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Letter from the Editor

Alexandra Jamieson

Appearing in the ninth volume of the St Anne's Academic Review (STAAR) are ten pieces from current or recent members of St Anne's College, University of Oxford. This edition of STAAR includes articles from the humanities, sciences, and social sciences as well as a new section, SPARK reviews. This is in order to have a dedicated section for film, TV and book reviews.

STAAR went through a number of transformations last year and we have ensured they were continued this year. Most notably, peer review was successfully conducted on all research articles and opinion pieces. In the online version the reviewer comments will be made available for download, in the spirit of open peer review. We are very pleased with how implementing this evaluation process has gone. I am very grateful to my team of editors who were enthusiastically behind inviting reviewers and handling the review process. It has been a great success with each of the five accepted articles having at least two reviews leading to a total of 13 reviewers involved with STAAR this year.

This year is the ten-year anniversary of STAAR and to honour this we have ten articles in this year's edition as well as a letter from the first editor-in-chief, Daria Luchinskaya. We are very grateful to Daria for writing this letter, reflecting on ten years of STAAR. While in the past STAAR has had a theme for the articles, the 2019 publication, with its five academic articles, has been made to allow members of the college to submit articles on any subject they wished. This has led to a very diverse set of articles, from dispelling misconceptions of nuclear energy to exploring artistic representation in the Roman period.

New to STAAR this year was SPARK reviews headed up by Daniel Mercieca. Dan was instrumental in creating SPARK reviews, including coming up with the name and developing it into its own section of STAAR. I am very grateful for all the hard work Dan has put into making SPARK reviews what it is today. Thanks to Dan's efforts there are five very insightful reviews ranging from a review of the book *Why We Sleep* to a review of the popular British television series *Years and Years*. I look forward to seeing SPARK reviews develop further over the next few years.

Last year STAAR ran a crowdfunding campaign to ensure it continued to have funds to support the running of the journal in the future. The campaign was a success, raising enough funds to keep STAAR self-sufficient for a few years. Again, I would like to thank everyone who donated funds to help STAAR back in 2018.

It was a pleasure to have worked alongside such a great team of editors. It has been a joy and I offer my sincerest gratitude to all. They maintained academic integrity throughout and were committed to ensuring the ninth volume of STAAR was a success. Additionally, I am thankful to Valeria Taddei for always being there to discuss ideas and for her commitment to the role of Production and Web Design Manager.

It has been a pleasure to serve as the editor-in-chief.
I hope you enjoy reading our ninth issue of STAAR.

Sincerely,
Alex Jamieson

Letter from STAAR initiator and editor-in-chief, 2008-10

Daria Luchinskaya

First, a huge thank you to everyone involved with this new issue and with previous issues of STAAR. It is wonderful to see St Anne's Academic Review go from strength to strength, and to look back at how it has progressed over the ten years (!) since its first appearance.

Back in 2008, interdisciplinarity was in the air at St Anne's. The MCR had set up informal discussion groups with invited speakers, and the College introduced Subject Family talks and dinners, to share research with College members. STAAR was founded in this context to promote the research interests and achievements of the St Anne's community, to bring together the junior and senior members of the College and to inform alumni of the exciting graduate research going on in St Anne's. STAAR also offered an opportunity for MCR members to get involved with the different stages involved in the making of a journal and to find out more about publishing. I learned a lot from my editorial board (Karen Heath, Michael Youdell, Christina Mayer, Rhianedd Jewell and Maria Amir) and from College members, to whom I remain grateful.

STAAR was originally envisaged as an online-only journal that would print research articles of around 1,500 words in length, and shorter pieces, for example, about the St Anne's discussion groups, prizes, scholarships, trips or project placements. The main aim was for all the articles to reflect the ethos of the Subject Family talks: written with an educated but non-specialist audience in mind. Our main challenge, however, was finding enough material to include, and understandably so, STAAR was a new initiative and people were busy. We persevered. After the very first issue launched on the 10th of December 2009, accompanied by drinks, vol-au-vents, and the St Anne's toy beaver mascot, it was much easier to continue with the second. Before we knew it, it was over to the next editor-in-chief, and one could say that STAAR became established at that point.

Over the years, STAAR has been evolving with every issue thanks to the dedicated editorial teams that have taken turns to direct the journal. STAAR always welcomed creativity and it's lovely to see poetry, creative writing, and now translation included throughout the issues. The new SPARK creative reviews of films, fiction, poetry and other cultural works, allow further playful engagement with the journal.

STAAR now looks much more professional than it did in 2009. The main changes that stand out are getting an ISSN in Volume 3 (2011), becoming typeset in Volume 5 (2014), and coming up with a consistent 'look' from Volume 7 (2017) onwards. I note that in Volume 8 (2018), the journal set up a peer review process, opening further avenues for becoming involved with STAAR. I am also pleased to see that the editors recently led a successful crowdfunding campaign. That's fantastic, beyond anything I could have imagined when our team started STAAR ten years ago.

I am very proud of and so impressed by all the hard work that each editorial team has put into each volume to make it their own and to get to where STAAR is today. I hope that STAAR continues to be a part of College life, and wish it, and future STAAR participants – writers, editors, readers, everyone, every success. If you've ever thought about becoming involved, give it a go! You won't be disappointed.

Daria Luchinskaya
Lecturer, Strathclyde Business School, University of Strathclyde

Research

The “Problem of Context” in modernist expression: myths of continuity and aesthetic individualism in Stein, Stevens, Eliot, and Auden

Luciano Grigera-Naon

Abstract. Although the concepts of “(historical or cultural) continuity” and “individualism”, just like the adjacent pair of terms “wholeness” and “particularity”, appear to oppose one another, both present attractions that potentially separate the individual from his environment and therefore from the consequences of his own actions. Such is the “problem of context” referred to in this paper’s treatment of modernist writing, which seeks to capture how navigating two discrete attitudes towards aesthetic and moral concerns—the “humanist” and the “religious” as critic T.E. Hulme put it—can serve as a framework for understanding some of the technical novelties employed during this literary period. That authors like Gertrude Stein, Wallace Stevens, T.S. Eliot, and W.H. Auden—a selection among which are included expatriates, skeptics towards liberal democracy, and members of the self-proclaimed “Lost Generation”—all pursued some degree of “objectivity” within their work, ironically, exposes the superficiality of analysing that task by a singular standard. Whether it be as a rebellion against abstract symbols of perfection, stability, and apocalyptic nostalgia in war-time, or as the representation of superhuman agencies that can justify both an impersonal mythical order and, contrarily, the individual need for moral awareness, these authors’ techniques offer radically different ways of assimilating their circumstances. It is precisely by attuning to their specific approaches that one can analyse how they reinvisioned the role, or the futility of the individual as a participant in his historical situation and thereby the stakes of this “problem”.

* * *

The ‘modernist’ label that is associated with American and British authors from the first half of the twentieth century—as a term implying some form of literary innovation—carries with it the connotation of Ezra Pound’s imperative to “make it new”, but ultimately addresses more than just a self-conscious renovation of style. This aspect of ‘recentness’ extends to unprecedented ways of assimilating the reciprocal influence bearing between the individual and his environment. Accordingly, the poetry and experimental prose of modernists such as Gertrude Stein, Wallace Stevens, T.S. Eliot, and W.H. Auden accommodate novel formulations of selfhood that destabilise the Rationalism of previous centuries, while also searching for faithful portrayals of a decaying interwar period more generally. Such a renewed consideration of the subject’s integration in the world often steered away from the aesthetic cultivation of self prominent in Romantic predecessors, and towards cultural pessimism: expressions of pantheistic unity between mind and nature, like the Wordsworthian “sense sublime” that fuses the speaker’s emotional interiority with the landscape’s description in *Tintern Abbey*,

became misplaced and ineffectual alternatives.¹ This paper aims to show that rather than offering a subjectivity in harmony with its exterior, modernist writers were confronted with the experience of having their context arise as an issue for their art; just as they coped with the temptation of imprudently abstracting the patent evil of mass death and of political disintegration from their social realities.

This discontent towards Romanticism, albeit a local concern about excessive emotional inwardness, is traceable to the skepticism of pre-modernists like John Ruskin, who, as Edward Lobb remarks, attributed clarity of vision to the act of “establishing the connection between *aesthesis* and *theoria*” in art—between perception of the outer world’s observable qualities and the apprehension of some moral content which is embodied within them.² The attempt to reconcile both of these elements may be seen, from another angle, as implying an adjacent disjunction relevant to modernist expression. One which—later inherited by proponents of the Marxist-materialist interpretive tradition like György Lukács—transposes the failure of objectivity into a denunciation of innovative formal techniques. Accordingly, novelty of style replaces subjectivity as the locus of blame for impairing the poet’s representation of actuality, including its socioeconomic and political themes, as *distinct* from his state of mind. So, if modernism’s subversion of “sentimental” poetry is both a conscious initiative to assimilate the situation of the age without disfiguring it, and, at the same time, answerable for the eccentricity of its performances, the question remains as to how such a form of engagement avoids contradiction.

T.E. Hulme’s critical writings gathered in *Speculations*, propose two alternative brands arising from this period’s standard of transparency towards the world, the “humanist” and “religious” attitudes, which provide a framework for understanding precisely how authors fused personal imagination with their surrounding contexts.³ Respectively, these assert either a relativism “lacking the sense of values as absolute” and celebrating, as is the tendency in Stein and Stevens, the vitality of elemental experiences, or on the other hand, an apologetics of Original Sin, which is variously manifested in the poetry of Eliot and Auden as the limitation that “man can never himself *be* perfect”.⁴ That modernists’ distinctive ways of mediating their integration in an exterior can be judged both as essentially occurring *within* the sphere of immediate human interactions and, conflictingly, as revealing a necessary continuity *beyond* the finite individual, suggests that analysing the stakes of their involvement renders any singular “ideal of objectivity” (and its enthronement) superfluous. Instead, in a less straightforward manner, looking at how such criteria as “clarity” and “perfection” are negotiated against particular mental traps ranging from seductive fatalisms to the estranging effects of social apathy, may provide more beautifully “definite” answers.

As a precursive influence to what Hulme identifies as the “humanist” strain in modern thought, the twentieth century saw philosophers and psychologists abandon the idealist conception of a “thinking I” or “soul”, which, independent from sense perception, exists as the intellectual activity in man grounding the possibility of experience altogether—or as Hannah Arendt puts it: the supremacy of

¹ Cf. Wu (2012), pp. xxxii–xlv

² Lobb (1981), p. 83

³ Hulme (1936), p. 47

⁴ Ibid.

a “noumenal” (a thing as it is in-itself) rather than a phenomenal foundation of reality that is “therefore the ageless, sexless, without qualities, and without a life story”.⁵ Such thinkers as William James and Henri Bergson avowed the relevance of empirical data and demanded, unlike the Kantian framework, that the notion of selfhood be defined according to the subject’s changing external relationships to his surroundings, including the multiplicity of sensations apprehended at different moments thereof.⁶ The difficulty of representing an unstable, contingent self mirrors the poet’s struggle for historical involvement within his time: art faced the predicament of assuming a degree of social realism that engaged the devastation of contemporary circumstances, without imprudently abstracting into the visionary, as opposed to the ordinary world. Moreover, a central challenge to modernism’s rendering of catastrophe lies in the threat of trivialising its urgency by invoking symbolisations that cast evil and destruction as superhuman forces beyond our control—and therefore our responsibility—to actively resist danger. As such, these abstract determinations of the individual’s role in history, whether they are manifested as coercive ideological commitments (e.g. Auden’s resistance to Fascism) or consolatory metaphysical ideas (e.g. Steven’s allegory of Satan), are the sources of danger compromising both personal and artistic agency. Through unique acts of defiance of their own, modernist writers employed various formal techniques and espoused notably different attitudes to adapt their language to the enterprise of authentically remaining ingrained in their particular contexts.

As a major proponent of contextualising the self by locating it in subjective experience rather than in an enduring, extra-sensible faculty or “*actus purus* of Thought”, William James (1842-1910) developed a “phenomenological method” that opposed theoretical constructions of consciousness.⁷ In this sense, his ‘radical empiricism’ discarded the metaphysical dualism that divided experience into objective and subjective categories as a mere heuristic device, favoring instead an account of “passing mental states” as the successive relations that form the individual’s continuously changing thought process and thereby serve as its fundamental ontological facts. James’ conception of a “functional identity” based on this “stream of consciousness”, and on a direct connection with the empirical world rather than an immaterial locus of subjectivity (in the Kantian sense), surfaces in one of his foremost pupil’s emulation of this penetrating mode of perception in her own writing.⁸ Gertrude Stein’s experimental prose, in its continuous rupture and reordering of semantic coherence, depicts human personality as a manifestation of this indefinite internal fluidity.

In particular, Stein’s discourse in *Three Lives* (1909) attests to the influence of her psychology professor at Harvard, relying on extended prepositional phrases that elude any firm markers of both the personality and descent of its protagonist, Melanctha. The subject of this eponymous narrative—and of the second “life” featured in the collection—is introduced as the daughter of “always that pleasant, sweet-appearing, pale yellow woman, mysterious and uncertain and wandering in her ways”, and who, as the sentence runs on, “was close in sympathy and thinking to her big black virile husband”. Melanctha’s status as a mulatto is not delivered in a conventional verbal phrase but is rather subsumed in an associative onrush of

⁵ Arendt (1978), p. 43

⁶ Schwartz (1985), pp. 20–49

⁷ Scott (1977), pp. 183–191

⁸ James (1892), p. 202

adjectives, which reveals other internally contrasting, non-physical aspects of her persona clashing against one another. In such sentences, nouns are subjugated to the insistence of the “transitive parts of the stream of consciousness”, or what James deemed the clauses that emphasise an immediate progression of interrelated differences cohering the objects of our mind. Thus, Stein’s exposition of Melanctha is a way of asserting, even of enacting the latter’s persona; it is not, therefore, developing a type-figure which corresponds to any recognisable psychological temperament. By disclosing an increasingly complex set of relationships, Stein frustrates any attempt at bringing order to its various elements and of thereby achieving insight into Melanctha’s interiority, which exists only as a partial representation constantly in process.

Without a centered subjectivity upon which the reader can ground his sympathy, Stein’s prose ceases to point towards an easily identifiable object and so often suspends the communication of pathos. As is initially suggested by her hereditary ambivalence, Melanctha’s sensibility is constantly presented in flux and is reinforced by the abundant piling of conjunctions in her descriptions. Conferring attention to the associative aspects of language in this way further enhances the “feeling of *and*” James attributes to the subject’s experience “as readily as we say a feeling of blue or a feeling of cold”.⁹ Similarly, in dislocating any stable predicate or signifier that could conclusively *define* Melanctha, Stein displaces the emphasis on discrete divisions laid out by traditional devices of plot (i.e. chronological ordering of events) and character (i.e. trait attribution).¹⁰ The ongoing insecurity of Melanctha’s lover goes as far as to attempt at stabilising the relational quality of her unpremeditated personality; he is, in his own words, perplexed by a “real beauty” that is as fleeting as seasonal change and “makes one feel like summer, and then a way to know, that makes everything . . . certainly seem to be real for the little while its lasting”. Flouting the project of describing Melanctha amounts to lending her a certain degree of autonomy, since part of redeeming her *nature* involves disavowing the comparative artificiality of linguistic determinations—those which reduce a multiplicity of spontaneous differences to rigid classifications.

As a member of the ‘Lost Generation’, a term Stein herself coined for the group of expatriate American writers (including T.S. Eliot) and that addressed a common recognition of aimlessness among the First World War’s survivors, she would come to formulate her cohort’s ethos in a later lecture as the product of alterations in their shared circumstances: “we inside us do not change but our emphasis and the moment in which we live changes”.¹¹ This extemporaneous responsiveness to their environment directly marks the opposition between ‘wandering’ and ‘wondering’ in *Three Lives*—two incompatible modes of loving, and of assimilating one’s partner in love. The former serves as both a euphemism for Melanctha’s sexual promiscuity and a metaphor for her thoughtless impulse or “power of mood” in the act of loving. Whereas, at times, even in explicit dissent, the latter ironically applies to her beloved Jeff Campbell, and his obsessive loyalty to preordained moral frameworks that cannot yield, via untiring analysis, an *understanding* of individuality as founded on feelings. This incompatibility surfaces in the lovers’ interaction when Jeff complains: “with your never remembering anything only what you just then are feeling in you”, which verbalises a tendency to define Melanctha’s love for him according to

⁹ Ibid., p. 162

¹⁰ Cf. Nicholls (2011), pp. 622–638

¹¹ Cf. Stein (1935), pp. 287–312

his standards. In this way, Jeff is imposing a historical record upon his lover’s perpetual self-actualisation, since she lives by the present moment of her experience, not her past actions. To rebel against such an oppressive demand, Melanctha rejects memory—Jeff’s insistence on “remembering right”—as justification for her sincerity and revises her lover’s stoic exhortation for narrative transparency: “it’s because I am always knowing what it is I am wanting when I want it”. By dialogically setting up both lovers’ attitudes as mutually dependent reactions of one another, Stein reveals the juxtaposition of two interdependent styles of speaking rather than a collision between totally differentiable characters.

This mutual play between Melanctha’s emancipatory disruptions and Jeff’s determinate expectations parallels, on a more local level, Stein’s view about history’s adaptability to prevailing social attitudes throughout time, as she states in a lecture titled “Composition as Explanation”: “each period of living differs not in the way life is but in the way life is conducted and *that* authentically speaking is composition”.¹² Stein clarifies that by composition she means the way a given state of affairs or situation is perceived at any determinate point, or in her words: “what those who describe it make of it,” in turn, “makes a composition, it confuses, it shows, it is, it looks, it likes it as it is, and this makes what is seen as it is seen”.¹³ In this light, Jeff’s self-reprimanding remark about being a “slow-minded kind of fellow, (...) never sure about what you mean by all that you are always saying to me”, informs the tension afflicting his epistemic uncertainty. He aspires towards an impression of his lover as vivid as a “real religion” despite Melanctha’s indiscernibility, her moment-to-moment emphasis of particular emotions. Jeff unsuccessfully projects sequential progression onto an object whose representation is the simultaneity of her relations and so, too, betrays his wishful illusion of containing her existence within an identifiable, rational space. Such an impression of coherence is sustained, in part, by Jeff’s insistence on a stable center of meaning external to the amorous relationship; he provides a set of references (e.g. his formulaic “always living good and being regular”) in relation to which Melanctha insubordinately “plays out” her subjectivity.¹⁴ Exposing the recalcitrance of Melanctha’s performativity against the pressures of rationalists like Jeff is itself an artistic gesture. It allows Stein to exert her own agency over language by denying “logocentrism” and by staging Melanctha’s relational determination within a constraining—all the while material—social environment.¹⁵

A similar mental act of revision, devising momentary stays against idealistic claims about reality at large, is manifested in the ephemerality of any totalising symbol of death in Wallace Stevens’ (1879-1955) “Sunday Morning”. This poem debuted in *Poetry* magazine in 1915, the same year as Eliot’s “The Love Song of J. Alfred Prufrock”, but expresses an ambiguous disillusionment altogether different from that of the latter. Hulme described its secular spirituality as delivering a “spilt religion”, one which invokes the earthly naturalism of the Romantics while at the

¹² Cf. Stein (1926), pp. 493-504

¹³ Cf. Ibid.

¹⁴ Cf. Ford (2002), pp. 26–7, 38

¹⁵ As used by Jacques Derrida, this term addresses concepts that fix structures of meaning and are invested with absolute authority, including examples such as Plato’s “form” or Kant’s intelligible domain; it is precisely this desire for “immobility” that Melanctha destabilises and emancipates herself from in her interactions with Jeff Campbell.

same time retaining a paganism that tempers its expressions of paradise.¹⁶ The deterministic force of prophecy takes on the appearance of fiction in this poem, and remains excessively distant from the immediacy of mortality as it is paled by the observable permanence of nature: “Neither the golden underground, nor isle / Melodious, where spirits gat them home . . . has endured / As April’s green endures”. In stanza VI, this worldly relocation of immortal domains is subsequently checked by a devalued promise for eternity; which, alternatively, is devoid of the spiritual remoteness of blessed abodes like the subterranean Elysium or the divinely bestowed Elysian fields listed before: “Or do the boughs / Hang always heavy in that perfect sky, / Unchanging, yet so like our perishing Earth?”. It doubts the metonymic representation of nature’s sensuality in the previous stanza—in which the impendingness of death propels “boys [to] . . . pile pears and plums” at girls’ feet—as an untenable sign for peaceful perfection. Stevens is hereby invoking a paradigm of revocable myths with a self-awareness in the use of metaphor as a necessary falsification of faith, one which transforms the “heavenly fellowship / Of men that perish and of summer morn” into a statement about mechanical death in wartime. The catalogue of imaginary afterlives, even as a pastoral hope for eternity in nature, is insufficient replacement for the human liability to dying in combat.

Yet, a compromise is arrived at through the questionably optimistic refrain: “Death is the mother of beauty”, and suggests that the imminence of destruction itself invigorates the experience of life. This sobering bathos, or anti-climactic transition into the trivial concreteness of the world, is allegorised by the last stanza’s philosophy; it couples the metaphysical weight of abstract generalisations (e.g. “We live in an old chaos of the sun”) with their ominously natural instantiations (e.g. “casual flocks of pigeons make / ambiguous undulations as they sink”). The descent into a ‘diminished aesthetic’ addressing mundane humanity ironises the poem’s final affirmations, since comforting naturalisms, regardless of whether they idealise the earth or a heaven beyond, falsely tame death. In this way, Stevens’ poetic concern with the opposition between imagination and reality also voices a conflict lying within language: the modernist preoccupation with symbols which are assigned the status of fate and render superfluous the renewal of metaphors. This, in turn, represents the loss of those expressive vehicles capable of temporarily attuning to the nuances of a changing context.¹⁷

It is telling that Stevens handles this threat of ‘romantic subjectivism’ using a mock-heroic idiom in “Comedian as the letter C” (1923)—a title which itself derides symbolic transformations—since irony, unlike straightforward signifiers, transmits meaning obliquely, or in a way that is not directly deducible from the words used to express it, but only from inference. The poem adopts different epithets to address a classical quest-figure, Crispin, whose scope of vision undergoes a dramatic enlargement. His enhanced perspective is expressed in the shift from his initial description as a “lutanist of fleas”, or examiner of the minute, to his transformation into “a skinny sailor peering in the sea-glass”, a hyperbole for the impression of a world so expanded that it only exists for the mind of a solipsist or “introspective voyager”, who, contrarily, denies empirical detail apart from his capacity as spectator (i.e. the “ruses that were shattered by the large”). The impotence of the isolated subject imagining his own private, rarefied world stems from Crispin’s grandiose ambition, “the thing that makes him envious in phrase” and drives his

¹⁶ Allen (2015), p. 2

¹⁷ Cf. Ford (2002), pp. 103–04

desire for achieving authorship of what he encounters as an instance of the sublime: “the quintessential fact, the note / of Vulcan, that a valet seeks to own”. Crispin’s mythological association of Vulcan, the Roman god of fire with destructive and fertilising powers, underlies his aesthetic ambition to appropriate the divinity’s terrestrial counterpart (“Gesticulating lightning, mystical”) as *his* own creative act, as the possession “for *his* quill to catechize” (emphasis added). Yet, even the promise of art as a medium for self-aggrandisement is eventually checked by Crispin’s realisation that debased terrestrial objects outlive the distortive artifice of their observers’ abstractions: “The plum survives its poems / . . . colored by ground / Obliquities of those who pass beneath”. Interpreting this as a comic parable for poetic frustration, however, does not license the elevation of earthly particulars into “fictive flourishes that preordained / His passion’s permit”. Such a reading rather reinforces Crispin’s self-awareness of his own process of mental decreation, which occurs in line with his abandonment of metaphors according as they become obsolete representations of their object. This acquired commitment to the concrete leads Crispin to reevaluate his assimilation of the external world, acknowledging that language should record “the surviving form, / For him, of shall or ought to be in is”, instead of rendering fixed mediate signs.

