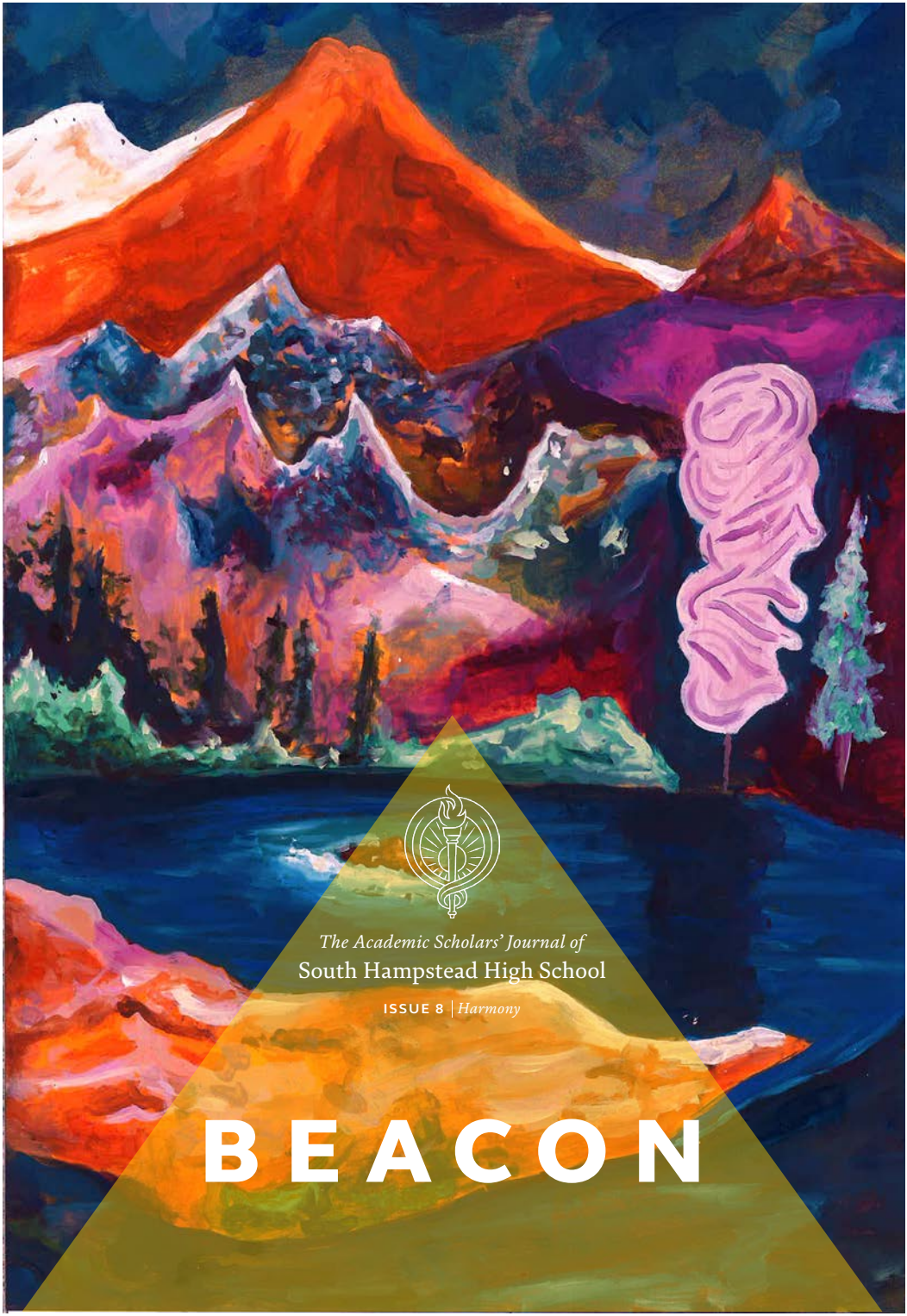

The Academic Scholars' Journal of
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ISSUE 8 | *Harmony*

BEACON

HARMONY

For this year's edition of the Beacon, our Upper School Scholars have written on the theme of harmony. Interdisciplinary harmony has been a key aim this year, and looking at the breadth of articles, from autoimmune disease in women to the theological foundations of Manichaeism, we can say with confidence that this has been achieved. Every article offers something new to consider – I hope you enjoy reading them as much as I did!

CHIARA, UPPER SIXTH

Deputy Head Girl - Academic & Scholarship

Contents

How Do Biological Processes Work in Harmony with Subjective Experience to Bring About Human Pain Perception?

ADA, LOWER SIXTH
MENTORED BY GABRIELLA S, UPPER SIXTH

After having undergone a surgical procedure, a patient wakes up to discover that the doctor has amputated their arm. The patient, who had been involved in a dangerous accident, is certain that they can feel an excruciatingly painful ache coursing through their arm, despite clearly being able to see that it has disappeared. They cannot shake the feeling of their nails digging unbearably into their palms and their fists tightly clenching. This is an illustration of phantom limb syndrome. Despite being well documented, it is a deeply complex and highly misunderstood phenomenon which displays the complexity of the human experience of pain. Advanced neuroimaging technologies have enabled scientists to investigate and explore the biological pathways involved in pain perception, but these scans are unable to capture qualia: the subjective conscious experience. Each individual experiencing pain – even if caused by the same injury – may report vastly different experiences. Therefore, pain is not purely a neural mechanism; biological processes are inevitably intertwined with the subjective conscious human experience, and neither component can, on its own, bring about the complex human sensation of pain.

The sequence of biological processes which underlie the human experience of pain involves: detecting harmful stimuli; transmitting electrical impulses; and finally, the brain interpreting them. Distributed throughout nearly all human body tissues are nerve cell endings of sensory neurons called nociceptors. These contain specific receptors and ion channels that detect damaging or potentially damaging stimuli, such as extreme temperature changes, harmful chemicals or pressure. The chemical or physical stimuli that activate the ion channels are called algogens. These harmful stimuli are converted into electrical signals in transduction at the peripheral terminals of two types of primary afferent nociceptors. These are the unmyelinated, slow-conducting C-fibres, and thinly myelinated, fast-conducting Aδ-fibres. The former are responsible for transmitting slow, aching pain, whereas the latter are responsible for transmitting sharp, fast pain. The electrical activity that occurs here generates action potentials, which are conducted along the nerve fibres to the projection neurons in the dorsal horn of the spinal cord. The projection neurons relay the signals to the thalamus in the brain, which then transmits the information to other areas of the brain, including the somatosensory cortex, the prefrontal cortex and the anterior cingulate cortex. The somatosensory cortex is responsible for identifying pain intensity and localising pain, while the prefrontal cortex evaluates and interprets the threat. The anterior cingulate cortex has been found to control the processing of the emotional aspects of pain perception. This distributed processing allows the brain to coordinate protective responses to physical pain and emotional reactions.

However, this pain pathway is not unidirectional. Melzack and Wall's gate control theory demonstrates that clear-cut biological processes form only part of the human experience of pain, as subjective experience also plays a vital role. The theory posits that the dorsal horns of the spinal cord contain a neurological 'gate' through which the brain modulates pain signals using top-down control. The gate can be closed to reduce pain perception via two main mechanisms: the brain can release endogenous opioids, such as endorphins and enkephalins, in response to positive emotions or distractions, or physical stimuli, such as applying ice or a massage, can activate A - fibres, which trigger inhibitory interneurons to release inhibitory neurotransmitters. This explains the instinctive response of rubbing an injury to lessen pain. Conversely, stress or anxiety may keep the gate 'open', resulting in more intense pain. Additionally, some mental health disorders, such as depression, are linked to individuals having a more 'open' pain gate due to impaired descending modulation from the brain. This demonstrates the integral role of psychological factors in pain intensity.

An even more striking illustration of the extent to which pain perception is shaped by subjective experience is phantom pain. Following amputation, the brain's neural connections are reorganised in cortical remapping, as specific neurons lose sensory input from the limb; in response, adjacent cortical regions invade the newly available area in the somatosensory cortex. The Penfield 'homunculus' (meaning 'little man' in Latin) provides insight into the effects of this cortical remapping in amputees. This map was proposed by the neurosurgeon in the 1930s, and it shows which parts of the brain control which parts of the body. Crucially, the region which corresponds to the face is adjacent to the regions controlling the arm and hands, meaning that, following amputation, touching the face can activate neurons in the hand. This was demonstrated in Ramachandran's experiments, which showed that amputees reported phantom hand sensation when their faces were touched. This phenomenon can also be observed from fMRI scans, as both face and hand regions may light up when arm amputees' faces are touched. Neural activity in this region persists despite the lack of peripheral input, generating genuine pain that can be observed in neuroimaging scans. In mirror therapy, a mirror box creates a visual illusion of a moving, intact limb superimposed on the phantom limb's perceived location, resulting in relief from phantom pain. This demonstrates that the brain actively constructs pain rather than passively receiving signals from the body. Thus, pain is not solely a biological process, but a nuanced conscious experience.

The phantom limb patient's experience highlights an important reality: pain emerges from the interplay between neural processes and subjective conscious experience. Gate control theory demonstrates psychological modulation of biological pathways through descending neural mechanisms, and mirror therapy demonstrates how visual input alone can eliminate pain. Understanding the interaction between biological and psychological mechanisms is vital to informing effective pain treatment, as interventions must address both. Ultimately, pain exists at the boundary where objective biology and subjective experience work in harmony, thereby exemplifying the interconnectedness of the body and mind in creating human pain perception.

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How Does Wes Anderson Achieve Visual Harmony in His Work?

ANNA, YEAR 11
MENTORED BY PALOMA, LOWER SIXTH

Since the release of his first film in 1996, American director Wes Anderson has gained a widespread following for his distinctive cinematic style. His complete commitment to visual harmony has contributed to his reputation as a director who focuses on even the tiniest details, which are a key part of his cinematography. In visual arts, harmony means the extent to which the elements in a painting (or film scene) work together to achieve balance and cohesion. This can involve colour, framing, shapes, texture, and even typography. Anderson combines many of these elements to create scenes that are not only easier for the viewer to interpret, but that also work to convey the emotions of his characters and themes of his films effectively.

Anderson primarily uses colour to tie his scenes together and help viewers to immerse themselves in the story. In colour harmony, there are a variety of different colour combinations that are considered cohesive, the most well-known being complementary colours. Complementary colours are most often two hues on opposite sides of the colour wheel, but they can also form a triangle (triads) or a rectangle (tetrads) on the wheel. When complementary colours are paired, they create contrast within a frame, which not only balances it and brings it together, but also makes the two colours appear more vibrant. Monet once said, “primary colors seem more brilliant when they are in contrast with their complementary colors", and the same is true in Anderson’s work; their appearance of equal saturation is what allows complementary colours to work together harmoniously in a scene while maintaining variation due to the contrast. However, within this contrast, Anderson also uses analogous colours (hues which are next to each other on the colour wheel) to maintain a cohesive colour scheme. For example, in The Grand Budapest Hotel (2014), he primarily uses pastel pinks, blues and yellows in a complementary triad, but also incorporates their analogous shades, such as purple, red and orange, which can focus attention on different characters and locations while maintaining harmony with the other elements. The perfect harmony of colours in his films helps Anderson to create the surreal, storybook feel which makes his cinematography so popular. By balancing his colour palettes, he also allows the symbolism of other colours that deviate from the established schemes to shine though, making his creative choices more noticeable and therefore effective.

Anderson’s most notable technique to achieve visual harmony is his carefully thought-out composition. More specifically, he is known for his continuous use of symmetry, which he uses to balance his shots and achieve his uniquely surreal style. Regardless of his subject’s distance from the camera, Anderson uses other objects or geometric shapes in the setting to bring them forward into the viewer’s awareness. Though his use of colour by itself could, in theory, create problems by causing characters to blend into the background, it is Anderson’s symmetrical composition which frames the subject of the scene, allowing him to achieve his desired aesthetic qualities and cohesion while bringing attention to the focus of the plot. In Moonrise Kingdom (2012), in a scene in which a girl stands atop a lighthouse, he uses the rectangular shape of the bright orange windowpanes and railings, as well as the octagonal roof, to frame her against the blue sea view, highlighting the girl’s presence while emphasising the surreal, empty sea in the background. His symmetry also helps to maintain this dreamlike atmosphere during fast-paced, active sequences through either static shots, in which the camera does not move but the subject does, or tracking shots, which exactly follow a subject’s movement. The static shots can maintain a sense of stability, so that the viewer can focus on the movement, while his static shots, which often involve a group of uniformly organised characters walking through a symmetrical setting, build energy but focus on the characters’ emotional responses. Through these techniques, Anderson maintains a feeling of control and stability while still showing the motion of an action sequence. His geometric, symmetrical framing is what makes his work so distinctive; every frame is deliberately crafted with the purpose of drawing attention to what he deems important in the story or his worldbuilding.

