Elite or Everyman?

"But Mozart was different!" Indeed he was. And winning a million pounds on the football pools is different from winning the price of a hot dinner.

The life of a fortune makes possible is not just more-of-the-same (hot dinners every day), but fundamentally different: in ambition, variety and freedom. The pools-winner must develop new skills, and venture into unfamiliar conceptual territory. It will take some effort to learn to sail a yacht, or to appreciate the Picasso newly hung on the living-room wall. Even the opportunity to give large sums to charity brings its own complications, new problems that could not have arisen before. But the pools-winner needs no special faculty: native wit can do the trick.

Does the difference between Mozart and the rest of us lie in some supernatural influence or special romantic power? Or is it more like the difference between winning a fortune and winning a meal-ticket, one of which engenders a space of opportunities and problems which the other does not? Specifically, could Mozart's genius have been due to his exceptionally skilful use of a computational resource we all share: the human mind?

The romantic and inspirational 'theories' see the historically creative as set aside from normal humanity: H-creative insights, and H-creative people, are supposed to be fundamentally different. Intuition, not to mention divine assistance, is said to be a special power that enables H-creators to come up with their ideas. (Mere P-creators, who have ideas that are not historically new but which they themselves could not have had before, are rarely considered.)

Both these myth-like approaches claim support from people's introspective accounts of their own H-creativity. We saw in Chapter 2 that great artists and scientists have frequently reported the sudden appearance of H-creative ideas in their minds. However, what is reported as sudden may not have been sudden at all. And what seems to have no conscious explanation may involve more consciousness than one thinks.

Consider the familiar phenomenon of noticing something, for instance. Noticing and noticing how you notice are two very different things. Think of the last time, or look out for the next time, that you notice something, and try to detail as many of the possibly relevant facts about your own mind (both conscious and unconscious) that you can think of. You may find this very difficult. If so, your humdrum achievement of noticing may come to seem rather mysterious – almost as mysterious as 'insight'.

Likewise, if you try to say just what it was which reminded you of something, or to detail the missing links between the first and last ideas, you will not always be able to do so. (A computational model of reminding, using concepts like those in the BORIS program, has outlined some of the schema-relating processes that may be involved.)

Your difficulty is only partly due to the hiddenness of the unconscious influences at work. For conscious thoughts can be elusive too, and people's sincere reports of them are not always reliable. Try, for instance, to recount all the thoughts that fleet through your mind while making up the next line(s) of a limerick beginning: There was a young lady of Brighton . . . .

You will probably come up with a sparse harvest.

It is not easy to catch one's thinking on the wing, and detail every fleeting image. (Normally, of course, one does not even try.) This is one reason why the notion of intuition, or inspiration, is so compelling. People rarely try to capture the details of their conscious thinking, and when they do so they do not necessarily make a good job of it.

Their lack of introspective success is partly due to lack of practice: they have not learnt how to introspect in a way likely to yield rich results. If you merely ask someone to 'think aloud', you may not get very much of interest. But if you tell them how to go about it, that may help. In his fascinating discussion of creativity, the psychologist Perkins suggests six 'principles' of introspection:

1. Say whatever's on your mind. Don't hold back bunches, guesses, wild ideas, images, intentions. [Notice that this is also very good advice on 'brainstorming', or 'lateral thinking'.]
2. Speak as continuously as possible. Say something at least once every five seconds, even if only 'I'm drawing a blank.'
Speak audibly. Watch out for your voice dropping as you become involved. Speak as telegraphically as you please. Don't worry about complete sentences and elocution.

Don't overexplain or justify. Analyse no more than you would normally. Don't elaborate past events. Get into the pattern of saying what you're thinking now, not of thinking for a while and then describing your thoughts.

Try it! (This time, you can complete: There was a young man of Tralaa...). You will very likely find (especially if you do this sort of thing several times) that you report a lot more going in your mind than you did in the previous introspective exercise.

In short, despite the importance of unconscious processes, myriad fleeting conscious thoughts are involved too. The fact that they are rarely reported is not decisive.

Unreliability in introspective reports of creative thinking has another cause, too. Self-reports are informed by the person's tacit theories, or prejudices, about the role of 'intuition' in creativity.

Introspection is looking into one's own mind, and it shares an important feature with looking into anything else: to a large extent, you see what you expect to see. A doctor in the midst of a chicken-pox epidemic, faced with a case of small-pox, is very likely to misdiagnose the disease. Indeed, much more startling examples of prejudice-driven misperception occur.

In one experiment, medical students were shown a photograph of a baby in a white gown with a simple frill at the neck, leaning against a brick wall. The students offered a number of diagnoses. They commented that the baby was sleeping peacefully, so certain illnesses could be ruled out. They argued about the apparent negligence involved in sitting a baby up against unyielding bricks, in contrast with the apparent care suggested by the spotless frilly nightdress. None perceived the situation rightly.

In fact, the baby was neither ill nor asleep, but dead. The nightdress was not a nightdress, but a hospital shroud (on which the medical students had seen many times). And the brick wall was the wall of the hospital mortuary, which — again — they had seen on numerous occasions. Their tacit assumption that they would be shown a living baby, not a dead one, led them to misperceive the situation to such an extent that even familiar things were misinterpreted (despite the apparent anomalies in the situation).

If this sort of thing can happen when several highly intelligent people take twenty minutes to discuss a photograph staring them in the face, how much more likely that a fleeting self-perception may be contaminated by preconceptions about what one will — or will not — find.

If you already believe that 'insights' come suddenly, unheralded by previous consciousness, then in your own introspective experience they are likely to appear to do so. And if you already believe that they are caused by some unconscious (and semi-magical?) process of 'intuition', you will not be looking as hard as you might for causes potentially open to consciousness. (Likewise, someone trying to explain someone else's thought-processes will look rather harder if convinced that there is something 'concrete' there to find. Livingston Lowes burrowed so meticulously through Coleridge's library, with the notebooks as his guide, precisely because he did not believe that Coleridge's poetry was generated by unnatural means.)

