes are one-offs, for instance getting your attic insulated, some require a change in patterns of behaviour, for instance how you get from A to B, but that pattern can be very regular (route to work) or infrequent (route to art gallery). Some behaviour change requires you to stop doing things, for instance leaving lights on, some to start doing new things, for

instance walking to work, and some to replace one form of behaviour with another, for instance changing your car.[59]

The deep challenge of environmental behaviour change is that many of the changes sought are regular habitual patterns of behaviour, not one-off decisions or things we only do rarely. Changing habits is hard, and takes time and perseverance. While many try to make some forms of non-habitual behaviour change as easy and automatic as possible it is widely recognised that one of the prerequisites for changing habits is forming an interest in how our habits come about, how they are reinforced and how they might change.*

It is widely recognised that one of the prerequisites for changing habits is forming an interest in how our habits come about, how they are reinforced and how they might change

Changing any engrained habit is hard work. It requires a real understanding of what is to be changed, the ability to imagine the new way of behaving, the commitment to change, and lots of practice in different situations to help the shift to become engrained enough. For some while the 'new' way of doing something feels just that, new. And it is all too easy to slip back into old, familiar ways of doing things.[60]

In other words, shifting habits requires curiosity into our own natures. This kind of curiosity helps us to be reflexive about our behaviour, and use our newfound self-awareness to shape our circumstances with awareness of our cognitive biases and habitual tendencies in mind. We have already trialled this kind of approach with the general public, with police officers and with taxi drivers.[61]

In summary, curiosity potentially offers three kinds of innovation for the energy industry. At the level of technology, we need to be more precise in connecting the kinds of feedback customers are looking for with the energy data provided to them. At the level of environmental messaging, we need to connect to questions that people naturally ask of the things they care about in their local environment, and create the experience of knowledge gaps such that people seek out the relevant new information themselves. Finally, at the level of behaviour change, we need to be more curious about our own natures, particularly about the complexities of habit formation and change.**

* For instance, a recent report by the Behavioural Insight Team at the Cabinet Office explored behavioural science and energy consumption. The study covered topics such as our tendency to discount the future, the power of social norms and the use of defaults, showing the potential of such insights to change behaviour. However many related to one-off behaviours rather than habitual patterns of behaviour which arguably matter more. See http://www.cabinetoffice.gov.uk/sites/default/files/resources/behaviour-change-and-energy-use.pdf

** For a deeper discussion of habits, see Transforming Behaviour Change by Jonathan Rowson, RSA 2011: www.thersa.org/projects/social-brain/transforming-behaviour-change

Implications for Education and Life-long Learning

Given what we have argued thus far about the complexity of curiosity and its multifaceted role in cultivating innovation, there can be no simple formula for how to improve the prospects of people becoming more curious. That said, there are certain implications for formal education and more generally for lifelong learning. We present some practical suggestions below to stimulate discussion.

The Case for Curiosity Supports the Wider Case for Making the Cultivation of Life-long Learning Dispositions the Central Purpose of Education

The first challenge for education is framing: how should curiosity be approached? Professor of Real World Learning Guy Claxton proposes eight 'big values' for 'The Learning Age' including curiosity, but the others also relate closely to the centrality of curiosity for learning: courage, exploration, experimentation, imagination, reasoning, sociability and reflection.[62] However, these 'values' are of course not values in the conventional sense, instead they reflect a particular attitude and sensitivity, and are perhaps best captured by the term 'disposition'.

Harvard educationalist David Perkins describes dispositions as 'the soul of intelligence'.[63] Our dispositions are formed over time by the way our motivations feed into our actions, and, in turn, receive feedback from those actions. Such dispositions become habitual, but they are not merely habits. Dispositions lie closer to our experience of freedom, and reflect our readiness to choose to respond in certain ways. The value of teaching for learning dispositions can be developed in a variety of ways, but there is a particularly supportive body of research on 'mind-sets' that suggests it is worth considering how the inculcation/nurturing of disposition to be curious should be considered in the curriculum.