Anderson seeks to unify every aspect of his films, down to their format. Aspect ratio, the width-to-height ratio of an image or film, has continued to change ever since the earliest silent films, often evolving along with camera and cinema technology. In The Grand Budapest Hotel, which tells the story of a once-famous hotel, the film jumps between three different time periods, and for each era, Anderson changes the aspect ratio to match the cinematic style that was popular at the time. At the start of the film, set in 1985, in which an author is interviewed about his trip to the hotel, Anderson uses the aspect ratio 1.85:1, which came into popular use more recently. Then, when he flashes back to the visit in 1967, he changes to 2.40:1, and for scenes set in 1932, at the height of the hotel’s fame, he uses 1.37:1 (sometimes called the Academy ratio), which was prevalent in early cinema. In an interview, Anderson said, “the different aspect ratios tell viewers where they are in the timeline”, but the variation does more than this; he manipulates the medium itself to ensure a harmonious relationship between the visual style of the era portrayed and the presentation of the film, completely immersing the viewer in his stories.

Perhaps most impressive is the fact that Anderson’s stylistic choices are not intermittent. Every frame of his work is carefully crafted to ensure that the colours, background and composition all create a cohesive visual atmosphere and immerse the viewer in his dreamlike worlds. While he still maintains visual interest through contrast, he also demonstrates that, sometimes, contrast is required in order to achieve balance and harmony.

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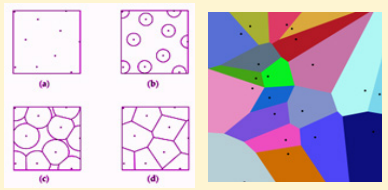
Mathematical Harmony in Generative Art

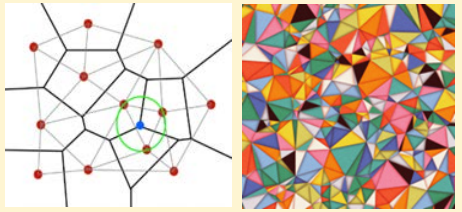
AVA, LOWER SIXTH
MENTORED BY SHIVANI, UPPER SIXTH

Generative art is art that is produced partially or wholly using an autonomous system, which means that the process involves a non-human decision maker. There are several techniques used to create this branch of art, most of which have strong footholds in mathematics, including Voronoi diagrams, circle packing, and Perlin noise. This results in aesthetic, harmonious pieces of artwork that the artist cannot always foresee or have direct control over; although they design the algorithms, there is usually a random element integrated into the code and therefore the computer is able to influence the product. This is where the beauty of generative art lies: the artist sets rules, and harmony emerges.

One methodology in designing generative art is the use of Voronoi diagrams. Imagine a randomly scattered set of points, called 'seeds'. If each seed expands into a circle that continuously grows, once two circles collide, they will both be squashed. If you pursue this until all the circles are now polygons with no empty space between them, you will have created a Voronoi diagram, as displayed by the image below. A real life, three-dimensional example is in bubbles, where, as they increase in a closed environment, they squash each other and create a Voronoi-esque structure. One of Voronoi diagrams' unique properties is that every seed's Voronoi cell consists only of points that are closer to this seed than any other. Therefore, the edge of each cell is also recognisable as the perpendicular bisector between two seeds. You may recognise some of the designs shown by the Voronoi diagrams below, as they closely resemble patterns found in nature; this is an example of biomimicry. Tortoise shells, plant cells, giraffes' skin, dragonfly wings, bee hives, even cracked mud… they appear everywhere.

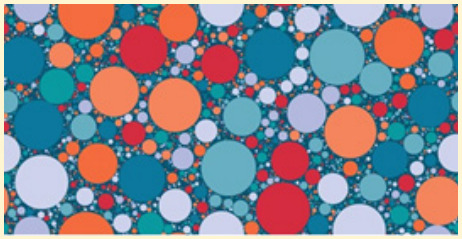


A closely related concept is that of Delaunay triangulations. This involves a set of seeds, again, which are connected to form triangles, with the sole condition that the circumcircle of each triangle (the circle that passes through all three corners of the triangle) contains no seeds. The reason that Delaunay triangulations are essentially the counterparts to Voronoi diagrams is that the centre of each circumcircle (also known as Delaunay circles), represented by the blue dot at the centre of the green circle in the diagram below, is the vertex of a Voronoi cell. Astonishingly, this works both ways: the seeds of each Voronoi cell, indicated by the red dots below, form the vertices of the Delaunay triangles. Therefore, in order to construct a Delaunay triangulation from its corresponding Voronoi diagram, you must simply connect the seeds in each Voronoi cell. In everyday life, Delaunay triangulations have several intriguing applications, such as being used in stellar astronomy in order to group stars into clusters and voids.

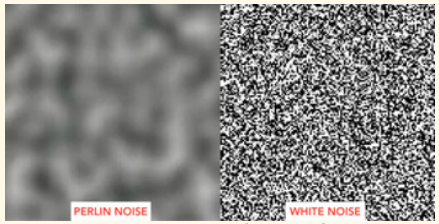


Returning to how Voronoi diagrams are created, we can adapt the process to perform 'circle packing'. This is where the growing circles do not squash each other as they enlarge but instead cease expansion. This generates a closely packed array of circles, which can be very visually appealing, especially when a colour scheme is implemented.

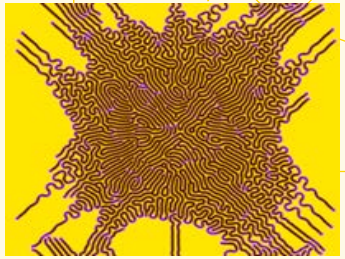
Furthermore, another device employed by generative artists is Perlin noise, used to create flow fields. A flow field is fundamentally a grid of vectors that simulates the behaviour of a fluid substance, enabling it to mimic the patterns made by smoke and flowing water. In order to explain Perlin noise briefly, we can compare it to white noise. In white noise, there is a grid of pixels where each pixel is randomly assigned a colour, resulting in a harsh and jagged pattern. However, in Perlin noise, the colour of each pixel is influenced by the colour of its neighbours, producing a smooth, fluid texture, as shown in the image below.



A concise summary of the process used to generate Perlin noise is as follows: a grid of points is initialised, where each point is assigned a random vector, and each point's colour (position on the greyscale) is determined by applying a series of mathematical functions to the vector and its surrounding points. Flow fields utilise Perlin noise to calculate the angles of vectors in the flow field grid. Once these angles are in place, smoothly curved lines can be drawn to connect aligned sets of angles. The resulting artwork is often exceptionally aesthetically pleasing.



One final genre of generative art is reaction-diffusion systems. This model, originally put forward by Alan Turing, demonstrates how the reaction between two chemicals can produce intricate patterns that bear a resemblance to motifs in nature, such as coral shapes, zebra stripes, leopard skin, and fingerprints. This reiterates the strong presence of nature and biomimicry in generative art. In the model, one chemical is described as an 'activator', which stimulates growth and spread, while the other chemical is an 'inhibitor', which restricts growth. They both work together in harmony to form an activator-inhibitor system, where, as the two chemicals diffuse at different rates, they create fluctuating patterns, analogous to a 'tug of war' between them. Eventually, an equilibrium is reached. The reaction-diffusion algorithm again creates beautiful art, dictated by the artists' assignment of diffusion rates.



Overall, generative art is a fascinating and often overlooked subject, with immense potential for deeper exploration, and it repeatedly mirrors what we see in the natural world, using biomimicry. From Delaunay triangulations to reaction-diffusion models, generative art successfully bridges the notorious gap between maths and art, illustrating that harmony can emerge between the supposedly rigid, logical nature of maths and the flexible, creative freedom found in art.

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How Did Queen Create Social Harmony Through Their Music?

CHLOE, LOWER SIXTH
MENTORED BY JESSICA, UPPER SIXTH

Queen were a British rock band made up of four members: Freddie Mercury, Brian May, Roger Taylor, and John Deacon. They were most known for their theatrical performances, powerful vocals, and highly unique sound. However, their eccentric style, shown through songs such as 'Bohemian Rhapsody' and their extravagant stage presence, was seen as unusual or even controversial within the rock scene. The band persevered through the criticism and refused to conform to trends, leading them to be one of the most successful bands of the 1970s.

Their discography's diverse range of genres is central to their cultural impact, as they consistently blended contrasting musical styles within both individual songs and across albums, bringing together audiences with different musical tastes. Rather than limiting themselves to one style, they experimented with different genres and moved fluidly between heavy rock, opera, funk, disco and pop – often within the same album. For example, arguably their most famous track, 'Bohemian Rhapsody', combines rock and opera, uniting theatrical and classical-inspired elements with mainstream guitar music. Another extremely popular track, 'Somebody to Love', draws on gospel influences, especially in its layered, choir-like harmonies, which evoke a sense of collective voice and spiritual unity. Meanwhile, 'Another One Bites the Dust' incorporates funk and disco rhythms, appealing to dance audiences. 'We Will Rock You' is globally recognised as a unifying chant, as Brian May utilises a rhythmic stomp-clap beat which allows their listeners, whether online or live, to follow along. By merging all these different genres into one discography, Queen broke down musical boundaries and demonstrated that different styles, and thus different social groups, could coexist within the same artistic space. This inclusivity made their music a shared language and encouraged listeners from all around the world, no matter who they were or where they were from, to connect through shared enjoyment, creating a sense of solidarity even among strangers. Because of this, Queen's music became a cultural meeting point, thus promoting social harmony.

Another way Queen promoted social harmony is through releasing songs that promote empowerment through both individuality and unity. For example, 'I Want to Break Free' conveys the theme of personal freedom and is often interpreted as a declaration of independence from restrictive societal expectations. This message is further emphasised by its music video, in which all four members dressed as exaggerated female characters, parodying British soap operas. Although, ostensibly, the video is humorous, it simultaneously challenged traditional gender norms and confronted societal expectations, encouraging audiences to question rigid notions about identity. Contrastingly, 'One Vision' focuses on unity, emphasising the strength of a collective and the importance of coming together as a community. Through these messages, Queen's music resonated across gender, cultural and social

boundaries by giving listeners reassurance that both their struggles and ambitions were understood, which created a sense of mutual respect, and thus social harmony.

Queen also created social harmony through the diverse backgrounds and personalities of its members, making the band as a whole more relatable to a wide audience. Freddie Mercury, the main vocalist and frontman of the band, originally Farrokh Bulsara to Parsi-Indian parents, was raised in Zanzibar. He embodied cultural differences and personal resilience, as his struggles with identity and desire for freedom of expression, particularly as a gay man in the 1970s, resonated deeply with listeners who felt different or marginalised from society. In contrast, Brian May, the lead guitarist, was admired not only as a guitarist but also as an astrophysicist, demonstrating that intellectual ambition and artistic passion could coexist. His construction of the famous Red Special guitar with his father symbolised creativity, perseverance and individuality, given that he built the entire guitar with recycled and household materials because he couldn't afford a Fender or a Gibson. Roger Taylor, the drummer, studied Dentistry and Biology, representing his drive and versatility, showing that people can balance professionalism with artistic expression. Lastly, John Deacon, the 'quiet genius', was known for his humility and unassuming nature, contributing iconic basslines to songs such as 'Under Pressure'. Although he never actively sought the spotlight, his musical creativity and innovation were fundamental to the success of the band. Together, their contrasting identities demonstrated that different personality types and backgrounds are equally valuable, reinforcing a message of inclusivity and collective fulfilment.