Moreover, someone who is (or aims to be) regarded as H-creative, and who accepts the romantic notion that H-creative individuals are somehow set apart from the rest of us, might not wish to find too much conscious richness in their mind. And what one does not want to find, one does not assiduously seek.

For all these reasons, then, introspective accounts of creative episodes cannot be taken at face value. Even if (which may not be the case) they are full and accurate reports of the person's conscious experience, they are structured by preconceptions much as 'outer' perception is.

Similar caveats apply to memory. Psychological experiments have shown that people's memories of specific events depend very largely on their general assumptions, on the conceptual structures that organize their minds. Broadly, only items that fit into the conceptual spaces within one's mind can be stored there; items that do not fit are 'squeezed' into (or rather, out of) shape until they do.

This casts further doubt on the reliability of 'introspective' accounts of creative insight, since most of these are not introspections but retrospections. Artists and scientists are usually far too interested in what they are creating to be bothered, at the time, to focus on how they are creating it. Moreover, the importance of the idea is often not fully realized until long afterwards. Only then does the creator, perhaps egged on by an admiring public, set down the (supposed) details of what actually happened in his or her consciousness at the time. All the more opportunity, then, for the creator's preconceived ideas about the creative process (and the 'specialness' of creators?) to affect the description of what went on.

For example, Coleridge's well-known account of how he came to
compose *Kubla Khan* (which he subtitled ‘A Vision in a Dream’) conflicts both with other self-descriptions of this episode and with documentary evidence. The best-known account comes from his Preface to the poem, published in 1816. There, Coleridge says that in 1797 (a full twenty years earlier) he ‘fell asleep’, and remained for some hours in ‘a profound sleep, at least of the external senses’. But in 1934 a manuscript in Coleridge’s handwriting was discovered which gave a slightly different version of the poem, and which referred to ‘a sort of Reverie’ rather than a ‘dream’ or ‘sleep’. Internal evidence suggests that this (undated) version was written earlier than the poem as he published it, for several of the ways in which it differs from the familiar version are closer to the sources, such as *Purchas’s Pilgrimage*, which are known to have influenced his composition.

In discussing this case, Perkins points out that besides being a prisoner of his own memory and his own theories of the creative process (as all of us are), Coleridge was not over-scrupulous about getting his checkable facts right. His own contemporaries regarded him as untrustworthy on dates of composition (the discrepancy was sometimes considerably more than a year or so). And literary historians have detailed a number of examples where his ‘factual’ reports simply cannot be accepted.

It does not follow that Coleridge was a rogue, or a fool either. Simply, he was human, and subject to the limitations of human memory (and to the temptations of laziness). The point here is a general one, applying to others besides Coleridge. Descriptions written years after the event are interesting, and may be used as evidence. But they cannot be taken as gospel.

Something else that cannot be taken as gospel is Poincaré’s view (widely accepted by writers on creativity) that incubation – time away from the problem – involves a special sort of extended unconscious thinking. To be sure, his insistence that it involves more than just a refreshing rest appears to be correct (Perkins has done several experiments to this effect). But there are other possible explanations why a change of activity may be followed by a creative insight that surmounts the original difficulty.

For instance, one’s mind may turn to an absorbing problem at many times during the day, perhaps while brushing one’s hair or doing the washing-up. As Perkins puts it, ‘time away from the desk’ is not necessarily ‘time away from the problem’. – Or one may be just on the point of solving some problem when an interruption occurs. On returning to the problem some time later, the solution that was about to pop up at the earlier moment may emerge now. The explanation here is memory, rather than any ‘incubatory’ thinking. – Alternatively, one may have picked up some cue, either consciously or unconsciously, during one’s time away from the problem. This is serendipity (noticing), not ‘incubation’.

Again, sleep provides time away from conscious thinking about the problem. It also seems to allow some relaxation of the logical constraints which are respected in the waking state (hence the many reports of original ideas occurring to someone as they wake).

Finally, the feeling that such-and-such an approach, on which one has already invested a great deal of effort, must be the right way ahead can block a solution. But this feeling may be weakened if, for a while, one thinks about other things and stops worrying about how to solve the problem. It is understandable, then, that shifting attention to a different (perhaps equally difficult) problem sometimes helps a person to master the first one.

As Perkins remarks, none of this proves that a special sort of incubatory thinking never happens. But there is no firm evidence that it does. And there is plenty of evidence in support of several alternative explanations of why leaving a problem for a while can often be helpful. In sum, there is no reason to believe that creativity involves unconscious thinking of a kind utterly different from what goes on in ordinary thought.

Creativity draws crucially on our ordinary abilities. Noticing, remembering, seeing, speaking, hearing, understanding language and recognizing analogies: all these talents of Everyman are important. So is our ability to redescribe our existing procedural skills on successive representational levels, so that we can transform them in various ways. It is this which enables young children to draw increasingly imaginative ‘funny houses’ and ‘funny men’, as we have seen—and one could hardly get any more ordinary than that.

To say that something is ordinary, however, is not to say that it is simple. Consider Kekulé’s vision of snakes, for instance. When we discussed Kekulé’s reports of his experiences by the fireside, and on the omnibus, we took a great deal for granted. We asked how he managed to come up with the analogy between snakes and molecules, but we did not question his ability to be reminded of snakes
in the first place. We took it for granted that Kekulé – like the rest of us – could see snakes as having certain spatial forms, and that he could notice that one had seized hold of ‘its own tail’. We took for granted, too, his ability to distinguish ‘groups’ of atoms, and to identify ‘long rows’, or ‘chains’. We simply assumed that he could see some atoms as ‘smaller’ and others as ‘larger’. And we raised no questions about his seeing snakes ‘twining and twisting’, or atoms ‘in motion’.

