

Sleep, disruption, and the 'nightmare of total illumination' in late-nineteenth and early-twentieth century dystopian fiction

Introduction (1)

Artificial light is often charged with disrupting the human body's biological processes and of interfering with the oscillating sleeping-waking cycle. Alluding to Prometheus's theft of fire from the gods, Steven Lockley and Russell Foster observe in *Sleep: A Very Short Introduction* (2012) that 'the ability to light the night fell into mortal hands at the end of the 19th century, with the development and widespread installation of electric incandescent lighting' (2, pp.119–20). They contend that, '[w]hile it was possible before this time to light night with fire, candles, kerosene and gas lamps, a steady, reliable, and safe source of nighttime illumination was only possible using electricity' (2, p. 120). Over the course of nearly two hundred years, electrification has significantly impacted daily life and, consequently, the circadian rhythm, effectively disrupting the result of 'thousands of years of human ecology' (2, p.123). In the twenty-first century, the deleterious effects of shift work and of 'extending [the worker's] day and reducing sleep' are disregarded in favour of the economic and social benefits of increased electrification (2, p.121). Foster returns to this argument in *Circadian Rhythms: A Very Short Introduction* (2017) by contrasting the 'largely agricultural' period before the nineteenth century with the 'increased industrialization, cheap electric light, and increasingly 24/7 society' that followed (3, pp.30–1). He avers that 'this headlong rush into modernity, without a second thought to our biology, is having profound effects upon our health' (3, pp.31–2). The visual art and cultural critic Jonathan Crary makes a similar, albeit more nuanced, argument in *24/7: Late Capitalism and the Ends of Sleep* (2014) when he suggests that street lighting, in the late nineteenth century, 'reduced the long-standing anxieties about various dangers associated with nocturnal darkness' and 'expanded the time frame and thus profitability of many economic activities' (4, p.16). Sleep represents 'the major remaining obstacle—in effect, the last of what [Karl] Marx called "natural barriers"—to the full realization of 24/7 capitalism' (4, p.17). When sleep is disrupted, individuals lose their ability to resist this realisation and they become complicit in their exploitation under capitalism. This article is interested in the intersection Crary identifies between the disruption of sleep, the increase in artificial illumination, and the exploitation of the worker that played out in the late nineteenth and early twentieth century.

The first half of this article explores this intersection in historic terms. I first establish what was known about the oscillation of sleeping and waking states and about light's influence on sleep at the end of the nineteenth century. Early experiments on the effects of prolonged sleep deprivation in the 1890s prefigured later research in the field of chronobiology in the 1960s that led to the identification of the circadian rhythm. Although light was known to impact sleep, the full extent of its impact was not known until the late twentieth century. Drawing on this pre-history of the circadian rhythm, I then turn to examine the claim that there was a concern that increased illumination in city streets and the workplace would impact sleep. Attention to the optimisation of the habits and conditions of sleeping and waking coincided with efforts to ameliorate lighting conditions in city streets and occupational spaces. However, as initial reactions to the first installations of public electric lights in London demonstrate, these efforts were restricted to improving vision and visibility or reducing glare. I reveal that sustained research on the physiological impact of electric light was not undertaken until the first decades of the twentieth century and it arose alongside governmental interest in preventing conditions of 'industrial fatigue.' It was hoped that improvements in illumination would decrease workers' fatigue and lead to increased productivity.