Although Crispin’s disciplined realism restrains his visionary formulations and thereby disenchants his surroundings, it prevents him from extrapolating his personal sense of futility to his environment: “Was he to company vastest things defunct / With a blubber of tom-toms harrowing the sky?”.¹⁸ The traveler’s conclusive “return to social nature”, which represents his settlement within both a quotidian and familial setting (“The world . . . daubed out / Of its ancient purple . . . / Came reproduced in purple / family font”), offers an implicit answer by portraying the final stanza as an affirmation of historical *continuity*. Therefore, by integrating himself within a community, Crispin ridicules the apocalyptic fantasy put forward by his previous rhetorical question and demonstrates the poet’s ability to inflate the vanity of personal endeavour into “an instance of all fate”, or into a claim about his entire generation’s catastrophe. This infringement of the private upon the public sphere motivates a rejection of historical teleology, especially as a narrative that inexorably tends towards cultural decline as its end point. Instead, by demonstrating how pressures of context interrupt introversion and compel the poet to situate himself within his time, Crispin demonstrates the imperative of “confronting, therefore, a set of events, not only beyond our power to tranquilize them in the mind, . . . [but] that engage us in what is direct and immediate and real”.¹⁹

Alternatively, T. S. Eliot’s “The Love Song of J. Alfred Prufrock” propels the unconsolidated relationship between its eponymous speaker and an anonymous lover by transplanting the purported subject of experience altogether. Personified objects reflecting Prufrock’s mental state throughout the poem become the locus of his unfulfilled desire and thereby confirm his insular subjectivity. Already in the opening lines, social failure infects the very impulse to courtship between “you and I” and initiates the transfer of Prufrock’s numbness to his atmosphere: “When the evening is spread out against the sky / like a patient etherized upon a table”. The simile dislocates the speaker from himself—as is dramatised by attributing the dissociated pronoun “you” to Prufrock’s identity—and enforces a lack of integrity

¹⁸ Cf. Longenbach (1991), pp. 92, 190, 201–04

¹⁹ Stevens (1960), p. 22

that blocks the possibility for action as does, in this case, the anaesthetic conditioning the agent's motivation.²⁰ Accordingly, the deferral of love is staged by Prufrock's own rhetoric as he segments himself into synecdochic bits ("How his hair is growing thin!"; "But how his arms and legs are thin") and similarly partitions time in a reiterated act of self-revision: "The eyes that fix you in a formulated phrase / (...) Then how should I begin? / (...) And should I then presume?" Stasis is metaphorically brought on by the spatialisation of time in language, the "*temps symbolique*" Henri Bergson puts forward in his concept of the "*moi sociale*", precisely because any mode of *representation*—as occurs in everyday dialogue or communication—clogs the flow of consciousness with words.²¹

Bergson, unlike James, sees the flux of experience, or what he deems the movement of "*les durées*" in real time, as the grounding of personal identity; which, in its turn, is disrupted by linguistic symbols that paralyse the fluid movement of thought by dividing it into discrete parts. Therefore, Prufrock's diminished state is not discovered, like Crispin's, by a sojourn in a sobering material world but is rather a self-inflicted consequence of his metonymic discourse, since it fragments his identity and precludes meaningful engagement with anything external to it. The self is discontinuous with its public figure on account of its anticipated disembodiment: "there will be time / To prepare a face to meet the faces that you meet". In "Prufrock", just as the perpetually diverted lyrical voice cannot affirm the unaddressed speaker's self-possession ("I have heard the mermaids singing each to each"), consummation always remains provocatively exteriorised and interposed: "the afternoon, the evening, sleeps so peacefully / Smoothed by long fingers, / (...) beside you and me".²² Prufrock's disengagement with his environment is therefore made literal by the transfiguration of his yearning, which is evoked by his own symbolic disintegration.

In Eliot's *The Waste Land* (1922), the impossibility for intimacy is encountered as a generalised condition beyond any personal plight. The suppressed voice migrates across multiple and strikingly undifferentiated personas, blurring the chronological or physical boundaries which establish individuality and instate separateness, especially as is exhibited by the vicarious prophet's self-portrait: "I Tiresias, . . . / Old man with wrinkled female breasts . . . / Perceived the scene and foretold the rest". "Like a taxi throbbing waiting", Tiresias' mythical reenactment is realised by the poem's mechanical sexual encounters; it dates back to antiquity but cannot be relegated to the past as it asserts itself in the exchange between stock-figures of modern times ("Exploring hands encounter no defence; / His vanity requires no response, / (And I Tiresias have foresuffered all)).²³ In other words, Tiresias serves a structural purpose in the poem by carrying over this paradigm of automaticity, which Eliot explicitly assigns to "the most important personage in the poem, uniting all the rest"—including the sterility of both sexes as they combine in one hermaphrodite body.²⁴ Thus, the meaninglessness of conforming to a detached social continuum does not merely carry over the anonymity and involuntary determinism of erotic behaviour, but it also upholds the cyclical sterility of the waste land. A generalised apocalyptic context is sustained by the impossibility of

²⁰ Cf. North (1991), pp. 74–80

²¹ Bergson (1955), p. 108

²² Ellmann (2013), p. 79

²³ De Man (1996), p. 96

²⁴ Eliot (2005), note to line (IV.218)

communicating personal emotions and the deinternalisation of the quest romance converges with the eradication of historical change, revealing a dormant moral conscience that endures unvaryingly throughout time. Just as Prufrock’s self-mortification is contemplated in the pervasive frivolity of his milieu (“And would it have been worth it . . . / After the novels, after the teacups . . .”), *The Waste Land* represents the urgency of arriving at a private morality to redeem the decadence of the public sphere.²⁵ The mythical backdrop of the Holy Grail legend in the poem tells about the archetypal search for a cure to the sterility of the Fisher King, which binds the cursed land.²⁶ Yet, this implicit hope is continuously frustrated: Philomel’s failure to articulate her violation (as a nightingale, her “inviolable voice” ironically transmits an unintelligible “Twit twit twit / Jug jug jug jug jug”) and Lil’s backhandedly articulated abortion (“its them pills I took, to bring it off”) episodically repeat the same quiescent infertility.

By transposing myth to realism, Eliot turns a specific type of social behavior into the norm; he diffuses the apathy of his generation—itsself conforming to a unified, transhistorical identity—and so develops within *The Waste Land* a method of abstract organisation, or “of controlling, of ordering, of giving a shape and significance to the immense panorama of futility and anarchy which is contemporary history”.²⁷ The comprehensive collapse of communication is not particular to any subject because it permeates the landscape, in which even silence is disturbed by “dry sterile thunder without rain”. There is thus no exterior that escapes the poem’s broken bricolage nor its violation of syntactical order. Accordingly, the quasi-elegiac tone of the speaker’s declaration that “these fragments I have shored against my ruins” mourns the final stanza’s spatial dispersal. It solicits coherence, instead, via the retrieval of a traditional form that both integrates antiquity and can be reconciled with actuality. It is in this way that Eliot’s concept of the “objective correlative” functions as a substitute for the ineffectiveness of dialogue, since it proposes both to evoke “a set of objects, a situation, a chain of events [that] shall be the formula of that *particular* emotion” and to orchestrate an alliance with his historical position thereof.²⁸

Taking seriously this appeal for a universal background against which the poet’s private agonies find their place involves prioritising their incorporation within the past predating the poem, in which they can, as it were, assume a contemporaneity of their own. The enterprise of curing the barrenness of the waste land, therefore, endorses an approach remarkably different from either Stein’s rejection of historical perspicuity in *Three Lives* or Steven’s denial of fatalistic signifiers of misery that replace their concrete instances. It can be interpreted as a type of *séance* in its own right, one by which the self-effacement of the author’s personality does *not* imply a resignation of artistic agency because his own extinction comes to stand for a purging of waste matter, or of anything that interferes with the assembled expression of the dead voices that preceded him. Therefore, by means of an impersonal aesthetic can the poet, quite literally, conjure up an admonition for both the cultural catastrophe in which he lives and the menacing *presence* of its precedents—“That corpse you planted last year in your garden / . . . Will it bloom this year?”.

²⁵ Mendelson (2016), p. 2

²⁶ Ackerley (2007), p. 23

²⁷ Kermode (1988), p. 177

²⁸ Cf. Miller (1966), pp. 150–51, 158–59, 176

Manifesting itself in a common interpretation of life to which all of the poem's disheartening scenes subscribe, the communicative power of *The Waste Land* upholds a sweeping ordering principle that is liable to contention. In Stevens' poem *Esthétique du Mal*, for example, specific settings of devastation are magnified into an aesthetic form, and commit what Friedrich Nietzsche originally termed as the "anthropomorphic error".²⁹ Multiple episodes risk domesticating the reality of war, particularly through allegories that encompass the whole 'human condition' and hypostatise it into "A too, too human god, self-pity's kin". As otherwise stated in canto VIII, "The death of Satan was a tragedy / For the imagination" because it denies the possibility of formulating a theoretical sense of evil, which, in virtue of remaining abstracted from personal agency, could serve as a source of validation for the ethical collapse and suffering of the here-and-now. Nonetheless, war remains present as a "capital / Negation" more robust than Satan in the fact of mass death, which overrides any autonomous forces of destruction. For poets like W.H. Auden (1907-1973) writing during the Spanish Civil War, such a reality transposed itself into a related suspicion of political reductionism. Ideological discourses had acquired the potential for "explaining" the contingency of political events and for justifying violence without reference to personal choice.

In Auden's poem *Spain 1937*, however, apocalyptic nostalgia, or the desire for expressions of despair that alienate our responsibility for historical outcomes, is not neutralised by seeking out a *humanistic* sublime in the humdrum realm "of what one sees and hears" like it is in *Esthétique du Mal*. Although the two poems share a fear of experiencing war-time destruction as an aesthetic consolation, Auden dismisses ideological dogmatism by exposing how rhetorical constructions determine both individual fate and historical struggle.³⁰ He sees the directedness of history as greatly influenced by individual personality, which is manifested in the complex of discourses deriving from the preoccupations of social beings and their limited versions of destiny within the poem. Simultaneously, the poet pleads his identification with nature in a Romantic apostrophe: "O my vision, O send me the luck of the sailor" (stanza VII); the scientist loses touch with his milieu by investigating the "inhuman provinces" of the germ and the planet, exhibiting self-sufficient systems in themselves (stanza VIII); and the poor are economically restrained to conceive of time as dominated by necessity ("Our time is our loss" (stanza IX)).³¹ This universal predicament is modulated in how it is lived by each person; it produces a multiplicity of crises that heighten the community's responsibility for interpreting the ever-present moment of choice in a shared context. "Life, if it answers at all" remains disengaged with ethical obligations as *it* merely occurs and does not distinguish between the "Just City" or the "suicide pact, the Romantic death". As potential outcomes, these radically opposed propositions for a social organisation are merely nominal. Nonetheless, they tacitly indicate the stakes of personal choice as the efficient cause behind avoiding both the threat of facile traditionalism and the lure of egoism.

Thus, unlike Eliot's technique of symbolic displacement, myth and its ritualistic historical pattern are not *functional* for Auden, or as Kenneth Asher puts it, they neither construe the decadent universality of human nature nor, as a result,

²⁹ Cf. Kaufmann (1974), section 109

³⁰ Rainer (2000), p. 106

³¹ Fuller (1998), p. 284

guarantee civic order without probing into the individual conscience.³² Instead, the impulse behind such a style of insight matches Rosetta’s artificial explanatory narratives in Auden’s longer poem, *The Age of Anxiety*, and her despair over the indemonstrability of an all-knowing deity upon which to ascribe “a total character of the world”.³³ Auden’s satire on Rosetta’s sentimental picture of continuity, however, points towards more than just a demand for creative renovation or a disruptive jab at the cynical stance of the poet, which, at times, practically serve as aesthetic premises in Stevens’ poetry. Here, the caricature “Of gloom and glaciers (...) / Preserved disasters, in the solid ice / Of frowning fjords” repurposes the rejection of symbolic proxies in favor of an external moral agent lying above the human sphere. By the poem’s last section this distrust of Utopia comes to manifest itself as a kind of higher-order journalism, one that presents the God-relationship as radical humility before an unfaltering spectator—“That Always-Opposite which is the whole subject / Of our Not-Knowing”. Religious faith, in coming to acknowledge the material reality of a fallen world, no longer focuses on “Original Sin” as a property inhering in man or as part of some supernatural spirituality. It rather points towards a “Truth [that] makes our theories historical sins” and so, too, rejects the projection of any collective archetype used to evade the anxiety of making concrete decisions as an involved individual. In their final dramatic monologues, Malin and Rosetta reclaim subjectivity by *personally* identifying with their own respective creeds, even, in the former case, with a historical individual in the Incarnated figure of Christ: “It is where we are wounded that is when He speaks / Our creaturely cry”.

The question facing the modernist, then, is not merely an aesthetic scruple about “objectivity” but, in some form or other, indissociably entails a context—an adaptation of the individual not just as historically situated but as a personal agent. Both Stein and Stevens, whether retroactively through Jeff’s stipulation of prescribed norms for assessing Melanctha’s behavior, or proleptically through pessimistic (and conversely, Edenic) judgements about the character of the world’s destiny, identify ways of disengaging with one’s immediate context and of neglecting the ever-present moment of decision. Moreover, the modes of inaction which derive from this inability of situating oneself as an active participant within his setting take on diverging forms in the poetry of Eliot and Auden. On the one hand, the paradigmatic senselessness of culture precipitates a separation between the individual and his sensibility, while casting this kind of detachment as a shared condition in both the private and public domains. On the other hand, passivity is posed as the fallacy, rather than the confirmation of nonintervention; it involves a grave misinterpretation of history as a self-fulfilling course of events by ignoring the critical role of separate persons in determining the fate of a collective. On all counts, however, the issue of expression concerns conveying the direness of an environment that impinges on and correlates with the individual’s actions so as to generate some sort of *response*.

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³² Asher (1995), p. 44

³³ Cf. Kaufmann (1974), section 109

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What do the artistic representations of Antinous reveal about his reception in the Roman period?

Emily Sherriff

Abstract. There are more portrait depictions of Antinous, a country boy from Asia Minor, than of most Roman emperors. Does the relationship between Emperor Hadrian and Antinous explain the high number of representations, or can it be explained by Antinous' deification and flexibility as a hero and god? In this article I have examined a selection of artistic representations of Antinous from different locations around the Roman Empire and discussed why these representations were made, and what they meant for those viewing them. In doing so I show that Antinous was more than just a favourite of Hadrian: to the people who participated in his cult, he became a genuine focus of worship, who had the tangible powers and abilities of a deity.

* * *

Introduction

Portrait depictions of Antinous were not reserved to one type or location; instead, these depictions have been found in a variety of settings across the Roman Empire and range from colossal statues and busts, to smaller portable items such as coins and cameos (Opper 2008, 186). Representations of Antinous survive in the largest numbers in marble sculpture and coinage - I will focus primarily on the sculptures as they are, in my opinion, the most representative of his reception and worship. The variety of representations of Antinous perhaps explains why there is such a vast quantity of depictions of him from the Roman world. Antinous is most commonly depicted with attributes or poses usually associated with deities, alluding to his deification and subsequent worship in the years following his death in A.D. 130.

It is impossible to discuss Antinous without also mentioning the Emperor Hadrian: it is through the beautiful and mysterious portraits of the former that their relationship is imagined, but this article instead hopes to consider how Antinous as an individual was presented and perceived by those across the Roman world. By discussing specific representations of Antinous, alongside architectural and epigraphic evidence, I will show that, in death, he was worshipped as a deity and celebrated as a hero without direct influence from Hadrian.

Literary Sources

Little is known about Antinous' life before he met Hadrian, and all sources date from after his death in A.D. 130. The literary sources agree on three facts about Antinous' life: first, he was from Bithynium in Bithynia, Asia Minor (modern-day Turkey); second, he had a relationship with Hadrian; and third, he drowned in the Nile (although the exact circumstances surrounding his death are not the subject of agreement). Cassius Dio, who was writing at the start of the third century A.D.,

some 80 years after Antinous' death, is perhaps the most accurate as he is a near contemporary source for a biography of his life (Vout 2007, 54). He states two reasons for Antinous' death in A.D. 130: accidentally falling into the Nile or, as he himself believed to be true, being offered for sacrifice by Hadrian and subsequently deliberately drowned in the Nile. (Cassius Dio. Roman History. 69.11).

From Pausanias, a second century A.D. writer, we are given an account of the beginnings of the worship of Antinous in Mantinea, Greece, as Hadrian established his honours there with a festival and mystic rites every year and games every four years, celebrations and honours which were intended to be regular and long-term events (Pausanias, Description of Greece, 8.9.8). Although he never saw Antinous alive, he knew him 'in statues and in pictures', indicating that images of Antinous could be found in a variety of settings across Greece (Pausanias, Description of Greece, 8.9.7). He states that the portraits of Antinous from Mantinea resemble Dionysius - an assimilation which is often found in his portraiture (Pausanias, Description of Greece, 8.9.8). Although there is very little known about Antinous' life, including his age and how he met Hadrian, the artistic depictions of him can reveal more information about how he was received by his contemporaries in the Roman period.

Context: Architectural evidence and epigraphic sources

As the literary sources on Antinous' life and death have been discussed, it is also relevant to briefly examine the epigraphic and architectural sources which are further illuminated by the sculptures and numismatic evidence. The founding of a city in the years following the death of Antinous, Antinoopolis, demonstrates the initial impetus by Hadrian for the subsequent deification and worship of Antinous. The city was founded on the east bank of the Nile close to the site where Antinous drowned, on the one hand facing the important Egyptian city of Hermopolis, and on the other facing the ruins of the ancient Egyptian city, Besa (Galimberti 2007, 106). Although little remains of Antinoopolis, there are a number of monuments and artefacts elsewhere that attest to the worship of Antinous in the city. One such monument is the Pincio obelisk in Rome, which in hieroglyphic script states the honours afforded to Antinous. It is thought to have originally stood in front of an *Antinoeion*, a temple to Antinous, at Hadrian's villa in Tivoli. The inscription describes, in detail, the original *Antinoeion* at Antinoopolis, of which nothing remains. According to it, the temple was built in high quality white marble, with numerous columns and with statues of a variety of gods (Opper 2008, 178). The inscription seems to suggest that the obelisk served as a funerary marker for Antinous' tomb, however no evidence for a tomb has been found at Antinoopolis or at Hadrian's Villa (Opper 2008, 177).

Other inscriptions illustrating the strength of the cult of Antinous have been found across the Roman world, and in a variety of settings and circumstances. The *Antinoeion* in Mantinea, the one mentioned by Pausanias, has one of the best examples of how the cult of Antinous evolved from the implication by Hadrian to the worship of Antinous as a divine being capable of divine acts. An evocative

inscription addressed to 'Antinous' is by a father asking that the god care for his son (Vout 2007, 64): it indicates that some residents of the city had a fervent belief in Antinous as a deity who was capable of divine protection. This fact demonstrates that in the years following his death Antinous had become more than simply the young and beautiful lover of the emperor, and instead, was regarded as a powerful individual in his own right. The connection between Mantinea and Antinous' birthplace, Bithynium, no doubt strengthened his cult in this city, but it is also clear that the cult was perpetuated by the residents of the city due to their genuine belief in Antinous as a god. In Antinous' home city of Bithynium a small limestone altar indicates that he was worshipped as a god: 'to the new god Antinous, Sosthenes (dedicated this) as a prayer' (Smith 2018, 53). The formula of the inscription indicates that Antinous had answered the prayer, confirming that, for Sosthenes, Antinous had tangible divine powers. At Lanuvium, some 20 miles south of Rome, a burial club based around the worship of Diana and Antinous is evidenced from an inscription (Beard, North and Price 1998, 272). Dated to June A.D. 136 and located on the wall of the *Antinoeion*, it sets out the rules for those in the burial association. Diana had a cult at nearby Nemi, whilst Antinous was a new god with associations with the underworld - an appropriate deity for a burial club.

The epigraphic and architectural evidence show the belief in and worship of Antinous as a divine being in a diversity of settings, from the city named after him in Egypt, to Hadrian's impressive villa in Tivoli, to the small altar in his home city. These examples present Antinous as a deity who was and could be celebrated and worshipped in a number of diverse circumstances by a wide range of people. The diversity of his worship and worshippers can be seen further in the artistic representations of Antinous that have been found in many forms across the Roman world.

Numismatics

Coins depicting Antinous allowed for his likeness, and thus associations of beauty and divinity, to be seen by a potentially large number of people as coins are very portable and numerous artefacts. Some thirty-three cities in the eastern Roman Empire (namely modern-day Greece and Turkey) minted coins depicting Antinous. Although this does not necessarily accurately reflect the popularity of the deified youth in the eastern provinces compared to those in the west. Coinage in the western provinces was minted and distributed from Rome whilst cities in the east minted their own coinage which allowed for a more varied and localised subject matter. (Smith 2018, 110). The coinage from Smyrna, Turkey is attributed to Marcus Antonius Polemon, an acquaintance of Hadrian and benefactor of the city. (Smith 2018, 110). Elsewhere the benefactors are also named on the coins which suggests that the depiction of Antinous was used to gain favour with the emperor rather than as a symbol of veneration or belief in him as a divinity (Jones 2010, 80). However, some of those named on the coins are described as "priests of Antinous" which could be a symbolic title but could also be a religious position with duties and rites to carry out (*Ibid*).



Figure 1: Bust of Antinous. National Archaeological Museum of Athens, Greece.

Sculpture

Sculptures of Antinous rely on a recognisable physiognomy and, in most portraits, hairstyle. The sweeping curled locks fall on his face whilst those at the back are longer brushing his neck and covering the ears. The curls are perfectly formed yet do not mimic deliberately styled hair (such as those seen on portraits of Hadrian) and instead reference the naturally beautiful hair of youthful heroes and deities (Smith 2018, 22). The standardised facial features suggest that the portraiture of Antinous was organised and modelled from an original portrait, perhaps authorised by Hadrian himself and modelled when Antinous was still alive. (Smith 2018, 28). Despite displaying the features of an idealised classical face, statues of Antinous also encompass portrait features which turns the idealised face into a more realistic or veristic depiction of an individual. This combination allows for depictions of Antinous to be almost immediately recognisable regardless of the pose or attributes that the sculpture may feature. The lack of secure findspots or contexts means that it is difficult to give statues of Antinous secure dates, although some can be dated with the use of sculptural techniques such as the drilling of eyes and other features which only began after the period of Hadrian (Smith 2018, 24). Whilst only a small number of sculptures have drilled pupils, they are significant as they provide evidence for the production of Antinous portraits after the death of Hadrian. The majority have been hesitantly dated for the period between the death of Antinous in A.D. 130 and the death of Hadrian in A.D. 138. Whilst this is a reasonable period for the sculptures to belong to, it will be suggested that it is likely that many of them belong to the period after Hadrian's death. The sculptures to be discussed will prove that the worship of Antinous existed without an explicit connection to Hadrian, and thus, artistic representations of the former would have

been created and venerated after his death. Of course, it is also likely that statues created in the period of A.D. 130-138 or in Antinous' lifetime continued to be used many years after his death.

The selection of pieces starts with a bust from Athens (Figure 1). It is a high-quality example of the typical Antinous physiognomy and hair (Meyer 1991, 29). Alongside the facial features, the downwards gaze is found in many statues of Antinous, perhaps most noticeably in the above bust type of which there are ten examples showing the nude full shoulder bust (Smith 2018, 28). The downward gaze gives the depictions of Antinous an impression of coquettishness, as if he is deliberately feigning the viewers' attention and admiration. Some full body statues also feature the downward gaze, in which his eyes meet those of the viewers creating an intimate connection between the audience and Antinous. A statue of this kind was found at Delphi, Greece in which Antinous had the attributes of Apollo - a wreath worn on the head as seen from the holes which would have supported it. (Meyer 1991, 37).



Figure 2: Bust of Antinous. Württemberg State Museum, Stuttgart, Germany.

One small bust in the Württemberg State Museum, Stuttgart, Germany shows that Antinous could be a highly personal deity who was worshipped in private, intimate settings (Figure 2). This small bust is believed to be from Egypt, specifically Antinoopolis, based on the materials used, specifically the alabaster of the bust and the green-stone acanthus leaf support. (Meyer 1991, 78). The bust comprises four individual parts including the bust itself and the three parts making the stand. The size, only 29 cm in height, and dismantlable nature of the bust suggests it was designed to be easily carried and transported, allowing for Antinous to be worshipped anywhere (Smith 2018, 54). It closely follows the nude bust type of

Antinous portrait and displays how one specific portrait type could be used for different purposes and needs.



Figure 3: Inscribed bust of Antinous. Syria. Private Collection.

A third bust (Figure 3), thought to be from the town of Balanea on the Syrian coast (modern-day Baniyas), is an important example of a representation of Antinous as it combines his standard depiction as a classical beautiful youth with an inscription confirming his status as a hero and an object of worship. The nude bust draws attention to the face and head, whilst the inscription on the stand is easily read by those viewing the statue. The foot of the bust is inscribed in Greek: *'to (the) hero Antinous, Marcus Lucceius Flaccus (dedicated this)'*. The two lines of text differ in the size of letters and spacing, respectively, meaning that they were carved at different times by different people. The first line, *'to (the) hero Antinous'*, was likely carved at the marble workshop before it was shipped to Syria (Smith 2018, 21), while the second one, *'Marcus Lucceius Flaccus (dedicated this)'*, could date back to the time it arrived in Balanea and was in the ownership of Flaccus (*Ibid*). The presence of the second line suggests that this bust was not for a private, domestic cult but rather for a public cult space where the dedication by Flaccus could be seen by the community. The combination of a recognisable portrait type and an inscription naming Antinous as a hero is significant, as it provides a secure example of Antinous' worship and veneration. The Syrian findspot of the bust is also important, as it demonstrates that the worship of Antinous had spread beyond the initial cult spaces, those based on

sculptural remains, which focussed on Hadrian's Villa and the surrounding Italian area.