How are these achievements possible? For achievements they are, achievements of the mind. (A camera can do none of these things.) Their mind-dependence is not due to the fact that Kekulé’s snakes, and his gambolling atoms, happened to be imaginary. Comparable questions arise with respect to seeing real snakes. Suppose Kekulé had noticed a tail-biting snake while strolling in the countryside. We could still ask, for example, how he identified the tail as the snake’s ‘own’ tail. Much as similarity is a construction of the mind, so is visual form.

The perception of visual form seems, to introspection, to be simple and immediate. Apparently, we ‘just see’ snakes, snails and snowmen. But these intuitions are misleading, even for such everyday seeing is not psychologically simple. On the contrary, it requires some fancy computational footwork.

To see snakes, and to imagine them, Kekulé had to be able to recognize individual figures, as distinct from the background. He had to pick out both spots and lines, and to do the latter he had to identify both continuity and end-points. (A snake biting its own tail is all continuity and no end-points.) He had to appreciate juxtaposition and distance, if he was to see ‘groups’ of atoms, long rows ‘more closely fitted together’, or a larger atom ‘embracing’ two smaller ones. And to see a row as ‘long’, or an atom as ‘larger’ or ‘smaller’, he had to judge relative size.

The interpretative processes involved are neither obvious nor simple. Even finding the ‘lines’ is difficult. Consider a photograph (or a retinal image) of someone wearing a black-and-white striped tie. You may think that identifying the stripe-edges is easy. ‘Surely,’ you may say, ‘each edge is a continuous series of points at which the light-intensity changes sharply: bright on one side, dark on the other. All one needs, then, is a tiny physical light-metre that can crawl over the image and find those points.’

Well, yes and no. Physical devices to pick up sudden changes in light-intensity are indeed needed, and they exist both in the eye and in many computers. The problem is that, in most real situations, there is no continuous series of change-points in the image which exactly matches what we perceive as a line. In general, the edge of a physical

object (such as a snake), or of a marking on a physical surface (such as a stripe), does not correspond to any clear, continuous series of light-intensity changes in the physical image reflected off it. In the image, there will be little segments of continuous intensity-change – but there will be gaps and offshoots as well. What is needed is a device that can recognize that the significant segments are colinear across the gaps, whereas the offshoots are not. What is required is not just physics, but also computation.

If the viewer is looking at a dalmatian dog lying on a zebra-skin rug, the line-finding device may require some help from depth-detectors. A single black region in the image may represent a black dog-patch adjacent to a black zebra-stripe. With respect to physical light-intensities, there may be no distinction here between the doggy part of the image-region and the ruggy part. Mere colinearity (with the lines representing the adjoining contours of the dog’s back) may not settle the matter, if there happen to be similar problems with regard to other dog-and-rug regions in the image.

But depth-detectors can help. The images falling on the left and right eye differ slightly, according to the object’s distance from the eyes. Consequently, a systematic comparison of corresponding point-images can detect depth-contours (where one physical surface lies some way in front of another). By this means, then, the visual system can find the contour of the dog’s body within the uniformly black region of the image. And if that depth-contour is colinear with one of the many line-segments running into the black region, then that line-segment is probably the one which represents the dog’s back.

There are texture-detectors in the visual system too, which can compute texture-differences between adjacent parts of the image. In the case of the furry dog lying on the furry rug, these might not be of much help. But if the dalmatian were lying on a black and white lino floor, they could help to disambiguate the dog-and-lino image-regions. (Such multiple constraint-satisfaction can be effected by parallel processing, as we saw in Chapter 6.)

If Kekulé had seen a viper lying on stripey grass and twigs, he would have needed not only line-detectors, but depth-detectors and texture-detectors too. Motion-detectors would also help to make the snake visible, since image-lines that move together normally represent real object-edges. (This is why many animals ‘freeze’ when they sense predators.) In short, to see snakes twining and twisting, or biting their own tails, requires complex computational processes.
Everyday visual interpretation is relevant not only to seeing snakes and imagining benzene-rings, but to the visual arts too. Think, for example, of the intricate line-drawings of John Tenniel, or the (much simpler) acrobats sketched by AARON. How are the individual lines identified, even in smudged newspaper reproductions? And how are they interpreted, as the hem of Alice’s dress or the bulging biceps of an acrobat’s arm?

Again, remember the Impressionist movement in the late nineteenth century. Or consider Picasso’s creative progression from the relatively realistic paintings of his charming Blue and Rose periods, through the austere analytic Cubism of *Les Demoiselles d’Avignon* and *Girl with a Mandolin*, to the distorted 1930s portraits of his mistress Dora Maar showing her with two eyes on the same side of her nose. Many art-connoisseurs at the time scorned these new styles as unnatural, unreasonable and (therefore?) ugly. Some people still do. But a computational psychology can help us to understand something that was intuitively grasped by the artists concerned (sometimes backed up by reference to the scientific theory of the time). Namely, such painting-styles are grounded in the deep structures of natural vision.

There are no natural situations (Narcissus’ pond excepted) in which we can see from two viewpoints simultaneously. Because our eyes are in the front of our heads, and we cannot be in two places at once nor assume two bodily attitudes at the same time, we always see things from a single viewpoint. This fact is deliberately exploited in computer models of vision, whose interpretative heuristics work only because it is true. The biological visual system, in effect, takes it for granted: our natural visual computations assume a single viewpoint.

No wonder, then, if we experience a shock of surprise on seeing Dora with (apparently) two eyes on the side of her face. Such a thing has never been seen before — and it could never be seen, in the real world. Our visual machine simply does not permit it.