Personally, I have always had an interest in Queen from a young age. I was particularly captivated by their fearlessness in the music industry and how they influenced others to embody this quality in ordinary life. My interest grew after I watched the Bohemian Rhapsody movie on a 14-hour plane ride. I got to learn about the band's history in more depth, especially Freddie's relationship with Paul Prenter, Mary Austin and each member's individuality and distinct personality. However, I was slightly disappointed to find out that some of the details of the movie were changed from what actually happened. A major detail that is inaccurate is Freddie's AIDS diagnosis timing, which was not until 1987. We are shown in the movie that he told his fellow band members about his diagnosis before their iconic Live Aid performance in 1985. Although the movie as a whole keeps the main story but changes timelines and simplifies relationships in order to make a clearer dramatic narrative, it is not a completely accurate retelling of the band's history.

Beyond their legacy as it is captured on the screen, Queen created social harmony through music that united people across generations, cultures, and backgrounds. By blending rock, opera, pop, and theatrical performance, they crafted songs that felt both grand and deeply personal. Anthems like 'We Will Rock You' and 'Bohemian Rhapsody' encouraged collective participation, turning audiences into communities. Their themes of resilience, love, individuality, and self-expression resonated widely, promoting acceptance and shared emotion. Because their sound was innovative yet accessible, it remains timeless, continuing to inspire listeners today. Queen's bold experimentation and powerful stage presence shaped the direction of rock music, leaving a lasting, influential legacy that still defines the genre.

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Autoimmune Diseases in Women

COCO, YEAR 11
MENTORED BY PJ, LOWER SIXTH

Autoimmune disease is when the body's immune system attacks its own healthy cells, tissues or organs. There is a disruption of harmony with the body, allowing the immune system to work against itself. Interestingly, around 80% of autoimmune disease cases are found in women, with around 8% of the population affected in general. The biologically female population has a predisposition, it seems, for the development of some autoimmune diseases, with women being 9-10 times more likely to have SLE (lupus), up to 19 times more likely to get Sjogren's syndrome, and 2-3 times more likely to get rheumatoid arthritis than men, as well.

Although autoimmune disease can arise from many different factors, often in combination, with genetics and the environment sometimes involved, the family of diseases itself is understood to a very limited extent, let alone why many occur more commonly in women. Possible answers include hormones, genetics and epigenetics.

Firstly, sex hormones are thought to influence susceptibility to autoimmune disease due to their interactions with the immune system. They are able to interact with the immune system by binding to receptors on the surfaces of immune cells. A study done on mice showed that removing the testes or ovaries reduced inflammation – the body's immune response – in both male and female mice.

This highlights the importance of sex hormones for the immune system, although it does not show the complexities of their involvement or the difference between the female and male hormones. For example, while oestrogen enhances the immune system, being pro-inflammation, testosterone has immunosuppressive effects despite its essential role in an active immune system. For this reason, women's immune systems are stronger than men's, which is useful in all respects except the associated risk that hyperactivity in the immune system can lead to autoimmune disease.

Additionally, oestrogen has been found to decrease the expression of the AIRE gene, a gene crucial for allowing self-reactive T cells (a type of white blood cell) to be detected and marked for deletion. This means that more self-reactive T cells are allowed to survive and cause autoimmunity.

Furthermore, oestrogen can cause increased levels of autoantibodies, antibodies which attach to the antigens on the body's normal cells and trigger the immune system's mistaken attack on its own cells. Oestrogen does this by inhibiting the negative selection process where B cells (antibody-producing white blood cells) that are self-reactive are deleted in the bone marrow before they can spread and do harm.

However, the female population is more prone to autoimmune disease even before puberty and after the menopause, when oestrogen and other sex hormones are low. Intriguingly enough, there is another, rudimentary element of the biologically female sex that heightens the risk of autoimmune disease, while it does not account for everything.

Having XX chromosomes naturally gives females twice the recommended dosage, as it were, of X chromosome. One of these chromosomes needs to be inactivated (in a process called X chromosome inactivation, or XCI). This is an epigenetic process, meaning it relates to how gene expression is changed by cells without changing the genetic makeup of the cell.

In an embryo, cells choose which chromosome out of the pair to inactivate, only letting one function before passing this down to the rest of the cells through mitosis. However, in practice, most of the time, inactivation will be incomplete and around 15% of the other chromosome is still active. This leads to the overexpression of some genes related to immune function and regulation, since many genes controlling immune function are found on the X chromosome. For example, the gene for TLR7, a receptor used for defence against RNA viruses but that can also be employed against the body's own damaged cells, has been linked to the pathogenesis of SLE (lupus) when overexpressed. Expressing two copies of this gene in male mice sometimes induced fully-fledged autoimmunity, but a variant of the gene created a lupus-like disease in mice as well, when it led to harbouring faulty memory B cells that drove chronic inflammation and tissue damage.

But what is even more problematic is that the act of X chromosome inactivation increases susceptibility to autoimmune disease whether the incomplete inactivation created the relevant overexpression or not. Xist RNA, the long non-encoding RNA that coats one of the two X chromosomes, rendering it inactive, causes problems itself: many of the molecules targeted by the body's autoantibodies are created by Xist RNA and the way it binds to proteins and DNA sequences, forming odd molecular structures that attract autoimmune function. Luckily, as shown in mice, this will only occur in those with autoimmune-favouring genetic backgrounds and if there has been stress that has caused damage to tissues (a viral infection or some other kind of injury, meaning the population affected by autoimmune disease is constrained).

Yet 15-50 million people face the realities of autoimmune disease in the U.S. and around 4-7 million do in the UK. In developed countries, it is the third most common category of disease. But it is consistently underfunded and there are many gaps in the research. Is this because it is a disease that primarily affects women?

It seems that the neglect of autoimmune disease has resulted from the medical default of the male test subject, and the way a male-dominated field has subsequently allowed itself to ignore the differences for women when it comes to disease.

Here, we find an interesting case study on the complexity of harmony in the female body due to the extent of hormonal influence and simply due to genetics itself. It warns us of the dangers of structural sexism in medicine – for instance, the Xist breakthrough had not occurred for many years because the male test cells did not produce Xist, so a major source of women's autoimmunity went unseen. Women of childbearing age have historically been excluded from clinical trials due to the effects it may have on fertility and the safe development of foetuses, but also because they did not want hormonal influences to meddle with trial results. This is ironic given that looking at hormones has often been the key to finding root causes, particularly in cases like autoimmune disease.

As such, the logical conclusion is that there should be a greater push to understand the harmony of the female body in medicine.

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Harmony and Dissonance: The Coexistence of Two Polar Opposites

DASHA, YEAR 11
MENTORED BY ADA, LOWER SIXTH

At first glance, harmony and dissonance are opposing concepts; they lie on polar sides of a spectrum, destined to clash. Despite this, in reality, one is not possible without the other. Harmony emerges not from the absence of discord, but from its resolution, or, perhaps more accurately, its management, whilst conflict can be the driving force behind progress and a sign that balance is on the horizon. In fact, the true measure of harmony may not be the silencing of opposition, whether politically or philosophically, but the capacity to coexist with it, and to allow dissonance to propel this harmony.

This paradox is most commonly witnessed in the political realm, where negotiation has always been built on managed dissonance. In fact, this type of harmony is often stronger than harmony that is built on forced silence, such as in dictatorships and police states. Although numerous examples can be drawn from the twentieth or twenty-first century, humans achieving political peace more successfully through dispute-focused celebration and cooperation can be dated back to one of the earliest civilisations: Ancient Greece. In Athens, dissonance was managed through the Assembly and courts, creating a more durable democracy where citizens could openly challenge leaders. On the other hand, Sparta enforced a 'fake harmony', where unity was seemingly created through fear, secrecy, and militarism. Although Sparta appeared stable, cracks emerged once external pressures mounted, leading to the decline of the state as a result of the inability to adapt. This shows that authoritarian regimes that achieve harmony by silencing dissent often fall quickly, most famously demonstrated in the last century by the Nazis. Meanwhile, democracy is an ideology that embraces disagreement, which generally strengthens stability. Unfortunately, however, society tends to lean to extreme conflict, such as war, in order to achieve resurgence. John Stuart Mill, an English philosopher and political economist, states in his 1848 book, Principles of Political Economy, '[a] war to protect other human beings against tyrannical injustice; a war to give victory to their own ideas of right and good, [...] is often the means of their regeneration.' This was demonstrated in the American Revolution, where protest and disharmony

between the American population and the British monarchy led to truer justice and freedom after a period of conflict. The US Constitution, one of the oldest surviving charters of government, was only created as a direct result of the tension between the federalists and anti-federalists. Harmony here did not mean one ideology winning but rather it was achieved by creating a framework that reconciled and acknowledged the concerns of both sides. Thus, it can be concluded that, in history, conflict has served as a calm before the storm – a violent bridge that two opposing groups must cross in order to reach peace, agreement and harmony, however temporary and unstable.

A philosophical approach can also be employed to analyse the extent to which harmony and dissonance can coexist. When broken down simply, conflict is the driving force behind progress and is simultaneously perceived as inevitable and crucial in modern society, as stated by theorists such as Karl Marx, Fichte and Nietzsche. Marxism proposes society as constantly being in a state of conflict due to the class struggle between the 'dominant bourgeoisie' (the owners of the means of production) and the 'proletariat' (the working class). The bourgeoisie's exploitation of the proletariat for financial gain is the primary cause of this conflict, and the social order is upheld by the wealthy's dominance over the poor rather than by agreement. Marxists think this conflict to be the catalyst for social change and history, possibly resulting in a revolutionary overthrow of capitalist systems and the establishment of communist ones in attempts to render everyone equal, as seen in the 1917 Russian Revolution. Thus, Marxism supports the idea that inevitable disparities in society bring about a result by opposing each other; however, it cannot be guaranteed that the most harmonious result will always be achieved. A triad coined in the philosophical world to explain this concept is 'thesis-antithesis-synthesis', a formulation originally devised by German philosopher Johann Fichte in his 1794 book 'Foundations of the Science of Knowledge'. Fichte used this concept to explain change and resolve philosophical contradictions (particularly those made by Immanuel Kant in his philosophy). The triad is a series of three concepts or assertions. The first concept, the thesis, is a formal statement that makes a point; it is followed by a second idea, the antithesis, which invalidates or contradicts the first; finally, the disharmony between the thesis and antithesis is resolved by the third idea, the synthesis. Essentially, harmony (synthesis) is only achieved from the opposition and conflict of two opposing sides (thesis and antithesis). Implications of this structure can be witnessed today, even in academic arguments, in which the classic pattern involves an idea (thesis) being proposed, an opposing angle (antithesis) being considered, and a revised idea incorporating both (synthesis) being reached. However, even this theory has been met with scepticism, including explicit criticism from other revered philosophers, such as Georg Hegel. In summary, in the theoretical world, different philosophers argue about the relationship between harmony and conflict, though some of the most notable ones view dissonance as the foundation of harmony, not a flaw in it.

Ultimately, achieving harmony should not be approached with the end goal of creating a static state of peace or unanimity, but rather it should be seen as a dynamic process shaped by negotiation and inevitable tension. Disagreement is not a failure of order, but a sign of its evolution. Instead of silencing conflict, societies and individuals alike may benefit more from cultivating the capacity to manage it, transforming it into dialogue and thus continually adapting.

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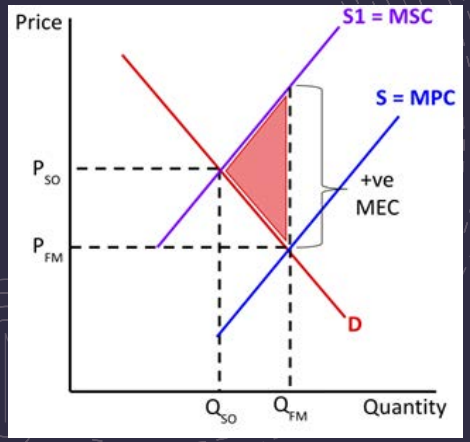


Harmony between Nature and Humanity: Can a Country Be Rich if Its Environment Is Poor?

