



GRESHAM COLLEGE

19 FEBRUARY 2019

CASTLES IN THE AIR: MAKING AND INHABITING A DIFFERENT REALITY

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Certain illnesses, mental and physical, are associated with a change in a person's experience of reality, sometimes referred to as *Psychosis*. They may see or hear things that aren't there or come to hold strong beliefs that others find irrational and baffling. In this lecture, I examine these experiences and reject traditional notions that they are fundamentally incomprehensible. I argue that, by looking closely at healthy perception, we begin to see that the whole process is actually remarkably creative. Our brains function as organs of prediction, which is enormously helpful in making sense of a complex, ambiguous, uncertain world. But this function confers certain vulnerabilities on us and one of these is the tendency to make up, and sometimes lose contact with, reality. I aim to show, through the course of the lecture, that the "normal" ways of experiencing the world, when we look at them closely, usually involve a great deal of guesswork and creativity. Close scrutiny of how we all perceive and make sense of the world suggests that we are not as intimately in contact with reality as we think.

This lecture is really a summary of the attempts I have made to make sense of psychosis. I don't have any definitive answers but I think that we are able to speculate in an informed way and, in doing so, to reject the idea that psychosis is a mysterious derangement or that its sufferers are beyond comprehension and reason.

A Background Note

Psychosis is quite a vague, descriptive term that is often misused and frequently misunderstood. In medical settings, it refers to the situation where someone appears to have lost contact with reality. I first became interested in it as a medical student on my attachment to a psychiatry service in Hackney, East London. I met a young man who was convinced that the television and media were sending him messages and instructions. As a consequence of some of these messages, he deliberately and severely injured himself. I was very affected by the story he told me of how this had come about. In particular, I found it hard to imagine how he, an intelligent, eloquent and very thoughtful man, could come to experience the world so differently from those of us around him.

What do we mean by psychosis and what are the problems in understanding it?

Psychosis ("loss of contact with reality") is characterised by abnormal perceptions (hallucinations) and beliefs (delusions) such that the sufferer can live in a bizarre and frightening world in which s/he seems fully immersed. The complexity of these symptoms makes one wonder about how we can ever develop an explanation that goes beyond simply describing the experience, and helps us to relate it to the underlying faculties and functions of the mind/brain. To be useful, such an explanation should be applicable at many levels of description, from the nature of the experiences themselves (beliefs, perceptions, subjective experiences) down to the cognitive, the brain processes and the neurochemical mechanisms. It is not that we should seek to "reduce" the experience down to the level of brains and brain cells (I believe that this would be impossible) but rather that we must aim for an understanding using concepts and ideas that cut across the different levels. This presents us with a real challenge because there are big gaps between the levels. What might be going on in someone's brain that could cause them to see a person who isn't there? Or to hear a persistent voice – one that talks to them or comments on their actions – when there is no one around?



I believe that the starting point to solving this puzzle is to look very closely at how all of us perceive the world under normal circumstances.

A closer look at “normal perception” – how do we make sense of reality?

Perhaps the best way to seek an explanation for a “loss of contact with reality” (i.e. psychosis) is to think carefully about how we all try to make contact with that reality. By examining the problems that the healthy brain is faced with in surviving in our noisy, data-rich and uncertain world we come across a very interesting possibility: that even the most apparently irrational of beliefs and the most vivid of hallucinations could actually be something of an occupational hazard related to the way that our brains normally make sense of the world. To jump ahead a bit, comprehending reality requires a delicately-poised balance between what we already know and what our senses are currently telling us. Even a very subtle shift in this balance could have profound consequences for how we understand and interact with the world.

I think that this simple insight gives us some interesting and liberating perspectives and helps us to think more clearly about many symptoms of psychiatric illness.

What does the brain actually do (or try to do)? Prediction is key.