Getting it wrong, being curious about why we got it wrong, and trying something different is likely to lead to novel and innovative solutions to problems

Carol Dweck's research, while not explicitly concerned with curiosity, offer a useful perspective on the kinds of mind-sets required to develop curiosity in schools.[64] Dweck tested and validated the theory that individuals occupy positions along a continuum according to their own assumptions about where their ability comes from. At one end of the continuum are those who have a "fixed" theory of intelligence, believing that their success derives from innate ability – i.e. one is essentially intelligent, essentially average, or essentially unintelligent. At the other end of the continuum is the "growth" or "incremental" theory of intelligence, in which individuals believe that their success is based on hard work and

learning. Dweck suggests that we are not necessarily aware of our own mind-set, but researchers, psychologists or observers can discern mind-sets by observing behaviour.

Reaction to failure is one key indicator of mind-set in this context. Those with a fixed mind-set dread failure because they interpret it as evidence of their innate ability being inadequate. Those with a growth-mindset are less likely to be concerned by failure because they realise and assume that their performance can be improved. Dweck argues that the growth-mindset is preferable and should be nurtured because it is far more likely to allow individuals to lead not only less stressful but also more successful lives. Getting it wrong, being curious about *why* we got it wrong, and trying something different is likely to lead to novel and innovative solutions to problems. We can only do this effectively if we operate primarily in the growth-mindset.

We have already argued that a necessary precondition for some curious inquiry, is that people are able to investigate something without a pre-determined goal or end being specified. Dweck's research into our assumptions about our own ability supports this need to encourage open exploration and be encouraging in the face of failure.

Relatedly, in her talk at the RSA[65] on her book, 'Being Wrong', Kathryn Schulz argues there is great value in being wrong, and more importantly recognising *when* we are wrong. Schulz suggests that in embracing ambiguity and error, and allowing ourselves to live with doubt, we are far more likely to stumble across solutions to problems in unanticipated ways. This is related to the need to make space for curiosity without an explicit aim or objective to focus it on. Asking ourselves 'what if I am wrong', Shulz argues is more likely to lead to novel ideas and innovative solutions, rather than persisting in chasing one particular line of investigation that we are already sure of.

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One might assume from Dweck's research that there is little to be done about pupils' mind-sets and that they are innate. However, Dweck makes a convincing case that mind-sets are formed and cemented in response to feedback. The way in which praise is formulated is therefore crucial if growth-mindsets are to be nurtured. When children are told that their work is good *because they are clever*, they are more likely to form and settle into a fixed-mindset. In contrast, if they are routinely told that their work is good because they worked hard on it, they are likely to develop a growth-mindset.[66] Dweck's work indicates that the framing and nature of praise is an important factor in whether or not pupils develop and maintain the capacity to persist despite setbacks. Having this resilient attitude is clearly desirable in and of itself, but it also relates to curiosity because this approach implicitly assumes that it is worthwhile to explore ideas and seek out information even if it does not lead to tangible success.

Arising from this change in framing, there are several simple suggestions to provoke curiosity in the classroom, for instance by highlighting challenging but manageable gaps; by asking questions, by creating a story, by building incongruity, by giving different groups of students different access to information (we want information that other people already have) and removing the stigma of being wrong, while encouraging curiosity into the causes of errors and promoting the educative value of a good question.

Keep Learning Outcomes Open

Corlis and Weiss[67] suggest 'program openness', which refers to the deliberate employment of pedagogical tools that do not have closed learning outcomes. Crucial to this process is that students are not burdened with a pre-determined expected outcome. Instead, they stress the value of finding ways of delivering educational material that require students to actively explore and investigate topic areas and create their own outcomes.