DIA, LOWER SIXTH
MENTORED BY ELEANOR, UPPER SIXTH

Nations today strive predominantly towards increasing wealth: economic growth is a primary macroeconomic objective. Higher GDP per capita results in increased individual incomes and this allows people to afford better lifestyles, raising standards of living. However, humanity's drive for wealth has led to the immense exploitation of our environment through intensive anthropogenic activities.

To achieve economic growth, there must be an increase in the value of output produced in a country. This drives environmental damage through the overutilisation of resources to meet rising production. Deforestation, mining and burning fossil fuels are all processes used to access these resources, releasing immense amounts of greenhouse gas pollution.

This degradation stems from market failures in the economy. Countries focus on growth, allowing firms to overproduce goods which have negative effects on society, such as pollution. Firms do not consider these negative externalities in their cost of production, thereby pricing them too low, and manufacturing excess quantities.

The graph on the left represents the production of a polluting industrial firm. The quantity produced is on the y-axis and its unit price on the x-axis.

The red curve represents demand for goods.

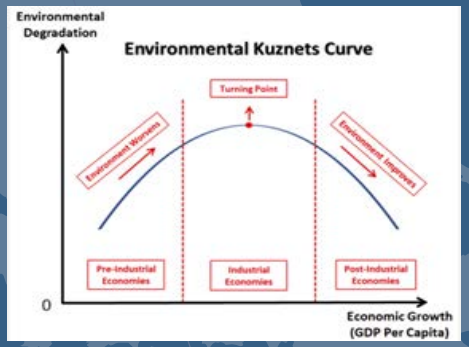
The blue curve represents Marginal Private Costs (MPC): the cost to the firm producing the free-market quantity (QFM) of goods.

However, we can see that the purple curve, Marginal Social Costs (MSC), which is the additional price to society, is higher than MPC, because the overall manufacturing creates external costs (MEC) of pollution which affect the health of citizens. Oversupply results in a welfare loss to society created by the firm (represented by the red triangle) by not producing at the socially optimal level.

China is a rapidly growing emerging economy currently suffering from this market failure. Manufacturing industries generate immense negative externalities, as they are not held accountable for environmental damage. Firms discharge toxic waste into water, resulting in serious contamination. Their Ministry of Environmental Protection reported that over 3 million families did not have clean water, and one third of the water system is below the safety standard. This occurs due to weak legislation, meaning that firms have no necessity to consider third-party impacts, immensely degrading the environment with the motivation of profit.

Economic definitions determine what constitutes an affluent country through monetary GDP figures and economic growth rates. However, it has been comprehensively argued that this economic indicator does not factor in other measures contributing to a nation's fulfilled 'richness'. Many prioritise an abstract concept of wealth, such as national happiness, life expectancy rates and education levels to measure the prosperity of a country.

Costa Rica ranks around 80th in the world for its GDP, whilst the USA is currently the world's largest economy. However, Costa Rica is a nation that focuses on raising standards of living through other metrics. Their investment into education and healthcare has led to an average life expectancy of 80 years (equal to the USA) and a 98% literacy rate (19% higher than the USA). Costa Rica also accesses 99% of electricity from renewable sources and over 25% of its land is protected as national parks. This environmental sustainability contributes extensively to citizens' wellbeing: it placed sixth globally and first in the Americas in the 2025 World Happiness Report. Comparatively, the USA were 24th within the same analysis. This convincingly illustrates that Costa Ricans could be seen 'richer' than US Americans through a more holistic interpretation. In this case, 'rich' countries, like Costa Rica, prosper exclusively alongside a healthy environment, with the harmony of humans and nature being a necessity.



Whilst a nation's desire for economic growth leads to destruction of the environment, this relationship is not linear. A theory, first introduced by Gene Grossman and Alan Krueger in 1991, suggested that their relationship could be concave curvilinear. It emphasised that environmental quality declines in the early stages of economic development and improves later. This is now known as the environmental Kuznets curve.

Pre-industrial economies have low wealth and income per capita, so they do not engage in a lot of industrial activity. They rely predominantly on the primary agricultural sector. This results in pollution being relatively low, as production is small-scale. Nonetheless, some deforestation and soil erosion can occur as local environmental damage.

Stage two involves a developmental shift, where economies become industrial. Rapid urbanisation and manufacturing expansion, alongside low regulation, lead to emerging economies causing maximum ecological destruction. Economic growth at this stage is the priority, with governments and firms focusing on jobs and output over sustainability. However, the turning point marks a significant change where priorities shift, and the environment becomes increasingly important.

The last stage is the transition into a post-industrial phase; there is a structural shift to tertiary and quaternary sectors of services and technology, which are less carbon intensive. Individuals are wealthier, so they spend a higher proportion of their income on luxury goods, such as sustainable, organic, more energy-efficient products that reduce harm to the environment. Public investment is spent on renewable energy infrastructure, global technology research and development, and increasing productive efficiency to reduce emissions. This leads to significantly less environmental degradation.

So, whilst nations are proven to become partly rich in the short-term by neglecting the environment, the Kuznets curve illustrates that a country's increased development will eventually meet a critical turning point. At this stage, sustained prosperity will not occur at the expense of the land but will instead require environmental protections to be in harmony with the economy.

Looking into the future, the consequences of climate change are accelerating. GEO-7 predicts that the world is approaching a series of climate-related critical thresholds. Thawing permafrost is intensifying global warming; rainforest deterioration destroys valuable carbon sinks; the altering thermohaline circulation threatens marine biodiversity significantly. Nations will have no choice but to alter their strategy of destructive anthropogenic activity to pursue growth. With fossil fuels estimated to deplete in 90 to 120 years, the energy mixes of the majority of nations will have to shift, focusing on renewable investment. Ultimately, due to these long-term consequences, the future demands an existence where economic progression must co-evolve sustainably with the natural world in harmony, and countries cannot become rich in any other way.

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Reclassifying Harmony: How Topology Helps to Find Order in Chaos

EVIE, YEAR 11
MENTORED BY AVA, LOWER SIXTH

We are surrounded by matter, which we insist on classifying and categorising through numerous frameworks. But developing frameworks that harmoniously describe the chaos around us is not easy. Harmony suggests neatness, regularity, symmetry and order, whereas chaos is associated with randomness and disorder. Essentially, they are antonyms. In the physical world, the divide appears intuitive: solid structures seem ordered whilst fluids are chaotic. However, harmony may be found not simply in the appearance of order but instead in the stability and persistence of matter. Such a framework is found in topology, the branch of mathematics studying properties of space that remain unchanged under consistent deformation. Through applying topological concepts to matter, we can rethink how states of matter are defined and begin to classify chaos harmoniously.

Most people are familiar with the three states of matter, although they represent only a part of a broader classification. In classical physics, states of matter are defined by the behaviour and arrangement of their constituent particles. Solids comprise particles held in fixed positions by strong intermolecular forces, resulting in a regular structure where particles vibrate. In liquids, particles are spaced further apart, allowing greater mobility and conformity to the shape of a container while remaining nearly incompressible. Particles in gases have enough energy to overcome most intermolecular forces, so they spread to fill any available volume, which makes gases highly compressible.

Typical classifications rely on these local particle arrangements to define states of matter, where this progression from solid to gas reflects an increase in disorder.

Introducing phase transitions – changes in the physical properties of a system as conditions are altered (e.g., ice melting) – further complicates the classification. Not all phase transitions involve obvious structural changes. When phase transitions occur, changes to the energy of particles can alter the symmetry of a system, resulting in an increase or a decrease in order. This prompted the idea of using symmetry to further classify phase transitions and states of matter. Due to its random distribution of atoms, a liquid can be said to have continuous translational symmetry. When this liquid undergoes a phase transition to crystal, its atoms align into a lattice. The crystal is said to have discrete translational symmetry because when the atoms are displaced by a discrete distance, the lattice will remain unchanged. This change in symmetry is an example of an idea called symmetry breaking, where the organisation of atoms will have different symmetries in two phases. However, not all phase transitions involve drastic changes in the symmetry of the system. In many cases, matter can retain some form of order whilst appearing disordered. This suggests that order may not necessarily depend on conventional structural symmetry alone.

In the late 1980s, chiral spin states were proposed as a new type of quantum phase. A chiral spin state is a phase where the spins of particles are arranged in a pattern, resulting in a non-zero, specific 'handedness' – meaning that the arrangement cannot be superimposed onto its mirror image. After attempting to use symmetry breaking to describe the chiral spin state, it became clear that distinct chiral spin states could share the same symmetry. This led to the realisation that symmetry alone is not a sufficiently precise tool to characterise order, leading to the proposal of a new type of order called topological order. In topology, geometrically different objects may be considered equivalent - for example a mug and a doughnut both have one hole and can be deformed into each other without tearing. The apparent shape and symmetry of structures do not always accurately represent the system's true, fundamental identity.

A topological transformation demonstrating a mug and donut as topologically identical figures.

The quantum Hall state of matter, discovered by Klaus von Litzing in 1980, marked a shift in the predictability of the states of matter. Previously, explanations and classifications were based on new discoveries partially due to chance, as the interactions between atoms became too complex to compute, hence their effect on material behaviour could not be accurately predicted. This state of matter exists where electrons are confined in a two-dimensional space at low temperatures with the presence of a strong magnetic field. For example, in semiconductors, when a perpendicular magnetic field is added, electrons will flow perfectly along the edges, but the semiconductor will act as an insulator everywhere else. Researchers were able to independently predict the possibility of the quantum spin Hall state, based on topology alone. Materials adopting the quantum spin Hall state would organise the movement of electrons based on their spin. Spin-up electrons would flow in one direction along the material's edge, whilst spin-down electrons would do the inverse. This state was experimentally observed a few years later in quantum wells of mercury telluride in between cadmium telluride. The success of topology in categorising phases of matter has allowed further exploration into the potential applications of highly specific and complex states of matter, prompting the development of a 'periodic table' of topological states using fundamental symmetries and topological order. Topology encourages us to consider the global properties of systems, rather than fixating on local symmetry.

The development of phases of matter challenges traditional ideas of harmony based on visual order and symmetry by focusing on stability. Discoveries such as chiral spin states and the quantum spin Hall state reveal hidden stability, despite the appearance of disorder. In this sense, harmony is not defined by regularity or neatness, but consistency of properties that persist despite distortion or imperfection. More broadly, the advancement of these concepts exemplifies science itself as an ongoing attempt to systematise the natural world. Each new framework provides more coherence yet exposes the limitations of previous explanations. The search for harmonious explanations about a chaotic natural world poses a greater philosophical question: whether nature can ever be fully captured by rigid classifications, or if our understanding must continuously adapt to reflect the emergent complexity it attempts to define. Harmony in nature is not something we impose through classification, but something that reveals itself when we reconsider the frameworks we use to understand it.

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Is Harmony Necessary for Good Design?

IRIS, YEAR 11
MENTORED BY MAZZY, LOWER SIXTH

Design is governed by a wide range of underlying principles, which create a framework for ideas and innovation. While there are differing views on which design principles are the most important, or even exactly how many there are, one that is frequently mentioned is harmony. Harmony in design can refer to many things but is generally considered to be the visually satisfying effect of combining similar or related elements to produce an impression of unity. Many design styles over the years have made several attempts at harmony, or even outright rejected any traditional aspects of it, but have they led to good design? And, perhaps more importantly, what is good design?

Design is unquantifiable as a mode of expression, and many people will disagree on any one aspect of it. Therefore, it is difficult to assign binary values to it. Even Dieter Rams, a successful industrial designer since the 1950s who created his own ten principles for good design, left some areas of subjectivity – there is no simple way to sort designs into 'aesthetic' or not, as is there no way to sort them into 'good' or not. Due to this, for the purpose of this article, 'good' design will refer to something well thought through and well respected amongst users and designers alike.

A style that would be considered a more traditional interpretation of harmony would be classical art and architecture, and, later, the neoclassical movement. Classical architecture is one of the foundations of Western harmony and involves the use of the three classical orders (Doric, Ionic, Corinthian) that functioned as a standardised system of design rules closely regulating aspects of Greek and Roman architecture. They ensured a sense of consistency and harmony in and between different buildings, and conveyed symbolic meanings, such as strength or luxury. Classical architecture also featured microadjustments to components of design such as staircases or columns, known as entasis, where very precise mathematical calculations were used to work out and apply a slight convex curve to a column to counteract the optical illusion of the column curving slightly. This was done to ensure that columns appeared perfectly straight, helping to ensure continuity between the elements of the building, and to unify everything by perfecting the small details. Similarly, the Parthenon in Athens contains perfectly symmetrical components of columns and pediments in order to create visual balance.