Though it may seem rather desiccated, and disappointing to those who see the primary role of the brain in terms of higher order occupations such as poetry and philosophising, it is useful to begin by acknowledging that the brain is a physical organ that, like the other organs of the body, is, foremost, in the business of promoting survival. Poetry and philosophy can only come after it has participated in this basic requirement. In order to do this it must have the capacity to *predict* the world, which requires a working model of what to expect from the world in a given set of circumstances. (This might seem counter-intuitive but, on reflection, one can see that the ability to predict is a remarkably good survival tool – far more useful to be able to make a good estimate of what’s going to happen in the future than to be fast, ferocious or strong).

So, the challenge is for the brain to establish itself as a predictive model of the world – using the signals that it receives to build up a picture of that world and all its complex associations.

How can we accurately perceive the world when our information about it is so complex and ambiguous?

For many of us, looking out on the world confers the comfortable feeling of being directly and intimately in contact with reality. But this feeling is illusory. The brain does not have direct access to the world. It has only a set of electrical inputs which are caused by events and objects in our surroundings. Consider vision. Our eyes are sensitive to only a thin sliver of the electromagnetic spectrum – visible light is one sign of the reality that is out there, but there are many other electromagnetic signals (Gamma, X-Ray, Infra-red, Ultraviolet, Radio waves etc) that we aren’t picking up. And even the signals that we do pick up go through a complex process of chemical and electrical transduction so that, by the time they reach the stage of conscious processing in the brain they are in a compressed code that must then be decoded and interpreted. And just to make matters more complicated, it is a signal that is very intensive and highly ambiguous.

I want to look closely at how we are able to cope with this challenge. I will pay particular attention to making sense of the world through visual processing but I feel that, to a greater or lesser extent, the same principles apply to using other senses to try to perceive reality.

A Fundamental Insight – Perception Is an Act of Inference

Let us distinguish between sensation and perception. For my purposes, sensation refers to the signals from the world that act on our sensory receptors and perception refers to what then happens to those signals – how they are processed, and represented in the brain. Perception is a conscious experience (though many of the processes that contribute to perception are unconscious). A *Hallucination* is formally defined as *perception in the absence of an external stimulus* (in other words, perceiving something when there is no objective reality that might give rise to the



relevant sensations). This is just a rough definition and one can find many instances where it doesn't seem to fit well, but it will suffice for our purposes. Bear this definition in mind as we look more closely at perception.

Herman von Helmholtz (1821-1894), the German physician and scientist, made the following statement about visual perception:

“The general rule determining the ideas of vision that are formed whenever an impression is made on the eye, is that such objects are always imagined as being present in the field of vision as would have to be there in order to produce the same impression on the nervous mechanism”

This is a very telling statement – v. Helmholtz is suggesting that perception involves imagining what actual object might have led to the (visual) sensations that we are receiving.

Vernon Mountcastle (1918-2015), a neuroscientist, put things in a slightly more poetic way:

“Each of us lives within the universe - the prison - of his own brain. Projecting from it are millions of fragile sensory nerve fibers, in groups uniquely adapted to sample the energetic states of the world around us: heat, light, force, and chemical composition. That is all we ever know of it directly; all else is logical inference”

Both v. Helmholtz and Mountcastle are saying that perception is an act of inference – of assembling the signals that we receive into the best estimate of whatever objective reality might have generated those signals. It is a particular type of inference known as *Abduction* (A term coined by Charles Pierce, (US Philosopher (1829-1914))). Abduction, unfortunately, appears to involve rather more guesswork than the other main types of inference (deduction and induction).