Figure 4: Antinous-Osiris. Hadrian's Villa, Tivoli, Italy. (Vatican Museums, Vatican City).

Of the sculptures of Antinous that have been found, the number associated with private or domestic settings is more than double those found in public locations, with the majority of the former category being found at Hadrian's villa in Tivoli (Vout 2007, 92). The depictions of Antinous from Hadrian's private residence confirm that Hadrian himself had input in how Antinous was depicted in artistic representations, thus having direct influence on how Antinous was received in his afterlife as an object of worship and desire. Although the sculptures of Antinous found at Hadrian's Villa are no doubt explicitly connected to and likely commissioned by Hadrian himself, they illustrate that during his lifetime, and even perhaps during the lifetime of Antinous, he was portrayed in the guise of different deities which is significant to the reception of these images in the years following Hadrian's death and the later Roman period.

The volume of statues and the possible presence of an *Antinoeion* indicates that Hadrian privately participated in the cult of Antinous, too (Smith 2018, 86). From Tivoli comes the statue of Antinous-Osiris which is also believed to be from the aforementioned *Antinoeion* (Figure 4). The association of Antinous and Egypt is significant as it not only connects him to his place of death and conflation with Osiris, but it also adds a layer of mystique and exoticism. The pose is reminiscent of Egyptian statuary whilst the realistic body and face follow that of classical statues (*Ibid*). The identification of this as Antinous does not rely on his signature hair which

is covered by the *nemes* (headdress), but rather on the physiognomy which is near identical to the standard Antinous portrait face (*Ibid*).



Figure 5: Mondragone Antinous. (Louvre, France).

Many artistic representations of Antinous incorporate attributes of deities such as Apollo and Dionysius. The choice of gods relates to the youthful, beautiful, countryside aspects of Antinous' character and reception. The Mondragone Antinous (Figure 5) is a colossal head which was once part of a cult statue (Smith 2018, 60). It is thought to have been part of an acrolithic statue - one in which composite parts are made of different materials including marble, wood and ivory. The holes visible in the hair of the statue originally supported a metal headdress and the eyes would have been metal or gemstones, and combined with the scale, the statue would have been an impressive and potent symbol of divine power (Smith 2018, 60). It was discovered as part of the Borghese collection at Villa Mondragone in Italy (from which the statue takes its name), and thus, the original location of the cult statue and subsequent cult space are lost. The hair with a central parting and elaborate style is reminiscent of classical depictions of Apollo (Smith 2018, 60). The face is inherently classical with the smooth skin and perfect features;

yet it is also instantly recognisable as Antinous (Meyer 1991, 114). The Braschi Antinous is another colossal cult statue of Antinous in which he is shown with the attributes of Dionysius - a wreath of leaves and berries. (Smith 2018, 60). Both the Mondragone and the Braschi Antinous are examples of large cult statues which would have stood in their own dedicated cult space.

Conclusion

It is clear from the selection of depictions of Antinous from across the Roman Empire that he became more than just the lover of Hadrian and, in death, to the people who participated in his cult, he became a genuine object of worship, who had the tangible powers and abilities of a deity. Through assimilation with familiar deities such as Apollo and Dionysius he was given immediate recognition within the guise of the Roman pantheon. The choice of representing Antinous as hero or god, and the choice of which mythological figure or deity with which to assimilate him, was dependent on the context and needs of the community or individual who used the representation of Antinous as a sacred object. By assimilating Antinous with classical, youthful deities, he is portrayed as an idealised and beautiful youth whose death facilitated his deification and worship. Whilst the impetus by Hadrian to deify Antinous after the latter's death may have started the worship of Antinous as a hero or god, this cult was clearly adopted by individuals and groups across the Roman Empire independent of efforts by the Emperor. Thus, although Antinous' reception in the Roman period was framed by his relationship with Hadrian and untimely death, he was quickly received as a deity and hero by those who participated in his cult - a cult that does not seem to be reserved to one part of the Empire, nor to a specific group of people. His worship and reception were as varied as the artistic representations of him, of which I have discussed but a selection. However, as the majority of artistic representations of Antinous that survive are marble sculptures, which are associated with the elite and wealthy, it is difficult to know if and in what ways those of a lower status participated in his cult. The large number of depictions of Antinous has in turn led to his popularity in the modern age - although the reception in the modern period is more closely tied to his relationship with Hadrian (Burns 2008, 121). Whilst we do not know much about Antinous' life or death, it is clear from the variety of artistic representations that his reception in the Roman world was widespread and for a number of reasons. From those commissioning statues to gain favour with the emperor Hadrian, to those worshipping Antinous as a *bona fide* deity, to those who may have done both.

School of Archaeology

Figure credits

Figure 1: Bust of Antinous. National Archaeological Museum of Athens, Greece. Photograph authors own.

Figure 2: Bust of Antinous. Württemberg State Museum, Stuttgart, Germany. Photo from Smith 2018, 55. Figure 25a. Stuttgart, Württembergisches Landesmuseum, inv. Arch 74/3.

Figure 3: Inscribed bust of Antinous. Syria. Private Collection. Photograph authors own taken during “Antinous: boy made god” exhibition at Ashmolean Museum, Oxford.

Figure 4: Antinous-Osiris. Villa Adriana, Tivoli. Vatican Museums, Vatican City. Accessed via <http://www.museivaticani.va/content/museivaticani/en/collezioni/musei/museo-gregoriano-egizio/sala-iii--ricostruzione-del-serapeo-del-canopo-di-villa-adriana/statua-di-osiri-antino.html#&gid=1&pid=1>

Figure 5: Mondragone Antinous. Louvre Museum, Paris, France. Accessed via https://commons.wikimedia.org/wiki/File:Antinous_Mondragone_Louvre_Ma1205_n5.jpg

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The molecular link between inflammation and cancer: ubiquitin

George Vere

Abstract. Ubiquitin is a small protein central to the regulation of many cellular processes. Ubiquitination involves the covalent attachment of ubiquitin to other cellular proteins, and ubiquitin itself can be ubiquitinated to form polymeric chains. There are several sites on ubiquitin where other ubiquitin molecules can be attached, and as a result there are different ways that the ubiquitin chains can be assembled. The variety of chain types allows ubiquitin to play roles in many cellular processes, such as inflammation. When inflammatory molecules or pathogens are detected by a cell, ubiquitin chains are assembled within the cell on receptors and mediate a proinflammatory response by the cell. These non-degradative chains act as a scaffold to recruit and activate proteins required for activating NF- κ B, the master regulator of inflammation. While inflammation is an essential part of the immune system and is normally a beneficial process contributing to the clearance of pathogens from tissues, deregulation of inflammation through chronic infection or mutation of proteins can lead to serious diseases, including immunodeficiencies and cancer. Inflammation can promote the survival and proliferation of cancerous cells. Mutations have been found which affect the assembly and disassembly of the ubiquitin chains in cancer patients, and recent studies have further suggested the importance of deregulated ubiquitin signalling in cancer. We have only just begun to understand the intricacies of ubiquitin in inflammatory signalling, and once it is better understood, it may present opportunities for therapeutic intervention in patients with inflammatory disorders or cancer.

* * *

Inflammation is an ancient concept in medicine, first described as redness and swelling with heat and pain in the first century A.D. by the Roman physician Cornelius Celsus [1]. Cancer is not a modern disease and has afflicted human civilisation for thousands of years. Bone cancer has been discovered in Egyptian mummies from around 2000 B.C.E., and the word *cancer* is derived from *karkinos*, the term used by Hippocrates to describe carcinomas and the Greek word for 'crab', perhaps in reference to a crab lying in the sand, akin to a tumour spreading on the skin.

In the mid 19th century, the acceptance of cells as the building blocks of life and the proposal of the germ theory of disease hailed new era of understanding in biology [2]. Rudolph Virchow drew a direct link between inflammation and cancer in 1863, hypothesising that chronic inflammation was the cause of cancer, where irritants, tissue injury, and inflammation cause excessive proliferation (division) and growth of cells [1].

While we now understand that cancer involves many factors beyond cell proliferation, inflammation is key in providing an environment for tumours to

develop. Solid tumours are complex structures, filled with immune cells, structural tissue, and dead tissue, possessing vastly altered metabolic profiles relative to normal tissue. Inflammation generates an interplay between the immune cells and cancer cells that both encourages cancer growth and suppresses the immune system [3].

In 2018, the Nobel Prize for Medicine or Physiology was awarded to James Allison and Tasuku Honjo for their pioneering work on cancer immunotherapy, which allows the harnessing of the immune system to kill cancer cells. Given that inflammation links cancer and immune cells, it has become more pressing than ever to discover how inflammation is regulated at the molecular level.

To understand the role of inflammation in cancer, we need to appreciate the normal role of inflammation in the body. Inflammation is one of the first defences of the body against invading pathogens. When a region of the body is infected by pathogen, it is recognised by the cells of the body, inducing an inflammatory response within the tissue which recruits other cells of the immune system to the area to fight the infection. This activates innate immune cells, which can immediately respond to the infection, and also primes an adaptive immune response, which require several days to come in to effect.

Cell signalling

Inflammation can, however, be damaging to cells and tissues, such that it must be limited, both in terms of its duration and the area of the body which is affected. As a result, tissues require a stimulus to mount an inflammatory response; a process which relies on cells being able to sense their environment. The stimuli come in the form of chemical messengers released by other cells to signal the need for an inflammatory response, or chemicals released by bacteria as they proliferate.

Cells must be able to respond to these inflammation-promoting molecules, and they do so via a process known as cell signalling. This serves to change the behaviour of the cells to generate an inflammatory response which involves the production of new proteins by the cell, which includes further inflammation-promoting molecules and proteins which alter the behaviour of the cell. However, the signalling process can also cause cells to die, a process generally referred to as cell death. The outcome of the signalling is complex and depends on the exact stimulus. At the heart of this signalling process lies the protein ubiquitin.

Inflammatory signalling

There are many extracellular factors which can initiate inflammatory signals in cells. The chemical signatures of pathogens, such as components of bacterial cell walls like lipopolysaccharide, are potent activators of inflammation. When our own cells sense these chemical messengers, they in turn release chemicals which affect other cells, causing an inflammatory cascade. The most important of these inflammatory molecules is tumour necrosis factor (TNF).

The power of TNF has been appreciated since its discovery in 1890, when the American surgical oncologist William Coley chose to research sarcomas following the death of one of his patients. He found the records of a surprising case, a patient who miraculously survived an apparently fatal cancer. Coley was convinced that the patient's survival was due to contraction of a post-operative infection. This research led to the discovery of 'Coley's toxin', a bacterial extract injected into patients. The treatment, first trialled in 1896, allegedly gave some positive results, but the outcome is hard to judge as Coley did not systematically trial his treatment [4].

Throughout the 20th century, the mechanistic basis of Coley's toxin was slowly unravelled. Lipopolysaccharide, a component of bacterial cell walls, was identified from this mixture in the 1940s, and was shown to induce tumour regression when isolated from bacterial extract [5]. However, as medicine advanced, more reliable and effective therapies, such as chemotherapy and radiotherapy, were developed and interest in Coley's toxin decreased.

During the 1970s research on bacterial extracts resumed and new techniques in molecular biology enabled the identification of TNF as one of the agents responsible for the effects of Coley's toxin [6]. However, TNF is not present in the bacterial extract itself - instead, the extract causes the host tissues to produce TNF and other inflammatory signalling molecules. TNF causes tumours to undergo necrosis, a form of cell death, and regress. It can cause cell death in certain cell types and cancer types, especially sarcomas. Injecting rodents with high doses of TNF caused tumour regression, as expected, but also had high toxicity.

In those with cancer, the injection of Coley's toxin can cause increased activation of the immune system, leading to the selective targeting and destruction of the tumour. However, this is different from persistent and chronic inflammation, which can be beneficial for tumour survival. In this case, inflammation provides an environment which promotes cell proliferation, growth, angiogenesis (the growth of new blood vessels) and metastasis (the spread of cancer throughout the body). The variety of effects of TNF and inflammatory signalling shows that we need to understand the molecular basis of the signalling to determine why inflammation can promote cancer in some instances, but lead to tumour regression in others.

Ubiquitination

Inflammatory signalling in cells requires the protein ubiquitin. The name of ubiquitin betrays its identity - it is ubiquitously expressed by cells - but this tells us little about its function. Ubiquitin is a small protein, comprised of only 76 amino acids, in contrast to the hundreds of amino acids found in typical proteins. Its function is to modify other proteins, leading to changes in their behaviour, through covalent attachment to the protein; a process known as ubiquitination [7].

During this process, the end of ubiquitin is covalently attached to the target protein. The enzymes which carry out this process are known as E3 ligases. However, these

enzymes do not work alone – they must be “charged” by the action of E1 and E2 ligases. This process is shown in Figure 1.

The addition of a single ubiquitin molecule to a protein is relatively common, but the real power of ubiquitination comes from the formation of polyubiquitin chains attached to a target protein. Once one ubiquitin molecule is attached to another protein, ubiquitin ligases catalyse ubiquitin polymerisation on the protein surface. Recent evidence has demonstrated that ubiquitin has eight different sites at which ubiquitin can be conjugated to itself by E3 ligases, enabling the formation of eight ubiquitin chains with different links between monomers [7].

Ubiquitin chains with alternative linkages have different shapes which are recognised by different binding proteins, with each protein partaking in different activities and roles within cells. Specific ubiquitin linkages can, therefore, perform different functions in the cell, the best studied of which is the targeting of a protein for destruction [7]. Ubiquitin chains tend to consist of one chain type, although branched chains containing different sub-types have been shown to exist [7], and are important in inflammatory signalling.

Of these eight ubiquitin chain types, two are important for mediating inflammatory signalling at the TNF receptor; K63-linked ubiquitin chains and linear ubiquitin. Ubiquitin chains can be trimmed down or completely removed from proteins by enzymes known as deubiquitinases (DUBs). This allows much better regulation of the length or presence of ubiquitin chains, analogous to the effect of the ‘brake’ in a car, playing a vital role in limiting the effect of ubiquitin ligases.

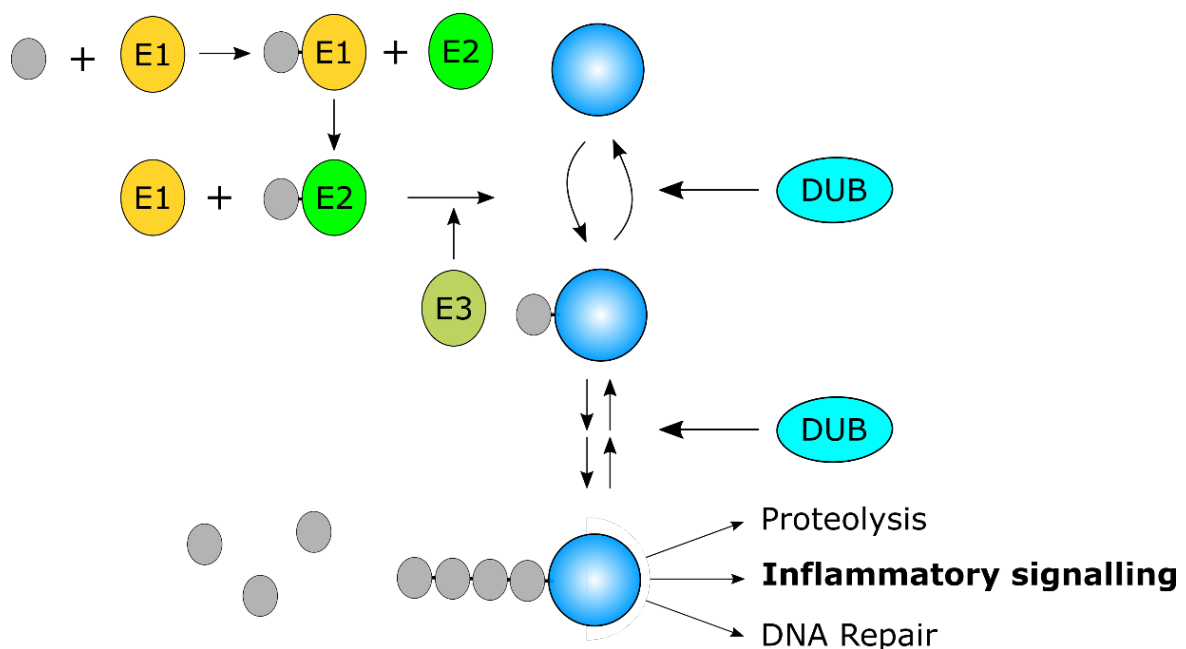


Figure 1: Ubiquitin (grey circles) chains are assembled on proteins (blue circle) by E1, E2 and E3 enzymes. Depending on the type of chain and the protein modified, ubiquitin chains lead to diverse outcomes, including inflammatory signalling. DUBs regulate the system by removing ubiquitin chains.

Ubiquitin in inflammatory signalling

The formation of ubiquitin chains is vital in inflammatory signalling. When TNF binds to its receptor on the cell surface (the TNF Receptor) it undergoes a change in shape leading to the association of many proteins with one another, forming a so-called receptor complex. Amongst these factors are E3 ligases, which polyubiquitinate other factors in the complex.

There is a hierarchical assembly of polyubiquitin chains at the TNF receptor complex. Initially, the E3 ligases assemble K63-linked ubiquitin chains. These serve as a scaffold to bring in another ubiquitin ligase known as the Linear Ubiquitin Chain Assembly Complex (LUBAC) to the receptor. LUBAC conjugates ubiquitin to various components of the TNF receptor complex, including to the existing K63-linked ubiquitin chains, and then on these ubiquitin molecules, assembles linear ubiquitin chains.

This leaves a complex ubiquitin landscapes, with both K63-linked ubiquitin chains and linear ubiquitin chains present at the receptor, and hybrid chains, that include both types of linkages. The linear ubiquitin chains are crucial for the following events in the signalling, and it still remains unclear why the branched chains are important [9].

Downstream signalling

The ubiquitin chains present at the receptor serves as a scaffold, to which other proteins bind and are activated. The further details in this signalling pathway are not important to our story, but the main effects of activation of these proteins is to enable the protein NF- κ B to alter the proteins produced by the cell to promote further inflammation [10].

Inflammatory signalling can also cause the cell to adopt other fates. At the heart of this decision is the structure of the ubiquitin scaffold, which determines whether the cell will survive or die. Genetic alteration of cells has shown that in the absence of linear ubiquitin chains, cell death predominates. The location, timing and amplitude of the inflammatory signalling is altered by the structure of the ubiquitin scaffold. Further study will show exactly how the ubiquitin landscape shapes this decision [11].

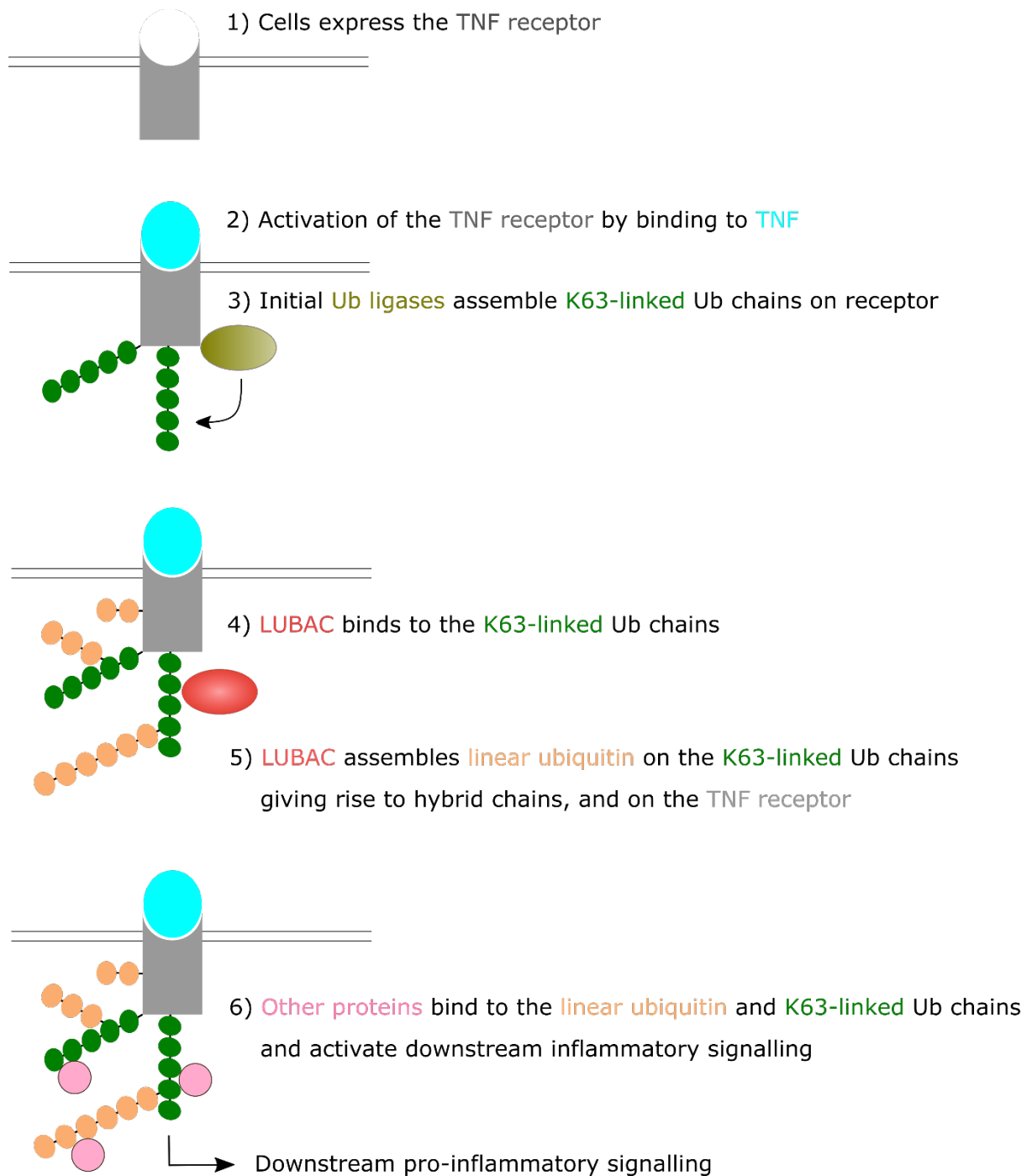


Figure 2: Tumour Necrosis Factor (TNF) activates the TNF Receptor causing a series of ubiquitination events that generates a complex ubiquitination landscape. The resulting ubiquitin chain landscapes tunes the downstream inflammatory signalling and can alter the fate of the cell.

Deregulation of ubiquitination

The length of polyubiquitin chains are tightly regulated by deubiquitinating enzymes (DUBs) capable of selective degradation of ubiquitin chains. In the case of inflammatory signalling, this allows the signal generated by the ubiquitin scaffold to be altered and fine-tuned. There are three DUBs which control ubiquitination on

the TNFR complex, each of which has subtly different roles in editing the ubiquitin chain landscape and removing ubiquitin chains [12].

Ubiquitination and cancer

Deregulation of ubiquitination in inflammatory signalling results in several diseases, including chronic inflammatory conditions and cancer. Heredity diseases due to mutations in proteins which regulate TNFR complex ubiquitination are relatively rare but mice models in which components associated with linear ubiquitination and K63-linked chain formation have been genetically removed exhibit increased cancer incidence [9].

The hereditary disease cylindromatosis results in the formation of tumours in the head and neck and is caused by mutations in CYLD, one of the three DUBs that regulates TNFR ubiquitination. It not known exactly why mutations in CYLD lead to this disease, as CYLD functions in other inflammatory signalling cascades and other unrelated processes, including cell division (by regulation of microtubules), these mutations generally affect the catalytic activity of CYLD. CYLD activity is also associated with cell death [11]. In the case of TNF receptor signalling, CYLD tunes the inflammatory signal generated by the ubiquitin scaffold. The loss of CYLD in cylindromatosis could increase the ubiquitination of the TNF receptor, increasing inflammatory signalling and giving rise to an environment promotes tumour survival and proliferation.