Oxford University's Mark Williams argues that mindfulness promotes approach behaviour as opposed to avoidance behaviour, and that curious exploration is at the core of mindfulness training

Promote Mental Training, Including the Practice of Mindfulness

There is a growing body of research suggesting that the practice of mindfulness can increase curiosity. Mindfulness has been defined as "paying attention in a particular way; on purpose, in the present moment".[68] Psychologist Todd Kashdan[69] argues that due to evolutionary reasons our psyches are hardwired to react with both anxiety and curiosity when we encounter certain novel situation. Exploring an unknown forest 10,000 years ago would mean both increased risk of being attacked and increased chances of finding new sources of food. Therefore, anxiety and curiosity are two competing systems and simultaneously acting systems, according to Kashdan. Mindfulness trains us to accept uncomfortable feelings, such as anxiety, without creating vicious circles, such as being afraid of the very experience of fear. A large body of research shows that mindfulness-based training is effective in reducing anxiety, depression, and distressing thinking, which can be real obstacles to curious exploration.[70] Oxford University's Mark Williams argues that mindfulness promotes approach behaviour as opposed to avoidance behaviour, and that curious exploration is at the core of mindfulness training.[71]

Whether mindfulness can be effectively taught to children is less clear but there is a number of studies suggesting that it can. It has been reported that mindfulness programmes led to "improvements in highly anxious 7 to 10 year olds' attention-deficit behaviours, test-anxiety and selective attention".[72] Another study claims that students with learning difficulties experienced improvements in anxiety, social skills and academic achievement.[73] Effectiveness of mindfulness training manifests in a number of different ways and cannot be judged only by a decrease of anxiety. Various other studies report that mindfulness training for children has led to increases in resilience, mindfulness and wellbeing,[74] improved attention social skills,[75] reduced stress-induced emotional arousal, rumination and intrusive thinking.[76] None of these studies measured effects on curiosity but the fact that other typical benefits were achieved supports that training was effective. This suggests that children can also learn mindfulness to better deal with anxiety, depressive symptoms and distressing thoughts thus unlocking more of their natural curiosity potential.

Stay Curious About the Personal Impact of Technology

While we have not found any evidence in the literature of a direct effect of modern technology on *curiosity* itself, there are some researchers who suggest that there is an effect on our attention spans more generally. If specific curiosity is a mechanism for sustaining attention, then perhaps rather than asking whether technology changes curiosity we should be

asking how can we cultivate curiosity to offset the potentially detrimental effect of modern digital technology on our attention spans.

In his book *The Shallows*, Nicholas Carr suggests that the Internet is changing us.[77] He claims that the main method of information dissemination (each iteration of information technology) alters our brain by effectively training it to acquire information in line with the technology itself. To read and digest traditional printed books, our brains were trained to focus and sustain attention, fostering deep thought and patient enquiry. In a printed book devoid of hyperlinks, we read linearly and follow the central idea of the book throughout.* In contrast, when using the Internet we flit from web page to web page, distracted by hyperlinks, pop-ups and advertisements, reading relatively short articles or blog posts. Carr cites research showing that hypertext** is mentally demanding; it interrupts attention to the original text and requires cognitive resource to evaluate the potential value of the hyperlinks and navigate through the new information. Thus, hypertext increases cognitive load (the information in our working memory) making it harder for people to learn, retain information, and make connections to information stored in long term memory to acquire deeper understanding. A high cognitive load also increases distractedness and makes it harder for people to identify which information is relevant.[78] So while the use of the internet may be improving our ability to quickly scan information for a surface understanding, it may also diminish our capability to think and learn deeply.

In schools, we create artificial learning environments for our children that they know to be contrived and undeserving of their full attention and engagement. Without the opportunity to learn through the hands, the world remains abstract and distant, and the passions for learning will not be engaged

– Technology Teacher

Winifred Gallagher, author of *New*, echoes this claim. She proposes that our current neophilia – our love of the new, novel – can undermine deep understanding. "The possibility that the wired life could habituate the brain to states of high arousal and actually train it to flit between targets from texts to tweets rather than to focus, so that distractedness becomes a learned behaviour or habit, is a legitimate fear".[79] Some things only become interesting once we have already committed a lot of effort to them. In the case of innovation, and in the context of the modern technological environment discussed, this could pose a real challenge. Recall that innovation requires both divergent thinking, which may flourish under modern technology and the ease with which we can access and navigate various new ideas, and also convergent thinking, focused thought, and grit. It requires a strong attention span, developed through sustained interest.