To put things in simple terms, my sensations are inherently ambiguous. I might see a moving black shape and infer (abductively) that it is a raven. But, if the shape is obscured, or in the distance, or seen in the half-light, how can I be confident that it isn't, say, a cat? This dilemma brings us to a crucial strategy that we use in making sense of the world: *prior knowledge*. We use what we already know, or have experienced in the past, to sharpen and optimise our abductions. For example, if the black object is sitting at the top of a tree, perhaps the best inference is that it is a raven, while, if it is rubbing against someone's leg, it seems more likely that it is a cat. Conversely, if we are swimming along underwater when we sense it, then neither cat nor raven seems plausible. *The crucial point here is that the perception requires more than just sensation to work well – it demands an appropriate use of prior knowledge.*

I will present, in the lecture, some practical examples in the visual and auditory domains of how prior knowledge can help to sharpen up our perceptions. I will also show some experimental data suggesting that using prior knowledge can have a profound effect on basic perceptual processes, potentially making us more sensitive to subtle signals that may hover below the level of consciousness.

Interim summary: The information from our senses is ambiguous and difficult to process. Perception is an essentially constructive act in which we must make the best inference possible about the cause of a given sensation. This (abductive) inference demands that we use what we already know in order to generate the perception that is most credible and probable given the context and sensory the signals. Using prior knowledge and experience can optimise perception by resolving ambiguities and boosting sensitivity. Having outlined the advantages of this strategy, I will now consider its perils and pitfalls

Perception as An Act of Inference: The Bad News...

Above, I described hallucinations – a key experience in psychosis – as perceiving something that isn't objectively there. But, if perception is an active and creative process as I have argued, this introduces the possibility that, even under the most boringly normal circumstance, we never quite experience the world as it really is but rather we refashion it to ensure that it fits in with our expectations. Visual illusions are beloved in the study of psychology because they seem to give us an insight into the tricks of perception and into the ways in which we actively construct our experience – sometimes to the extent that we ignore or add to the evidence of our sense. I will



illustrate this with a number of examples ranging from basic visual processing of lines and contours to more complex perception of faces and emotional expressions.

Strictly speaking, illusions (“misperceptions”) are not hallucinations (“made-up” perceptions), but their existence should cause us to question just how reliable our picture of reality may be. Indeed, some have gone so far as to suggest that normal perception actually has a strongly hallucinatory quality. The French historian, Hippolyte Taine (1828-1893), made the remarkable statement in an essay that:

“...external perception is an internal dream which proves to be in harmony with external things; and instead of calling hallucination a false external perception, we must call external perception true hallucination”.

De L’Intelligence 1870 - Translated by T.D. Haye

This was later echoed in the more pithy statement attributed to Ramesh Jain that “perception is controlled hallucination”. If this is indeed the case, then we may have a toehold on the question of how it is that a person might create and inhabit a reality that is not shared by those around them

Reconsidering psychosis in light of these ideas...a finely-balanced system

I have raised the idea that our apprehension of reality depends on a process of balance or negotiation between the signals that we receive and the predictions that we make based on experience. These predictions are crucial to making good perceptual inferences but this comes at a cost – the price of being useful is that we may not be absolutely accurate. This is generally not a problem, we tend to be very good at interacting optimally with the world. But this is a system in a delicately-poised balance. Higher level predictions are matched against incoming information and, if there is a mismatch (what is referred to as a “*prediction error*”), the system must respond to this. It may do so by ignoring the prediction error - perceiving what is expected and ignoring any deviation of reality from this expectation. Alternatively, it may respond to that prediction error by updating predictions (i.e. by learning) so that these fit more closely to incoming signals.

It’s important to remember that there is no easy way to identify which strategy is best and, indeed, the appropriate response to prediction error will differ in different contexts. For example, in noisy and unreliable conditions, perhaps we shouldn’t trust our senses as much and should rely on what we already know, favouring prediction over input. Conversely, if the input is sending us a clear and strong signal that we have made the wrong prediction, then it would be important to update that prediction. The truly successful system will sometimes ignore the error and sometimes use it to generate new learning. Crucially, the successful system will have the capacity to select the appropriate strategy for any given circumstance. A change in this balance may, I suggest, lie at the heart of psychosis. In order to clarify this, I give below some examples of psychotic experiences that have different causes and then go on to consider how they might be explained by a change in this balance. I will focus on hallucinations.