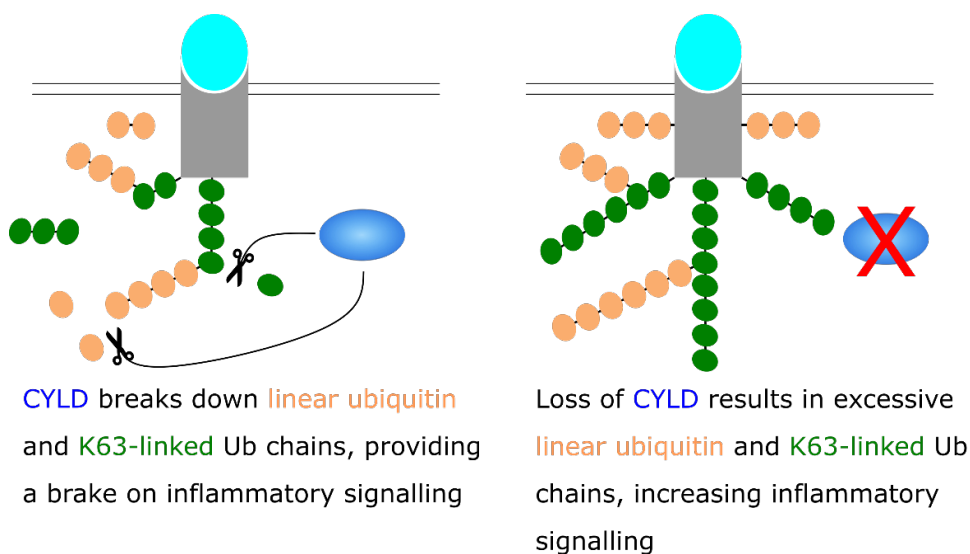
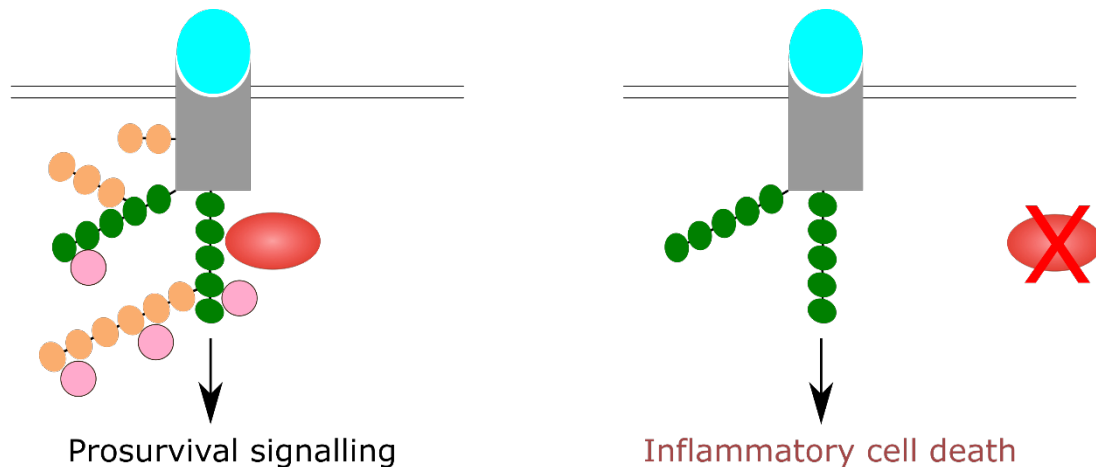


Figure 3: The loss of CYLD DUB activity causes excessive ubiquitination of the TNF receptor. The loss of CYLD is found in the cancer cylindromatosis, which could increase levels of inflammatory signalling by the TNF receptor.

Deregulation of linear ubiquitin chains has deleterious effects on cells. Loss of LUBAC causing excessive cell death in cell culture models [8]. In mice, genetic alteration of LUBAC components causes chronic skin inflammation. The loss of linear ubiquitin chains causes cell death in the skin of the mice, and the dead cells release inflammatory molecules into the extracellular environment. Cells can detect

the molecules released by other cells as they die, and they trigger an inflammatory response. This positive feedback loop of cell death driving inflammation, driving cell death, causes chronic skin inflammation in the mice (Figure 4) [10]. While no direct link has been shown, chronic inflammation driven by loss of LUBAC could provide an environment for tumour survival and proliferation.



Linear ubiquitin is required for the stabilisation of the TNF receptor, and promotes prosurvival inflammatory signalling

The loss of LUBAC prevents linear ubiquitin chain assembly on TNF receptor, so the receptor is destabilised and instead promotes inflammatory cell death

Figure 4: Without LUBAC, no linear ubiquitin chains are assembled at the TNF receptor. This activates a signalling pathway that results in cell death.

Summary and outlook

Inflammation affects tumour cells in opposing ways: it can either promote cell death as illustrated by Coley's toxin but also provides an environment in which allows cancer cells to survive, as a result of TNF inducing pro-survival genes in cells. Linear and K63-linked ubiquitin chains are assembled at the TNFR complex following stimulation, and the ubiquitin chains coordinate events at the receptor required for either gene activation or cell death. However, much is left to be discovered about how the ubiquitin chains coordinate those events, and how the cell decides which fate to adopt.

Has our increased knowledge of ubiquitin's role in inflammatory signalling given us tools for treating inflammatory diseases and cancer? While the degradative ubiquitin signal has been known about since the 1970s, the machinery that generates Linear ubiquitin was only discovered in 2006 so the machinery that modulates its assembly or breakdown is not yet targeted by any drugs [9, 10]. There are still many unanswered questions regarding the role of ubiquitin in inflammatory signalling, and this field will continue to grow. As we understand more about the interplay between cancer cells and inflammatory signals, we will be able to develop better therapies that can modulate the inflammatory signals in cells, allowing us to continue the War on Cancer into the 21st Century.

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Opinion Pieces

Dispelling misconceptions of nuclear energy technology: How Generation IV nuclear reactors could become the key to achieving the Paris Agreement and the United Kingdom's net zero CO₂ emissions target by 2050

Thomas Davis

Abstract. Climate change is a consequence of the release of carbon dioxide (CO₂) from non-natural sources, the largest contributor being the combustion of fossil fuels to produce electrical energy. Since the 1960's, nuclear energy has been reliably produced on a large-scale with near net-zero CO₂ emissions. The expansion of nuclear energy to tackle climate change is seen as a necessary pillar to meet the Paris Agreement, signed by 195 countries in December 2015, in addition to a law enacted by the Government of the United Kingdom (UK) in 2019, which requires the UK to bring all greenhouse gas emissions to net zero by 2050. However, widespread dissemination of misconceptions and misinformation about nuclear energy has chronically damaged the industry, leading to an erosion of public confidence in the energy source. Dispelling these misconceptions will therefore be integral to reinvigorating the industry's image, and three important misconceptions in this article will be addressed. These are the downturn in the UK nuclear industry market, the limited lifetime of the global uranium supply, and the production of plutonium becoming a significant proliferation risk. Generation IV nuclear reactors have been in development over the last 20 years. It is these reactors that provide credible solutions to the supply issues surrounding uranium, reduce the UK plutonium stockpile, revive the UK nuclear industry, and provide a constant base-load electrical supply with near net-zero CO₂ emissions. As of 2019, the UK Government has released policy papers and committed to investments that will establish a path to build these Generation IV nuclear reactors in Great Britain.

* * *

Introduction

The Paris Agreement was signed by the 195 United Nations Framework Convention on Climate Change member countries on 12 December 2015. The agreement sets out, for the first time, all nations to undertake ambitious efforts to combat climate change. Moreover, the United Kingdom (UK) Government enacted an amendment to the Climate Change Act 2008 that requires the UK to bring all greenhouse gas emissions to net zero by 2050 [1] (however, the amendment did not provide a strategy or plan on how to achieve this target).

Intergovernmental Panel on Climate Change (IPCC) is a United Nation body that provides objective and independent science views on climate change. The IPCC in 2013 [2] reported with 95% certainty that humans are the cause of recent climate change, a conclusion with which 97.1% of scientific papers published on climate change agree [3]. CO₂ levels rose with the global temperature after the ice ages [4], as shown in Figure 1. From the 1850s, the industrial revolution and modern era produced nearly twice the levels of CO₂. The difference in temperature, in comparison to that from 150 years ago, strongly suggests that human activity is warming the globe, again shown in Figure 1. It is clear from the trend in CO₂ parts per million that the release is a result from the industrial revolution and modern era. This is the fundamental scientific evidence that links human activities to the change in climate [5, 6, 7].

How can we mitigate this rise in CO₂? Energy production is by far the largest contributor to CO₂ emissions through the burning of coal, oil and natural gas [8]. Replacing these large-scale energy production methods with a near net-zero¹ CO₂ emitting energy source is therefore one clear answer.

Wind and solar energy are considered major alternative energy source candidates, however, an often misunderstood large-scale, reliable, and near net-zero CO₂ emission energy source is nuclear fission. The need for a “green” energy source will become increasingly important with time as consumption of energy will only increase, regardless of the efficiency savings, with the rapid expansion of electrified rail, vehicles and steel industry. Electrical vehicles consumption alone will increase from 0.03% in 2014 to 9.5% in 2050 [9].

The expansion of Nuclear Energy to tackle climate change is seen as a key stepping-stone to meet the Paris Agreement signed in December 2015, but its success will require increased governmental and public support. This claim echoes statements made by the International Energy Agency [10], Bill Gates [11], the IPCC [7], and the MIT Energy Initiative [12]. As nuclear power has been known to be a reliable, large-scale and safe energy source since the 1960s, why then do we not embrace nuclear energy and expand it greatly to curb climate change?

One reason is the dissemination of misinformation by the media leading to ill-informed policy makers and politicians. Examples include claims that the UK nuclear power industry is slowly dying [13], the uranium fuel supply can only last another 100 years [14] and nuclear reactors are fundamentally a proliferation hazard from the plutonium they produce [15]. Producing scientifically accurate accounts of nuclear energy is therefore imperative in combating the spread of misinformation

¹ It is ‘near’ net-zero rather than net-zero due to the CO₂ emission from the manufacturing of steel, concrete, uranium fuel (mining and enrichment) to transport and decommissioning. A full life-cycle analysis of all major energy production methods can be found in the 2014 Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. No energy production source is net-zero CO₂ emission.

to the general public, which will in turn lead to increased governmental support for the nuclear industry.

The first objective of this article is, therefore, to present an account of the nuclear sector from a scientific perspective, drawing on the author's personal experience of working within the nuclear energy sector. This article will evaluate whether the nuclear power industry is shrinking in the UK, the lifetime of the global supply of uranium, and if weaponisation is the only viable use of plutonium, and which technology could provide a credible solution to meeting government climate change targets.

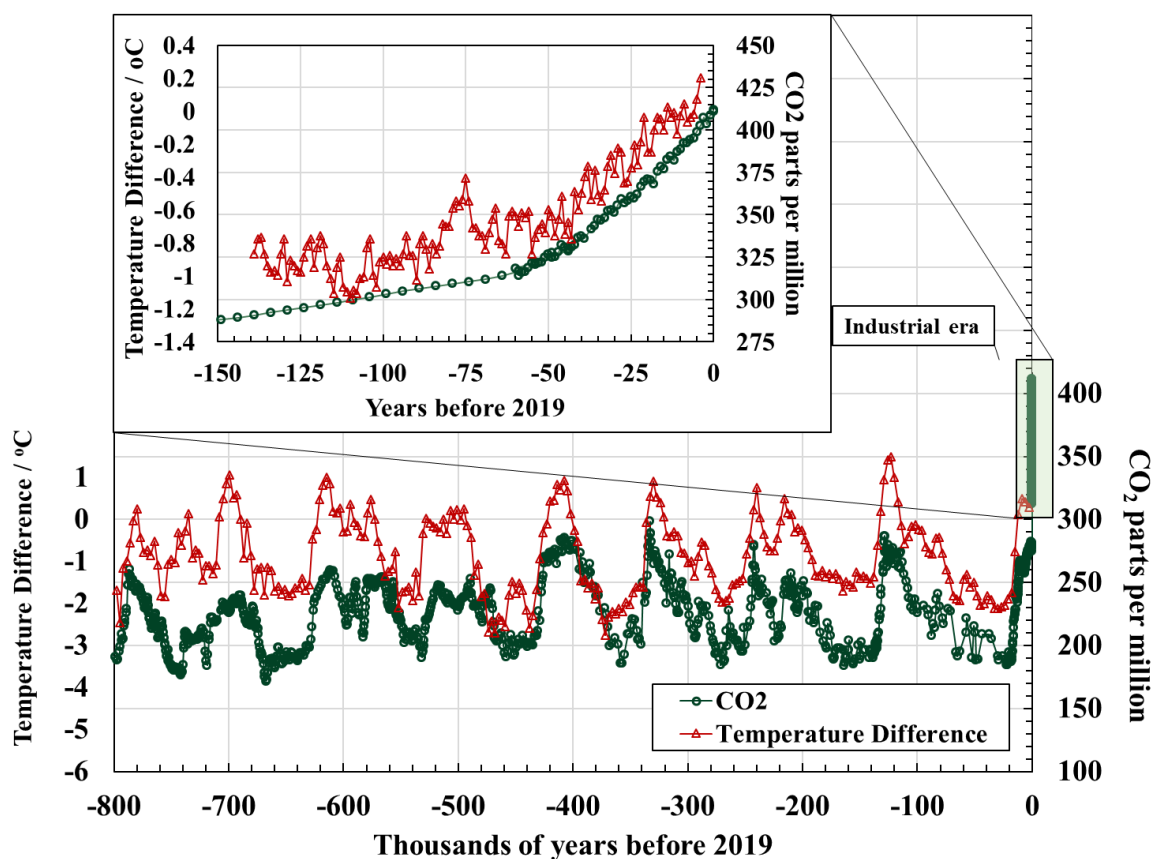


Figure 1: The measurements of carbon dioxide and temperature difference as a function of years over the last eight hundred thousand years. This is achieved by monitoring the concentrations of various trapped gases in Antarctica's ice². The data has been compiled from Vostok and EPIC Dome C ice cores. See reference [5] and [6] for the original raw data.

² The measurement of CO₂ is a direct measurement of the gas concentration trapped in the ice. The temperature difference measurement is an indirect measurement, based on the ratio of deuterium (isotope of hydrogen) and oxygen-18 (isotope of oxygen) to today's value (see reference [43] for further detail). The reference value is the natural ratio of deuterium found in nature.

The UK's nuclear industry is shrinking

There were 448 operational nuclear power stations worldwide that produce a total capacity of 392 Giga Watt electrical (GW(e)) output, as of 31 December 2017, and an additional 59 units which will produce 60 GW(e) are under construction. The total contribution to the world's electricity supply is therefore 10%. Further, a conservative estimate from a recent 2018 International Atomic Energy Agency (IAEA) report on world energy [16] estimates an increase to 511 GW(e) by 2030 and to 748 GW(e) by 2050.

The IAEA report assumes that current market, technology and resource trends will continue with no changes made to current laws and regulations. The misconception that the market is shrinking loosely follows the low estimates determined by the IAEA's report. The fact that the industry has not changed significantly since the 1960-1980 rapid construction phase, during which most of these 448 operational reactors were built, does reinforce this misconception.

The UK nuclear industry directly and indirectly employs 155,000 people [17], generates ~20% of the UK electricity, and contributes £12.4 billion to the economy [18]. The UK newest nuclear reactor in construction at Hinkley Point C, England, is using pressurised water reactor technology that has evolved over the decades. This reactor design, called Evolutionary Power Reactor (EPR) by EDF Energy, has optimised the use of water to cool and moderate a nuclear fission chain reaction. However, the suspension [19, 20] of the Advanced Boiling Water Reactor (ABWR) nuclear power station in January 2019 at the Wylfa site, does not bode well for the UK industry. This is regardless of the reactor design's regulatory approval [21], and Horizon Nuclear Power and Hitachi-GE Nuclear Energy Ltd. Were ready to begin construction. It should be noted that the suspension is related to the project's financing and not on a technology or engineering basis.

The suspension has forced the UK Government to reassess its financing model of new nuclear power stations. It is clear from both Hinkley Point C and Wylfa that allowing the free-market to fund a full nuclear power station is not ideal as it would be too great of an expense for a single corporation [22].

This sentiment was echoed by the Secretary of the Department of Business, Energy and Industrial Strategy (BEIS), the Rt Hon Greg Clark MP [23], in an oral statement to parliament where he acknowledged that the current financing model is non-optimal, stating that the government "[...] are therefore reviewing the viability of a Regulated Asset Base (RAB) model and assessing whether it can offer value for money for consumers and taxpayers" BEIS published a public consultation of using the RAB model for nuclear on 22 July 2019 [24] and closes on 13 October 2019. The consultation aim is to set out the core principles, industry views, and implementation methods of the RAB model for the nuclear industry.

The RAB model [25] ultimately mitigates the construction risk of projects by enabling investors to receive returns before the project has been completed (i.e. at the start of construction, the owner receives a revenue stream rather than waiting for the first day of electrical generation to the grid). If the model was applied to Hinkley Point C nuclear power station, the project could be up to 20% cheaper [26]. This change in the Government's approach might allow the Wylfa project to continue, once the announcement is made this summer. The RAB model could be applied to EDF Energy's future reactor at Sizewell C, China Nuclear Systems Ltd's HPR1000 reactor at Bradwell C, and the Moorside site in Cumbria, enabling a strong industry for the long-term future.

If we look to the next 20-50 years, Generation IV nuclear reactor designs have been positioned as 'advanced'³, passive, safe, proliferation resistant, fuel efficient, and economically favourable nuclear reactors compared to the in-construction Generation III (EPR, ABWR and HPR1000 reactors, for example). The 'Generation' definition for nuclear reactors is shown in Figure 2. However up until 2017, the UK Government has not officially announced any formal involvement with Generation IV reactor designs.

The Clean Growth Strategy was announced by BEIS in October 2017 [27] and outlines the policy to decarbonise all sectors of the UK economy through the 2020s. Specifically for the nuclear sector, the policy released £460 million to support future nuclear fuels, new manufacturing techniques, reprocessing, and advanced reactor design⁴. In addition, the aims of the Nuclear Sector Deal [18], which was launched on 28 June 2018, are to reduce the cost of nuclear technology by 30%, increase the percentage of women in the nuclear industry to 40%, and investing a total of £2 billion in domestic and foreign supply chain contracts by 2030. Further, the Deal shows an interest in Small Modular Reactors (SMR), which are an existing nuclear power station type but are on a smaller scale (300MW(e)), as well as showing an interest in the funding for Generation IV nuclear reactors (called Advanced Modular Reactors (AMR) within the policy). BEIS announced on 23 July 2019 that £18 million funding has been invested to kick-start the SMR consortium led by Rolls-Royce plc to construct a working reactor by early 2030s [28].

The investment released by the Government has ignited the nuclear industry to innovate and move towards the SMR and AMR markets; these markets are in their infancy and, if action is taken quickly enough, the UK could become an epicentre of advanced nuclear technology. Further, the Nuclear Innovation and Research Advisory Board released their 2019 review [29] and recommend the UK Government should invest £1 billion from 2021 to 2026 into the advanced reactor market to meet the Clean Growth Strategy.

³ The term advanced does not actually mean anything tangible unless context is provided. The current Advanced Gas Reactors that are operating in the UK since the 1970s are 'advanced'.

⁴ Advanced in this context is referencing Generation IV nuclear reactors.

Today’s nuclear export market is dominated by Russia’s Rosatom⁵ [30, 31], and soon-to-be China’s ‘go global’ policy⁶ [32], both of which use their exports as a strengthening mechanisms to grow their spheres of influence. There is potential that the UK could become a significant nuclear export country again with the export of SMR and AMR reactors from the 2030s and beyond. If the UK is to become a nuclear exporter, the overarching message is that investment and policy changes need to continue to enable large-scale production⁷ [29] of SMRs and Generation IV nuclear.

So, is the UK nuclear industry shrinking? From the re-evaluation of the financial models to the funding of new nuclear reactors, as well as for the UK’s potential to become an advanced nuclear export country, the UK’s industry is very much becoming revived.

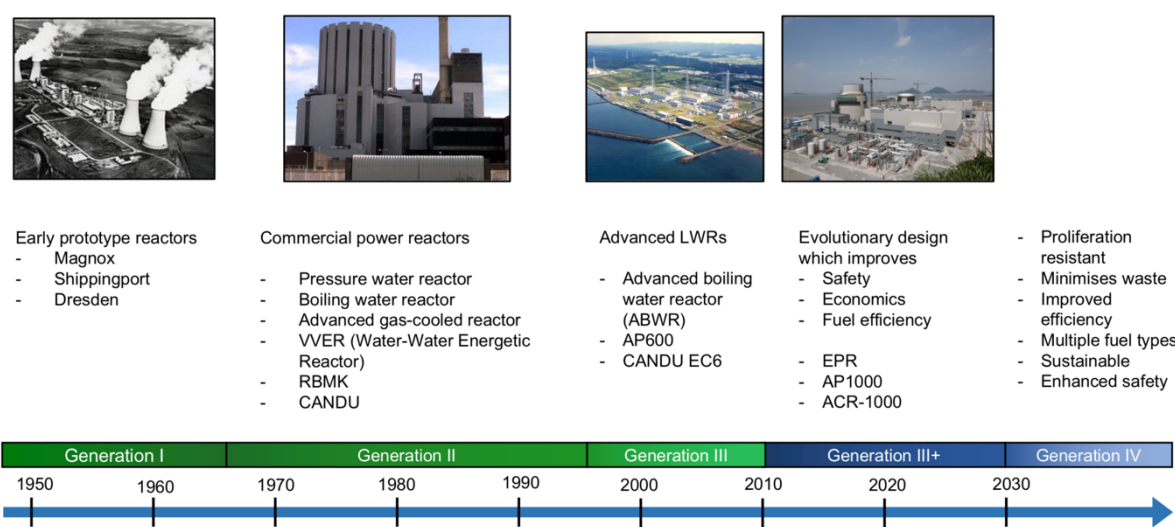


Figure 2: Timeline of the Generation definition for nuclear reactors. (Light Water Reactor (LWR).)

The lifetime of Uranium

Issues surrounding the lifetime of uranium for nuclear reactors (and weapons) have been raised ever since the energy security issues were realised during the 1970s oil crisis [34]. It is worth noting that during this oil crisis, the French government decided to reduce the country’s dependence on oil by producing 72.3% of their electricity through nuclear energy [35]. Climate change was not discussed at the time, however, their decision has been quite fortuitous; France’s CO₂ emission per GDP was less than half of the OECD average in 2014 [36]. This is not surprising

⁵ Rosatom is the Russia Federation’s state-owned and state-operated nuclear energy corporation.
⁶ China National Nuclear Corporation, China General Nuclear Power Group and State Nuclear Power Technology Corporation are the three main communist party-controlled and communist party-led nuclear export corporations.
⁷ Large-scale production is defined as more than four nuclear reactors or more.

when recent analysis (2013) show that nuclear energy reduces the long-term CO₂ emissions [20].

Globally, the total identified recoverable uranium is 6,142,000 tonnes of low-cost uranium metal [34] and 7,988,000 tonnes of high-cost uranium metal. There are two naturally⁸ occurring isotopes⁹ of uranium; uranium-235 and uranium-238, possessing a relative natural abundance of 0.720% and 99.244% respectively. Generation I-III (1960s to 2030s) nuclear reactors primarily use Uranium-235 although it must first be enriched¹⁰ to maintain a sustainable chain reaction for power production. The assumption made in the IAEA report [34] is that current global nuclear fleet maintains these operating conditions, with no new advanced nuclear reactors deployed, resulting in a 130 year supply of uranium-235.

There are six Generation IV nuclear reactors in consideration, four of which have a 'fast'¹¹ neutron energy spectrum. Splitting uranium (also called nuclear fission) produces sub-atomic neutrons with a spectrum of energy, with slow¹² neutrons only being able to split only uranium-235, not uranium-238. Generation I-III reactors are only able to split uranium-235 because the neutrons are slowed down by either water or graphite (reactor design dependent) and can therefore only utilise 0.720% of the natural uranium supply. Generation IV reactors have neutron energies that range from slow to fast, thus majorly increasing the likelihood of transmuting¹³ uranium-238 to plutonium-239 and -241¹⁴. The fast neutrons have enough energy to fission plutonium-239 and -241. In summary, Generation IV reactor technology can utilise uranium-238 as fuel. The key message is that Generation IV nuclear reactors can theoretically utilise the entire supply of naturally occurring uranium, as fission of both uranium-235 and uranium-238 is possible, leading to a significantly longer supply lifetime than that estimated by the IAEA [29].

If we neglect the assumption that no new Generation IV nuclear reactors will be built, then the natural uranium supply lifetime (T) will be a ratio of potential Generation IV utilisation to the Generation I-III utilisation. While Generation IV reactors could theoretically utilise 100% of the natural uranium, they are limited to an utilisation range between 43.2%-57.6% [37], by engineering, design, economic and fuel cladding material lifetime restrictions (T. P. Davis). These utilisation ranges have shown to be economical with the successful deployment of sodium-cooled fast

⁸ Natural references the element can be naturally found on the Earth.