How does this relate to curiosity? Diversive curiosity may potentially be thriving given our modern technology. But specific curiosity may be the casualty. Specific curiosity plays a significant role in sustaining interest and providing the intrinsic motivation to persist devoting time and effort to an endeavour ('grit').

"When people feel curious, they devote more attention to an activity, pro-

* Sir Ken Robinson makes a similar point in his talk to the RSA. Robinson argues that divergent thinking decreases with age from kindergarten to adulthood. He blames the education model which teaches that there is only one right answer and discourages collaboration – see www.thersa.org/events/video/archive/sir-ken-robinson

** "A computer-based text retrieval system that enables a user to access particular locations or files in webpages or other electronic documents by clicking on links within specific webpages or documents." from the American Heritage Science Dictionary. Retrieved June 11, 2012, from Dictionary.com website: http://dictionary.reference.com/browse/Hypertext

cess information more deeply, remember information better, and are more likely to persist on tasks until goals are met."[80]

So by encouraging or cultivating specific curiosity, we might help to mitigate the hindrance to innovation associated with shallow understanding and distractedness.

While the use of the internet may be improving our ability to quickly and scan information for a surface understanding, it may also diminish our capability to think and learn deeply

Encourage Embodied Learning

As argued above under 'tactile curiosity' there is a strong case that one of the best ways to cultivate curiosity is by encouraging people to learn by doing, particularly with their hands. For instance, writer and mechanic Matthew Crawford makes reference to a technology teacher who argues: 'In schools, we create artificial learning environments for our children that they know to be contrived and undeserving of their full attention and engagement. Without the opportunity to learn through the hands, the world remains abstract and distant, and the passions for learning will not be engaged.'[81]

In summary, curiosity might be cultivated in school through various techniques. Teaching for the development of dispositions like curiosity, encouraging forms of mental attention such as mindfulness, keeping learning outcomes open to make learning more exploratory, encouraging reflexive awareness of students' own natures and learning patterns, remaining vigilant about the impact of screen-based technologies on different kinds of curiosity, and giving people a chance to learn something in considerable depth and/or using their hands are all viable suggestions to allow curiosity to flourish in the education system.

Conclusions

We hope that this report has left the reader curious about curiosity, and that we have made a good case for why it is timely and important to attempt to foster curiosity to address our energy challenges.

Curiosity can fuel three kinds of innovation to help tackle our energy challenges. At the level of technology, we need to be more precise in connecting the kinds of feedback customers are looking for with the energy data provided to them. At the level of environmental messaging, we need to connect to questions that people naturally ask of the things they care about in their local environment, and create the experience of knowledge gaps such that people seek out the relevant new information themselves. Finally, at the level of behaviour change, we need to be more curious about our own natures, particularly about the complexities of habit formation and change.

Shallow curiosity can now be quickly satiated through Google or similar devices, but deep curiosity that arises from sustained focus and engagement is arguably not supported and protected in the culture at large as much as it could be

Our research indicates that curiosity may play an important part in stimulating innovation in ways that we urgently need to meet energy challenges in Britain. Understanding curiosity can help to create more effective feedback on home energy consumption, improve how we communicate environmental messages, and develop more sophisticated strategies to change behaviours that are habitual in nature. We also explore several ways that we could try to build on the natural curiosity of young people in educational settings.

If there is an overarching impression worth ending on, it is that curiosity may have been hollowed out in some sense. Shallow curiosity can now be quickly satiated through Google or similar devices, but deep curiosity that arises from sustained focus and engagement is arguably not supported and protected in the culture at large as much as it could be. Creating a truly sustainable economy is an issue worthy of deep and sustained engagement from all of us, and it is hoped that a deeper appraisal of curiosity in all its forms may help to achieve this.

Appendices

Appendix 1. National Survey Questions

On a scale of 1 to 7, where 1 is "Strongly agree" and 7 is "Strongly disagree", to what extent do you agree or disagree with each of the following statements?

- I view challenging situations as an opportunity to grow and learn
- Simple explanations leave me with a lot of questions
- When I hear an unfamiliar noise I need to know what caused it
- I enjoy learning about unfamiliar subjects
- When I come across something puzzling I like to try to find a solution
- I am a person who is generally curious about things

Appendix 2. Curiosity Quiz

In addition to the national survey, the RSA designed a curiosity quiz which will be available on the British Gas website and Facebook page. The quiz was designed to elicit both an overall curiosity score and a curiosity profile showing on which dimensions of curiosity the participant is dominant.