It is important to note that a large proportion of classical architecture was reliant on mathematical ratios, such as the 4:9 ratio used in the Parthenon for the spacing of the columns, as well as the width to length ratio of the stylobate (the topmost step of a Greek temple's foundation). Another ratio believed to have been applied to the construction of the Parthenon is the golden ratio. The golden ratio (1:1.618) is the number found when a line is split so that the ratio of the whole line to the longer split part is equal to that of the longer split part to the shorter split part. It was identified and studied by several Ancient Greek mathematicians and is first known to have been written about in 300 BC. It is linked to the Fibonacci sequence and is used in nature and design alike to create pleasing proportions, including in Greek temples and classical architecture.

Neoclassicism is heavily derived from classicism and seeks to reintroduce its symmetry and proportion to design. It emerged around the 1750s in Britain and France, and emphasised harmony and simplicity as a large part of its ideals. Much of its art resembled that of the Ancient Greek classical period, with greater importance placed on clean lines than colour or less geometric shapes. An example of art from the classical period is the Ancient Greek vases, which used only three colours and employed intricate linear patterns and shapes, as well as depicting a wide range of myths. Like the vases, neoclassicist art also contained mythological references and used relatively muted colours. This helped to create a sense of harmony through patterns and colours that complemented each other and the myths they were presenting, and a large part of this movement was chasing the harmony that was present during the classical period.

In contrast, brutalism is an architectural style that is not typically considered harmonious. It originated in the 1950s post-war period, and is characterised by expressive, functional design. It was a deliberate rejection of the traditional aspects of harmony and beauty, and is generally associated with materials such as concrete, brick, glass, steel and stone, which were visible as rough or unfinished surfaces. Due to this, brutalism was branded by many as unwelcoming and inhuman, which led to its decline in the 1970s. Despite this, I believe that there are buildings from the brutalist movement that do meet all of Dieter Rams' ten principles for good design. While brutalism was, in many ways, a challenge to classical views of harmony, it still displays a certain sense of unity and integrity. The materials it combines, while raw and exposed, are related in the fact that they form a single unified vision, though without as many rules and extraneous details as are associated with classical design.

Therefore, while the interpretation of harmony can differ between different styles and movements, it is difficult to find any good design that contains an absolute absence of it. While there are more traditional interpretations of it, such as in classical architecture and art, or in neoclassicism, which have produced many carefully considered designs venerated for their harmony, such as the Parthenon in Greece, even designs that are thought to reject its traditional elements can also be considered harmonious. Harmony contains many layers of complexity and should not be restricted to similar elements; it is instead the dynamic process of integrating diverse elements into a whole.

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Harmony: Static or Dynamic?

JULIA, YEAR 11
MENTORED BY CHLOE, LOWER SIXTH

Harmony is the unique balance between various elements to create a state of unity and cohesion. Harmony can be found practically everywhere in nature, such as via the golden ratio, the Fibonacci sequence, fractals, and symmetry. Since antiquity, humans have expressed a desire to achieve this equilibrium that can be found so effortlessly within the natural world but is so elusive to achieve personally.

The Ancient Greeks worshipped the goddess Harmonia (the goddess of harmony and concord and the daughter of Ares and Aphrodite), who symbolised the balance that could be achieved by the uniting of opposing forces. This suggests that harmony is not the absence of any variation but is instead achieved via the combination of contrasting elements.

This concept of proportion and structured harmony is mirrored in Pythagoras' principle that numbers and ratios can explain the natural world, and that harmony is the structured, static arrangement of the universe.

According to the Syrian mathematician Nicomachus of Gerasa (potentially apocryphal), while studying four blacksmith hammers, Pythagoras discovered that regular intervals between harmonic notes correspond to simple numerical ratios by comparing the tones made by each hammer with their relative weight. The first and second hammers seemed to make the same note (they were an octave apart), and their relative masses of 12lbs and 6lbs created a 2:1 ratio. The third hammer (9lbs) created a perfect fourth with the lowest hammer, while the fourth hammer (8lbs) created a perfect fifth with the lower hammer, ultimately, arriving at the ratios of 2:1, 4:3 and 3:2. These ratios were mirrored when later tested with strings of varying length, delineating a clear mathematical pattern.

He then extended this pattern to the universe, since if moving objects such as oscillating strings make a sound, then he surmised that moving celestial bodies would also make sounds. This then led him to conclude that each planet must produce a unique sound as it orbits the unmoving centre of the universe (Earth): the music of the spheres. Pythagoras took this concept of balance and proportion and extended it to other aspects of life, such as ethics and human behaviour as well.

Despite this theory later being discredited, it has had a large influence on other philosophers, astrologers and mathematicians. Philo of Alexandria concluded that Moses heard the "music of the spheres" while receiving the tablets on Mount Sinai, while Kepler used this theory to explain the mathematical proportions of the natural world via music.

This idea of static harmony was also represented by the Canon of Proportions developed by Polykleitos (an Ancient Greek sculptor and theorist), which was a set of rules for constructing the human form involving fixed ratios to achieve symmetry and 'ideal' beauty, echoing the Pythagorean belief that beauty stems from mathematical proportion and not individuality. Some of these rules included the head of a statue being a seventh of the statue's overall height and are evident in many famous works such as Polykleitos' Doryphoros.

Pythagoras' ideas underwent a resurgence in the Renaissance, as they rediscovered ancient Roman and Greek works. Architects such as Leon Battista Alberti and Andrea Palladio believed that in order to obtain a sense of divine order, a building's proportions would have to correspond to musical harmonies. This manifested itself in that when Palladio designed a villa, he would decide a room's width and length based on the musical ratios of 2:1, 4:3 and 3:2.

Leonardo Da Vinci's The Last Supper is another well-known example of the use of mathematical ratios to divide a canvas into invisible grids to create visual balance. In Raphael's School of Athens, Pythagoras himself is featured prominently in the front left of the fresco with a tablet containing musical ratios, highlighting his significance and his vast impact on the very foundations of Renaissance art.

While Pythagorean views focus on the concept of harmony as static and set, others, such as the Greek philosopher Heraclitus of Ephesus, put forward the notion that harmony is in fact always in flux (panta rhei).

Heraclitus proposed the unity of opposites, wherein the world is a system of opposites (such as hot and cold, life and death) that constantly rotate in order to maintain a state of equilibrium. He believed that, without strife, balance would not exist, similarly to how the tension of a lyre creates a functional musical instrument.

Despite this belief in constant change, Heraclitus thought that this change was governed by a rational principle, or logos, that is divinely ascertained. The logos is described as the fundamental principle that ensures the unity of the cosmos and is an objective truth beyond personal viewpoints and opinions.

This idea influenced another Ancient Greek philosopher: Cratylus. He was an extremely radical follower of Heraclitus who later went on to teach Plato and was known for taking Heraclitus' theories and extending them. He attempted to correct Heraclitus' famous line, 'you cannot step in the same river twice,' by claiming that 'you cannot step into the same river even once' due to the fact that everything is currently changing. He believed that, because of this, nothing stays the same for long enough to be known, so therefore language can't exist, leading to the breakdown of society.

Despite the clarity and certainty that Pythagoras' model brings, it fails to take into account the nuances and volatility of the world that we live in. Conversely, Heraclitus of Ephesus' theory acknowledges that harmony can live alongside conflict instead of being a separate entity. Yet without any stability, constant change would lead to chaos, suggesting that harmony must rely on both structure and instability in order to exist. Harmony is therefore not a perfect state that we must strive to achieve; instead, it is a balance that we are required continually to maintain.

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How Can We Work in Harmony with the Deep Sea to Discover New Drugs?

LILIA, LOWER SIXTH
MENTORED BY ROMILLY, UPPER SIXTH

The sea is the least explored part of the Earth, as only less than 0.0001% of the deep sea has been explored by humans. The oceans form the most diverse ecosystem on Earth, with extremely large ranges in both pressure and temperature found there. The deep sea has an immense pressure of over 1000 atmospheres, which is 1000 times the pressure on Earth. It lies in near or complete darkness and is home to at least 250,000 species of plants and animals. This causes some organisms living there to be more biochemically active in order to survive these harsh conditions. Remarkably, many of these compounds have medically desired effects in humans, such as being anti-cancerous, antibacterial or anti-inflammatory, which enables them to be isolated and synthesised into drugs. By 2021, approximately 30,000 bioactive compounds had been discovered in marine organisms; however, only 2% of those compounds were found in deep sea organisms. This highlights the vast number of new compounds that could be discovered and used for medicinal purposes. One of the most common uses for the chemicals found in deep-sea organisms is cancer treatment, as they help to defend the organisms that secrete them by killing or damaging cells in other organisms that are trying to attack them. This is just one example of a chemical that an organism produces for its benefit because of evolution that can also be useful for humans.

Another example is sea sponges, which secrete neutralising chemicals to prevent attacks or harm from damaging organisms or objects. Sea sponges are invertebrates with two thin layers of cells and a fluid, jelly-like layer in between them. Sometimes they have spicules, which are internal skeletons made of minerals such as silica or calcium carbonate. They are filter feeders, which is why they must produce bioactive compounds, as they are constantly in contact with sea water that might contain pathogens (microorganisms that cause disease). Most of the chemicals are produced by sea sponges with the help of symbionts attached to them, and they are secondary metabolites, which means they are not used for growth, reproduction or development but rather are used as defence mechanisms in this case. Manzamine A is an alkaloid compound extracted from multiple marine sponges in the Haliclona genus. First discovered in 1986, Manzamine A has a wide range of applications in the medical world due to its unique properties. It is antibacterial, anti-malarial, cytotoxic (so it can be used to treat tumours), anti-viral and neuroprotective. Currently, it is being tested in preclinical trials where it has been successful in both in vitro and in vivo testing, where it has inhibited the growth of drug-resistant tumours in mice and has had significant ability to kill Plasmodium spp., the malaria parasite.

Similarly, fungi in the deep sea also secrete bioactive compounds as a part of their defence mechanisms. These chemicals are necessary for their survival, as they can live up to 1000 metres below the surface and cannot move, so they are limited to physical and chemical methods of defence. Between 2020 and 2022, 184 new compounds were identified from deep sea fungi. Xanthocillin X is found in the Penicillin Commune deep sea fungi and exhibits strong antibacterial properties towards E. coli and Staphylococcus aureus bacteria. These bacteria cause gastrointestinal disease and staph infections (which begin with lesions on the skin), respectively. Xanthocillin X also has cytotoxic properties, meaning that it can potentially be used to kill cancerous cells. The use of a wide range of different bioactive compounds is useful in medicine, as it allows different drugs to be used for the same purpose. Especially as antibiotic resistance in harmful bacteria strains is constantly increasing, the exploration of chemicals secreted from deep sea organisms that have different chemical structures can be used to manufacture new drugs that are still effective.

On the other hand, many people object to deep sea exploration, as human interference can put stress on sensitive organisms such as corals and sea sponges. This can cause the death of whole populations, as organisms often depend on one another through symbiotic relationships. The extraction and removal of bioactive compounds can lead to these stresses and end up damaging food chains or multiple other organisms in a chain reaction. Once the chemicals have been isolated and extracted, they still must be tested, so there is no guarantee that they will be useful even after having killed organisms to collect the chemicals. This causes the environmental and ethical issues associated with deep sea exploration, as some people believe that we will destroy the whole ecosystem or that humans do not have the right to build specific technologies to 'disturb' organisms and environments. Also, for these compounds to be tested, a quantity is needed that is usually larger than the amount present in one organism, which means that multiple organisms need to be harvested for the chemical to be extracted and tested. Even after that whole process, even if the drugs are effective, due to the vast economic cost to reach and isolate these compounds, if another way to produce the chemicals (perhaps synthetically) isn't found, the drugs will not be able to be produced. These economic barriers create another challenge, as the process is currently not economically viable for the drugs to become manufactured and available to the patients who need them despite them seeming to have many potential benefits.