But who ever said that the artist must accept all the constraints of the real world? Enough if he can use them, challenge them, transform them, in ways that are somehow intelligible to us. The pictures of Dora are intelligible (they are even recognizable, if one has seen a photograph of Dora). She does have two eyes, after all; and she does have a nose with a Roman profile. Simply, we cannot in real life see her as having these three things together. If the painter chooses nevertheless to depict all three on the one canvas, why should we complain? Is he really doing something utterly unnatural, with no intelligible grounding in our knowledge and visual experience? Or is he, rather, exploring the conceptual space within which things may be seen either frontally or in profile?

Similarly, if the Cubist chooses to analyse visual form in geometrical terms, what is wrong with that? Why should Picasso have had to keep his *Demoiselles* rolled up in his studio for twenty years, spurned even by his closest admirers and friends? What was wrong with Cézanne’s advice to a fellow-artist to ‘deal with nature by means of the cylinder, the sphere, and the cone’? It is a valid aesthetic question, how far a painter can intelligibly depict nature in these ways.

(Even scientists may approach nature by using similar ideas. Some psychologists have tried to explain our perception of spatial forms in terms of ‘generalized cylinders’. The idea is that the visual system computes the shape of a wine-bottle as a long, narrow cylinder whose diameter is especially narrow at the top; a sugarhump would be a short, fat cylinder with a squared cross-section; and a snake would be a very long, very thin, cylinder with a curved axis. This method of representation is used for some special applications, but is not widely accepted. How, for instance, could it capture the shape of a crumpled-up piece of paper?)

Impressionists focused on patches of light, rather than realistic visual interpretations. A painter like Monet can help us to realize that distinguishing colour-patches is one thing, and seeing them as water-lilies is another. Indeed, computational theories (and computer models) of vision suggest that our visual perceptions are constructed on several successive representational levels. Colour-patches and line-segments are identified at a relatively early stage. Physical surfaces, located relative to the current position of the viewer, come later. Solid objects, independently located in three-dimensional space, come later still. And named things, such as water-lilies, are constructed last of all. What the Impressionists did, in effect, was to remind us of [some of] this, and to suggest what our vision would be like if we could not compute interpretations at the higher levels.

The Impressionists were well aware that their artistic style is relevant to visual psychology, which they discussed at some length. Other painters, too, have been influenced by scientific theories. Bridget Riley’s canvases, for instance, are based on psychological studies of visual illusions. The pointilliste Seurat, who chose his palette by reference to theories of optics, even wrote to a friend: ‘They see poetry in what I have done. No, I apply my method, and that is all there is to it.’

But most creative artists are content to ignore theoretical questions about how the mind works. They take our everyday abilities for granted, even while tacitly exploiting their subtleties in their work.

John Mascfield did not need a course in phonetics or speech-
perception to contrast the mellifluous ‘Quinquireme of Nineveh’ so effectively with the ‘Dirty British coaster with a salt-caked smokestack’. Nor did the director of the James Bond film Dr No need a degree in psychology to know that British cinema-goers would notice Sean Connery noticing the portrait of the Duke of Wellington, recently stolen from the National Gallery, in Dr No’s lair. Private, and not-so-private, jokes like this one are legion in the arts: think of the allusions in The Waste Land. (Even nuclear physicists occasionally play such games; why else would they speak of ‘quarks’?) Such delights are possible because artists have a good intuitive grasp of what the human mind can do.

The psychologist, however, cannot take our ordinary abilities for granted. Rather, the aim is to understand them as explicitly as possible. How do we manage to notice something? How do we remember things, how do we understand English sentences, and how do we appreciate analogies? A computational psychology can help us to identify the detailed mechanisms that underlie everyday capacities.

Without these mechanisms, creativity (and its appreciation) would be impossible. No noticing, no Newton. No analogy, no Antonioni. And for sure: no memory, no Mozart.

That Mozart had an exceptional memory, at least for music, is clear. Anecdotes abound, for example, about his ability to write down entire cantatas after having heard them only once (and to imagine whole symphonies before hearing them at all).

To be sure, anecdotes are unreliable. A supremely creative individual such as Mozart attracts an accretion of anecdotes, not to say myths, some of which are downright false. One famous passage, quoted by Hadamard and often repeated by his readers, is probably a forgery. Mozart probably did not write these words: “[Sometimes], thoughts crowd into my mind as easily as you could wish. Whence and how do they come? I do not know and I have nothing to do with it. Those which please me I keep in my head and hum them; at least others have told me that I do so.’ Nor did he write (a few lines later), ‘Then my soul is on fire with inspiration’, nor (later still) ‘It does not come to me successively, with various parts worked out in detail, as they will later on, but it is in its entirety that my imagination lets me hear it.’

Musicologists have rejected this spurious ‘letter’ since the mid-1960s. Yet, a quarter of a century later, it is still being cited without qualification by some writers on creativity (tact forbids references!). It is, of course, seductively plausible – for it fits in with the romantic and even the inspirational views, and endorses our hero-worship of Mozart to boot. (I am reminded – why? how? – of Voltaire’s remark, that if God had not existed it would have been necessary to invent Him.) The lines about conceiving the music ‘in its entirety’ are especially plausible. A variety of evidence suggests that Mozart, and many other H-creative people, could indeed imagine an entire conceptual structure ‘all at once’ (as we say). This way of putting it, like the passage from the forged letter, seems a natural way of expressing what a number of H-creative people have told us. Coleridge’s notion of the poetic imagination marked this type of thinking, in which he somehow envisaged The Ancient Mariner as an architectural whole. And Mozart, apparently, could be simultaneously aware both of a composition’s articulated inner structure and of its overall form.