Four of the quiz questions measure curiosity in general, and serve to provide a "curiosity score": a rough indication of a person's overall level of curiosity. The five curiosity scores range from 'not too curious' to 'extremely curious'. These questions are either adaptations of item statements from Litman and Spielberger's 2003 curiosity scale or they were developed in-house by RSA researchers.

The remaining six questions tease out the participant's tendency towards a given curiosity type. That is, they assess whether, in general, the participant's curiosity is more epistemic or more perceptual, more specific or more diversive. For accessibility, rather than presenting a profile by its technical name (following Berlyne's model) such as "epistemic-specific", we reveal the personalized profile by explaining the type of curiosity and providing an example of an activity which is likely to be motivated by that particular type of curiosity. The questions in this section were designed with consideration of existing scales and with an appreciation of the multi-faceted construct of curiosity.

We expect people to find the quiz engaging, and hope that the results will provoke thought and perhaps stimulate even greater curiosity.*

* The quiz is now live and can be viewed at https://apps.facebook.com/bgcuriositytest/

Quiz Questions

1. In general, I think of myself as being:
   a. satisfied with what I know
   b. always inquisitive and wanting to know more

2. When somebody teaches me something new, generally I:
   a. Am satisfied with the explanation
   b. Ask a lot more questions

3. When listening to music, I prefer to:
   a. Stick with my favourite groups/artists
   b. Try out listening to new or unusual types of music

4. When I get a new gadget (phone, toy, bicycle), I:
   a. Don't want to mess with it too much
   b. Experiment with it to try to see how it works

5. In general, I tend to:
   a. explore many different things, jumping from one to another
   b. pick something that really interests me and spend time exploring it

6. If visiting an art gallery, I generally prefer to see an exhibit by:
   a. someone I've never heard of before
   b. an artist whose work I already know so that I can see their work in real life

7. When learning about a new topic, I tend to:
   a. explore several questions about many different aspects of the topic
   b. have one or two key questions about the topic and try to really understand their answers

8. If I'm at an art gallery, I usually spend more time:
   a. looking at a painting's brush strokes
   b. reading the curator's remarks about the painting

9. When I'm at school or at work, I am generally more interested in:
   a. my surroundings – the desks, computers, people around me
   b. the lesson or the work I'm doing

10. I see a hedgehog in a park. I'm more likely to want to know:
    a. what its spikes would feel like if I touched it
    b. why it has spikes

Appendix 3. Historical and Cultural Aspects of Curiosity

Curiosity hasn't always had the positive connotation it has today, and has even been viewed as a "demonstration of a lack of self-restraint".[82] Saint Augustine of early Christianity wrote about curiosity as being one of three major sins (along with carnal pleasure and pride).[83]

In the 1600s and 1700s the moral view of curiosity began to change. In the wake of scientific discoveries by Galileo and Newton among others, curiosity became more morally acceptable, although still reserved to the privileged classes.[84] At this time, 'curiosity cabinets' appear, to house people's collections of curiosities: exotic or rare objects.

Post-Enlightenment, the term curiosity referred less to an object and more to a disposition (as we would understand it today) or to the person embodying that disposition. However, pre-1950's, it would not have been an obvious compliment to call someone curious. Rather, it meant overly-inquisitive, strange, or odd. Today, curiosity is generally considered to be something to be embraced.[85]

But even in the periods where curiosity is widely viewed to be a virtue, as it is today, there is often a distinction between the 'good type' of curiosity and the 'bad type', based on its motivation and outcome. In general, this distinction is that curiosity is positive when the topic of investigation is a respected one, motivated by scientific discovery,[86] societal advancement, or a "love of knowledge".[87] On the other hand, it is negative, or even harmful, when it is gossipy, as in when someone is curious about the details of a neighbour's or celebrity's private life. Hume made this same distinction in 1777,[88] and it seems, at least anecdotally, that this view is maintained today.[89,90]