⁹ Isotope is the name given to atoms of the same chemical element which have different atomic masses.

¹⁰ Increasing the abundance of uranium-235 to 3-4%.

¹¹ Fast indicates the neutrons have an energy between 0.5 MeV to 2 MeV.

¹² Slow (or also called Thermal) neutrons have an energy in the range of 0.025 eV.

¹³ Transmutation is the nuclear process that converts one chemical isotope into another chemical isotope.

¹⁴ It should be noted that uranium-238 transmutes to plutonium-239 (fissile) and plutonium-240 (fissionable); the plutonium-240 captures a fast neutron and transmutes to plutonium-241, which is now fissile.

reactors (a type of Generation IV nuclear technology), BN-350, BN-600, and BN-800, in Russia [39].

$$\frac{T}{130 \text{ years}} = \frac{43.2 \text{ to } 57.6 \%}{0.720\%}$$

$$T = 130 \text{ years} \times \frac{43.2 \text{ to } 57.6 \%}{0.72\%} = \mathbf{7,800 \text{ to } 10,400 \text{ years}}$$

It can be argued, however, that the future of the uranium supply should not be of a concern to the human race because in a few hundred years, a more optimum energy source such as nuclear fusion energy will have been developed [12]. An assumption made is that Generation IV reactors can be constructed and operated today; however unrealistic this is, it does not alter the conclusion. Moreover, this analysis disproves 100-year uranium supply claims [14].

The only use of Plutonium is as a weapon

It is often believed that the plutonium produced from the transmutation of uranium-238 in operating reactors can only be used for nuclear weapons. However, there are two different categorisations of Plutonium containing mixtures, depending on the mixture's composition:

- i) Weapons-grade plutonium: plutonium-239 with less than 8% plutonium-240. It is not produced in civil operating reactors in the UK because the desire for these reactors are to produce electricity, so the fuel irradiation time is longer¹⁵.
- ii) Reactor-grade plutonium: 55-70% plutonium-239 with more than 19% plutonium-240. This grade is produced in all civil operating reactors and comprises about 1% of all used fuel.

Reprocessing is the name given for the extraction of plutonium from spent fuel rods¹⁶. Sellafield, the nuclear fuel reprocessing, decommissioning site, and home to our nuclear waste, in Cumbria, England, has the world's largest civil stockpile (126 tonnes of plutonium) [40].

Reactor-grade plutonium cannot be weaponised once used as fuel for a fast neutron spectrum-based reactor, such as Generation IV nuclear reactors. As explained in Section III, the fast neutron spectrum will fission plutonium-239 and -241. This fact enables companies, such as GE-Hitachi in 2011, to propose a Generation IV reactor

¹⁵ The longer the irradiation time, the more chance you will convert artificially produced plutonium-239 to plutonium-240 through neutron capture physics process.

¹⁶ Once the fuel rod in a nuclear reactor has been permanently pulled out from the core, it is now classified as spent fuel.

to be built in the UK that solely uses the plutonium stockpile as reactor' fuel. The reactor, called Power Reactor Innovative Small Module (PRISM), could dispose all of the UK's plutonium stockpile through the generation of 25% of the UK's electricity for the next 100 years [41, 42]. With the recent UK Government's announcement and investment in Generation IV nuclear reactors outlined in Section II, the reality of reducing and removing the plutonium stockpile in Sellafield is therefore within reach. A direct solution to the justified concerns by the public [15].

Conclusion

Climate change is occurring due to the release of CO₂ from non-naturally occurring sources, primarily due to energy production. The Paris Agreement was signed by 195 and the UK Government have made it a legal requirement that the country must reduce its greenhouse gas emission to 0% by 2050. Nuclear energy is reliable, safe, large-scale, and produces near net-zero CO₂ emissions offering a means of both satisfying the world's energy demands and a method meet the Paris Agreement's goals to mitigate climate change. In order to achieve this ambition, the public perception of nuclear energy requires improvement, through recognition of the existence and viability of sound scientific and technical options to solve the current challenges facing the industry.

Generation IV nuclear reactor technology can provide tangible solutions to:

- 1) The shrinking nuclear industry by the recent published UK Government policy papers that outline the appetite and revival to develop Generation IV nuclear reactors in the UK, which could be exported around the world;
- 2) The uranium supply by extending the lifetime up to 10,400 years;
- 3) The plutonium stockpile proliferation risk by utilising this nuclear waste as fuel for the reactors.

The future is growing for the global nuclear industry, research community and energy markets because of the long-term potential of nuclear fusion energy has on reducing carbon emissions. Generation IV reactor technology can become a means through which the aims of the Paris Climate Agreement and UK's 0% target by 2050 could be met, leading to a large-scale reduction in climate change.

Department of Materials

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The Design of Everyday Numbers

Matthew Lau

Abstract. What are numbers? Why are they everywhere? Why do they work so well? Can they be made better? Here, we will see where numbers come from and how to approach these questions.

* * *

Introduction

I am sure we would all agree that the wheel is a crucial invention that has pushed humanity forward. Hence, it is important to make sure that it is well designed. Wheels come in many different forms – from simple blocks of wood in a toy train to sophisticated multifeatured ones in a racing car – depending on various factors such as need, aesthetic, technology and cost. However, they all have the same underlying structure of a circular disc. Could this seemingly perfect circular disc design be improved? How should one go about customising wheels for a particular object? To answer these questions adequately and possibly reinvent the wheel, one would need to understand the underlying principles of wheels and their design.

Similarly, numbers are very influential. They seem to work smoothly, though we should question whether they are the right tools to have. Likewise, various systems of numbers have been developed. We have a few standard systems – from the natural numbers children first learn to count with, to the complex numbers used by physicists and engineers. There are also many lesser known systems, such as the octonions and the ordinal numbers. Moreover, each of these number systems has countless customisations that suit different purposes. In this article, we will try to understand where numbers come from, with a focus on the most ubiquitous systems: the natural numbers (with numbers like 0, 1, and 2) and the real numbers (with numbers like 1, -0.5 and π).

Comparing Apples and Oranges

We need some sense of what “numbers” mean in order to analyse them. We can begin with a glance at the concept of counting, which will shed light on this question and allow us to proceed with our investigation.

The phrase “comparing apples and oranges” expresses the idea that objects need to be sufficiently similar for meaningful comparisons. Contrary to this popular idiom, although the two fruits differ in many aspects, they certainly share the property of being countable. For example:

- “Three apples are more than two apples” is analogous to “Three oranges are more than two oranges.”
- “Putting three apples and two apples together, we have five apples” is analogous to “Putting three oranges and two oranges together, we have five oranges.”

Counting apples is equivalent to counting oranges: a person who can count apples would also be able to count oranges, and vice versa. In fact, counting has little to do

with apples or oranges. Many types of objects can be counted: apples, oranges, fingers, days, dragons, etc. are all counted in an analogous way. By drawing this analogy and extracting the common underlying structure, we arrive at a system of “pure” counting with entities like “one”, “two”, “plus”, “greater than”, and so on (Figure 1). We can then make sense of sentences like “Three plus two is greater than four”, and reapply this knowledge to apples and oranges.

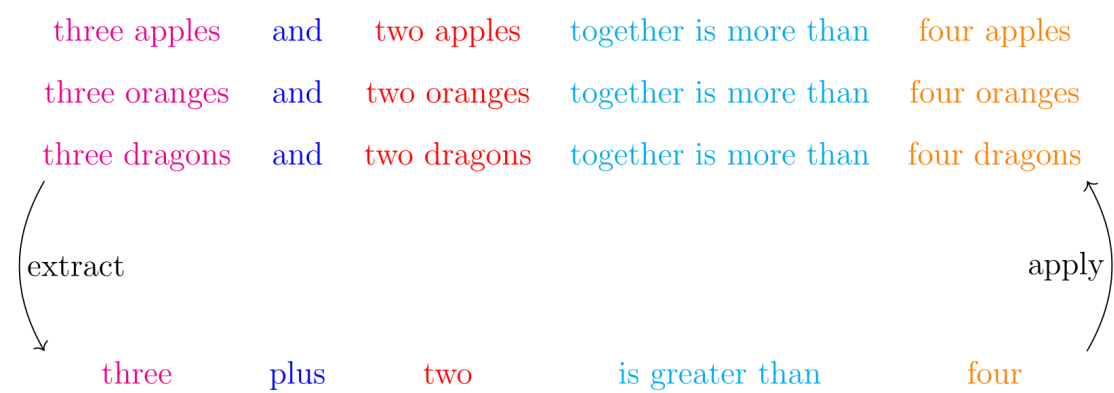


Figure 1: An Analogy of Counting

In general, a number system extracts from certain concepts, which can then be studied abstractly and applied wherever these concepts are found. In other words, a number system is designed for certain concepts, just as a wheel is designed for certain transportations. A good wheel designer is one who is proficient in matching wheel designs with demands. On one hand, the designer, upon a particular request, can pinpoint and elaborate on the desired purposes and features for the wheel. On the other hand, the designer can construct wheel prototypes and analyse them for their properties. These are the two main skills that a wheel designer needs – given a demand, the designer would know the properties to seek for and come up with designs that has those properties. Similarly, in designing number systems, there are two main direction of approaches: concept-oriented and system-oriented.

In a concept-oriented approach, we aim to design number systems for a given concept. We are interested in the features and properties to seek for.

- In what ways can the concept be formalised? A concept can have many facets and there can be multiple formalisations. As an example, time has various facets that result in different formalisations, such as:
 - the notions of past, present and future.
 - moments in time (e.g. the beginning of the universe).
 - moments in a day (e.g. 4 PM).
 - intervals of time (e.g. the year 2019).
- What assumptions are being made in a particular formalisation? Assumptions might not completely reflect our perceptions of the concept, but idealisations are often necessary for useful and insightful formalisations. Awareness of assumptions is critical for recognising potential flaws. For example, we can think of time going indefinitely far into the past, but this might be an issue when one is talking about the beginning of the universe.
- What formal features are available to the numbers? For example, the natural numbers have features such as comparison, addition and multiplication. Without any features, these numbers are just names (e.g. ‘Matthew’) that we cannot do very much with and the system would not be very useful.

- What notion in our concept would the given feature extract from? A feature would be more relevant if it had a corresponding notion. For example, addition corresponds to putting two collections together. However, an “unnatural” feature (e.g. adding 4 PM with 11 AM) might also be powerful and provide new insights about our concept.
- Can the given feature be amended and in what ways? A certain feature might be desirable, though it might conflict with other features or there could be multiple ways of amendment.
- What are the utilities in amending or not amending the given feature? Amending a feature can be useful, but can also create complications. For example, addition is often useful, but unnecessary for a tally counter which only lists the numbers in order.
- Can we develop a widely applicable standard system? Given the many choices of features, various systems are possible, which can cause confusion for potential users. Hence, a small number of standardised systems would be desirable. We have a few guidelines for choosing these:
 - It is better to have a tool that is left aside than to not have the tool when it is needed. A standardised system should be inclusive enough to meet a wide range of needs. However, we should also be choosy: conflicts can occur, and simplicity is beneficial.
 - Something often used or requested should be included, if possible.
 - The system should be flexible. Ideally, users can obtain common alternative systems through easy adjustments to the standardised ones.

This is where system-oriented approach comes in to help us analyse and compare various number systems.

In a system-oriented approach, we investigate a number system by inspecting its extractions, applications, and mathematical properties. This system would then be available for building and understanding prototypes when we try to design number systems for a concept.

- What are some primary concepts that the system is extracted from? In general, a number system can be extracted from many concepts and it would be difficult to list them all. However, a system is usually associated with a few prototypical ones. For example, the natural numbers are associated with counting.
- What modifications to the system are available? How does the system compare to other systems? A number system can be tailored for specific usage or similar concepts (e.g. the natural numbers can be modified to count days of the week, which are limited to seven). This also indicates the flexibility, capabilities and limitations of the system.
- How are the entities in the system represented? Representations are necessary for computation, recording and communication. Effective representations are important for efficient and intuitive usage.
- What is the collection of axioms (i.e. rules) that characterises the system? Having a collection of axioms is essential, since:
 - To know whether the system can be extracted from a concept, we only need to check the concept against a collection of axioms.
 - Axioms allow us to describe the system directly, which is particularly important for teaching and implementations in computers.

- It is convenient to create modifications and extensions by dropping, adding and changing axioms.
- Axioms prevent mistakes since they tell us for what we are allowed to do when using the system.
- From the axiom, we can derive handy tricks and facts for more efficient usage.

By combining the concept-oriented and system-oriented approaches, we should be able find number systems that extract from a given concept. Let us come back to our guiding question: where do the natural numbers and the real numbers come from? As we will see in the next few sections, they are designed for the concepts of counting and proportions, respectively.

Systems for Counting

We shall now have a more detailed look at counting within the framework of a concept-oriented analysis. We have a type of object (e.g. apples) which has a smallest unit (e.g. an apple) that we would like to count. Various formalizations are possible. Here, we will focus on the formalization where a number in our system would represent the “quantity” of a collection of such objects (e.g. “Three” represents “a collection of three apples”.) There are many assumptions to be made.

We will list a few important and perhaps subtle ones.

- We suppose that it is clear what the smallest unit of counting is. It is perhaps possible to use our system to count apples that are sliced, burnt, rotten, blended, etc., though we leave it for the user to decide on an appropriate unit of counting in each of these contexts.
- We assume that, for example, we can have a collection of just one apple. This might not be the case if, for example, we are counting trees in forests, which would necessarily have more than an individual (since a forest has multiple trees).
- We expect that, for example, we can always add an apple to any given collection of apples to get another collection. This might not be the case if, for example, we assumed that the apples are to be put into a basket of a fixed size.
- We expect that, for example, we cannot add a few apples to a collection of apples and end up with the same number of apples. This might not be the case if, for example, we naively try to count blended apples: two apples blended together could be the same as just one big blended apple.

Having decided on the formalization and the assumptions, we will now look at a few features available to the numbers. For each feature, we will address the three questions as in the concept-oriented approach.

- Succession.
 - Each number can have a successor: the next number after it. Taking the successor corresponds to adding an object to a collection (Figure 2).

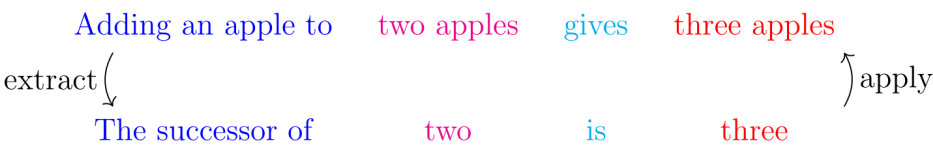


Figure 2: Succession corresponds to adding an object.

- There is only one way to include the feature of succession – the assumptions specified above give restrictions as to how succession should behave. For example, we expect to get a different size by adding an object to a collection, so we might have an axiom that says that the successor of a number should not be itself (Figure 3).

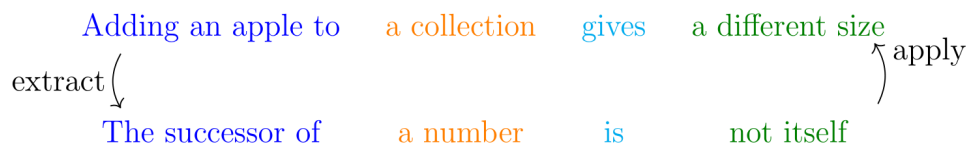


Figure 3: Rules for succession come from our assumptions.

- Succession is an essential feature. Many other features are built on top of it. It is useful and easy to understand – it is the feature that children first learn about.
- Addition.
 - It is quite clear what addition corresponds to: the size given from putting two collections together.
 - Addition can be defined by using successors. In fact, it is an extension of succession, which is essentially “adding by one”.
 - Addition is fundamental to the applicability of the number system. It allows us to determine the size of a collection by partitioning it into multiple sub-collections and summing their sizes. On the other hand, there is utility in a system with succession but without addition, such as the use of a tally counter for tracking arrivals.
- Multiplication.
 - We certainly use multiplication to count in practice. However, it is not always clear what multiplication corresponds to – what should two apples “times” three apples mean? To have multiplication, we actually need a more involved extraction process, which we will look at later in this article.
 - Multiplication can be defined with successors.
 - Similar to addition, multiplication is fundamental, though it can be complicated.
- Zero.
 - There is little ambiguity as to what zero corresponds to: an empty collection.
 - Zero behaves well with standard features (e.g. succession, addition, multiplication, etc.).
 - Having zero is often useful or even necessary. For example, zero (or something synonymous) would appear in the record for a student who never attended any lectures. On the other hand, it can also be useful to teach without zero and there are many instances where zero is irrelevant, such as when we are not interested in keeping track of empty collections.
- Negative numbers.
 - It is fairly clear what negative numbers correspond to: negative two represents “missing two objects”.
 - As with zero, negative numbers can be included with no issues.

- The motivation for negative numbers is similar to that for zero, though the utility for not having negative numbers is more apparent. For example, it would be quite tricky for an attendance record to have a negative number for a student.
- Infiniteness.
 - The size of an “unlimited” collection would be infinite.
 - We will not go into details regarding the notion of infinity. What should be noted is that infinity can be incorporated in multiple ways.
 - On one hand, features related to infinity are often avoided or not used and make the system more complicated. On the other hand, infinity is a very practical and indispensable notion, as used in disciplines such as physics and computer science.

Having glanced at several available features, we would like to develop a standardised number system for counting. Here, we should think from a system-oriented perspective to understand and compare various number systems. However, we will be skipping over the technical details and only make some important notes. One possible choice would be the succession system which only has the succession feature: the most ubiquitous feature across different contexts. The succession system is simple and contains the necessary functionality for building other common concepts. However, counting often involves much more than succession. The natural numbers with their usual operations would also be a good proposal – addition and multiplication have clear meanings for counting and constitute a more well-rounded toolkit. With a system-oriented analysis on the natural number, we would come to these conclusions:

- The system of natural numbers is very flexible. Many other counting-related systems – trees in forests, apples in a basket, missing items, infinity – can all be built from the natural numbers.
- The natural numbers have effective representations. We will come back to this topic later.
- The assumptions we have made above regarding counting should guide us in our choice of axioms, though we will not go into details here.
- The natural numbers can be built from the succession system. This has two important implications:
 - Extraction of the natural numbers can be broken down into two steps. Firstly, we need to ensure that the target concept (e.g. counting) does indeed instantiate succession as specified by the axioms for the succession system. Secondly, we need to make sure that other features, like addition and multiplication, built from succession, do in fact correspond to the notions that we anticipate.
 - Wherever we find the succession system, we can apply the extra features from the natural numbers. This might lead to surprising, and possibly unintended, results. For example, we can “multiply” apples, though it is not clear what this means; this issue is addressed in the next section.

With these points in mind, we would reasonably suggest the natural numbers as the standardised system for counting. Indeed, we have been using them to count for centuries.

Remark: One might question whether “natural numbers” should refer to a system with or without zero. This is an important question to resolve, at the very least to avoid miscommunication. However, this is largely a matter of convention and the question is left to interested readers.

In this section, we have an outline of how the natural numbers become the standardised number system for counting. Many concepts involving counting in some manner, which is why we see the natural number applied everywhere. Next, we would like to see where the real numbers come from. However, we first need to address couple of issues.

One Number, Two Systems

Let us try to extract numbers from the positions in a race. We use “1”, “2”, “3”, etc. to respectively represent “first in the race”, “second in the race”, “third in the race”, etc. We then come to the succession system: the first is followed by the second, which is followed by the third, and so on.

Suppose I finish three places after the second place. What position in the race am I at? By using addition borrowed from the natural numbers, we have that $3+2=5$. It is tempting to conclude that I came fifth in the race. The answer is correct, though the reasoning is flawed.

- In the expression “ $3+2$ ”, we were trying to use “3” to represent “third after” though we actually meant for “3” to represent “third in the race”.
- How should we interpret “third in the race” plus “second in the race”? Knowing who are third and second in the race generally tell us little about the fifth place, which might not even exist!

The issue is that “3” is confusingly being used to represent multiple things simultaneously: “third in the race” and “third after”. In fact, we are working in a system with two subsystems: a succession system that represents positions in a race and an addition system that represents relative positions (Figure 4).

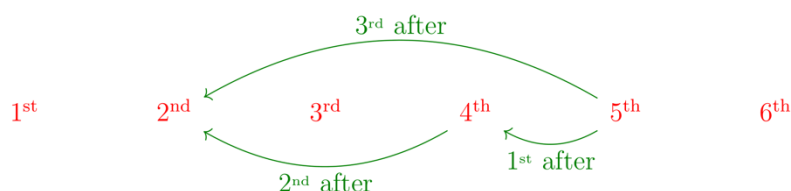


Figure 4: Positions (Represented by the Succession System)
And Relative Positions (Represented by the Addition System)

Furthermore, we have two types of additions: one within the addition system (Figure 5) and another one between the two subsystems (Figure 6), where we reach from one position to another by adding a relative position.

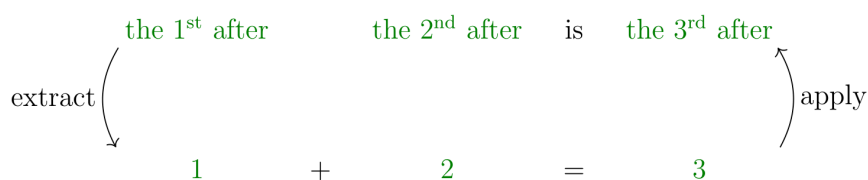


Figure 5: Addition Within the Addition System of Relative Positions

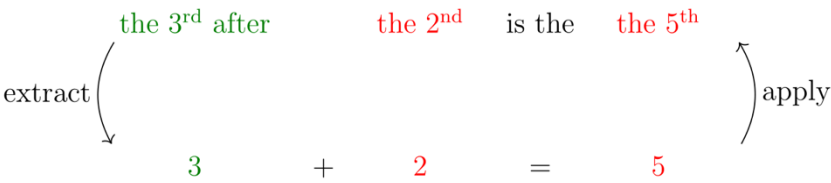


Figure 6: Positions (Represented by the Succession System)
Added by Relative Positions (Represented by the Addition System)

Similarly, when using multiplication to count collections of apples, we have a pair of subsystems: an addition system for counting apples in a collection and a system of natural numbers for counting collections (Figure 7 and 8).

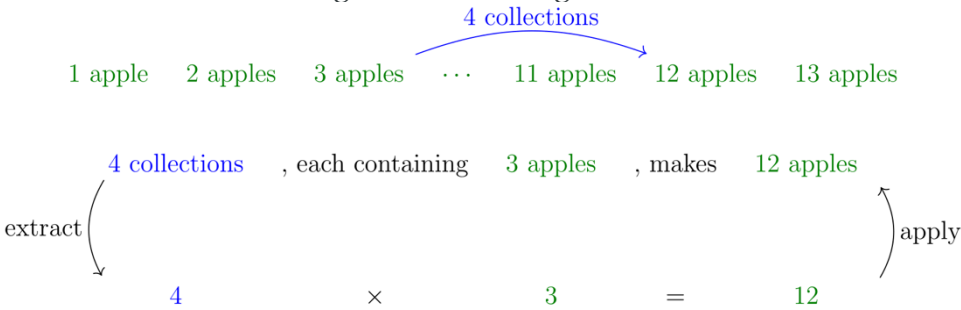


Figure 7: Apples (Represented by the Addition System)
Multiplied by Collections (Represented by the Natural Numbers)

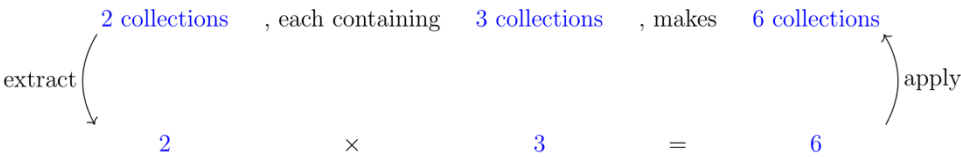


Figure 8: Multiplication of Collections in the Natural Numbers

There are two important notes to take away here. Firstly, an extraction can generally involve multiple number systems (and possibly multiple copies of the same system) with interactions among them. Secondly, the successor system, the addition system, and the natural numbers are related but distinct systems. For example, there is a number called “five” in each of these systems. We can draw analogies between these numbers that happen to share the same name, but they are ultimately different numbers as they express different meanings.

Systems for Proportions

We saw that the natural numbers form the standardised system for counting. Another well-known system is the real numbers, which is the standardised system for proportions. We should similarly take the concept-oriented approach on the concept of proportion and arrive at the real numbers. However, we will be glossing over most of the details as the procedure is parallel to that for counting but has much more complexity and technicality. We shall focus on the formalisation process and the desired features, which would be indicative of how the real numbers emerge from the notion of proportion.