According to the eminent historian of science and technology Wolfgang Schivelbusch, the early twentieth century was marked by a progression towards 'total illumination,' a culmination of the expansion and improvement of the public street lighting projects begun in the nineteenth century with the introduction of gas lamps. He proposes that the most important development in this progression was not electrification, but the introduction of a system of public street lighting in cities. As a theoretical example of such a system of 'total illumination,' Schivelbusch discusses Sébillot and Bourdais's 'Colonne-Soleil'—an Egyptian obelisk-inspired tower topped with a monumental statue of Prometheus designed to light much of central Paris from above (5, p.130,6, pp.70–1). Although it ultimately failed, he contends that the sun tower system enabled the state to exert control over the individual by ensuring that '[t]he utopian dream of nights lit up as bright as day was transformed into the nightmare of light from which there was no escape' (5, p.134). He also identifies a further example of this 'total illumination' in 'H. G. Wells's negative Utopias' (5, p.134). Indeed, as I argue in the second half of this article, the most

vociferous concerns about the impact of artificial light on the body and its rhythms were not expressed in scientific studies, trades journals, popular science texts, or letters to the editor, but in literary texts. In a recent article, Martin Willis explores depictions of sleep in a range of utopian and dystopian fictions by ‘dovetailing sleep’s historical narratives with a contemporary ethnographic story of sleep research’ (7, p.262). By placing fiction at the centre of his research, Willis demonstrates its ‘epistemological’ potential for understanding the role sleep plays in waking life. He contends utopian fictions allow careful readers to engage with sleep in an imaginative as well as an historical capacity’ (7, p.276).

Dystopian fiction offered the opportunity to represent contemporary anxieties about the impact of science and technology on individuals and society—in this instance artificial light and increased illumination—from the unsettling distance of a remote future. Through a close reading of the role artificial light articulated in three influential dystopian fictions, I address concerns around the potential of illuminary technologies to disrupt the human body’s biological rhythms. However, rather than ‘dovetailing’ my account of the pre-history of the circadian rhythm and the history of the introduction of electric street lighting in London with this close reading, I oscillate from the historical to the imaginary. In H. G. Wells’s *The Sleeper Awakes* (1899), the eponymous sleeper emerges from a cataleptic trance into a future in which electric light and power are used to oppress the working classes. His narrative exposes how easily the state can co-opt technology for its own purposes. In Aldous Huxley’s *Brave New World* (1932), constant artificial illumination coincides with the chemical and behavioural conditioning of individuals in a post-Fordian society. The proliferation of commercial lighting installations and ‘electric’ pleasures disturbs urban dwellers’ connection with nature and with night. In George Orwell’s *Nineteen Eighty-Four* (1948), access to electric current (and thus light) is strictly limited; brownouts occur intermittently and electrical rationing is politically and ideologically motivated. Individuals believed to have betrayed Big Brother, the party leader, are tortured and reprogrammed through exposure to continuous and excessive illumination. In each instance, this new technology is not seen as inherently disruptive. Rather, the encroachment of increased illumination is a consequence of the privileging of the needs or desires of certain individuals above those of others, or of society as a whole. In these novels, the exploitation of the worker, the increase in artificial illumination, and the disruption of sleep intersect to reconfigure the individual’s

relationship with nature, as well as with the state, society, and the self, revealing just how vulnerable our 'natural rhythms' are.

From 'natural' to circadian rhythms in sleep science

Sleep science in the late twentieth and early twenty-first centuries has identified a number of *zeitgebers* (or, 'time signals') important to the circadian rhythm, of which light remains the most significant (2, p.119,8, p.84). In *Rhythms of Life* (2011), Leon Kreitzman and Russell Foster explain that '[t]he natural world is full of daily, monthly and annual rhythms' that serve as exogenous factors alongside a number of endogenous factors to maintain the circadian rhythm (8, p.1). The discovery of these factors and the ability to unpack the relationship between the deeply interconnected biological processes they inform is largely due to the emergence of the field of chronobiology in the mid-twentieth century. However, as I explore here, such an understanding of the circadian rhythm is predicated on developments in the field of sleep science in the mid-1890s that helped to reframe the scientific discourse around sleep. Rather than being conceived as a passive state, supplementary to and less interesting than dreaming, sleep began to be considered as an active, conscious process worthy of further investigation. Unlike previous research in the nineteenth century, which comprised 'medical case reports of insomniacs and the mentally ill,' 'the reports of military commanders and soldiers under the strain of battle,' and 'historical reports of sleep deprivation as a means of torture' (9, p.512), the research of this period was experimental. Focusing on Marie de Manacéine's and G. T. W. Patrick and J. Allen Gilbert's experiments in sleep deprivation, undertaken in 1894 and 1896, respectively, and on Manacéine's survey of contemporary sleep science, in her 1897 monograph *Sleep: Its Physiology, Pathology, Hygiene and Psychology*, I demonstrate the impact sleep deprivation research had on the emergence of an idea of the circadian rhythm at the end of the nineteenth century. While light is not essential to this early sleep research, it is important to chronobiology in the second half of the twentieth century and in contemporary sleep science research. In considering this more recent sleep research, I connect it with concerns expressed in the late eighteenth and early nineteenth centuries about the disruptive potential of artificial light, especially regarding the prescription of ideal sleeping and waking hours, and sleeping habits, to optimise the individual body's relationship with nature.