Will your next medicine come from a sea sponge or a sea fungus? Probably not. However, many of these compounds are currently in clinical and pre-clinical trials, so that hopefully we can reap the benefits that these chemicals have to offer in the future. Despite the environmental and economic challenges, I believe that there are many interesting and important discoveries to be made by studying deep sea organisms, such as creating new drugs to counteract cancer, E. coli infections and many other diseases. Overall, I think that there is plenty of inspiration to be taken in the medical world from the chemicals secreted by deep sea organisms, as scientists can utilise different chemical properties between different compounds to complete the same function.

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The Harmony Between Acting Techniques and Performance

MAIA, LOWER SIXTH
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Acting is more than the ups of booking credits and gaining fame; rather, it is the harmonious process of shaping a character. To portray a character realistically, actors must understand actor-audience psychology and the ability to evoke a certain emotion or reaction from an audience or another person in a scene. To do this, the actor must understand the harmony between human behaviour patterns, the emotions that influence them, and the final reaction. In this article, I will delve into three different acting techniques and how they shape an actor's performance.

One of the most influential figures in acting is the Russian theatre practitioner Konstantin Stanislavsky. He believed that actors should not pretend to be a character; instead, they should fully understand a character's motives, emotions, and backstory on a personal level. It prompts actors to use the given circumstances of a character and their own experiences and emotions to truly be in the situation of the character. This is called 'the magic if,' the practice of asking yourself, 'what would I do if I was in that situation?' And by tapping into past emotional memories and experiences, an actor can bring a raw, unfiltered, true emotion to a scene that stops them pretending to be in a situation and rather transports them to a related situation that they experienced themselves. This allows actors to draw from personal experience but can quickly become dangerous and triggering for the actor.

Lee Strasberg developed an acting technique formally known as method acting. This approach pushes emotional realism, as an actor steps into the day-to-day life of their character, adopting their emotions, psychological state, and physicalities in the process. The actor becomes an extension of the character, bringing them to life in parallel to themselves. In turn, the actor can produce consistent, realistic performances with an extremely prominent level of true emotional depth, as they live vicariously through the character. This, however, can become dangerous quickly, as it is known for its intensity and the emotional toll it takes on the actor.

A well-known example of an actor who committed to method acting was Heath Ledger, who is most famous for his groundbreaking performance as the Joker in The Dark Knight. The director of The Dark Knight, Christopher Nolan, pre-cast Heath Ledger into the role before writing the script for the movie. This gave Ledger an extended period to develop and live his life fully through the Joker. His preparation for the role included isolating himself in a London hotel room for a month whilst preparing a diary for the character of the Joker. Alongside this, he experimented with many different voices and accents in the hopes of creating an iconic voice specific to the Joker. After conducting his many months of research and diary writing in the character, Ledger had created a fully layered, multi-dimensional character that he could understand and immerse himself in fully, thus meaning he was able to portray the mannerisms and reactions of the Joker in an extremely natural way for the character.

It is speculated that this intense preparation for the role and the sudden separation of Ledger from the Joker once the movie had wrapped led to a flare up in his preexisting insomnia and anxiety, leading to his fatal prescription drug overdose, as he attempted to numb the effects of his mental disorders. He tragically passed away aged 28 on 22nd January 2008, just three months after wrapping The Dark Knight. Ledger posthumously won an Oscar for Best Supporting Actor for his role in the film at the 81st Academy Awards in 2009, and his family, including his father, mother, and sister, accepted the award on his behalf. Ledger passed away before ever seeing the finished product of the movie and never saw the impact his performance had on many viewers. Heath Ledger thus acts as a prime example of the detrimental effects of acting techniques and character preparation and was a massive call for changes in the support that actors receive in the industry.

Another distinctive technique is the Brechtian technique, also known as epic theatre. This technique was created and developed by Bertolt Brecht in the 1920s. This technique focuses on making an audience actively analyse a play's political standpoint and connect with a character's social ideas instead of passively empathising with a character via their emotions. Key Brechtian techniques include breaking the fourth wall, as actors address the audience directly, and commenting on a moment in the play or an action performed by themselves or another character. This is used to stop an audience becoming too immersed in the other world of the play and to make them realise that they are simply watching a performance. It also involves minimalist staging (a limited, simple set, props, costume, and makeup) to reduce the realism of a story, as the actors are restricted to a certain number and style of props, which are usually repurposed for multiple scenes. This ensures that the audience focuses on the political message of the play and not the world created. Finally, there is multi-roling, which refers to a technique where one actor will take on multiple characters in a performance, a famous example of this being Mother Courage and Her Children. This technique is usually paired with visible costume changes, which prevents an audience from becoming immersed in the illusion of a story and rather reminds them that they are watching a built performance that they should analyse instead of simply watch. This technique focuses on the harmony between an audience and a play's political message rather than on the relatability of the characters in the play.

Ultimately, each technique uses a different approach that varies greatly and is highly dependent on the type of story and character being portrayed, as well as the actors' strengths and weaknesses. Overall, acting techniques are crucial in aiding actors to create a harmonious performance specific to their character and a performance with which an audience can connect.

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The Harmony of Knowledge: Rethinking the Study of Polymathy

MARINA, YEAR 11
MENTORED BY MOLLY, UPPER SIXTH

In a field where even its definition is disputed, attempting to conduct tests to discover the root cause, traits and potential

implementations is futile. Polymathy, from Ancient Greek, is literally the study of many things. Now, however, it is often interpreted as the invention of a variety of things. This shift has frequently been attributed to the intellectual progression of humanity.

As more of the general populace becomes educated to a higher standard, it follows that competition within education increases. And competition famously breeds two things: specialisation and innovation, both of which are the enemies of an easy route into polymathy. In the days of Pliny the Elder (77 AD), it was enough to have studied others' work to be a leading polymath because, in terms of innovation, he could still compile them and write the first known encyclopaedia. Unfortunately for the rest of us, the first compilation of knowledge has already been written, so, to innovate, we must discover or invent something ourselves – an arduous task. In terms of competition, Pliny the Elder had little because scholarship was already limited to upper-class boys, and of those, few wished to continue the pursuit of knowledge, instead entering into family legacies in politics or the military. In fact, Pliny himself did the same at various points during his life, eventually becoming a general and then governor. However, along with commanding the imperial fleet and governing provinces from Spain to North Africa, the Roman scholar wrote a book on grammar, investigated mining techniques and wrote another book on spear-hurling. So, despite the fact that Pliny's scientific contribution mainly derived from Aristotle's and Theophrastus' work rather than his own, his talent for engrossing himself in a range of subjects is still notable and should be admired.

If this is the quality we most value in Pliny, why was it also necessary for him to have created something of his own to be considered a polymath? Why could we not adapt the term 'polymathy' to omit the implied 'innovator' requirement? The answer lies with prestige. Being a polymath has, since the word's inception in the early seventeenth century, always been a distinguished position; becoming one was seen as no mean feat. In a world of specialisation, polymaths are the exception, displaying a range of abilities: to obtain new skills more rapidly than the average person; to make more connections between their different fields of knowledge; to possess a deep, conceptual understanding of their subjects; and having an insatiable curiosity for learning. We could, today, consider everyone who deeply studies at least two subjects in different fields to be a polymath, but we'd end up adding millions more to the ever-growing list, thereby decreasing the title's prestige. So, adding the innovator clause seems a relatively decent solution – except that, in misrepresenting innovation as the admirable part of polymathy rather than engagement in a variety of activities, we let the beauty of diverse study be forgotten. As a result, it becomes a mysterious, impenetrable quality, which we assume is inherited and therefore futile to try to learn.

In fact, the study of it is equally murky. Over the past century, various scientists, researchers and psychologists have investigated polymathy, all with similar conclusions. But in 2009, two groups attempted to discover how we could apply polymathy in our daily lives: those led by Sriraman, and by Kaufman and Beghetto. Over three years, Sriraman had conducted tests to measure polymathic thinking traits in students, as well as their ability to understand Russell's paradox verbally. The fact it was given verbally is important because this was the difference between a symbolic expression of the paradox, which aids visualisation more, and this: 'Does the set of all sets that are not members of themselves contain itself?' If it does, it doesn't; if it doesn't, it does.' The latter is clearly harder to understand because the skill of translating the words into visual representations of those sets (groups of numbers or values) adds another layer of difficulty to the already baffling problem. This skill is more prevalent in polymaths because their brains are wired for associative thinking, where they make neural pathways between unrelated topics to aid memory and think more creatively. So, maybe it isn't so surprising that da Vinci painted iconic paintings while also pioneering discoveries in human anatomy and engineering or that Hooke redesigned the building of London as well as revolutionising microscopy.

When we know this, Sriraman's observations that those more engaged in solving the paradox also displayed more polymathic thinking traits seem unsurprising. Additionally, he concludes by suggesting that fostering polymathy in the classroom may be helpful to students but gives little guidance on how to do this. Kaufman and Beghetto never conducted an experiment but instead created a model with which to identify polymaths. They then wrote articles, such as one titled 'Do we all have multicreative potential?', which avoid answering the initial question by concluding that discovering our polymathic potential doesn't matter and that we should simply attempt to foster polymathy in those already displaying traits of it. Again, any idea about how to do this fostering cannot be found.

By glorifying polymathy, we have distanced ourselves from it until achieving any aspect of it seems unattainable. And research hasn't helped. When we hear of scientists struggling to find out whether polymathic tendencies are present in everyone, the worry that interdisciplinary study is too difficult for us grows. With that, the resistance to trying grows, too. So, whilst it might be easier to look at a smaller list of polymaths and worship those for their transformative innovations, we should recognise the everyday polymaths amongst us, because a world without polymaths is a world in which the limits and richest parts of our scholastic potential are never fully explored.

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The Harmonious Link Between Tradedy and Catharsis?

MAZZY, LOWER SIXTH
MENTORED BY SOPHIA, UPPER SIXTH

In a world divided by much, there are few things that can bring us together and none so effective as mutual horror and sadness at tragedy. The same impulse that impels humans to watch the news, to "rubberneck" at accidents on the motorway, to share gossip is the unifying factor that brings us together and reminds us of our shared humanity. The Ancient Greeks believed that the shared experience of watching tragic theatre could affect audiences in multiple, beneficial ways. Their influence has had theatre in a chokehold throughout time, including into the twenty-first century. Every year, new variations of Greek tragic plays have crept into the West End. These plays usually include variations of violence, seen in conflict, discourses and vengeful acts. Our modern ideas of violence are "extreme force" or "actions that are intended or likely to hurt people or cause damage". For the purpose of this essay, violence will be interpreted as the latter. Why does this form, so upsetting to watch that

it provokes powerful feelings of sadness in the audience, endure in popularity?

In his book, On Poetics, Aristotle's central concept is Mimesis (imitation): poetry, drama and art are natural, pleasurable imitations of human life. He claims that humans find joy in representation from childhood, or as Paul Kottman redefines it, "shared memory". Through Mimesis, Aristotle outlines six main tragic techniques in order of importance: Mythos (plot), Ethos (character), Dianoia (thought), Lexis (diction), Melos (song - this tends to be the musical accompaniment of a chorus)and Opsis (spectacle).4 He also identifies two outcomes facilitated by these; Hamartia (a fatal flaw) and Catharsis (emotional release/cleansing).

Mimesis and Catharsis are the principal elements of Greek literary and philosophical criticism most notably identified in tragedy. In tragedy, Mimesis allows the viewers to experience fear or pain, while Catharsis is the result of those emotions. Aristotle's teacher, Plato, explicitly states that "this [mimesis] is precisely what makes tragic pleasures so paradoxically attractive: they are a kind of mixture of pain and pleasure", attributing the pleasure to knowing that we do not have to experience the tragedy's pain in the real world, yet feeling discomfort while watching it.