Let us suppose that we have a train station with a straight train track that extends indefinitely to the west and to the east, imagining hypothetically that the Earth is flat. Firstly, we shall formalise the concept of position (Figure 9).

- “0” represents where the track meets the station.
- “1km E” represents the position on the track that is 1 kilometre east of the station.
- “4.276km E” represents the position on the track that is 4.276 kilometres east of the station.
- “2km W” represents the position on the track that is 2 kilometres west of the station.

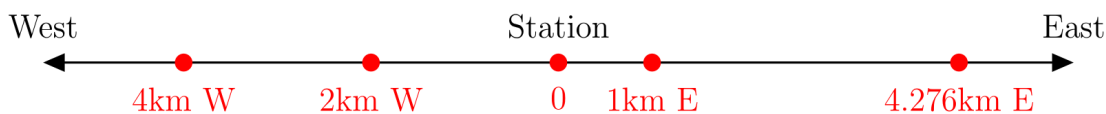


Figure 9: Positions on a Train Track

We would then extract a system of numbers permitting comparisons. For example, 2km W is to the east of 4km W. However, we do not have features like addition or multiplication. Indeed, it does not mean much to “add” positions: what position would the sum of Hong Kong and Oxford be? We can then formalise the concept of movements.

- “0” represents “staying still”.
- “3km E” represents “moving 3 kilometres eastward”.
- “0.889km W” represents “moving 0.889 kilometres westward”.

We now arrive at a system where we can compare and add (Figure 10), though we are unable to multiply.

$$3\text{km E} + 1\text{km W} = 2\text{km E}$$

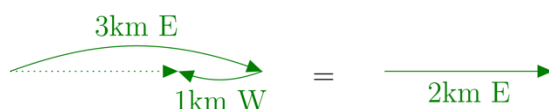


Figure 10: Additions of Movements

We can also move from one position to another by “adding” a movement (Figure 11).

$$2\text{km W} + 2\text{km W} = 4\text{km W}$$

$$3\text{km E} + 2\text{km W} = 1\text{km E}$$

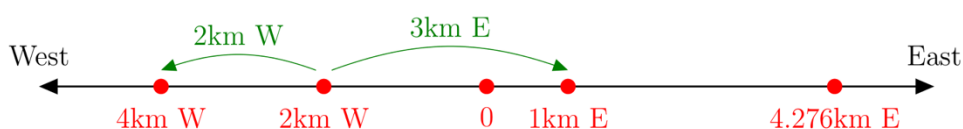


Figure 11: Positions Added by Movements

Finally, we can formalise the concept of proportions.

- “4” represents “scaling a movement by a factor of 4”.
- “-0.5” represents “scaling a movement by a factor of 0.5 and switching direction”.
- “0” represents “scaling to no movement”.

As expected, we can scale a movement by “multiplying” with a proportion (Figure 12).

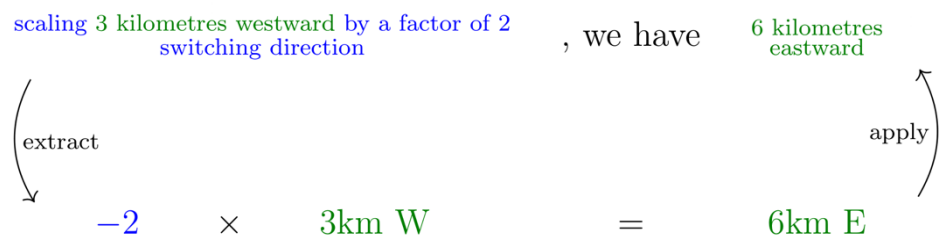


Figure 12: Movements Scaled by Factors

We have a system representing proportions where we can add, subtract, multiply and divide (Figure 13).

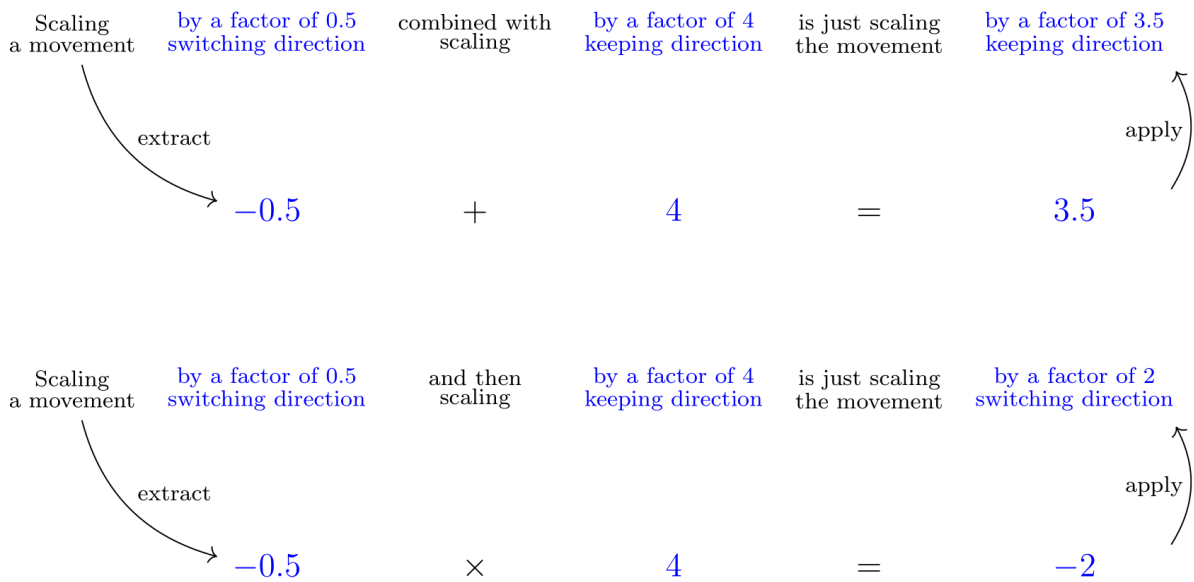


Figure 13: Mathematical Operations on Scales

The concept of proportion comes up in many situations besides our train track example. From architecture to music, from sociology to physics, proportions are everywhere. With a variety of assumptions and decisions in the concept-oriented approach, we would reach the real numbers as the standardised system for proportions.

One query in making our assumptions does merit particular attention. Should we include infinitesimal proportions? In the case of a train track, to have infinitesimal proportions is to have small undetectable movements. From the perspective of measurements, there is no need for minuscule movements, as such things will never be recorded; this is the view held by the system of real numbers, which has no infinitesimals. However, they formalise the intuition of a very small object or movement and are useful for describing things from tiny superheroes to calculus.

Representation of Numbers

Good representations of numbers are crucial for their applicability. Here, we will focus on the representation of real numbers. Natural numbers are generally represented as a subsystem of the reals. Numbers have been represented in many

ways in various civilisations and in various mediums (from carvings to electrical charges). However, aside from variations in syntax, the place-value notation has become the world standard.

- The place-value notation requires a chosen natural number greater than one as the base. Ten is the commonly-chosen base, and we will use it here for illustration.
- There are ten digits (such as “0”, ..., “9” in Arabic numerals) to represent the numbers zero through nine along with additional symbols (such as “-”, “.” And “,”) for indicating negativity and position.
- In the representation of a number, digits are put in a sequence. Each position, based on where it appears in the sequence, is given a distinct weight that is a power of ten. A negative sign indicates that the number is negative. (Figure 14)

$$-80.67 = -1 \times (8 \times 10^1 + 0 \times 10^0 + 6 \times 10^{-1} + 7 \times 10^{-2})$$

Figure 14: Place-Value Notation for Real Numbers

- The sequence of digits may be infinite and symbols are used to indicate that the sequence is endless or repeats indefinitely (Figure 15).

$$\begin{array}{rcl} \pi & = & 3.141592\dots \\ & & \frac{2}{11} = 0.181818\dots \\ & & = 0.\overline{18} \end{array}$$

Figure 15: Numbers with Endless Digits

We will consider and discuss some characteristics of this notation.

- It allows for a concise and precise representation of a large range of numbers. For comparison, consider the representation of natural numbers “one-by-one” using fingers, apples, grains of sand, etc.:
 - One would have trouble representing large numbers, such as 10000, with fingers or apples.
 - A few grains of sand can represent a small number while a heap can represent a large number. However, moving and counting sand grains is tedious: it would be tricky to preform precise calculations and comparisons.
- Many important numbers, such as π , would require infinitely many irregular digits and so they could only be approximated in this notation. In most practical instances, approximations of these numbers are quite sufficient. The place-value notation can simply be extended (with notations like “ π ”) when exact computations are required.
- The scale of numbers is made transparent and it is easy to compare numbers that are close by. For example, consider these numbers and their representations (Figure 16).

$$\begin{array}{rcl} 2^{16} & = & 65536 \\ \frac{22}{7} & = & 3.142857\dots \\ \pi & = & 3.141592\dots \end{array}$$

Figure 16: Numbers in Various Representations

From the right-hand side, it is clear that the first number is at a much larger scale than the second, which is just a little bigger than the third. In contrast, this information is not laid out on the left.

- It only requires a fixed number of specified symbols which is useful for memorisation and implementation in computers. In contrast, the words “ten”, “hundred”, “thousand”, etc. do not follow an easy pattern.
- Each digit is a symbol and is used the same way in all positions. In contrast, Roman numerals require multiple and distinct symbols to represent the same value at different positions. For example, “VI”, “LX”, “DC” represent “6”, “60”, “600” respectively.
- It allows for effective computations. The commonly-taught method of vertical calculation takes advantage of various mathematical tricks that are made applicable by this representation. Furthermore, these computational methods only require a fixed amount of memorisation (e.g. the multiplication table), which is again useful for computers. For example, we can see below how summing 67 with 324 can be done neatly with the standard method, saving a lot of tedious steps (Figure 17).

$$\begin{array}{rcl}
 & & 67 + 324 \\
 \begin{array}{r}
 1 \\
 + 67 \\
 + 324 \\
 \hline
 391
 \end{array} & = & (6 \times 10 + 7) + (3 \times 100 + 2 \times 10 + 4) \\
 & = & (3 \times 100) + (6 \times 10 + 2 \times 10) + (7 + 4) \\
 & = & (3) \times 100 + (6 + 2) \times 10 + (7 + 4) \\
 & = & 3 \times 100 + 8 \times 10 + (1 \times 10 + 1) \\
 & = & 3 \times 100 + 9 \times 10 + 1 \\
 & = & 391
 \end{array}$$

Figure 17: An Addition Method Using Various Tricks

- Numbers in weaker subsystems (such as the succession system and the addition system) are represented in the exact same way. These differences are somewhat respected in languages (e.g. “third”, “three” and “thrice”), but they are not indicated in mathematical computations. Introducing and using notations (such as “1st”) for distinguishing numbers in different systems would potentially improve understanding and reduce errors in reasoning.
- It requires a choice of a base. Various bases have different uses. There are a few factors to consider.
 - How intuitive is the base? This is relevant for humans but not so much for computers.
 - How large or small is the base? Smaller bases have less memorisation and easier computations, at the cost of longer representations. For example, the multiplication table in base-two only has three entries ($0 \times 0 = 0$, $1 \times 0 = 0$ and $1 \times 1 = 1$) while the representation for a thousand is long (1111101000).
 - How divisible is the base? When trying to share the bill for a meal evenly, three people often run into issues. This is essentially because the common monetary systems use base-ten, in which one third has an infinite number of digits (0.333...). In contrast, ten is a multiple of five, so base-ten is good for divisions by five. A base with many small factors would be desirable: divisions of natural numbers are less likely to require infinitely many digits and multiplication tables are easier to memorise.

Modern computers, which speak the language of on-and-off signals, are most suitable for a base-two notation. However, there might be a “chicken and egg” dilemma here: base-two computations are easy to implement, and this would conversely promote the use of on-and-off signals in computers.

Which base is best for humans? Mediums (such as text and speech) used by humans have room for more digits, allowing for a larger base. At the same time, we are not terribly good at large amounts of precise memorisation and a base too large might be difficult to use. Ten is probably a decent size and is quite intuitive since each of us typically has ten fingers. However, it has the drawback of not being divisible by three. There are many common situations in which one needs to divide by three, so bases like six and twelve might be better alternatives. Regardless, it would be a tremendous task to have societies around the world switch to a different base, and the benefits might be insignificant, as computers are gradually performing more computations for us. I shall leave the rest of this debate for the reader.

Representations of numerical operations are important as well. We will look at two factors in particular.

- To express the sum of two and three, we put a plus sign in-between the represented numbers: “2+3”. This is intuitive as the plus sign connects the two numbers and indicates that we should combine them. Nonetheless, other conventions are available. For example, the Polish notation puts the plus sign in front of the numbers (e.g. + 2 3) and this can be more efficient for computers.
- Brackets are used to indicate the order of operations in an expression. To avoid the clustering of brackets, it is helpful to have operation precedences. For example, the common standard is that multiplications are done before additions unless bracketed otherwise (Figure 18).

The expression $2 \times 3 + 5$
would mean $(2 \times 3) + 5$
and not $2 \times (3 + 5)$.

Figure 18: Operation Precedence

This is a good convention because we can expand any complicated expression containing multiplications and additions into one that does not need any brackets (Figure 19).

$((a+b) \times (c+d)) + e$ can be rewritten as
 $a \times c + a \times d + b \times c + b \times d + e$ which is bracket-free.

Figure 19: Brackets Removed by Expansions

In contrast, this is not the case if we take the convention of doing additions before multiplication. For example, it would not be possible to remove the bracket in the expression $(a \times b) + c$.

Overall, we see that there are a lot of factors that contribute to the design of representations for number systems. Different notations are suited to different purposes (e.g. approximate vs. exact) and users (e.g. humans vs. computers). The current standard of notation, though not without its flaws, works well and will undoubtedly continue to be used to represent the real and natural numbers in the foreseeable future.

Conclusion

An essential part of humanity is our ability to conceptualize the things we observe and to build a large variety of systems for understanding such concepts. These systems are complex and diverse, but they ultimately share a lot of common subsystems. For example, counting and proportions underpin a lot of concepts, and it is therefore not surprising that their standard systems – the natural numbers and the real numbers – are so ubiquitous. It is undeniably useful and important to have such common systems for building other systems. Hence, we inevitably give them the label “number” that they deserve.

Numbers are everywhere since they are the standardised systems extracted from various primitive concepts. With works spanning across civilisations, mathematicians have provided us with effective and efficient number systems. However, it would be fallacious to use these numbers blindly. Many subtle assumptions and decisions are made in an extraction of a concept and the resulting system often involve a range of interacting subsystems. The number systems we have are well-rounded and applicable tools to have, though please feel free to try to improve upon them.

Institute of Mathematics

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SPARK Reviews

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TV and Film Reviews

From barbecues to by-elections: feeling through the future in Russell T. Davies' *Years and Years*

Michael Bicarregui

Review of: *Years and Years* (2019) UK

Written by Russell T. Davies

Directed by Simon Cellan Jones (4 episodes) and Lisa Mulcahy (2 episodes).

Danny Lyons, a council worker who manages temporary housing for asylum seekers, offers his neighbour a lift while driving past her on their Manchester street. Fran tells an initially-bemused Danny that she is a professional storyteller; later in the episode, Danny has arranged for Fran to bring her act, the tale of a woman who circumnavigates the mouths of hungry animals by hiding inside an enormous pumpkin, to the refugee camp where he works. Amongst an enraptured audience, Danny listens to Fran's story with Viktor, a Ukrainian refugee who will soon become his lover. This scene of narrated wonder ends with a cut to a starker shot of both characters standing behind wire fencing (Figure 1). A sharp contrast, this cut juxtaposes the freedom of narrative immersion with the real-world politics that confine and cage individuals. In this encounter, storytelling rests as a precarious form of empowerment, transporting Viktor to a fantastical world of free movement, but drawing poignant attention to the borders imposed on him. Through this metanarrative device, Russell T. Davies sets up *Years and Years* as a six-episode whirlpool of thickening plot, political confusion and family conflict, where story, including the story Davies is writing, acts as an alternating current between truth-telling and manipulation, escapism and cold reality, the weightless virtual realm and grounded geographical stakes.



Figure 1: (From Davies, 2019).

Fran proffers to Danny that stories let us ‘make sense of the world’. Meanwhile, the series opens with the related words ‘I just don’t understand the world anymore.’ This statement is made by Vivienne Rook, Davies’ analogue for the Trump-Farage figure. Rook’s project, like those of her real-world iterations, is to complain that the world is increasingly convoluted while ensuring that no one can understand her own network of political actions and statements. Rook’s image surrounds the series’ principal characters, the four siblings of the Lyons family, looming on billboards, televisions, laptops, and phone screens, shifting intangibly between the background and foreground of each episode’s shots, and the characters’ minds. If stories enable us to process and understand reality, Rook is the politician who weaves overwhelming and self-contradictory rhetoric to escape narrative’s grasp. An undecodable figurehead, Rook becomes the epicentre of an interplay between dichotomies of sense and senselessness, economic connection and cultural discord, meaningful narratives and untraceably modulating soundbites. Through this conflict between story and the struggle to form it, *Years and Years* plots a trajectory of Britain in the worryingly near future, yet Davies’ real triumph is a move beyond mechanism to humanity, illuminating the personal side of political and technological change.

‘It’s just like Viv Rook says’: Languages of Politics and Elitism

Davies interrogates the precise mechanisms by which far-right politics burrow their way incrementally into acceptable public discourse: in a series of brash generalisations crammed with subtle nuances, the parasitic Rook misleads and redirects the political conversation, using her peripheral position to avoid accountability. In her first appearance, Rook is almost excluded from a televised panel for claiming not to ‘give a fuck’ about the Israeli–Palestinian conflict. The episode traces various characters’ responses to this comment, ranging from ‘she

can't say that' to 'she's brilliant'. Years later, Rook flickers chillingly between humorous references to her 'little faux pas' and sincere proclamations of her victory against 'censorship'. Yet even in that initial scene, Rook easily evades the censors by switching the word 'fuck' to 'monkeys'. By changing one word, Rook casts herself as a hero of free speech instead of an apathetic monster, branding those who attempt to preserve respect and compassion as an out-of-touch elite. Rook's speeches stir up political frustration akin to the sensation one feels in a nightmare, where situations unfold and the dreamer has no power to prevent them.

Davies also elucidates the link between rises in anti-academic sentiment and the normalisation of far-right politics. After months of Rook's media bombardment, Rosie Lyons criticises an elite of 'the bankers, the experts'. Echoing Michael Gove's infamous statement that people have 'had enough of experts' (2016), this conflation demonstrates how blame for the disenfranchisement of ordinary people is directed away from true causes of inequality towards projects of knowledge and understanding. This media-engineered distrust of all things intellectual dilutes public awareness of how injustice is perpetuated and deprioritises fact-checking in political discourse. For example, Ralph is frustrated by Danny's scepticism towards a website claiming the non-existence of germs. Gradually, the culture shifts: respectful debate is demonised as censorship and critical thinking is rebranded as an ivory tower; Rook spreads political lies while also brandishing the universally-applicable accusation of 'fake news'.

Davies turns the convolution of society into a case for understanding and compassion, distinguishing between the intellectual and the elitist by demonstrating the difference in his own intricate writing. Mastering its well-informed and self-reflexive intelligence, Davies' script remains rooted in a process of validating and empathising with the experiences of ordinary people. Precisely by understanding the characters, their emotions, how they speak and absorb political speech, Davies demonstrates exactly how Rook lacks this empathy. Davies' answer to concerns of academic elitism is to make nuance and critical thought understandable.

'Hotter and faster and madder': Technology, Pace, and the Personal

Just as *Years and Years* splits the atom that conflates elitism with thought, so does it sift apart technological innovation and the dangers of a virtualised world, separating technophobia from healthy scepticism. The first episode opens with warm, connected family relationships facilitated by smartphones, which evolve into the 'family link' through which the four siblings regularly communicate. Rosie organises a date by tapping phones with a prospective partner for his address, but is alienated on discovering his sexual activities with a humanoid robot named Keith. An ordinary family breakfast is broken by eerie conversation mediated by a real-life 'filter'; one sinister shot has the camera track around Stephen Lyons' daughter Bethany's head, revealing her distressed face hidden behind the superimposed cartoon mask that simultaneously protects and isolates her (Figure 2).



Figure 2: (From Davies, 2019).

Edith Lyons, an overseas activist, asserts in an interview that ‘the world keeps getting hotter and faster and madder’, and the pacing of *Years and Years* communicates this speed, adapting its visual grammar to the racing technological world it documents. When the Lyons siblings communicate using the family link, which is hosted by an Alexa-style device in each of their homes called ‘Signor’, the scene cuts between shots of the characters speaking and listening to each other as if they were engaged in a normal conversation in the same room, the camera passing through the link with seamless connectivity. Yet each cut displays a different household’s background, a different side conversation running amongst each sibling’s immediate family. This frequent cutting between multiple sets of surroundings accommodates for a script whose information flow is rapid and complex, lending these domestic scenes an engaging pace while enabling the siblings’ characters to be quickly developed by comparison with each other.

Davies also writes rapid pace into the series' wider narrative structure. Each episode, set a year after the last, features a sequence that cuts between the explosive motif of New Year fireworks, televised news clips, and substantial developments in the life of the Lyons family. These sequences, with a punchy score, compress a year of current and personal affairs into minute-long reels, linking the characters' lives to broad socio-political tides. Alluding to social-media-style videos made up of a few seconds of footage from each day in a year, these highlights reels tap into how we feel and measure the sensation of time's passage in the modern world of media saturation.



Figure 3: (From Davies, 2019).

As well as offering a critical response to technology while showing its benefits, *Years and Years* offsets the tone of the family link and newsreels with scenes set in the siblings' grandmother Muriel's spacious but decaying house (Figure 3). Muriel and her world, in which 'the tsunami is an entirely modern invention', act as a ballast that prevents the series from losing the feeling of weight as it soars into a future of hopes and terrors. However, rather than positioning the grandmother as a stock luddite, Davies uses Muriel's character to personalise and ground the story's futuristic elements. By the last episode, Muriel asks her great-grandchild to retrieve the 'old Signor device', now obsolete, from the back of a kitchen cupboard, explaining 'I like having something to look at'. When Signor lights up to explain Muriel's reference to *Shirley Valentine*, 'lost on' her family, she delightedly exclaims 'You see? My little friend' (Figure 4). Anne Reid's performance, absorbing technological change into a refreshing and comforting mundanity, communicates and makes believable the charming nostalgia Muriel holds for this electronic device

of a future past, an emotional attachment to a cultural relic that the Lyons siblings cannot understand.



Figure 4: (From Davies, 2019).

Where Muriel is not offsetting the future's pace with her old ways of gardening and fussing over her great-grandchildren, she lends Davies' technological predictions a sense of real history by absorbing them into lived experience and oral, almost-ancestral memory. Muriel's resurrection of Signor offers the possibility of resistance through memory, holding onto the outmoded in the face of a society that prefers to forget the past. Eventually, Edith hopes that downloading human memories onto molecules of water will permanently record, archive and validate personal histories, addressing problems of data preservation in the digital age and defying regimes that erase their own oppressive acts.

Davies also complicates the series' futuristic style through interactions with carnivalesque imagery. Along with each episode's firework displays, multiple scenes depict characters dancing and rioting around fires; one disorderly yet almost-ritualistic family brouhaha is tied into distinctly modern experience by its pop song soundtrack (Figure 5). Davies' consistent return to the carnivalesque blends his vision of the future with historic methods of aestheticizing public consciousness, celebration and oppression, and the passage of seasonal time. Despite their misfortunes, the Lyons family continue to gather for an annual 'winter feast'; this determination to celebrate in the face of adversity reasserts the characters' relentless humanity, while also highlighting their complicity, escaping into temporary exhilaration and failing to object to the social changes taking place around them. As the simulated chaos under Rook's rhetorical spell disguises an authoritarian regime, Davies adopts carnivalesque images and narratives to approach and understand the frenzied madness of this dystopian story.



Figure 5: (From Davies, 2019).

'It's all your fault': Compassion in the Virtual World

Through examinations of how technology integrates into lived experience, Davies sets British television's social realism in dialogue with aesthetics and ideas from post-humanism and science-fiction. While Bethany's computer-chip implants enable her to feel the sensation of being anywhere in the world, Rook uses the 'blink', which disables nearby online devices, to block the transfer of information out of concentration camps. The blink is a virtual tool that creates pockets of real geographical isolation, merging the physical and simulacral realms into a dystopian but grounded space. While the Lyons family communicate virtually across borders of counties and nations, the filmmaking style homes in on challenges of actual transit, prioritising images of cars, vans and boats, gates, cages and barriers (Figure 6). Davies pays constant attention to his characters' lines of movement, defying the nebulous array of constantly shifting and untraceable connections that mirror Rook's political rhetoric.