In 1892, the Russian physician and physiologist Marie de Manacéïne assessed the effects of extended sleep deprivation in 10 juvenile dogs. She reported her findings, that sleep deprivation was more fatal than prolonged starvation, in a paper published by the *Archives Italiennes de Biologie* and presented them at the International Congress of Medicine in Rome, both in 1894 (10, p.571,11, p.316,12, p.498). Already the author of a successful monograph, *Sleep as One Third of Human Life, or Physiology, Pathology, Hygiene and Psychology of Sleep*, the first edition of which was published in 1889 and the second in 1892, Manacéïne's experiments motivated subsequent studies by Patrick and Gilbert (1896), Lamberto Dadi (1898), Giulio Tarozzi (1898), Cesare Agostini (1898), Kuniomi Ishimori (1909) and René Legendre and Henri Piéron (1928) (10, pp.571–2,11, p.317,12, p.498,13, p.512). Patrick and Gilbert in particular, who designed experiments during which they would keep their 'subjects awake continuously for 90 hours' to 'determine some of the physiological and mental effects of *enforced abstinence* from sleep,' note their debt to her earlier study (14, p. 469, italics for emphasis). They devised tests of 'reaction-time, discrimination-time, motor ability, memory, [and] attention' to measure the effects of sleep deprivation; their subjects, however, were not canine but human (14, p.469). Even though Manacéïne's experiments were performed on juvenile dogs and were notable for their cruelty and high fatalities, Patrick and Gilbert's research was considered more extreme because they used 'healthy human subjects' (13, p.512). When she reviewed their study for the 'revised and significantly expanded' English edition of her *Sleep* monograph in 1897 (11, pp.316–7), Manacéïne associated their experiments with the use of 'forced sleep deprivation' as 'a form of torture, and even of capital punishment' in 'antiquity, as well as China' (9, p.69).

The two studies were further distinguished by their respective approaches. Manacéïne's background in biochemistry informed her physiological approach to the topic. Discovering 'small hemorrhages [sic] all over the cerebral cortex' in post-mortem examinations of her subjects (13, p.512), she concluded that the brain was the organ most affected by sleep deprivation (9, p.66). Patrick and Gilbert's research was more interested in the psychological aspects of sleep deprivation. They contextualised the effects of insomnia alongside normal sleep by considering 'the depth, character, and amount of sleep following the period of waking' (14, p.469). As a result, they found that 'during a prolonged period of sleep deprivation, sleep propensity waxes and wanes with a period of approximately 24

h[ours]' (15 p.280). This finding accorded with previous accounts of the natural rhythms of sleep, such as that offered by the Scottish surgeon and philosopher Robert Macnish in *The Philosophy of Sleep* (1830), wherein he explained that sleep 'has a natural tendency to recur every twenty-four hours, and the periods of its accession coincide with the return of night' (16, p.14). But Patrick and Gilbert's study marked a shift away from investigations positing a mechanical or automated model of sleep—in which sleep was a curative reaction to the fatigue of living that could be optimised through a series of behavioural and moral correctives—towards research interested in discovering factors influencing the 'periodicity of sleep,' or a natural oscillation of sleeping and waking.