But does this imply some special power, granted only to the artistic elite? Or is it a highly developed version of a power we all share?

A terrestrial explorer can survey an entire valley, seeing it simultaneously as a patchwork of roads and villages and as a glacial formation in the mountain-range. A party-goer can see, and a courtier can imagine, the structural outlines and detail of a ballgown, all at once. One can even, perhaps, imagine the song “Where Have All the Flowers Gone?” all in a flash. – Well, perhaps. Do the flowers and the girls and the young men and the soldiers really dance together in the imagination? Or would a better description be that the successive verses and images are called up in one’s mind almost simultaneously? When we speak of imagining the song all at once, do we merely mean that we can represent the abstract, ‘circular’ structure of the lyrics, perhaps with the first phrase of the melody thrown in for good measure?

Sometimes, without a doubt, we can see a hierarchical structure at several different scales-of-detail simultaneously. For instance, we can see the pattern of herringbone tweed, whose stripes are made up of smaller stripes, without having to move closer or refocus our eyes. But what about glacial valleys, or books, or folksongs – not to mention the pattern of a cantata or a symphony? Do we really experience such rich structures all at once?

We are facing the problem of introspection again. What may be (to you, me or even Mozart) the most natural way of describing a particular experience may not capture what actually goes on in consciousness. Still less does it identify the underlying memory-processes. Even if we do experience the valley or the folk-song all at once, the question remains as to what sorts of computation make this possible.
Our discussion of frames (in Chapter 5) is relevant here. The representation of a frame identifies both its overall structure and the items in the slots. Some slots may be unfilled (not marked as empty, but left indeterminate). Others may be filled, boringly, by pre-assigned default values. Others may have been filled, boringly or otherwise, by inspection or mental fiat. It would be impossible to represent a frame without any slots. And it would be unusual for every slot to be indeterminately empty (though pure mathematicians strive to define frames whose slots are as abstract as possible). Since some frames contain, or give pointers to, other frames, they can represent structures on several hierarchical levels; and again, some of the slots and sub-slots will be filled. If frames approximate some of the computational structures in our heads, then, it is not surprising that we often seem to be aware of a structure ‘in its entirety’.

Similar remarks apply to other abstract schemas we have discussed, such as plans, scripts, themes or harmony. Plans involve structured computational spaces, with representations of goals, sub-goals, choice-points, obstacles and action-operators. Is it surprising, then, that your plan for getting to London tomorrow may sometimes appear ‘in its entirety’ in your mind? Think of the script going to the sales, or of the theme escape: don’t these conjure up a number of different, yet structurally related, ideas ‘all at once’? Even listening to a melody seems to involve the recognition of overall harmony ‘at the same time’ as accidentals, modulations or dissonance (although, as we have seen, the home-key must be established first).

These everyday examples suggest that what Mozart was able to do was of the same kind as what all of us can do – only he could do it better. We can do it for valleys, ball-gowns, trips to London and perhaps folk-songs. He could do it for symphonies.

The reason he could do it better, at least where music was concerned, is that he had a more extensive knowledge of the relevant structures. Memory, as noted earlier, stores items in the conceptual spaces within the mind. The more richly structured (and well-situated) the spaces, the more possibility of storing items in a discriminating fashion, and of recognizing their particularities in the first place. (Broadly: the more frame-slots, the more structurally situated details.) Children, as we have seen, describe and discriminate their skills on various levels, becoming increasingly imaginative as a result. Very likely, adults do so as well.

If you could not see stripes, and mini-stripes, you could not appreciate a herringbone suit. Someone who knows nothing about glaciers cannot recognize a moraine, so cannot remember (or imagine) it either. And someone who knows nothing about tonal music cannot interpret the sounds of a Western folk-song as a melody, nor recognize a modulation or a plagal cadence. (They need not know the technical terms; but verbal labels can sometimes help to ‘fix’ schemas in the memory.) In short, Mozart’s exceptionally well-developed musical memory was a crucial aspect of his genius.

The word ‘genius’ comes to mind here because Mozart was one of the very few people who have a constant, long-lasting, ability to produce H-creative ideas. Shakespeare was another, Gauss yet another. How is this possible? In other words, how can there be a degree of P-creativity so great that H-creative ideas are generated over and over again?

(We must ask the question in this way, for we saw in Chapter 3 that there can be no psychological explanation of H-creativity as such. What we identify as ‘H-creative’ depends to a large extent on historical accident and social fashion. Manuscripts are lost, and sometimes rediscovered; several unknown Mozart scores turned up recently. And even Mozart was not always revered as he is today; his music went out of fashion in Vienna after being celebrated there for years.)

Thinking can be H-creative – indeed, superlatively H-creative – in different ways. For instance, I have heard some musicians argue that Haydn was more daring than Mozart, that he challenged the musical rules more than Mozart did. If so, then Mozart’s H-creativity was primarily a matter of exploring the rules to their limits (and bending and tweaking them at many unexpected points), rather than breaking them at a fundamental level. In other words, the glory of a Mozart symphony may be largely based in richly integrated musical equivalents of Dickens’ exploratory use of seven adjectives to qualify one noun: we hear it with delighted amazement, for we had never realized that the relevant structural constraints had such a potential. Someone who agreed with this musical judgment might nevertheless regard Mozart as the greater genius – perhaps because his music is more diverse than Haydn’s, or because it shows us the full potential of a given genre even though he did not invent it in the first place.

Whether or not an instance of H-creativity involves exceptionally radical transformation, it must involve the exploration of conceptual spaces. Accordingly, expertise is essential. If one does not know the rules (not even tacitly), one can neither break nor bend them. Or rather, one cannot do so in a systematic way.