Much of the human drama in *Years and Years* revolves around decision-making in the virtual domain. Ralph, furious at Danny's affair with Viktor, uses his phone to photograph and report Viktor while he works illegally in a petrol station, another liminal space of unsustainable explosivity. The camera shows how virtualised detachment prevents and protects Ralph from realising the human impact of his actions. Ralph turns away from a close-up on his conflicted face, leaving a wide shot of Viktor out of focus behind a window. Ralph turns again, lifting his phone into the foreground of the same shot and we see Viktor in profile through the phone's screen, now in a tighter frame and clear focus (Figure 7). The real view of Viktor,



Figure 6: (From Davies, 2019).

safe and anonymous, is surpassed by a digital image that exposes and threatens him. When Viktor comes into focus through the phone screen, so does Ralph's resolve, in a shift from moral uncertainty to vengeful clarity. Viktor's life is reduced to a collection of movable pixels that enables others to manipulate him with reduced emotional consequences in their own lives. However, along with Muriel's attachment to Signor, Bethany's disquieting smile while contemplating full bodily integration with the digital, and her horror as she watches the passing of another computerised sentence for Viktor, display more compassionate and embodied understandings of the virtualised world.



Figure 7: (From Davies, 2019).

'We don't have to look that woman in the eye, the woman who's paid less than us': Current Affairs and Conclusions

Technology, therefore, becomes a vital part of the characters' moral lives, and Davies writes their decisions and personal stakes in startlingly convincing integration with infrastructural change. The resonance in this writing of the future relies on its grounding in the non-fictional present. Stephen's extreme exploitation as a courier, or 'lifestyle enhancer', is only a minor exaggeration of the working conditions and contracts of Uber and Deliveroo drivers. His manager's claim that 'you make people's life feel better' connotes the present economy where we are encouraged to take advantage of increasingly demanding services and ignore the livelihoods of the people who provide them. Rook appears on television promoting 'British wine for British people', alluding to Tim Martin's anti-EU campaign removing European products from Wetherspoons pubs. Viktor's struggle in border crossing is hardly changed from today's reality, from the UK's 'hostile environment' immigration policy to Italy's ban on rescue boats docking in its harbours, leaving refugees to drown in the Mediterranean Sea.

Davies is unafraid to face the complicity we all share in harmful systems, expressing it deeply and widely, from Muriel's rant about the disappearance of supermarket till workers due to automated checkout machines, to Rosie's voting for the woman who oversees the deportation of her brother's partner, political actions that produce psychopathy through complacency and unawareness. Listening to her grandmother connect her decisions with wider cultural shifts, it is Rosie's realisation of her power to impact the system, positively or negatively, that inspires her to fight back. Davies refuses to shy away from positioning one moral act as human brilliance, and another, no matter how understandable, as human failure. However, these bleak aspects of *Years and Years* are, in some senses, reassuring. Fran emphasises to Danny 'the shape of stories, and the need for them'; we do not just require narratives to understand the world, but narratives with shape, quality, and affect. It is inspiring to know that there are writers, in positions of privilege to write, who both understand the need to address the current state of politics, culture and technology, and have the talent to encompass vast cultural mechanics and compelling intimacy with human emotion and behaviour. Far from depressing, *Years and Years* proves that television remains a force for engagement, integrity, and honest commentary. Davies captures the sensation of today's current affairs: the feeling that we have no idea what is going to happen. Lucy Mangan (2019) observes the 'sense' of the characters' 'inner gimbals ceaselessly recalibrating, like ours', to each political development. Through the most baffling and distressing events, Davies tunes into human experience with curiosity, insight, and empathy: as the rightly terrified Rosie asks in the final moments of episode one, 'what happens now?'

Humanities Division

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The language of power: Luca Guadagnino's *Suspiria*

James Dobbyn

Review of: *Suspiria* (2018) Film

Written by David Kajganich

Directed by Luca Guadagnino

In the opening credits sequence of Luca Guadagnino's *Suspiria*, Thom Yorke's haunting "Suspirium" is overlaid with the rasp of tortured breathing. The breathing belongs to the mother of Susie Bannion (Dakota Johnson), our main character. It hangs over the interior and exterior shots of Susie's childhood home, omnipresent in the contained, rural setting. In the final shot of the sequence, the mother's eyes stare lifelessly yet accusingly from her deathbed, straight into the camera. She dissolves into a shot of her daughter arriving in Berlin (Figure 1).

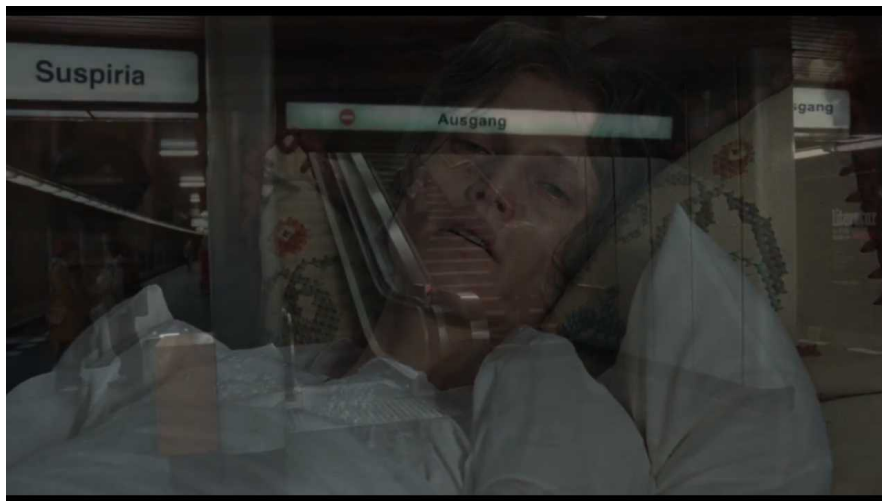


Figure 1: (From Guadagnino, 2018).

Guadagnino's *Suspiria* is a homage to Dario Argento's 1977 film of the same name. The power of this opening sequence illustrates the meaning of its namesake: sighs. Sighs are the domain of Mater Suspiriorum, one of the three 'Ladies of Sorrow' of Thomas De Quincey's *Suspiria de Profundis* (1845), from which Argento's and Daria Nicolodi's original screenplay drew inspiration. These are not sighs of boredom or longing but of total despair. They belong to 'the baffled penitent reverting his eyes for ever upon a solitary grave, which to him seems the altar overthrown of some past and bloody sacrifice, on which altar no oblations can now be availing, whether towards pardon that he might implore, or towards reparation that he might attempt' (De Quincey 1845). As we learn later, Susie's birth is the irrevocable, unforgiveable sin for which her mother sighs: "She is what I smeared on the world".

Violence and Fascism

Just as despair resides in the breath, so does power. In the maiming of the dancer Olga (Elena Fokina), one of the most effective and gruesome body-horror sequences in film, Susie's controlled exhalations are intercut with her victim's hyperventilations, whimpers, and screams of pain. Susie acts as a perverse puppeteer, breaking Olga's body and throwing her across the room in time with the movements of her dance. And yet the force which injures Olga, who is isolated in a room deep within the Academy, appears to come from within her own body. This mode of ventroliquised violence represents a radical thematic departure from Argento's Gothic conceptions of power and the body, which generate chills through psychological symbolisms.

In Argento's *Suspiria*, threat most commonly appears in the form of a breaking-through or puncturing. See, for example, the hairy demon-arm which bursts through a window (Figure 2) and seizes Patricia (Eva Axén), the way Patricia herself crashes through a glass ceiling at the end of a noose, or how one of those glass shards picturesquely embeds itself in her friend's face. Likewise, Susie's method of dispatching Markos is to stab her through the neck with what appears to be a large glass peacock quill (the symbolism of which is deliberately elusive).



Figure 2: (From Argento, 1977).

The Markos Academy's oppressive aura is similarly figured in Argento's version as a force pressing inward, crushing. In both versions, the protagonist's body acts as the focal point of the coven's collective power, but whereas Dakota Johnson's Susie absorbs and channels it, Jessica Harper's Suzy is weakened under its assault. The food, water, and blood-red wine she is forced to consume constitute an invasion of her body, which becomes the site of the coven's control over her. In one scene, the black-clad, tyrannically German Ms. Tanner (Alida Valli) is seen literally forcing water down an ailing Suzy's throat.

In Guadagnino's retelling, this pressure bursts outward with violent energy. These are horrors of the soul, compulsions arising from deep within. In a scene in the

witches' communal living space, one (perhaps foreseeing the advent of Mother Suspiriorum) suddenly plunges a dinner knife into her own neck, killing herself. The thematic mirroring with Markos' defeat in the original film dramatically highlights the interiority of this kind of violence. Both representations of control and force involve more-or-less overt references to German fascism but seem to disagree on the mechanisms of its operation. Argento's model of fascism is hierarchical and downward-facing, originating with the ultimate evil (Markos) at its pyramidal apex. This model is optimistic about the individual's ability to disrupt and destroy this hierarchy, to, as one character puts it, "cut off the snake's head." Guadagnino's *Suspiria* depicts a bottom-up fascism which draws its power, like the ritual dance, from the decision of each dancer to remake herself 'in the image of [the dance's] creator,' as Blanc says. It supposes the existence of an evil which cannot be destroyed and will only be reincarnated and reperformed, again and again. The most stunning narrative innovation in his retelling of *Suspiria* is the decision to root this evil within the heart of the protagonist. The primary source of narrative tension is thus shifted from a conflict between Susie and the witches to the conflict between the viewer's idea of Susie and the reality of her character.

To the passive observer in a darkened audience, this form of narrative conflict is far more confrontational, almost accusatory. Because we are led to identify with Susie, her gradual transformation into Mother Suspiriorum becomes highly uncomfortable to watch. Olga's mutilation is a pivotal moment in this transformation, a deliberate disruption of our mode of observation towards Susie, which up until this point has been that of aesthetic appreciation. Note that while Olga is alone within her mirrored prison, Susie's dance occurs in the communal space as her fellow dancers look on.

The Political Dance

Depictions of the manipulated public sphere enacting forms of violent control are prominent throughout *Suspiria*. Contrary to the claims of reviewers such as the *New York Times*' Manohla Dargis, Guadagnino's use of the politics of the German Autumn is not merely a decorative set-dressing with 'dead-end references both to 1970s German politics (cue the tear gas, riots and Baader-Meinhof mentions) and, more egregiously, to the Holocaust' (Dargis 2018). Though the exploits of the Red Army Faction only ever seem to waft onto the screen like the smell of a bomb in the street, the two dramas are intimately linked. The violent unrest unfolding around the hermetically sealed Academy is reflected in the power struggle between two rival factions of witches: the first, led by the putrefying Helena Markos (Tilda Swinton), seeks a rebirth of the ailing coven leader's power through a fresh vessel. The other, led by Madame Blanc (also Tilda Swinton), champions an aesthetic revolution which would surely spell destruction for Markos herself. Initially their conflict is mediated democratically, and Blanc's support falls short of Markos', power.

Just as the British Royal Air Force (in its own view) strives to purge Germany of its Nazi elements and set it on a new political course, Blanc's faction seeks a new

apparatus of power, centered in the communal dance (*Volk*) and free of the rotting horror that is Markos. Ultimately, all it achieves is senseless bloodshed and a renewal of the cycle of violence. West Berlin itself becomes like Olga's torture-chamber within the Academy, its inhabitants subjected to the force of the USSR's projected power.¹ In the same sense, this force is also channeled through the political body of the West German people as an insurgency. The existence of an end to this hideous dance seems highly dubious (indeed, the RAF's campaign of terror did not end with the 1977 death of Andreas Baader). As Susie says to Blanc, "It's all a mess: The one out there. The one in here. The one that's coming".

Dr. Josef Klemperer (again Tilda Swinton, as Lutz Ebersdorf) passes back and forth between these divided worlds in his role as "The Witness". He ritualistically travels between his office in the West (his working, investigating life) and his *dacha* in the East (his ruminative world of memories). He alone can go from the regimented, regulated public space of police stations and quiet lunches into the insular world of the Academy, where even physical laws break down, and back again. He is the film's lens on history and rationalism. A witness to the horrors of the Nazi regime, he sees 'magic' as a shorthand for the cult-like power of the group which denies the individual's responsibility for its crimes (Figure 3).



Figure 3: (From Guadagnino, 2018).

Guadagnino's *Suspiria* is at its best when it is fully wrapped up in this dance of politics, history, and performance. It feels simultaneously urgent and visceral, in stark contrast to Argento's dreamy, fairy-tale timelessness. By grounding the film as much in the body as in its German setting, Guadagnino produces one of contemporary film's most gripping tales of the nature and exercise of power.

¹ It is worth noting here that the USSR is thought to have been provided with training, weapons, and logistical support by the East German Stasi, whose 'agents trained Red Army Faction members to use the anti-tank grenades they fired in a failed attempt to kill Gen. Frederick Kroesen, commander of American forces in Europe, in September 1981' (Kinzer 1991).

Power, Guilt, and Shame

The language of power, according to Blanc, is a nonverbal one. Guadagnino's *Three Mothers*, like De Quincey's *Ladies of Sorrow*, speak only in 'pulses in secret rivers, heraldries painted on darkness, and hieroglyphics written on the tablets of the brain' (De Quincey 1845). The dancer's wordless movements shape the poems, prayers, and spells which are the essence of the witches' power. Violence is the imperative and truest expression of this aesthetic power, and the body is both its conduit and its object – as Blanc says to Susie, "We must break the nose of everything that is beautiful". And yet, there is nothing chaotic or indiscriminate about the dance or the violence – both rely on the structure of Blanc's choreography to take form. Where they lack this form, as when Susie begins improvising during the performance of *Volk*, the spell is broken and the power-structure collapses.

The climactic purge of the Markosites (each of whom is pictured, literally up against the wall, in a cutaway immediately before her execution) is a ritual typical of all violent regime change. While the symbology and rhetoric of power change, its essence and exercise remain the same. Markos' blasphemous propaganda effort, her self-stylization as *Mother Markos* and the 'only mother,' is a purely rhetorical claim to power. The true Mother Suspiriorum, a black, skeletal figure, remains totally silent as she delivers the kiss of death to Markos' acolytes. As the ritual sacrifice prepared for Susie degenerates into a chaotic slaughter, it achieves its highest synthesis of the atavistic and the artistic. It is at this point that Susie appears most compassionate, cradling Sarah (Mia Goth) in her arms after granting her request for death. As the dancers wheel madly on the blood-soaked floor, Susie, now fully embodying Mother Suspiriorum, gasps, "Keep dancing. It's beautiful. It's beautiful".

While Argento's *Suspiria* ends on a shot of the Academy in flames, the coven destroyed forever, Guadagnino envisions its continuation under new leadership. The result is a far more unnerving conclusion – the look on Miss Tanner's (Angela Winkler) trembling, blood-smeared face as she surveys the remainder of the Academy's students could be a vacant, shell-shocked stare or terrified anticipation of what is to come (Figure 4).



Figure 4: (From Guadagnino, 2018).

The absolution which Susie/Suspiriorum delivers to Dr. Klemperer by wiping his memory is also unsettlingly ambiguous. “We need guilt and shame,” she insists, “But not yours.” This reassurance seems disingenuous in light of the film’s insistence on the deep-rooted nature of evil and the dangers of unconsidered participation. The most important word here is “we”. Is Susie speaking on behalf of a modern world which wishes to exorcise the demons of the past, or is her “we” aligned with those very demons? Johnson’s simultaneously soothing and menacing performance betrays nothing. As the horrors of the mid-20th century begin to die out of living memory and far-right nationalism sees a surge across the developed world, a shared anxiety is born: Is it all right to forget? And when we have forgotten, what comes next?

Department for Continuing Education

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“It is fun to be Queen sometimes”: The competitive sport of winning royal favour

Muhammad Babar Suleman

Review of: *The Favourite* (2018) Film

Written by David Kajganich

Directed by Deborah Davis and Tony McNamara

Sharp and witty, Yorgos Lanthimos’s *The Favourite* (2018) is a darkly humorous study in spinelessness.



Figure 1

How far should one go to please a monarch who has the personality of a petulant toddler?

Farther than any reasonable parent would, if you want to remain in favour.

So argues Yorgos Lanthimos’s aptly titled new film that hangs self-respect out to dry when power is so imbalanced as to make a Queen decide the most important aspects of one’s life. In *The Favourite*, two very capable and ingenious women battle it out for royal approval in a delicious chain of lies, opportunism and (fleeting) triumphs. The film is based on real-life characters but enjoys a great deal of creative liberty in imagining their actual personalities and relationships, and strictly steers clear of any flattering portrayals.

Take for instance the monarch at the centre of the film about whom Alexander Pope once wrote:

*"At length great Anna said, 'Let discord cease!'
She said! the world obey'd, and all was peace!"* (Pope 1713).

Pope would find his sycophantic tribute greatly challenged by the depiction of 'Anna' in *The Favourite*.

Set in Eighteenth-Century England, Olivia Colman plays a suicidal and self-pitying Queen Anne who is suffering from gout, sore-covered legs and self-doubt. In a constant state of grief over her still-born and dead children, her only joy seems to come from the seventeen rabbits she keeps in her bedroom and the hotly-demanded attention of Lady Sarah Churchill aka Lady Marlborough (played by Rachel Weisz), who is her lover and political manager.

Churchill puts up with the Queen's demands in a manner akin to an overworked parent. She's often very terse and tough because she believes it is for the good of the Queen and the country but ultimately, she must give in when the Queen's tantrums take over.

Churchill handles the day-to-day of running the country, only referring to the Queen when she absolutely needs it. Unfortunately, the Queen is exceedingly capricious and, depending on how she feels about Sarah on the day, more than willing to upend any progress or previous decisions. Sarah, spread thin but always shrewd, has known the Queen long enough to press the right buttons to usually get what she wants - much to the chagrin of the male officials around her.



Figure 2

“You look like a badger”: The price of honesty and duty

England is at war with the French and that greatly distracts Sarah from attending to the Queen to the latter’s satisfaction. She must deal with other officials in the court (such as the excellent Nicholas Hoult who plays the first Earl of Oxford with obvious cruel joy and deep-seated resentment) and doesn’t fully realize that the biggest threat to her mission is brewing right under her nose. That would be her newly turned up and long forgotten cousin, Abigail (played skillfully with wide-eyed naïveté and unparalleled manipulation by Emma Stone). In a moment of patronizing compassion, Sarah allows her a position amongst the maids. This is a mistake to remember.

Abigail quickly sets her sights on establishing a firm foundation for herself in the Queen’s court - one that isn’t dependent on her cousin’s puny generosity or affected by her (correct) suspicions. She quickly senses all the problem points in the Queen’s relationship with Sarah, and eagerly fills the cracks with her own soothing presence. Watch as Abigail tells the Queen how beautiful she is or pretend to be interested in the names and personalities of her prized pets. Compare it to Sarah telling the Queen she looks like a badger earlier. The latter was perhaps sincerely trying to help but the Queen wants magic, as they say, and not realism.



Figure 3

“I am on my side always”: Shifting loyalties

Pursued by the handsome and respectable Masham (played by Joe Alwyn, none other than the subject of Taylor Swift’s “Gorgeous”), Abigail is quick to seduce him but smart enough to blue ball him all the way to (and even half-way through) their

wedding night. Masham seems to believe he has an upper hand at the beginning. However, on their wedding night, it is fully revealed to be an absurd notion. She is playing a game that outstrips him by leagues.

In her fiercely duplicitous and no holds barred race to the top, Abigail also sets up an uneasy alliance with her former tormentor, the Earl of Oxford. He is so full of spite for Lady Marlborough that there is nothing he would be opposed to doing in taking her down. Sarah, slightly late to the uptake, had not realized how much she had taken the Queen's support for granted until Abigail begins to illustrate how easily it is swayed. Soon enough, the two are out for blood and, at the very least, a complete and decisive win.

The witticisms and barbs form a significant part of the battle but there are also actual physical assaults aplenty, some that land better than others. Sarah eventually receives the brunt of the abusive actions and words, but she does not shy away from reciprocating them either. Watch Abigail deftly duck and swerve as Sarah throws a torrent of library books at her. Her mental agility is on display moments later when she takes one of those very books to cause actual injury to herself for stellar effect and long-term benefit. Physical comedy often turns into physical assault, but intelligence asserts itself as the top weapon of choice for these women.

It is a 'winner takes all' theatrical game, even when the winnings themselves are of a dubious quality. Along the way, there are plenty of laugh-out-loud quips at nearly everyone's expense, resembling the satiric bite of eighteenth-century playwrights such as John Vanbrugh and Thomas Southerne.



Figure 4

“I wish to make a statement to the Queen”: An unusual English court

Lanthimos has made some very interesting films leading up to *The Favourite*: in the world of *The Lobster* (2015) (which also starred Weisz and Colman), single people are transformed into animals in a surrealistic version of our society and, in *The Killing of a Sacred Deer* (2017) a couple is tasked with choosing one of their children for sacrifice in order to save the rest of the family from a curse. If you’re wondering how Lanthimos’ dark, uncomfortable and often surprisingly humorous sensibilities translate to the English monarchy, *The Favourite* has a few scenes that stand out: consider the childish grotesque faces of the English courtiers while egging on their ducks in a racing competition, the bizarre dance moves of the rich and well-heeled in the court, or the pelting of an semi-naked man with tomatoes. Yet, somehow these borderline-absurdist visuals still sit comfortably besides the familiar visual conventions of a period drama. We may have seen enough Jane Austen adaptations to think of period dramas as all English politeness and decorum but *The Favourite* is a timely reminder that things were never that great or lovely. The characters here are coarse, in full command of the c-word and never opposed to the crude, distasteful or vulgar. The competitive gameplay between the characters and their individual agendas provides the foil for the otherwise silly theatricality of societal rules and rituals, and the consequent repulsive behaviour seen on screen constitutes for what *The Columbian* accurately describes as a “comedy of ill manners” (Hornaday 2018).

The rivalry between the cousins is reminiscent of a film by another director: Justin Chadwick’s soapy drama, *The Other Boleyn Girl* (2008). Chadwick’s film depicts the Boleyn sisters (played by Natalie Portman and Scarlett Johansson) vying to be “the Favourite” of King Henry VIII (played by Eric Bana). Lanthimos’s *The Favourite* couldn’t be more different in tone with less melodrama and more caustic one-liners, but it still plays up female rivalry for all its worth.



Figure 5

“I’m capable of much unpleasantness”: A Feminist Critique

The Favourite may be an enjoyable caper for many but, as noted above and as I realized in my conversation with a female friend, there has been an uncomfortable and stereotypical pattern of women in depictions of abuse and humiliation in several of Lanthimos’ films (see Nicole Kidman’s disturbingly groveling plea for her children’s lives in *The Killing of a Sacred Deer* (2017), for another instance). The women clearly have agency and intelligence, and the men are often shown as weak pawns (and, in *The Favourite*, in plenty of silly makeup and wigs) or eye candy, there are still some undeniably tired gender tropes at play: women are shown to be jealous and sly when they are not being pushed into the mud or threatened with rape. While an argument can be made for why the situations were warranted in the context of the storylines, it still doesn’t necessarily take away from the actual images on screen. It may be time for Lanthimos to flip the script and perhaps switch up the genders when he’s looking for his next target for on-screen mortification.

Admittedly, this is an unpopular opinion and you have to only look so far as to the *New York Books Review* of the film to find an argument for how the treatment of, for instance, rape in *The Favourite* is not gratuitous but “suggest instead the reality for women” (Serpell, 2018).

Also, for a film that keeps its balancing act so finely-tuned for much of its running length, the ending sequence is surprisingly weak and on-the-nose. The film lands so many finely calibrated punches leading up to the finale that the simplistic depiction of Abigail living out a demeaning scenario, akin to the rabbit she cruelly

squeezes under her foot only moments before, closes the film with the weakest of whimpers.



Figure 6

“How goes the Kingdom?”: Quite well, really.

If not for the uncomfortable treatment of women and the wisp of an ending, this would be a near-perfect film in Lanthimos’s oeuvre.

The soundtrack is a welcome collection of baroque and modern classical pieces including concertos by Handel and Vivaldi, some Bach and Purcell and more recent works by the likes of composers Anna Meredith and Olivier Messaien. Elton John appears via the ballad ‘Skyline Pigeon’ over the closing credits.

Costume and production design are top-notch thanks to the work of Sandy Powell and Fiona Crombie et al.

Powell, in a risk that pays off, largely restricts the colour palette for the costumes to black and white, which make for a visually pleasing contrast against the opulence of Hatfield House. The silhouettes are in line with the period but, as the designer tells *Vogue*, “fabric-wise, artistic license was taken” (Newbold 2019). As the fashion bible is quick to note, the kitchen servants’ uniforms were made from thrifted denim!