Manaceïne was interested in investigating sleep as 'the resting-time of consciousness' (9, p.59). She believed the decrease Patrick and Gilbert observed in their subjects' memory and alertness following the 'enforced abstinence' supported her hypothesis that sleep was a precondition of consciousness (memory and alertness being conditions of consciousness). Yet, due to the relatively small number of research subjects and the broad remit of their study (14, p.483), Patrick and Gilbert's own stated conclusions were heavily qualified and were 'characterized by considerable individual variability' (13, p.514). Despite their potential to motivate further study into 'how and why sleep and waking performance oscillate' or 'how may oscillators contribute to this phenomenology' (15, p.280), their experiments on human subjects did not immediately impact the direction of sleep research in the late nineteenth century. Sleep scientists only returned to this question of oscillation, or 'natural' rhythms following the emergence of chronobiology in the mid-twentieth century.

In a paper on the relationship between the adrenal cycle and '24-hour periodicity' published in 1959 (17), Franz Halberg devised the term circadian (from the Latin *circa*, 'about,' and *diem*, 'a day') to describe the 'physiologic rhythms' (18, p.675) long observed by those studying sleep. Halberg's research, and the field of chronobiology that coalesced around it, heralded a new phase in sleep research that sought to uncover connections between its endogenous and exogenous factors. The findings of experiments Halberg subsequently performed with Frank Ungar in the early 1960s indicated the existence of a natural cyclical adrenal activity: the circadian rhythm. Using a more precise methodology and devising more focussed experiments than those of Patrick and Gilbert, Ungar and Halberg isolated individual processes in a way that the earlier study could not (19, p.1060).

While later than the research and literary works covered in this article, Ungar and Halberg's work is relevant because they imposed an enforced 'lighting regimen' on their rodent subjects, approximating a generalised version of human's diurnal activity (19, p.1060). This regimen helped to establish a baseline cycle oscillating between light / waking and dark / sleeping states and established the imbrication of sleep in exogenous factors, such as exposure to light, as well as endogenous ones, like the adrenal responses to adrenocorticotrophic hormone. This research prised open the complexity of our diurnal-nocturnal rhythms and their relation to our environment to an unprecedented extent.

Subsequent work in the field of chronobiology has focussed on investigating factors that disrupt or interfere with the circadian rhythm. Kreitzman and Foster review many of these factors in *Rhythms of Life* (2011) (8, p.9), positing that, whereas we once lived in harmony with the natural rhythms that distinguished our environments, such as the rising and setting of the sun or the changing of the seasons, '[t]here is no longer any connection, so we believe, between our [body] clocks and the cycles of nature' (8, p.10). Since light is the most important of *zeitgebers* to the circadian rhythm (3, p.119,8, p.84), they naturally observe that the introduction of 'the first electric lights [...] in domestic homes in the 1880s [...] markedly changed the natural photic environment' (8, p.242). Since then the disruption of artificial light has increased exponentially. They are concerned by the disjunctive reality in which '[w]e are diurnal creatures but we live in a 24-hour world' (8, p.1), but their insistence that renewed attention to '[o]ur internal clocks' would allow us 'to optimise time as a moment' (4, p.240) overlooks the longer tradition for such calls for reform. Late eighteenth-century and early nineteenth-century literature on the topic of sleep hygiene criticised contemporary proclivities to prolong the day and disrupt the night, as I explore below.