The definition of Catharsis is not entirely clear, but it roughly relates to "the purgation or purification of emotions, specifically pity and fear". In On Poetics, Aristotle signifies Catharsis as an emotional release that restores, balances and renews the audience after watching intense suffering, cleansing them of negative emotions by evoking these through dramatic art. The viewers experience a cathartic response (perhaps a good cry) as an emotional release. To Aristotle, Catharsis was an essential and communal emotional outlet. As for Mimesis, scholars have deduced its rough translation to be the "imitation" or "representation" (rather than the direct copying) of reality. An example of this is Oedipus Rex by Sophocles who (supposedly) based Oedipus on Pericles, the Athenian leader during the Peloponnesian War. He had absolute power, like Oedipus, over Athens, but made Athenian citizens anxious about his rule potentially becoming tyrannical (Athens had a long history of tyrants before it became a democracy). Additionally, Sophocles plays on this fear in Oedipus, showcasing his descent into paranoia and arrogance when challenged, as he places his own intelligence above the gods. Aristotle considers Mimesis a natural concept that allows humans to learn, to explore how things potentially could be, and to experience pleasure.

Moving on to Mythos, Ethos and Dianoia, three of the six main elements of tragedy that Aristotle defines, Mythos broadly refers to the plot, structure or arrangements of incidents in a tragedy. A good plot must include universality and turning points (for example, a reversal of circumstances, recognition, sufferings, etc.). This engages the audience, encouraging them to suspend their disbelief, which is the key to eliciting the emotions associated with tragedy, making it the most important of all the six elements. Ethos is the second most important element, loosely translating to character, habit or custom. According to Aristotle in his Rhetoric (Book 2), Ethos includes three components: Arete, or virtue, Phronesis, or practical wisdom, and Eunoia, or goodwill towards the audience. He argues these make a character appear credible and trustworthy to an audience, leading to a deeper emotional connection. This is where Hamartia comes in. In Ancient Greek terms, Hamartia is the flaw specific to a tragic hero's fatal error in judgement that leads to their downfall. In Oedipus Rex, Oedipus' hamartia is his pride and hasty judgement. The third element is Dianoia; understood today to be the themes, ideas, or arguments expressed, or the ability to say what is appropriate in a situation in the play. It is generally understood to be the process of thinking things through. In his On Poetics, Aristotle splits dianoia into practical and theoretical knowledge. Technē (reason concerned with the production of art) is particularly important, as it allows characters to make arguments and to prove points. It uses the characters to reveal the ideas, values and philosophical themes of the play. In relation to the plot, it works to reverse the emotional impact on the character in a believable way.

Finally, the last three of the six elements Aristotle highlights as important to a tragedy are Lexis, Melos and Opsis. Lexis is essentially the diction or the rhythm of the words, seen, for instance, in Shakespeare's use of iambic pentameter. In On Poetics, Aristotle connects diction to Logos (a larger discourse or argument), used to convince the audience of the apparent truth. Melos is utilised by the chorus, a staple of Greek plays, it refers to a purposeful combination of words and rhythm within a tragedy, most notably rhyming couplets within chorus phrases. Having a chorus was vital in a Greek tragedy. They acted as the narrators, the connection between the actors and the audience, the necessary context-setters of the show, and the forum for philosophical reflection on the action. In Oedipus Rex, for example, the Chorus reflects on the human condition (specifically, the fragility of human happiness), along with the inevitability of fate and the limitations of human knowledge. They critique Oedipus' hubris and they watch, amused, as he solves the riddle of the Sphinx yet remains blind to the truth about his own identity. The final, and least important, of the Six Elements is Opsis. Translated to sight or appearance, it is understood today to be the physical look of a person or object in the context of the play. Aristotle considers Opsis to be the theatrical spectacle of the tragedy, subordinate to the plot and the least technical of all six elements. He implies that a tragedy could still succeed in triggering catharsis with less-than-perfect Opsis, but the latter can be used as a visual motif that acts as a symbol at crucial points of the drama. For example, Sophocles uses sight and blindness as Oedipus' Opsis. Tragic playwrights still utilise Opsis, manifesting itself in set, props, costumes, lights and more.

In summary, the connection between tragedy and catharsis is healthy, natural and harmonious. Aristotle recognised this and praised tragic plays based on the cathartic response from the audience. The six elements that make up tragedy are vital in ensuring its success, logically leading on to the audience's release of emotions in a cleansing way.

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Harmony or Dissonance: Can Manichaeism Be Considered Christianity?

PALOMA, LOWER SIXTH
MENTORED BY ISABELLA, UPPER SIXTH

The original faith of St. Augustine (prior to his immeasurably significant conversion in 386 AD), Manichaeism, contains a patchwork of elements from several theological frameworks, including Zoroastrianism, Buddhism and Christianity. However, are the assertions of the heresiologists of early Christianity false in suggesting Manichaeism

to be a blatantly heretical religion (Baker-Brian), or can it be truly harmoniously reconciled with Christian doctrine? In order for Manichaeism to be considered the Christianity of the Bible, which asserts the value of human life almost immediately within its exposition, and the Nicene Creed (the foundational confession of Christian orthodoxy established in the fourth century, which unequivocally affirms the existence of one God and the true divinity and humanity of Jesus Christ through the hypostatic union), it must be a purely monotheistic religious framework. It must accept the hypostatic union of Christ, and it must affirm the value of human life. Since Manichaeism does not fulfil any of these necessary conditions satisfyingly, I contend that Manichaeism is not a religion that harmoniously fits within Christian doctrine, but is a syncretic philosophy, dissonant to the Christian theology from which it takes inspiration.

Manichaeism seemingly affirms the triumph and sovereignty of 'Light' over darkness, suggesting belief in a single Creator. The first line of the Mani Codex (the principal text of Manichaeism) asserts the individual sovereign power of the Creator. It asserts that this 'Power' was eternally existent prior to the creation of 'all things' (C. G. Scibona). This pre-existence of the eternal God is thus affirmed to be at the forefront of Mani's theology, whilst the 'dark material reality' is placed into the background. This surely means that Mani believed in the transcendent and sovereign God of classical theism, present in Christianity. However, it is undeniable that Manichaeism is ultimately dualistic. Instead of being a theological framework rooted in Christian theology, Manichaeism has its intrinsic groundwork in Zoroastrianism, from which the Manicheans 'appropriated [..] concepts, and themes' (BeDuhn). Zoroastrianism is a profoundly dualistic tradition, whereby there is 'a supreme lord, Ahura Mazdaand' and a 'demon spirit' counterpart, 'Angra Mainyu' (Kronen and Menssen). In Manichaeism, this metamorphosed into a similar supreme battle, where darkness emerges from 'the evil essence', and can only be overcome through harsh ascetic practices that would 'separate the soul ("Light") from the body imprisoning it' (Kronen and Menssen). Despite the surface of Manichaeism appearing to follow Christian doctrine, in truth, it finds its skeletal framework within the much older dualistic tradition of Zoroastrianism, clearly co-opting the integral dualistic aspect of its theology into its own dogma. The ascetic practices of Manichaeism clearly desert the orthodoxy of Christianity, proposing an individual battle to be a more important aspect of religious life than faith in a singular, personal Creator and the Saviour within the Godhead of Christianity.

Mani appears to support the substantial model of the Incarnation, where Christ possesses a unity of divinity and humanity (hypostatic union). He refers to Jesus as 'saviour' and refers to himself as an 'apostle of Jesus Christ' (Franzmann), reflecting, practically verbatim, the introductions within the Pauline Epistles, where St. Paul explicitly calls Jesus 'our great God and saviour' (Titus 2:13), which suggests both the intrinsically inspirational role of the Epistles to Christian doctrine and an affirmation of their theology within Manichaeism. Despite Mani's attempts to 'mould himself' on St. Paul (Carveley), Manichaeism remains a clearly docetic theology, asserting that Jesus' physical existence and body were merely an illusion (Pedersen), thus denying the key principle of the hypostasis of Christ, that He was also fully human. Whilst Manichaeism clearly advocates for elements of Christ's divinity, it thus refutes an element that is integral to Christian doctrine.

Much of Christian doctrine and practice is based on the principle of imago dei, the belief that humanity was made in the 'image of God' (Genesis 1). This has led to the Christian belief that life is sacred and has inherent value. Within Manichaeism's ethics, the value of sentient life is clearly asserted. In fact, in Manichaeism's doctrine, the forces of 'Light' are found within all sentient creatures, which led followers of Mani's religion to avoid even the killing of plants, as such an act would cause 'pain' to this inner Light (Iran Chamber Society). This certainly suggests a value in all life. However, the value of life suggested by Mani is intrinsically rooted in paleo-animistic philosophy which differs from the biblical assertion of the higher value of human life due to humanity's image-bearing status (Baker-Brian). Furthermore, the casing of this 'Light' is considered 'demonic', although 'the human spirit is transcendental and celestial' (Esmailpour and Mair), suggesting that human flesh innately lacks value and, in fact, that it is derivative and wretched. Manichaeism's suggestion of an invaluable inner 'Light' is certainly reminiscent of Christianity's assertions about the soul; however, the implication of Mani's philosophy that the body is 'evil' is that flesh is not to be valued and stewarded, suggesting a very different level of regard for the value of human life within Manichaeism compared to Christianity, suggesting that the two theologies are irreconcilable.

In examining the theological foundations and doctrinal claims of Manichaeism alongside orthodox Christian tenets, it becomes evident that despite superficial similarities, Manichaeism cannot be reconciled harmoniously with Christianity as defined by biblical scripture and the Nicene Creed. While Manichaeism affirms a transcendent Creator and venerates the figure of Christ, its dualistic worldview, docetic Christology and ascetic valuation of human flesh diverge fundamentally from core Christian doctrines such as monotheism, the hypostatic union, and the sanctity of embodied human life. The syncretic nature of Manichaeism, drawing heavily from Zoroastrian dualism and paleo-animistic ethics, positions it not as a variant of Christianity but rather as a distinct religious philosophy that appropriates Christian elements without fully embracing its theological essence. Thus, Manichaeism stands as a dissonant counterpart to Christianity.

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Subatomic Harmony

PJ, LOWER SIXTH
MENTORED BY ROMILLY, UPPER SIXTH

When I say subatomic harmony, I am referring to the phenomenon in quantum physics called quantum entanglement. Quantum entanglement is one of the core concepts of quantum physics and has the potential to be groundbreaking for future quantum technologies.

However, it is important first to define quantum mechanics and its principles. Quantum physics is the study of matter and energy at the most fundamental

levels. It can explain phenomena where classical physics fails, compensating for gaps in our knowledge of the universe. Classical physics governs a predictable world, while quantum physics describes a more unpredictable and unsettling world, where multiple solutions to problems can coexist. A key principle of quantum physics is the identification of energy and matter as discrete 'packets' (quanta). These quanta will have a minimum value associated with them. For example, light will deliver energy in quanta called photons. These photons will have the same energy as each other and cannot be broken down into smaller units.

Other important principles of quantum mechanics include wave-particle duality, the uncertainty principle, entanglement and superposition. Wave-particle duality describes how light and matter can act like or have the properties of particles or waves depending on how they are measured. Superposition describes an object that is in multiple states simultaneously. In maths, this can be illustrated by an equation that has more than one solution. The uncertainty principle describes how two properties of an object (like its position and velocity) cannot be precisely known at the same time. If you measure the position precisely, you won't be able to measure the velocity as precisely.

The key concept I want to discuss is quantum entanglement. It details that particles of the same origin that were once connected will always remain connected, even if they are separated across vast distances of space and can even be thought of as a single system. The state of one object cannot be described without information from the other object; they have a new unified quantum state that they maintain forever. When two particles (e.g., photons and electrons) become entangled, they can remain connected even if separated over very large distances. Quantum entanglement can be described as the superposition of two separate places, such as, for example, a light source that emits two photons at a time. The polarisations (the representation of the direction of the oscillations of a photon's electric field, perpendicular to its direction of motion) of the photons may be random, but they will be correlated. Their positions being correlated means the polarisation state of one particle is inextricably linked to the other. This essentially means that they don't have independent states. If you know the polarisation of one particle, you know the polarisation of the other. The same goes for the spin (the total angular momentum or intrinsic angular momentum of a body) of entangled particles. If one particle's spin is up, if the pair are correlated, the other particle's spin will be down.

When entanglement was first discovered in the 1930s, scientists found it quite confusing. Einstein famously called it 'spooky action at a distance', as the particles seemed to be communicating faster than the speed of light, which would violate the rules of relativity. Einstein initially proposed that 'hidden variables' should be added to quantum mechanics in order to explain entanglement, and to restore the 'causality' of the particles. 'Causality' dictates that an effect cannot happen before its cause, and causal signalling cannot travel faster than the speed of light. However, Einstein's 'hidden variables' theory has since been disproven, and quantum entanglement has been proven experimentally as a foundation of quantum mechanics.