The fact that Lanthimos is able to move the camera around so freely and swoop into some interesting details (like the micro-world of the rabbits with their miniature

jugs) or pan out for a glorious shot of the court, and change perspective while still not losing visual richness is thanks to the work of Crombie who was able to have a free creative rein in choosing the details for the production design. As Crombie mentions to *Town and Country Magazine*:

“Yorgos was involved in the big conversations, like palette—deciding to strip out color and to really be very concise with our palette. But he just let me run with how I decorated the rooms, and what the elements were that we brought in.” (Foussianes 2019).

The performances from the cast are all-around stellar. Stone has the showier character of the two rivals, but Weisz brings a believable restraint and a deep sense of integrity to her character. It is clear she would shoot you straight up in an honourable duel but is unwilling to lower herself to the level of her brown-nosing cousin. Unfortunately, such high-mindedness would be to her own apparent detriment. As it stands, besides a direct appeal to the Queen, she doesn't ever take her gloves off in this battle. Weisz embodies her character so well that this behaviour seems to naturally flow from a life lived vivaciously, and not merely in the service of a plot device.

Olivia Colman does her best trying to balance the Queen's genuine ethos while still allowing for the ridiculous streak that would enable the behaviour we see most often on the screen. And yet, watch her as she glows up talking about her rabbits. Lady Marlborough would have been wise to be kinder to the little furry beings if she were to truly serve her country.

The Favourite has picked up ten Oscar nominations for the 2019 ceremony, including Best Director (Lanthimos), Best Supporting Actress (for both Weisz and Stone with the former currently having a small edge), Best Picture and Best Original Screenplay, while Olivia Coleman took home the Oscar for Best Actress. The 91st Academy Awards took place on the 24th February, 2019.

Ruskin School of Art

Editor's note: This review is available with gifs on the STAAR website as originally intended.

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Book Reviews

Why We Sleep: it is high time we slept deeper in order to dream bigger.

Virginia Casablancas-Antras

Review of: *Why We Sleep* (Scribner: New York, 2017)

Written by *Matthew Walker*

"Not explaining science seems to me perverse. When you're in love, you want to tell the world".

— Carl Sagan, 1995 (American cosmologist).

There are many aspects of Sagan's quote that are in dialogue with Matthew Walker's *Why We Sleep*. A British medical doctor turned sleep researcher, Walker is totally in love with the phenomenon of sleep, and he certainly wants to share it. So, let me ask: How many hours of sleep do you get every night on average? Do you actively prioritise sleep? Among many fascinating pieces of information in this book, the most striking make you question your own habits. Walker aims to inform us how crucial sleep is not only for our health but for multiple aspects of our lives. Walker wants us to realise that we are, at least collectively (and probably individually), sleep-deprived, and that this is increasing our chances of becoming ill, of having car accidents and being unproductive. Sleeping well is neither a priority for many of us nor the subject of public health efforts to the extent that it deserves.

Walker promises to tell us "the good, the bad and ugly of sleep". Even if we learn some uncomfortable truths – both about our individual behaviour and about the societal factors contributing to the sleep epidemic declared by America's Centers for Disease Control and Prevention (CDC) – Walker's findings are an important wake-up call.¹ Any health topic can be subject to misinformation and sleep is no exception (Robbins *et al.* 2019). In this review, I aim to disseminate some of these findings and provoke the reader to reflect on their habits, while encouraging them to learn more by reading what I think is a very entertaining and well-written scientific text. In the words of Mark O'Connell (2017): "It might be too soon to say this book changed my life, but it was certainly an eye-opener".

The Circle of Life: Sleep in a Nutshell

"Happiness consists in getting enough sleep. Just that, nothing more."

— Robert A. Heinlein, 1998 (Starship Troopers).

¹ According to the CDC, 20% of the population suffer from chronic sleep problems.

“Mornings are for coffee and contemplation.”

— Jim Hopper, 2016 (Stranger Things Season 1, Episode 1).

Walker begins with the basics and proceeds to clearly explain the circular pattern of wakefulness and sleep. This rhythm, which has cycles slightly longer than one day, is internally generated in humans independently of light (although light contributes to reset the timer).² As Walker notes, the physiological significance of light was evidenced in 1938 by Kleitman and Richardson, who spent six weeks in a cave totally deprived of sunlight while recording their sleeping times and body temperature. We also learn that there is a fine interplay between our internal clock, sleep pressure and the signalling of darkness, as well as clearly defined cycles of two types of sleep: REM sleep and NREM sleep. The main concepts of sleep are as follows:

Circadian rhythm: *an internal body rhythm, approximately one day, which is generated deep in the brain by the suprachiasmatic nucleus (located above the crossing of the optic nerves). It regulates wakefulness/sleepiness and other bodily functions including eating, metabolism, hormone release and body core temperature.*

Melatonin: *a hormone released by the pineal gland after dusk as a signal of darkness.*

Adenosine: *a chemical that builds up during wakefulness and generates sleep pressure; it is cleared during sleep. Caffeine is a competitor of adenosine for binding to cell receptors.*

Jet lag: *tiredness caused by the mismatch between the day-night pattern and the internal circadian rhythm that occurs after travelling across time zones.*

REM sleep: *rapid eye movement sleep is a deep sleep characterised by synchronous slow waves during which we lose consciousness and is key for the consolidation of memories.*

NREM sleep: *non-rapid eye movement sleep, or paradoxical sleep, is the sleep period during which we dream, characterised by the absence of muscular tone. An 8-hour night sleep is made of 4-5 cycles of NREM + REM sleep phases.*

Having set these bases, we are ready to really understand, at the biological level, that familiar feeling of morning stupor which motivates us to consume caffeine as a result of sleep deprivation. As Walker argues: “the consumption of caffeine represents one of the longest and largest unsupervised drug studies ever conducted in the human race, perhaps rivalled only by alcohol” (27-28). The reason we are still sleepy in the morning is that we didn’t allow enough time for our liver to clear out the chemical adenosine, which signals the need to sleep to the brain. By consuming caffeine, we can temporarily block the effect of adenosine on our cellular receptors, although adenosine levels are still maintained. Therefore, once the caffeine has been metabolised, the sleep pressure we had accumulated will make us sleepy again. Unless, of course, we consume more caffeine... A recurring side effect of trying to conquer tiredness via copious amounts of caffeine is disturbed sleep the following night, since caffeine has a very long life in the body (8 hours – this means that if you had coffee at 4pm, by midnight half of that caffeine dose is still circulating). This

² It was already known in plants since the 1770s thanks to experiments performed by DeMairan.

way, what should be cycles of wakefulness/sleep, finely regulated by our bodies, becomes a vicious cycle of permanent tiredness.

“The Good”: Marvelling at Sleep

“I can just play” (Walker, 124).

Part II of the book, “Why should you sleep”, opens with the statement above, made to Walker by a professional pianist when reflecting on the experience of arising and being able to perform a difficult passage that he’d struggled with the previous evening. Reading this resonated with my own experience as a musician. The comment led Walker to perform several studies in which he showed that time specifically spent asleep helps us improve skill memories, particularly in difficult tasks, and involves phenomena other than short to long-term memory transfer. In that initial study, Walker designed a model exercise that was like playing the piano: he asked participants to learn a specific keyboard sequence and to type it quickly and accurately. He then tested participants after some time, during which one group slept and the other did not and measured their performance increases. He also found that it was precisely the duration of stage 2 (of 4) of NREM sleep which correlated to increases in performance accuracy, and that the effect was more prominent during the last two hours of an 8-hour long sleep. These last two hours are most frequently lost – an important point for anyone practicing motor skills!

This passage (123-128) exemplifies the virtues of Walker’s balance between dramatic effect and empirical rigour, which characterises his engaging scientific style. On one hand, he lures readers in by narrative accounts of scientific discoveries and their significance; for example, by the intriguing meeting between himself and the pianist mentioned above. On the other, he explains to us in a simple but detailed and accurate manner how a sleep research team performs the experiments that have led them to such discoveries. The richness of detail, and attention to key scientific papers (although as a scientist I would have preferred a more complete bibliography!), makes this book appealing to a specialised audience as well as a general one.

“The Bad and the Ugly”: The Dangers of Sleep Deprivation

“All work and no sleep makes Jack a bad doctor.”

“Never waste any time you can spend sleeping.”

— Frank H. Knight, 1998 (American economist).

Sadly, the book quickly moves past such awe-inspiring discoveries (of which many more are found in part III, “Why we dream”), onto less cheerful matters, in particular an exhaustive account of the numerous and far-reaching consequences of the current sleep epidemic: car crashes, cancer, diabetes, Alzheimer’s, teenager’s impaired learning and mental health, poor response to vaccines, medical errors, low productivity, etc.

As disturbing as I found all these revelations, a couple are worth expanding upon. The practice of twenty-four-hour shifts by doctors, still in place in many countries, was promoted by an American physician in the 1890s, whose ability to get by without sleep was directly linked to his cocaine addiction. Shockingly, “1 in 20 residents [in the US] will kill a patient due to a lack of sleep” (Walker, 319). The fact that teenagers’ circadian rhythms are delayed in comparison to adults has been known for decades. There is a causal relationship between sleep quality and academic performance which is ignored by school start times. According to Walker, teenagers are forced to rise at the equivalent of 4am for an adult, impairing their learning and posing risks to their mental health at a difficult stage of their lives. How are these practices justified in the light of all this evidence? Change is needed at many levels.

A Shared Responsibility

“Sleep is a necessity, not a luxury.”

— Dr. Safwan Badr, 2014 (President of the American Academy of Sleep Medicine).

Sleep is probably more fashionable in the scientific world than in daily life; 2017 saw the Nobel Prize bestowed upon Jeffrey C. Hall, Michael Rosbash and Michael W. Young “for their discoveries of molecular mechanisms controlling the circadian rhythm” (Nobel Media, 2019). Yet I suspect that, collectively, we have a fairly negative view of sleep, associating it with laziness. Modern society is characterised by a cult of busyness; Korean philosopher Byung-Chul Han goes so far as to argue that “today, everyone is an *auto-exploiting labourer in his or her own enterprise*. People are now master and slave in one. Even class struggle has transformed into an *inner struggle against oneself*” (Han, 17). I wonder if looking after our health via (often questionable) diets and exercise is seen as somehow more virtuous than *just* a good night’s sleep. *Why We Sleep* encourages us to think about this apparently “dead” time as a universal remedy for many problems.

So, what should we do about our sleep? The guidelines are simple: have a regular schedule, giving yourself 8 or more hours of sleep opportunity, avoid sleep-disturbing substances and keep your bedroom cool and dark (i.e. free from phones and computers). On the substances-to-avoid list, we find caffeine (from the afternoon), alcohol and large meals (a few hours before bed) and nicotine. Walker also recommends avoiding late naps (after 3pm) and having some wind-down time, which if in the form of a hot bath would also help our body to cool down.

However, given the pressures of modern life, it is worth noting that placing excessive weight on individual behaviour might not be healthy. Darian Leader, author of *Why Can’t We Sleep?* (2018), writes in his 2019 review: “In a world of massive job insecurity, long commutes, economic precarity and the pressure to maintain a positive image, how well can we really be expected to sleep? [...] With the aspiration to become “well-slept individuals”, we see a wholesale redrafting of social problems as individual ones. [...] No one is measuring what it feels like to strive for a sleep that escapes us, or factors in the effects of the resulting sense of

failure"). I think Leader's criticism of Walker's message to us as individuals is slightly unwarranted since Walker does consider these societal factors. Walker states: "Five key factors have powerfully changed how much and how well we sleep: (1) constant electric light as well as LED light, (2) regularized temperature, (3) caffeine [...], (4) alcohol, and (5) a legacy of punching time cards" (265).

I do see some dangers in Walker's vision of technology-aided sleep improvement (325-331) which align with Leader's point of view. In that section Walker imagines a future smart house in which temperature and light levels/colours are fine-tuned to suit individual sleeping schedules (and inner rhythms), all of it monitored by our smartphones. This usage of technology intrigues me, especially when Walker discusses applying it to environments such as hospitals where, paradoxically, sleep conditions are poor. We can't currently *really* assess in a precise way how well we slept last night and with such technology, we could. Heeding Leader's caution against obsessive sleep monitoring, we might react adversely to a quantitative measure of how poor our sleep is. I believe there are currently many low-tech opportunities of intervention for individuals, although I agree with the immediate potential of some more advanced measures in health care spaces.

It is clear that coordinated efforts at many levels are required to face this challenge. One first step that Walker contributes with this book is that of public education: "failed by the lack of public education, most of us do not realize how remarkable a panacea sleep truly is" (107). The US is paving the way by means of their Sleep Awareness Campaign, but this still has a long way to go when compared with other campaigns such as the UK's 5-a-day nutrition campaign.

It probably won't surprise you to learn that the sleep epidemic has more far reaching consequences than immediate health problems, as evidenced by the RAND Corporation report which estimates that industrialised nations lose a few percent of gross domestic product due to sleep losses (Hafner *et al.* 2017). Nike and Google are examples of companies that are learning from the evidence and implementing more flexible work schedules to suit both morning larks and night owls, as well as introducing napping pods which provide a dark and sound-isolated environment.

Final Thoughts

"Sleep well, be well."

— Sleep Education mantra, 2019.

"To sleep, perchance to dream."

— William Shakespeare, 1609, *Hamlet*.

On the purely scientific side, psychologists/psychiatrists will be particularly interested in the section about "How and Why We Dream", since many links are being found between mental illness and sleep disruption patterns, which if explored can increase our understanding of these complex disorders and lead to new therapeutic strategies. Anybody involved in biomedical research should take note of Chapter 8: "Cancer, heart attacks, and a Shorter Life: Sleep Deprivation and the

Body” (164-189), as sleep quality should be treated as a confounding factor in clinical trials of diseases it can affect.

As a student myself, I am guilty of trading sleep for better chances of success; having read this book (especially Chapter 6: “Your mother and Shakespeare knew: The benefits of sleep for the brain”, 107-132) I now reflect upon those choices as poor, and it has already changed the way I prioritise sleep.

Fixing the economic consequences of the sleep epidemic (health care costs, productivity, etc.), may require large-scale action from governments and industry, but surely as individuals the evidence presented in *Why We Sleep* should provoke us to seriously reflect on our habits, strive towards better health, and demand structural societal rearrangements. We need to talk about sleep, and we *desperately* need to sleep.

I leave the reader with Walker’s closing remarks:

“I believe it is time for us to reclaim our right to a full night of sleep, without embarrassment or the damaging stigma of laziness. [...] Then we may remember what it feels like to be truly awake during the day, infused with the very deepest plenitude of being.” (340).

I would add that we may then be able to read such a book and purely wonder at the phenomenon of sleep, and not so much at our lack of it.

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***The Book of Why*, by Judea Pearl & Dana Mackenzie. A book about how we ask questions and how to ask (and solve) better questions.**

Adrian Soto-Mota

Review of: *The Book of Why* (Basic Books: New York, 2018)

Written by *Judea Pearl and Dana Mackenzie*

"If our conception of causal effects had anything to do with randomised experiments, the latter would have been invented 500 years before Fisher." (Pearl 2016).

Engaging in the cause-effect analysis is something we cannot escape doing. Regardless of what you study, regardless of where you live, regardless of when you grew up, we all make causal inferences every day of our lives. From the African plains to Twitter feeds, almost seamlessly, the question is asked: *why* do we perform thought (or actual) experiments before we act accordingly, both intentionally and unconsciously?

Everyone has a personal stance in debates about politics, the environment or the consequences of vaccinating children. Yet despite having different opinions, our perspectives are connected by an underlying belief in causal relationships; a concept examined by *The Book of Why* which speaks to all audiences. Reading Pearl's text has made me question and reconsider my own arguments from a new perspective. I invite you to test the logic of your own arguments by doing the same.

Judea Pearl is a distinguished computer scientist and philosopher who was among the first to mathematise causal modelling. During the last decade, he has written many "technical" books about causal inference and, in *The Book of Why* explores the very intuitive but slightly daunting concepts of causal modelling and its algebra. While doing it, he also tells the story of their development and the implications of their current and future implementation in empirical sciences and daily life.

"Correlation is not causation" but... What is causation?

Anyone who has taken a Statistics course knows and lives by this mantra. No one can dispute its veracity or relevance, and it is a guiding light for data analysts. However, these words obscure the meaning of causation in our approach to modern scientific investigation.

What is causation? Have you ever asked yourself that after hearing or repeating "correlation is not causation"? Honestly, I had not.

Definitions by negation (cold as the absence of heat, darkness as the absence of light) are usually considered imperfect because they do not actually explain what the

subject means or is (Macagno & Walton 2013). It is likely that your life currently revolves around elucidating one or more causal relationships through this process of negation. But, if correlation is not causation, how do you know when you have done your job? How do you know when you already found a causal relationship? Indulge me by engaging in a thought experiment:

Imagine you stopped for a takeaway chicken wrap on your way home. You are about to get to your place when a cosmic accident throws you to a parallel reality.

You arrive at a primitive Earth populated by farmers. They have developed statistical knowledge because of its usefulness in crop and cattle management but have no clue about Physics, Biology or Geography. Of course, this civilisation is highly dependent on agriculture and therefore, the Sun.

These people are convinced that rooster's crow makes the Sun rise and therefore, worship them as deities. Remember that chicken wrap in your bag? Guess what...? They found it! Logically, you are facing death accused of the ultimate form of blasphemy in this world.

Your first reaction is, of course, telling them that they got it mixed-up, however, they quickly refute your claims by showing you their "Big-data". For the last two millennia, they have carefully collected detailed datasets, and they proudly show their beautiful plots showing almost perfect correlations between the rooster's crow and the Sun rising.

To save your life, you would correctly discard their 0.99 correlated data directly on the grounds of being ludicrous and would immediately propose experiments blinding or muting the roosters to prove the Sun would rise anyway.

My example posits how we are inclined to agree that a carefully designed and simple experiment can unveil cause-effect relationships more effectively than large and immaculate datasets. However, many of our methods, and even further, many of our questions focus on correlations and elude the true notion of causality. How did this happen? As Pearl asks, *why* did this happen?

Asking 'why' is a much more complex process than simply identifying input-response mechanisms and attempting to manipulate them (there are a lot of beings capable of similar feats). When we ask why, we engage in the abstract exercise of explaining exact causes and their direct effects.

Despite being quite complex, asking why comes naturally to us. Perhaps you haven't paid much attention to how you (or anyone) assess cause-effect relationships? This human trait changed the world because it allowed us to outperform all other species in manipulating the environment.

Our brains excel at finding patterns or explanations. This explanation thirst is so ingrained in our nature that we feel anxious around uncertainty and can be susceptible to accept almost any explanation rather than none. As a result, we are ironically prone to make wrong causal-effect conclusions (particularly in complex scenarios).

Pearl's investigation reveals that it was not until we started attempting to teach machines and artificial systems how to learn and how to produce cause-effect

conclusions, that we were forced into thinking about how we think, and into formalising the language and steps involved in causal inference.

About the Book

The book has ten chapters and three main objectives:

1. Explaining the core concepts of causal modelling in non-mathematical language.
2. Reviewing the history of how empirical science went astray from causal inference and the recent efforts made towards mathematising causality.
3. Analysing the consequences of implementing causality algorithms in machine learning as we stand in the dawn of the Big-data/machine-learning/ AI era.

A Glossary of Key Terms:

Causation: *a relationship that connects one element (the cause) with another element (the effect), where the first is at least partly responsible for the second, and the second is at least partly dependent on the first.*

Correlation: *The statistical association between two variables.*

Counterfactuals: *a conditional containing an if-clause which is contrary to fact.*

Spontaneous generation: *an obsolete body of thought on the ordinary formation of living organisms without descent from similar organisms.*

Randomised controlled trial: *A research model where participants are randomised to receive the treatment that is being studied or a placebo. Differences between groups are assessed statistically at specific times.*

Bradford-Hill's Criteria: *A group of nine criteria a proposed "cause" should fulfil in order to be accepted as such.*

Critique and Conclusion

I confess that, at the beginning of the book, I felt it was a bit over-enthusiastic with some of the ideas and that adjectives such as "revolution", "paradigm-shift" or "ground-breaking" were used lightly. However, after a few chapters and particularly after the historical review concerning how statistics regarded (or should I say disregarded) causality in chapter 2, I could not agree more with the use of these words.

The Book of Why has changed my view on the true relevance and role that clinical trials such as double-blind, placebo controlled, and randomised studies have in the advancement of medical knowledge. Pearl develops the ideas of Fisher, Pearson and Bradford-Hill who view causality not as a direct object of study, but as a logic automatically implied when we find strong correlations that correspond with our theoretical background.

After reading the first two chapters, the idea of using counterfactuals (asking "what if?") as a better tool for approaching causality seemed so obvious and intuitive that made me feel slightly embarrassed of having accepted and defended Bradford-

Hill's 'Nine Criteria for Causality' (Bradford-Hill 1965) as the gold standard for causal relationships in my field.

As Pearl and Mackenzie identify in chapter five while discussing the causal relationship between smoking and cancer, Bradford-Hill's criteria are still useful as a description of how a discipline comes to accept a causal hypothesis in the light of new evidence. However, they are limited by the lack of methodology for their implementation or quantification. In other words, because they rely on the plausibility or coherence of an idea, they are still too subjective to be scientifically useful (or coded into a machine).

What has been the biggest debunked myth in Biology? I propose *spontaneous generation* (living creatures arising from non-living matter, as in maggots from rotten meat). There was a time when challenging this idea could bring one professional, social and even legal problems. Today, even the most recalcitrant creationists would agree that "maggots come from flies, not from rotten meat". How did this happen? A very simple counterfactual is enough (What if I isolate the rotten meat?). Perhaps you remember Francesco Redi's experiment from high school, in which he placed a piece of rotten meat in a closed jar and a piece of rotten meat in an open jar to test spontaneous generation. Redi shocked his contemporaries' central belief about life by finding that maggots only appeared in the meat in the open jar.

Again, imagine that you are asked to prove the same idea "maggots come from flies, not from rotten meat" without using counterfactuals, but just the statistical methods you typically read in scientific journal of choice. How would you do it?

I knew about Redi's experiment before reading this book, I knew correlation is not causation, I knew I am supposed to find causal relationships in my work and somehow, I totally ignored counterfactuals in my methods or while I read scientific papers. Of course, there are limitations (practical, ethical and legal) to asking, "what if?" particularly in Biomedical Science. However, acknowledging that there is an "ideal" way of proving a certain idea can improve our methods even if we can't actually test it.

To conclude, I genuinely think that amidst the era of supercomputing and Big Data, the mathematisation of causality and the concepts contained in the 'the ladder of causation' (Pearl & Mackenzie 2018, Figure 1) are paradigm shifting and entail a real revolution for Science.

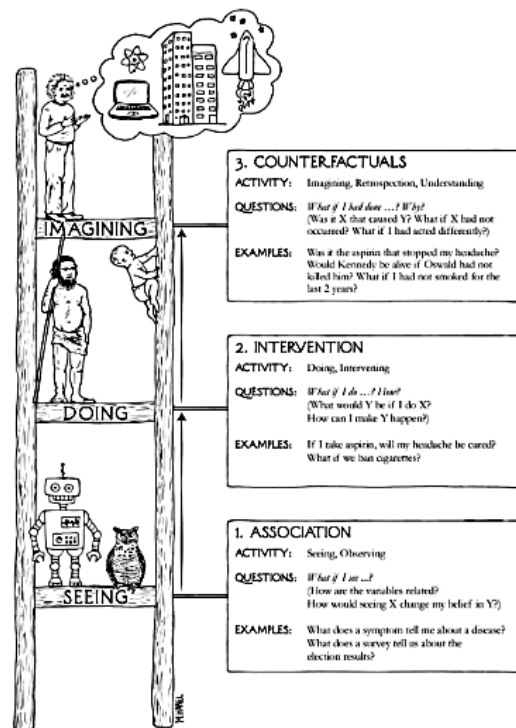


Figure 1: The Ladder of Causation (from Pearl and Mackenzie, 2018, p. 465).

Written in an accessible style, *The Book of Why* is worth reading regardless of your main academic focus or level of expertise in computer science, statistics or philosophy. From Mount Intervention to Mediation, Pearl succeeds chapter after chapter in giving the reader a new topic to consider. I would not be surprised if *The Book of Why* becomes a regular reading in many Science and Philosophy syllabi. The experience of reading and conceptualising the book's hypotheses is enriched by Pearl's narrative talent; historical events unfold before the reader's eyes, glimpsed through the authors' vivid descriptions as if they had seen them happen in the flesh. In 2019, we can manipulate our environment as was never possible in the past. Reflecting upon causal inferences is therefore more important today than ever before.

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