The charge that artificial light disrupts the human body's biological processes and interferes with the oscillating sleeping-waking cycle emerged alongside late eighteenth-century utilitarian prescriptions for improving sleep. This concern further developed alongside scientific research interested in 'sleep and its causes' (9, p.5) in the early nineteenth century. In his *Lecture on Diet and Regimen* (1800), the German physician and medical writer Anthony Florian Madinger Willich warned against 'confound[ing] the natural wants of the body' by over- or under-sleeping (20, p.426). Because '[d]ay-light is best adapted to active employments; and the gloom and stillness of night to repose,' he

contended that '[s]leeping in the day-time' and 'keeping awake the greater part of the night' contravened the 'order of Nature' (20, p.491). To ameliorate one's 'sleeping and waking,' he recommended, 'no candle or rush-light should be kept burning during the night in a bedroom' because it 'disturbs and prevents the rest of those whose sleep is uneasy' (20, p.501). Moreover, he advised, 'the light of a candle stimulate[d] the brain, [and] consequently the whole nervous system' (20, p.502). In his estimation, light was not excessively disruptive to sleep but he included limiting use of artificial light among his recommendations for adopting habits and arranging conditions conducive to improved sleep hygiene.

If Willich's *Lecture* was dour and overly prescriptive, the essay in which the American polymath Benjamin Franklin criticised the use of candlelight over sunlight was playful and subversive. Published as an anonymous letter to the editor in the daily *Journal de Paris* under the heading 'Économie' in the spring of 1784 and subsequently translated into English with the title 'An Economical Project' (17, pp.511–3, 18, pp.24–6), it recounted Franklin's astonishing discovery that one could align his waking with sunrise (21, pp.511–2). Accordingly, and prompted by his 'love for economy,' he calculated that 'an enormous sum' could be saved if everyone in Paris eschewed extending their nights by candlelight and woke at daybreak (21, p.512). The *Journal de Paris* was known for 'the publication of utilitarian articles on nutrition and other domestic concerns [...] in addition to news and belle-lettres' and the essay likely appeared there as 'a gentle parody of this type of article' (22, p.25). While Franklin did not identify candlelight as disruptive to sleep, his use of hyperbole as a corrective implied that this overreliance on candles signified a disruption to the natural order.

In *The Philosophy of Sleep* (1830), one of the first systematic studies of sleep, the Scottish surgeon and philosopher Robert Macnish warned that 'whatever stimulates the external senses, however slightly, may prevent sleep' (16, p.199). Even 'the light of day, peering in at the window,' he noted, 'may awake us from or prevent slumber' (16, p.194). To better 'manag[e] sleep,' he advised keeping blinds half-shut to avoid '[t]he extremes of too much and too little light' (16, pp.306–7). Observing that the eyes 'suffer[...] much more from candle-light [...] than from natural light of day' (16, p.251), he was aware artificial light was impacting eyesight and pushing bedtimes later ('whether [the lights] be employed in study, dissipation, or pleasure'), resulting in longer working hours for labourers (16, pp.250–1).

Macnish drew on both Willich and Franklin to support his observation that ‘day [was], in a great measure, [being] converted into night, and the order of things reversed in a measure at once capricious and hurtful’ (16, p.259), although its connection with Franklin’s disapproval of ‘the absurd custom of polished society’ is more direct. This connection, in turn, demonstrates the longevity of the eighteenth-century concern for artificial light’s impact on the ‘order of things.’ He may not have been aware of the satirical context of ‘An Economical Project,’ but Macnish certainly noted its satirical tone (16, p.259), which allowed Franklin to advocate for moderation by making fun of the excessive and fashionable tendencies of modern, urban life in late eighteenth-century Paris. And, while Macnish and Franklin criticised society for disrupting sleep, both identified technology as facilitating this shift away from natural rhythms. However, the tendencies which had once been fashionable had become increasingly conventional by the 1830s, as is evident when we situate Macnish’s concerns in the context of the history of the introduction of street lighting to cities.