Examples of hallucinations

(i) Isolated visual hallucinations in the Charles Bonnet Syndrome

In 1760, in his “Essai Analytique sur les Facultes de L’ame” Charles Bonnet described how his father, suffering from corneal degeneration began to see birds, buildings and faces. Charles Bonnet syndrome entails the experience of remarkable, often very vivid and elaborate visual hallucinations in the setting of visual deteriorations (for example as a consequence of retinal degeneration). Sufferers often retain their insight into the hallucinatory nature of these experiences, recognising that they are not real.

“...having had hallucinations such as a huge snake and a Chinese lady in full Chinese costume...I now know when I see things that aren't really there they are all part of the Syndrome”

(taken from <http://www.charlesbonnetsyndrome.org>)

(ii) Sensory deprivation and the “Prisoner’s Cinema”

Intriguingly in healthy people, fleeting, usually fairly rudimentary visions can be induced by reducing sensory input. In full sensory deprivation, florid visions can occur from an early stage. This has also been seen in prisoner’s



confined in darkened cells – the so-called “*prisoner’s cinema*” entails an experience of flashing lights, geometric patterns, shifting shapes and faces that appear and disappear.

(iii) Hallucinations following trauma

In many instances, though not all, experience of severe adversity and trauma may be associated with psychosis in later life. In Post-traumatic stress disorder too, there may be, following severely adverse experience (both as a single event or following more prolonged and persistent trauma) a person may experience “flashbacks”, re-experiencing the trauma in vivid detail. One well-known example of this is that of the first world war poet Siegfried Sassoon who was treated for “shellshock”. His experiences are eloquently detailed in Pat Barker’s “Regeneration” trilogy and includes the following exchange between Sassoon and his psychiatrist

“...when I woke up the nightmares didn’t always stop. So I used to see...Corpses. Men with half their faces shot off, crawling across the floor.

...the pavement was covered in corpses. Old ones, new ones, black, green” His mouth twisted. “People were treading on their faces”

(Pat Barker Regeneration (1992)).

(iv) Hallucinations in the chemically disturbed brain

Drugs acting on various neurochemical systems in the brain can produce florid hallucinatory experiences. Indeed, drugs like ketamine, psilocybin, LSD and amphetamines have all, in their time, been used as a “model” of such symptoms in order to try to get a deeper understanding of the chemical changes that might give rise to psychotic illness. Drug withdrawal too may produce profound and deeply distressing hallucinations. For example, in the “Delirium Tremens” associated with alcohol withdrawal, the sufferer may experience a terrifying shift in reality. In the following passage from “The Posthumous Papers of the Pickwick Club” (1836), Charles Dickens vividly conveys the confusing visual experiences of a man in the terminal stages of alcohol-associated delirium:

“...There were insects, too, hideous crawling things, with eyes that stared upon him, and filled the very air around, glistening horribly amidst the thick darkness of the place. The walls and ceiling were alive with reptiles--the vault expanded to an enormous size - frightful figures flitted to and fro - and the faces of men he knew...peered out from among them...” (Chapter 3 – *The Stroller’s Tale*)

Applying Ideas of Normal Perception to Understanding Hallucinations

We see, above, how profound and potentially distressing a change in the perception of reality may be. In the last part of my talk, I consider how the ideas about normal perception, outlined above, can help us to understand how such experiences may arise in different ways, producing overlapping but subtly differing consequences.