The reluctance of embracing curiosity when it is deemed 'trivial' presents a challenge for attempts to foster innovation. What may begin as an investigation into something that some people perceive to be trivial, might eventually result in a product, system, or technique which has applications in an unexpected field

The reluctance of embracing curiosity when it is deemed 'trivial' presents a challenge for attempts to foster innovation. What may begin as an investigation into something that some people perceive to be trivial, might eventually result in a product, system, or technique which has applications in an unexpected field. Who determines what is trivial and what is not? Research for curiosity's sake may lead to innovation. In a system of research funding where there is an increasing reliance on impact assessments as a criteria for support, do we put these unexpected innovations at risk? Because it may be hard for large scale projects to accommodate spontaneous curiosity, perhaps we should embrace smaller-scale, curiosity-driven projects.[91]

More generally, the appearance of curiosity in cultural and artistic forms appears to have declined in the last two centuries. In the introduction to their book, *Curiosity and Wonderment in the Renaissance to the Enlightenment*, Weston and Marr demonstrate the significance of curiosity as a prime motif in literature in the early modern period. During the sixteenth to nineteenth centuries, great value was placed on curiosity as a crucial element in scientific advancement and technological progress, and this was very much reflected in the literature of the time.

George Eliot's masterful novel, *Middlemarch*, published in 1874 is one such example. The character Tertius Lydgate, who is a scientist of the most curious disposition, leaps out as the most obvious example of a character illustrating the enthusiastic attitude towards curiosity as an attribute to be prized. But he is not alone, and many other of Eliot's characters in this novel are appealing to the reader precisely because of their curiosity about

the world in which they are living. It is clear from her writing that Eliot herself was someone who was motivated and inspired by her own curiosity about not only human nature but also the natural world.

John Ruskin, a contemporary of Eliot's, is another example of a writer whose admiration of representations of curiosity and own curious disposition in relation to the world led to not only prolific output, but also discoveries of enormous social significance. Ruskin recorded changes in weather and the environment and in doing so was the first person to identify a link between industrialisation and pollution.

Although social psychologists, educationalists and anthropologists have invested considerable time and resources into better understanding the concept of curiosity, its appearance in popular culture and literature in recent times is less cogent and arresting than it was in the early modern period. Mark Haw, a lecturer in the School of Chemical, Environmental and Mining Engineering at the University of Nottingham, has argued that contemporary cultural portrayals of science and scientists are relatively thin on the ground because of a decrease in curiosity in general. He points out that we need to realise that we don't have to be a professional to be curious and suggests that in the face of environmental degradation that "if we were encouraged to be curious, we would stand a better chance of survival".

the secret tragedy of innovators is that their desire to improve the world is rarely matched by support from those they hope to help

The demise of curiosity as a feature of contemporary culture is further highlighted by the former Microsoft manager Scott Berkun, in his book, *The Myths of Innovation* (2010). Here, Berkun says that the love of new ideas is a myth, and that in fact we prefer ideas only after others have tested them and proved their worth. He states that "the secret tragedy of innovators is that their desire to improve the world is rarely matched by support from those they hope to help".[92]

A possible reason for the demise of curiosity could be to do with the fact that in itself it is not goal directed. Being curious is dependent on a degree of freedom to explore one's fascination with no specific purpose. The results of curious inquiry may lead one to hit upon a discovery, but by its very nature, it often helps when this discovery is not anticipated in advance. Because of this, it could be said that curiosity is a product of having the luxury of available time to ponder and consider with no pressure or expectation to arrive at a profitable end.

Mark Haw points out that the proliferation of curiosity and its breadth of appearance in the literature of the nineteenth century could in part be due to the fact that the 'leisured classes' had both the time and financial liberty to allow curiosity to bloom.[93]

It seems therefore, that attempts to foster and harness curiosity may be dependent on the recognition and acceptance of the need to make space and time for it. This in itself represents a not insignificant challenge for educational, organisational and political structures.

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8 John Adam Street,
London WC2N 6EZ
+44 (0)20 7930 5115

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