But how does quantum mechanics not violate the theory of relativity if the particles seemingly communicate faster than the speed of light? Special relativity dictates that no information carrying a signal or matter can travel faster than the speed of light in a vacuum.

The outcome of measuring entangled particles is random. The result cannot be controlled, so the sender cannot transfer a message faster than light. As well as this, the connection between the particles is instantaneous, or produces an instant correlation, instead of being a faster-than-light communication. So, although Einstein initially believed quantum entanglement violated the theory of relativity, further experiments have proved it is coherent with our current understanding of physics.

So how can quantum entanglement be utilised for innovative technologies? One of the major ways quantum entanglement is being utilised is for encryption keys. This new technology involves using quantum mechanics to strengthen and enhance cryptographic protocols. Two examples of quantum entanglement used in cryptography are Quantum Key Distribution and Quantum Cryptography protocols. Quantum Key Distribution can create a cryptographic key with provable security. One individual prepares a stream of entangled qubits. One qubit (which, unlike bits, can store 0 or 1 or a combination of both) is kept and the other is sent to a second individual via a quantum channel. Any individual that tries to interfere with the communication would cause the entanglement between the qubits to break down, resulting in evidence of attempted interception. By measuring their individual qubits, the two individuals can create a shared secret key over the channel. Any changes in the entanglement will appear in the measurement results, which allows the individuals to identify if someone is attempting to intercept information. Moving on to Quantum Cryptography protocols, quantum entanglements can be used to enhance the security of protocols like authentication and encryption. In terms of authentication enhancing, the non-locality correlation of the entangled particles is used to check the authentication of sent messages or data and identify any possible tampering efforts.

Looking more into other methods of the use of quantum entanglement, we can discuss qubits a bit further. Qubits rely on entanglement and superposition to represent multiple states simultaneously (0, 1, or both). This therefore allows for calculations and modelling of complex molecules that would take classical computers thousands of years. Another potential use is deep-space communication. The Lunar-Laser Communication Demonstration showed laser communication could transmit data faster than radio waves. This technology could enable deep-space communication over vast distances by utilising quantum entanglement, which could be resistant to interference.

Quantum entanglement is truly a fascinating phenomenon, and though it seems 'spooky' and impossible by nature (similar to a lot of quantum mechanics), it is definitely a necessary concept to understand and research so that we can improve our understanding of the universe, as well as utilising the fascinating features of the concept in order to further the complexity and proficiency of our technologies.

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CERN: Where Science Becomes Global Endeavour

SOFIA, LOWER SIXTH
MENTORED BY CHIARA, UPPER SIXTH

On the morning of 8th October 2013, the scientific community waited in anticipation to find out who would receive the forthcoming Nobel Prize for Physics. It seemed inevitable that the award would recognise the discovery of the Higgs boson, which had been found at CERN (the European Organisation for Nuclear Physics) in July of 2012. The detection of what is controversially referred to as the 'God particle' confirmed the existence of the Higgs field, which had been proposed 50 years earlier to explain how fundamental particles acquire mass. But the question now was who would receive it: the theorists who predicted the particle in 1964, the experimentalists who discovered it almost half a century later, or both? This dilemma exposed a deeper tension within modern science: whether scientific progress is best understood as the triumph of individuals or as the product of sustained collective harmony.

When Alfred Nobel established the Nobel Prizes in his will, he envisioned them to recognise annually the 'one person' who 'conferred the greatest benefit to humankind' across five different fields. Just as Nobel's words suggest, science has long been portrayed as a solitary act: one person hunched over a desk, quietly uncovering the biggest revelations of the universe. This perception is reinforced repeatedly by headlines, ceremonies and student textbooks. However, it is increasingly becoming incompatible with the collaborative reality of modern science. In 2013, the Nobel Committee was constrained by its own rules, which limit the scope of recognition. Such restrictions do not sit easily with projects such as CERN, where discovery is inseparable from large-scale cooperation.

CERN was founded in 1954 by 12 countries with the aim of facilitating European cooperation and peaceful collaboration in scientific research after the horrors of the Second World War. In the context of a Europe that had been deeply fractured, lacking social cohesion, CERN represented an attempt to replace political rivalry with shared intellectual purpose. Currently, CERN has 22 member states, collaborating with over 16,000 scientists from over 75 countries. The successful pursuit of open access, tolerance and freedom of thought promotes the CERN model as a blueprint for global collaboration and encourages similar multinational institutions in other fields. Intrinsic to its success is that all partners are equal; there is no leader country, so everyone is empowered to contribute to a common aim.

CERN has made major contributions to our understanding of the universe. The discovery of weak vector bosons in the 1980s and 1990s and the more recent discovery of the Higgs boson have contributed much to the Standard Model of Particle Physics, the unifying theory that describes the subatomic structure of matter. Bosons are force-carrying particles each responsible for a different fundamental force. Among them are the W and Z bosons, known as weak vector bosons, responsible for the weak nuclear force of radioactive decay. These groundbreaking discoveries at CERN are not only significant for uncovering the physics beyond our current understanding but are also testament to the social cohesion present at CERN and would not be possible if scientific progress had been reliant solely on individual achievement.

To achieve this, physicists, engineers and technicians of more than 110 nationalities, languages and cultural backgrounds worked together for over two decades to design, build and commission thousands of components for the flawless operation of CERN's Large Hadron Collider. The LHC is the world's largest and most powerful particle accelerator, taking the form of a 27km ring-shaped tunnel sitting 100m underground on the Franco-Swiss border. Inside the accelerator, two high-energy particle beams travel close to the speed of light before they are made to collide at one of four distinct points along the accelerator ring, corresponding to the positions of four particle detectors equipped to analyse collisions and better understand the fundamental building blocks of all matter. CERN drives collaboration by uniting people with a passion for knowledge and a common goal. In fact, the World Wide Web was invented in CERN in 1989 with the goal of efficient information sharing to bridge scientific communication around the world.

Scientists are driven by curiosity but are split by how they pursue that curiosity. Are they experimentalists or theorists? And which group came first? Christophe Grojean, a theorist who collaborates with the experimental physicists working on the LHC, claims, "It's a bit like the chicken and the egg." Are experimentalists dependent on theorists' predictions for their discoveries or do theorists rely on experimentalists' data to prove their models?

A common misconception is that theorists and experimentalists work independently when it comes to scientific frameworks, as they have opposing work mindsets: the mindset of experimentalists is that something is only true if you can measure it, whereas theorists believe there is no need for evidence because the laws of physics hold greater power. However, this could not be further from the truth. Theorists devise models, whereas experimentalists test them. In physics, developing models and performing experiments go hand in hand, so collaborations between modellers and experimentalists are the only way to bring about advances in the field. Research at CERN is a perfect example of the essential cooperation between theoretical and experimental physicists that drives scientific progress. Take the 2012 example: the experimentalists' search for the Higgs boson was driven by theory, but now the theorists are waiting for more data, provided by experiments, to prove their theories and expose their flaws for further refinement and experimentation.

The appeal of CERN does not lie in the countless scientific breakthroughs and successes it has brought to light in the last half century. Rather, it is the idea of CERN as a global institution that is so inspiring. Thousands of minds work together for a common objective – to learn about the universe we inhabit. In a world of increasing division and geopolitical tension, CERN is a source of hope for the future of humanity. No wonder the 2013 Nobel Prize in Physics, recognising two theorists rather than the collaborative effort of thousands of experimentalists, has attracted so much criticism.

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The Storytelling Harmony in Video Game Art

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For centuries, storytelling has evolved through forms of art such as literature, theatre, and film. Each of these mediums relies on harmony – the careful balance of structure, tone and aesthetic expression – to create meaning. Harmony is the foundation of all great art, whether it be the blending of notes in music or the composition of colour in painting. In the modern era, video games have emerged as a new form of storytelling, and with their development, they have introduced a new dimension: interactive harmony. Unlike passive forms of art, games combine visual design, music, spatial composition, and atmosphere to create worlds for players to immerse themselves in. With many of these experiences, every visual and auditory detail contributes to the narrative, and it is the harmony between the senses that truly sets apart video games as a powerful storytelling medium.

Visual storytelling in videogames acts alongside the written storyline, so that the graphics can communicate meaning without spoken dialogue. In a game where visuals and narrative are aligned, the artwork will elevate the depth of the story. Through environmental design and spatial composition, video games embed a narrative within their worlds. The architecture can show a rise or fall in civilisation, lighting can establish emotional tone, and scale can influence how powerful or insignificant a player feels within a space. This technique, described as environmental storytelling, allows meaning to emerge from the setting itself. When these elements align with the game's theme, artistic harmony can emerge from what the player sees and what the story conveys. A powerful example of this dynamic is in the game Journey, in which the cover art shows empty desert hills only constructed using a combination of yellow hues. The minimalistic art style removes visual clutter, directing attention towards the distant mountain, which acts as a progression metre through the journey itself. The emptiness of the scene reflects the game's themes of isolation, whilst the gradual climbing of the mountain throughout the game symbolises a growing inner purpose. Without explicit communication of the story, the visual design alone is able to create emotional depth. With this, the art direction becomes a narrative force rather than a backdrop. Harmony is achieved when composition, colour, and environment consistently reinforce the intended themes, allowing the world itself to tell the story. The result is a form of storytelling that is felt visually as much as it is understood conceptually.

While visual design constructs the physical world of a game, music and sound shape its emotional landscape. In harmonious video game art, sound doesn't only accompany a narrative but helps to amplify it. Unlike film, where music supports a fixed sequence of events, video game soundscapes respond dynamically to player movement and atmosphere changes. This creates a layered form of storytelling in which changes in mood are reinforced through auditory cues. Silence, ambient noise, and recurring tunes help to guide a player's emotional interpretation of the story, often signalling hope, danger, or loss before the events unfold. When sound design aligns with visuals and narrative, it forms an essential part of artistic harmony, ensuring that what a player hears reflects what they see and feel. This is illustrated well in The Last of Us, in which the sparse acoustic soundscape mirrors the emotional fragility of its characters and post-apocalyptic world. Rather than relying on grand orchestral arrangements, the limited use of guitar riffs and ambient noises conveys emotional intimacy and vulnerability. Moments of near silence heighten tension, allowing for only the sounds of footsteps or distant echoes to communicate danger more effectively than dialogue. The auditory restraint blends with the game's muted colour palette, reinforcing its themes of survival and loss. Harmony emerges not from complexity but cohesion of auditory design and thematic ideas, showing how storytelling in videogames is experienced not only through sight, but a carefully manipulated balance of the senses.

Another dimension of storytelling harmony emerges when all artistic elements are unified to reflect a character's internal emotional journey. When these elements develop alongside a character's emotional state, the player experiences a sensory evolution. In these cases, narrative progression is intertwined with aesthetic change, allowing emotional development to be expressed symbolically rather than explicitly. In Gris, the gradual reintroduction of colour mirrors the protagonist's journey through the five stages of grief, transforming the visual landscape as their emotional state evolves. The evolving art style, developed by Conrad Roset, assigns an emotion to every colour that is introduced. The monochrome opening conveys the denial of absence and loss, followed by red for anger, green for bargaining, blue for depression, and finally yellow for acceptance. The steady emerging of vibrant tones indicates the character's internal restoration, resilience, and recovery. Through this alignment of colour and visual transformation, aesthetic design becomes inseparable from the emotional narrative. Harmony in this context pushes the emotional change and enhances the sensory journey of the player.

Storytelling harmony in video game art lies in the deliberate unity of visual design, sound, and aesthetic progression to create meaningful narratives and experiences. As seen through these compositions, video games are able to communicate stories not solely through dialogue or plot: they are also brought to life through sensory cohesion and development. Unlike traditional media, video games immerse players within this harmony, allowing them to experience the narrative as a culmination of sight, sound, and emotion. It is this integration of artistic disciplines working collectively that establishes video games as a uniquely powerful and evolving form of storytelling art.

Colour progression in *Gris*

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