To rehearse the ideas briefly, perception is an active and inferential process based on an integration of incoming signals with existing expectations/predictions. The system is in a finely-tuned balance (between predicted input and actual input) and the overall goal is to minimise prediction error (either by ignoring/over-writing signals in favour of expectation or updating expectations so that they accord with the incoming signals, or, perhaps, a bit of both). There are several ways in which this balance might be altered. Suppose that we experience profound reduction in the incoming signals (as is the case in Charles Bonnet Syndrome or sensory deprivation). This will lead to an imbalance such that the predictions will be relatively strong and will outweigh the now-reduced input leading to an internal creation of perceptual experience that is cut off from the real inputs. Importantly, in both Charles Bonnet Syndrome and sensory deprivation, there are expectations at a higher level that provide an explanation to the person about why this is happening. These higher level prediction processes are unaffected so that the person retains a realistic view of their perceptual experiences and recognises them as hallucinations.

What if something happens to a person such that their predictions become profoundly changed? A serious trauma or persistent adversity (especially in early life) will necessarily mean that their expectations about the world (and the people in it) become shifted, sometimes radically. Such expectations (perhaps, that people are untrustworthy, or cruel, or that the sufferer themselves is unworthy or guilty in some way) will have a serious impact on how they



process the incoming signals from the world. Perhaps faces - that might be viewed by another person as neutral or benevolent - will be seen as angry or ill-intentioned. Perhaps innocent physical gestures will be construed as aggressive or threatening. This, in turn will re-confirm the initial expectation that the world is a dangerous and unpleasant place.

And what about a chemical disturbance? For example, changes to the chemical messengers of the brain, produced by drugs or other factors, could lead to changes not in the predictions or inputs themselves but in how they are integrated and communicated in terms of a prediction error signal. A disturbed prediction error signal would lead to compelling and consistent experience that one is perceiving the world incorrectly, perhaps leading to ever more outlandish predictions and ensuing rapidly-changing perceptual experiences that grow further and further from reality. This is what we see in alcohol withdrawal as described above.

These, it must be acknowledged, are all vague speculations. But they show how this simple model of perceptual processing offers us a range of complementary ways of understanding how disturbances of very different types may radically change a person's apprehension of reality. In the final part of the lecture, I present some more formal experimental demonstrations that support such speculations. In particular, I will show evidence that:

- (i) The "prediction error" signal appears to be altered in people experiencing psychosis. Consistent with this, controlled administration of a drug that is known to produce an experience of psychosis will produce a similar pattern of prediction error disturbance.
- (ii) In people who are prone to subtle hallucinatory experiences, we can demonstrate an increased tendency to weight predictions more strongly than those who do not have such experiences.
- (iii) There is some recent evidence to suggest that auditory hallucinations are associated a stronger tendency to uses learned associations as a basis for predicting perceptual experiences and, as a consequence, to rely more on such predictions than on the actual sensory input.

Final Thoughts

Much of what I have written, and will talk about, is speculative. We cannot be sure if it will prove to be correct but I would argue that it is a useful and comprehensive way to approach, in a scientific way, a complex and often mystifying set of experiences. In thinking about psychosis – an apprehension of reality that is not recognised or shared by other people - it can be tempting to dismiss the experiences as crazy and incomprehensible. But by thinking more closely about normal healthy perception, and seeing it as an active and creative process that is by no means always accurate or reliable, we can perhaps think more constructively and empathically about psychosis. In particular, the perspective that I have outlined emphasises that the brain is a shaped by its world but that it also creates its world. This means that the explanations I have sought are not merely a matter of simple reductionism but rather a quest for multi-level understanding. According to this view, we do not simply say that psychosis (or any mental illness) can be thought of solely as being caused by the brain or, conversely, purely in terms of the environment or society. Rather such conditions arise as a consequence of an altered interaction between brain and world. The ideas are deeply informed by our growing knowledge of neurobiology but they are not defined by it, since it is clear that a person's prior experiences and their current environment are critical in understanding mental processes.

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Recommended Reading

Henry's Demons: Living with Schizophrenia, a Father and Son's Story – Patrick and Henry Cockburn (2011)
Making up the Mind: how the brain creates our mental world – Christopher Frith (2007)
The Ordeal of Gilbert Pinfold – Evelyn Waugh (1957)