Mere systematicity, however, is not enough. The cartoon-Einstein
described in Chapter 4 was exploring a system (the alphabet), and his very next thought would have been \( e = mc^2 \). But since there is nothing about the alphabet which makes \( c \) special, nothing which relates it to the speed of light or any other concept of physics, the cartoon-Einstein could not have recognized it as what he was looking for. Even everyday P-creativity requires that systematic rule-breaking and rule-bending be done in domain-relevant ways.

Consistently H-creative people have a better sense of domain-relevance than the rest of us. Their mental structures are presumably more wide-ranging, more many-levelled and more richly detailed than ours. And their exploratory strategies are probably more subtle and more powerful. Anyone can consider the negative. But they have many other (mostly domain-specific) heuristics to play with. If we could discover some of these, our educational practices might be radically improved: some of Mozart's powerful exploratory techniques, for example, might be taught to aspiring musicians.

These rare individuals, then, can search—and transform—high-level spaces much larger and more complex than those explored by other people. They are in a sense more free than us, for they can generate possibilities that we cannot imagine. Yet they respect constraints more than we do, not less. Where we can do nothing, or at best mentally toss a coin, they are guided by powerful domain-relevant principles on promising pathways which we cannot even see. (Sometimes, we cannot see them until many years after they were originally traversed.)

A lifelong immersion in music lay behind Mozart's ability to abstract subtle musical structures, and to develop powerful exploratory strategies. From his very earliest years under the tutelage of his father, his life was filled with music. Pretty girls and scatological jokes aside, it seems to have been the only thing he was interested in (hence much of Salieri's exasperation).

But Mozart was not merely interested in music: he was passionate about it. In general, motivation is crucial if someone is to develop the expertise needed for H-creativity. As George Bernard Shaw put it, creativity is 'ninety per cent perspiration, ten per cent inspiration'. Even Mozart needed twelve years of concentrated practice before he could compose a major work, and much the same seems to be true of other composers.\(^5\) In short, a person needs time, and enormous effort, to amass mental structures and to explore their potential.

It is not always easy (it was not easy for Beethoven). Even when it is, life has many other attractions. Only a strong commitment to the domain—music, maths, medicine—can prevent someone from dissipating their energies on other things. So Darwin's hypochondria, although admittedly a family trait, functioned to protect him from the tiring, time-wasting, hurly-burly of the social and scientific round. 'Resting' at home, he was not resting at all, but constantly developing and refining his ideas about evolution.

Sometimes, the emotional investment pays off in moments of pure exhilaration: on glimpsing a mathematical result (not yet a mathematical proof), André Ampère, as he recorded in his diary, gave 'a shout of joy'. Darwin's emotional satisfactions, one suspects, were of a less dramatic character. But satisfactions they were.

Creativity did seem to come easily to Mozart. (Poor Salieri!) And he was much more gregarious than Darwin. But even Mozart had to commit himself whole-heartedly to his chosen field. Creativity does not come cheap.

Sometimes, it comes at a very high cost indeed. Even ideas later recognized as H-creative may cause their originators more anguish than joy. Koestler tells the tragic tale of Ignaz Semmelweis who, having discovered how to prevent puerperal fever (by washing the hands in disinfectant before attending the mothers), was exiled and eventually driven mad by the resentment of the medical profession. He remarks:

Apart from a few lurid cases of this kind we have no record of the countless lesser tragedies, no statistics on the numbers of lives wasted in frustration and despair, of discoveries which passed unnoticed. The history of science has its Pantheon of celebrated revolutionaries—and its catacombs, where the unsuccessful rebels lie, anonymous and forgotten.\(^7\)

These people's potentially H-creative ideas did not bring the recognition they were seeking. On the contrary, they often brought scorn, poverty and loneliness. The motivational commitment must have been exceptional for such misery to be endured.

This commitment involves not only passionate interest, but self-confidence too. A person needs a healthy self-respect to pursue novel ideas, and to make mistakes, despite criticism from others. Self-doubt there may be, but it cannot always win the day. Breaking generally accepted rules, or even stretching them, takes confidence. Continuing to do so, in the face of scepticism and scorn, takes even more.

The romantic myth of 'creative genius' rarely helps. Often, it is insidiously destructive. It can buttress the self-confidence of those individuals who believe themselves to be among the chosen few...
(perhaps it helped Beethoven to face his many troubles). But it undermines the self-regard of those who do not. Someone who believes that creativity is a rare or special power cannot sensibly hope that perseverance, or education, will enable them to join the creative elite. Either one is already a member, or one never will be.

Monolithic notions of creativity, talent or intelligence are discouraging in much the same way. Either one has got ‘it’ or one hasn’t. Why bother to try, if one’s efforts can lead only to a slightly less dispiriting level of mediocrity? It is no wonder if many people do not even achieve the P-creativity of which they are potentially capable.

A very different attitude is possible for someone who sees creativity as based in ordinary abilities we all share, and in practised expertise to which we can all aspire. They can reasonably hope to achieve a fair degree of P-creativity, and – who knows? – perhaps some H-creativity too. Even if their highest hopes are disappointed, they may be able to improve their imaginative powers to some significant extent.

The computational view of intelligence leaves room for such hopes. Indeed, it has led to an educational method now used in many countries: Seymour Papert’s ‘LOGO’ programming-environment, which aims to foster skills of analysis and constructive self-criticism in children as young as five. The children write simple programs telling a mechanical turtle how to draw a house, or a man, or a spiral. If the turtle’s house turns out not to be a proper house, the child knows that the program was somehow faulty – but the fault can be identified, and fixed. Papert claims that, as a result, children learn to analyse their own thinking as a matter of course, and gain the self-confidence both to make mistakes and to correct them; and a colleague has reported excellent results with severely handicapped children. (The question of LOGO’s educational effectiveness remains open, for some research suggests that the improvements do not generalize to other sorts of thinking, as LOGO-proponents assume they will.)