Franklin and Willich were writing in the infancy of what W. S. de Beer considered the ‘modern period’ of street lighting (23, p.311). Networks of gas lighting in any way comparable to twenty-first century street lighting had not proliferated in major European cities until the mid-nineteenth century. But, even though this proliferation coincided with more earnest scientific investigation into ‘sleep and its causes’ (9, pp.41–59), this research did not examine artificial light’s disruption of sleep. Rather, advances in illumination were thought to increase productivity and improve workers’ health. By the late nineteenth century, the beginning of the period considered here, the prevalence of lighting in streets and workplaces was a feature of modern life. The advent of the electric light in the late 1870s introduced some novelty to the discourse around artificial light’s role in society, but did not bring about immediate or widespread changes to the illumination of public, urban spaces. The history of street lighting is a distinctly cosmopolitan enterprise, but I will restrict my discussion of this history to London, as it is with London (and future London) that the dystopian fictions considered later in this article were concerned. By examining attempts to ameliorate street lighting in late-nineteenth and early-twentieth century London and connecting these efforts with a broader movement seeking to optimise the working body, I suggest a compelling explanation for the belated focus on artificial light’s impact on the circadian rhythm in sleep science.

Reversing the charge: the artificial/natural light binary

In his account of street lighting in *Disenchanted Night* (1995), Schivelbusch proposes that the end of the nineteenth century marked artificial light's rupture with the 'rhythms of nature' (5, p.90). He rightly suggests that street lighting's transgression of the divide between day and night was a gradual one. Indeed, it did not immediately alter city dwellers' 'natural rhythms' (5, p.91). However, as I establish, the concern for street lighting's impact on these rhythms was more protracted than he asserts. Schivelbusch's tendency towards generalisation perpetuates a narrative presuming the technological ascendancy of the electric light that warrants further investigation. For, although his account of street lighting sparked interest in the history of science and technology, this narrative shaped subsequent critical discussion of artificial light's relationship to nineteenth- and twentieth-century urban experience.

More recent scholarship has begun to push back against Schivelbusch's narrative and is indicative of wider changes in the field of history of science and technology. The historian of technology David Edgerton, for instance, proposes we consider 'history-of-technology-in-use' rather than studies focussing solely on innovation, invention, and introduction (24, pp.xii-xiv,xi). The literary critic and historian of technology Alex Goody invites us to reconsider the influence of technology on 'the human-inhabited spaces of the twentieth century' as bi-directional in history of technology studies (25, p.17). Rigorous historicist research by Graeme Gooday offers an important corrective to Schivelbusch's 'linear tale of modernization' as well as to his assumptions about the prevalence for electric lights in domestic settings (26, pp.15–6). Chris Otter's more general criticism of *Disenchanted Night* rightly points out the colonialist implications of the 'powerful, influential narrative' created by 'twentieth-century cultural historians' that 'depict "Western modernity" in terms of the relentless expansion of illumination' (27, p.2). A more subtle and yet more invasive aspect of Schivelbusch's account of street lighting is the natural/artificial light binary he constructs. This binary originates in his implication that gaslight, candlelight, and the light from oil and spirit lamps were less impactful on the human body than all forms of electric light, simply because the former were considered less invasive forms of artificial light. Building on the work of Edgerton, Goody, Gooday, and Otter to deconstruct what is 'natural' about

Schivelbusch's 'natural rhythms,' in reviewing the physiological approach to street lighting adopted at the end of the nineteenth and the beginning of the twentieth centuries, I will demonstrate that, in its 'local circumstances,' street lighting was conceived as matter of public sanitation and hygiene, not just as a technological innovation. I will then extend my discussion to include the contemporary concerns about artificial light's impact on public health during that period.