Despite Papert’s stress on self-confidence, the computational concepts he uses focus on cognitive (‘intellectual’) matters. The same is true of this book: computational theories of motivation were mentioned only when we discussed the understanding of stories (in Chapter 7). Until now, I have asked how novel thoughts can arise in human minds, simply taking it for granted that humans are interested in thinking them. The reason for this underlaying of motivation is that how novel thoughts can arise is the question that interests me most.

However, you may suspect a deeper reason. You may feel – as many people do – that motives and emotions necessarily lie outside the scope of a computational psychology. Motives, and the purposes they generate, are the origin of our actions, and are closely related to personality and the self. Emotions are seemingly opposed to rationality, since they lead us to do things without thinking – sometimes, things we would prefer to have left undone. How, then, could such aspects of the human condition be explained in computational terms?

The answer is that these phenomena will be found in any intelligent creature with many different, and potentially conflicting, goals. Such a creature has to be able to schedule its activities, and harmonize its many purposes, so as to optimize its success. Intelligence implies emotions, because emotions play an essential role in integrating diverse activities. And the more varied and complex a creature’s goals, the more it will need higher-level structures (such as personal preferences, moral rules, and even a self-image) to organize its behaviour. For instance, goals of great urgency and importance must take precedence over the current activity, whatever that is. If we see a tiger, we run. Evolution has seen to it that we do not wait to find out whether it really is a tiger, for if our ancestors had done so we would not be here to tell the tale. Sometimes, we end up looking foolish (if the tiger was stuffed); and sometimes, our unthinking response is disastrous (if we were standing near the edge of a gorge). Occasionally, rational thought might have saved the individual concerned. But only an automatic interruption of the current goal-seeking activity could save the species. Quite apart from the fact that our animal-ancestors were incapable of rational thought anyway, thinking takes time – and time (in cases of urgency) is precisely what we lack. In short, the emotion of fear is not a mere feeling: it is a computational mechanism evolved for our protection.

Similarly, anxiety is a mechanism that leads us to consider more possibilities than we otherwise would, whereas confidence enables us to continue our present line of thought despite the lack of any quick success. Anxiety typically results in what computer scientists call breadth-first search, a continual hopping-about from one potential solution-path to another; confidence favours depth-first search, a calm and determined effort to follow a particular solution-path as far as necessary. Both rest on a judgment about the likelihood of success, a judgment that concerns not only the intrinsic difficulty of the problem but the person’s self-image, too. Anxiety also involves estimations of the urgency and importance of the unachieved goal.

Like fear, anxiety and confidence evolved in non-human animals. They can mislead us, if the solution lies further down the mental search-tree than other animals are capable of going (so we should have
stuck to our guns, instead of anxiously flitting about), or if – through overconfidence – we take undue advantage of the human capacity for sustained thinking. In either case, an unrealistic self-image can block the most suitable strategy of action. Someone who misjudges their own intellectual resources, or even their personal traits (determination, for example), may abandon a task too early or pursue it without chance of success.

Even a sudden surge of joy, on solving a difficult problem, can be seen as part of a functional mechanism: it rewards the person (or animal) for their perseverance, and releases them for other activities. But in human minds it can sometimes be dysfunctional, because people have many different values which must be satisfied – if at all – within a certain cultural milieu. Mozart, for most of his life, enjoyed the satisfactions both of creativity and of social acceptance. Semmelweis did not; he might have been happier, overall, if he had valued the joys of creativity rather less.

These sketchy remarks tell us nothing specific about the motives of Mozart, or anyone else. Today’s computational theories of motivation are painted with a broad brush. They have given us some intriguing hypotheses (and some systematic analyses of emotional terms), but they are not backed up by detailed computer models. It is difficult enough to specify how to achieve even one goal. A fully detailed account of how to deal with mutually competing purposes, in a rapidly changing and largely unfriendly world, is beyond our current understanding. But that is what motivational structures are for: the emotionless Mr Spock of Star Trek is an evolutionary impossibility.

Mozart, unlike Mr Spock, was fundamentally like the rest of us. But his motivational commitment was exceptional. It is hardly surprising if most people never come up with H-creative ideas. Even supposing that they have the self-confidence required, and above-average expertise, they have other fish to fry. People who live a normal life, filled with diverse activities largely prompted by other people’s priorities (employers, spouses, babies, parents, friends), cannot devote themselves whole-heartedly to the creative quest. One of the ways in which Mozart was special is that he chose to do so.

"Surely," you may say, "expertise and commitment cannot have been all there was to it. After all, Salieri devoted his life to music too. Mozart must have been special in some other way as well."

You may be right. Possibly, there was something about Mozart’s brain which made it exceptionally efficient at picking up musical regularities, and perhaps at exploring them too. There is some evidence that musical ability (and mathematical or graphic ability too) is to some extent innate.12

Granted, child prodigies like Mozart are usually greatly rewarded by adults (and encouraged to practise for hours on end), so have much more opportunity to learn than other children do. Even "ordinary" children can attain great heights, given the appropriate education. One illustration of this involves Mozart’s predecessor Vivaldi, who for some years taught in a Venetian orphanage. Many of these destitute children grew up to be highly accomplished musicians, and the orphanage-concerts (at which Vivaldi’s challenging new works were played, and played well) were the talk of Venice.13

Nevertheless, inborn factors may help certain individuals to develop the conceptual structures required. Some structures may even be inaccessible in the absence of such factors. If so, then no amount of education or commitment could suffice to form a Mozart. (Most of us, of course, would be happy enough to have a fraction of the competence of a Salieri. His music can still excite our admiration. A friend who knows Mozart’s music well told me how she once switched on her wireless and was surprised, and delighted, to hear a lovely Mozart-composition which she had not heard before – it turned out to be by Salieri.)

Just what these inborn factors are, assuming they exist at all, is not known. But whatever they are, they are not supernatural. And almost certainly, they are more efficient versions of mechanisms we all share – not something profoundly different.

The capacity of short-term memory, for example, is something which might depend on fairly ‘boring’ facts about the brain. But the psychological implications of having a larger short-term memory might not be boring at all.

When discussing jazz-improvisation in Chapter 7, we noted that grammars of different computational power put different loads on short-term memory. Consequently, brains allowing a larger short-term memory might make certain complex structures more readily intelligible. A jazz musician might then be able to improvise new chord-sequences, as well as improvising the way in which a given chord-sequence is played. This would not explain why specifically musical structures should be favoured (though it is worth remarking that musical and mathematical ability often go together). But it might be one of several constitutional factors underlying exceptional musical prowess.
What those other factors may be is anyone's guess. Perhaps certain sorts of 'wiring' of certain groups of neurones - but which sorts, and which groups? Until we know a lot more about how the brain enables ordinary thinking and remembering to happen, we shall not be in a position to ask sensibly how Mozart's brain might have been different.

The same applies to Mozart's mind, to the structure-building strategies he used in composing his music. The better we understand everyday creativity, the better our chance of understanding Mozart.

In the last analysis, perhaps we never shall. Scientists will never be able to answer all possible scientific questions. And in a case like this, the scientists need the help of the musicologists. Perhaps the musicologists, no matter how hard they try, will never manage to identify all the musical structures implicit in the operas, the symphonies and the chamber music. It does not follow that Mozart's genius was essentially mysterious, a matter of myth rather than mechanism. Supreme puzzle, he may be. But even he was human.

Of Humans and Hoverflies

Holiday beaches in summertime display an awkward minuet, danced by advancing waves of spume and retreating waves of deck-chairs. As the tide rises, the deck-chairs are repeatedly moved up the shore. Only when they are safe above the high-water line do the sunbathers really relax, knowing that their territory can be encroached upon no further.

The history of science shows a similar pattern, the advance of scientific theory being matched by the retreat of anthropocentrism. Copernicus, Darwin and Freud successively challenged comfortable beliefs: that Earth is the centre of the universe, that homo sapiens was created in the image of God, and that people are fundamentally rational creatures. Since the Renaissance, the deck-chairs of our self-glorification have been moved several times.

Human creativity, in this scenario, lies even further up the beach than rationality does. Inspirationists and romantics lounge there at their ease, confident of being safe from science. - But is their confidence misplaced? Sometimes, after all, the high tide covers the beach, and the deck-chairs must be abandoned. Is creativity inviolable?

Well, the three intellectual revolutions cited above each showed some cherished belief to be false. Geocentrism, special creation, rational self-control: one by one, these bit the dust. If modern science were to claim that creativity is an illusion, we could sadly add a fourth example to the list.

But science claims no such thing. The previous chapters have acknowledged creativity over and over again. In brief, a scientific psychology does not deny creativity: it explains it.

To say this, however, is not enough. Many people fear that explanation in and of itself must devalue creativity. Forget computers, for the moment: the conviction is that any scientific account of creativity would lessen it irredeemably. Even an explanation in terms of brain-
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8 Papert, Mindstorms.

Chapter 11: Of Humans and Hoverflies

2 J.R. Searle, Minds, Brains, and Programs', reprinted in Boden, The Philosophy of Artificial Intelligence, ch. 3. (A fuller version of my reply is 'Escaping from the Chinese Room', in Boden, The Philosophy of Artificial Intelligence, ch. 4.)

Chapter 9: Chance, Chaos, Randomness, Unpredictability

1 A patient suffering from Tourette's syndrome, described by the neurologist Oliver Sacks in an essay in the New York Review of Books.
4 Quoted in Livingston Lowes, The Road to Xanadu, p. 148.

Chapter 10: Elite or Everyone?

1 Schank and Childers, The Creative Attitude.
3 D.C. Marr, Vision (San Francisco, 1982).
from jazz improvisation to the diagnosis of soybean disease, she explains how all forms of creativity spring from the same cognitive devices and mental maps, demonstrating how the average person's creativity is related to that of a Mozart or a Shakespeare.

Boden argues that comparing humans to machines does nothing to lessen the marvel of creativity. "Much as geology leaves the Cheviot Hills as impressive as ever," she writes, "so psychology leaves poetry in place. Indeed it adds a new dimension to our awe."

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THE CREATIVE MIND

MYTHS & MECHANISMS

MARGARET A. BODEN

AUTHOR OF ARTIFICIAL INTELLIGENCE AND NATURAL MAN
"Margaret Boden is compelling reading. In The Creative Mind, she brings her lucid intelligence to bear on demystifying creativity and manages to be highly informative without obscuring the great darkness of her subject."—JEROME BRUNER, Research Professor of Psychology, New York University

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"Over a century ago, people were asking how the diversity of biological species, and the layered order within the fossil record, are possible. Darwin criticized the cramped imagination of those who could wonder only at piecemeal special creations. ... Similarly, to attribute creativity to divine inspiration, or to some unanalyzable power of intuition, is to suffer from a paucity of ideas. ...

"The matters of the mind have been insidiously downgraded in scientific circles for several centuries. It is hardly surprising then if the myths sung by inspirationists and romantics have been music to our ears. While science kept silent about imagination, antiscientific songs naturally held the stage.

"Now at last computational psychology is helping us to understand such things in scientific terms. It does this without lessening our wonder, or our self-respect, in any way. On the contrary, it increases them, by showing how extraordinary is the ordinary person's mind."

—from The Creative Mind