To begin with, Schivelbusch's use of 'natural' is far from neutral. Biological rhythms or processes may seem 'natural' because they are processes that arise without any artificial (i.e., technological) interference. In such a paradigm, technology is always artificial, and can never be natural. But exogenous influences have long been understood to inform and impact endogenous sleep processes, as the above discussion of apprehensions about artificial light's impact on sleep in the early nineteenth century establishes. In addition to artificial light, a number of factors associated with the modern world—consequences of industrialisation and urbanisation such as air pollution and noise pollution, overcrowding, poor sanitation, traffic, overwork—distinguish the environment in which the 'modern' body dwells from those inhabited by 'pre-modern' or 'primitive' bodies. Admittedly, 'modern,' 'pre-modern,' and 'primitive' are all contested terms; there is also no definite moment in which the modern world supplanted the pre-modern world. And yet, certain exogenous factors which have come to define the modern world have been deemed less 'natural' or more 'unnatural' or 'artificial'—even if they were not.

The electric light was the only form of artificial illumination not to have a flame. In this way, gaslight was similar to the light produced by candles and oil or spirit lamps. Although gaslight was significantly brighter and involved more technologies than these similar forms of artificial light, Schivelbusch deems it less disruptive and thus more natural when compared with electric light. In so doing, he establishes within the existing binary of natural and artificial light a paradigm in which some artificial light is more natural than other forms—a paradigm reproduced in subsequent critical studies concerned with street lighting and typified by Lynda Nead's stark observation that '[g]as lights darkness; electricity annihilates it' (28, p.83). The ostensible differences between gas and electric lighting are primarily superficial: early electric lighting installations, with their limited network of wires and local generating plants, were more invasive than the pipes, refineries,

and gasometers associated with the existing system of gas lighting. It is also worth recalling both that not all forms of electric light were as bright as arc lighting and that the incandescent gas mantle was significantly brighter than contemporary electric incandescent lights (5, pp.48–9,29, p.22). By deconstructing Schivelbusch's claims about the 'natural,' the complexities involved in determining the impact artificial light had on the 'rhythms of nature,' beyond determining whether a certain light is more or less natural, become apparent. In light of the practical and legislative connections between street lighting and the diurnal cycle in the late nineteenth century, these complexities become more evident.

When gaslights were first introduced to London streets in the 1820s, they were lit individually by a lamplighter carrying an 'oil lamp on a pole' (27, p.47) until the Austrian chemist Carl Auer von Welsbach developed the incandescent gas mantle in 1885–6 (5, p.175). Brighter and more technologically complex, the incandescent gas mantle had a continuous pilot flame and a switch allowing lamplighters to turn the supply of gas on or off; in this respect it proved a more convenient and affordable competition to contemporary electric lighting (5, p.177). The need for lamplighters was eliminated a few years later following the development of a timer-operated switch for individual lamps (30, p.130). Early electric street lighting also required daily maintenance; each time the arc lamps, first developed by Pavel Yablochkov, were extinguished they needed their carbon rods replaced (31, p.101). Arc lamps were no more disruptive than the existing gas lamps; their maintenance only reinforced the divide between day and night that predated any system of artificial illumination (5, p.35,27, pp.223,247). Although incandescent filament lamps were introduced in the 1880s, until incandescent lamps overtook arc lamps in popularity for use as street lighting in the mid-1890s, street lighting needed continual, individual maintenance (5, pp.125–8).

Well into the twentieth century, streetlamps in London were not permitted to burn through the night. Moreover, the power to decide for how long streets should be illuminated at night was decentralised to vestries and district boards, so there were local variances in the legislation surrounding 'lighting-up times' (27, p.223). These timings were often determined by financial constraints, not just out of concerns for public safety and hygiene, and were related to each area's ability to raise taxes from their ratepayers (27, p.228,29, p.307). Local

authorities had significant discretion over how street lighting was implemented and could consider how best to augment the vision of individuals according to their 'local circumstances' (27, pp.226–8). Establishing a schedule for street lighting became, as Otter contends, required negotiating with diverse 'local circumstances' to strike a balance between 'freedom and security' (27, p.222). A significant illuminary disparity developed across the city as an unintended consequence of this decentralised approach to public utilities—a disparity that defined London's unique 'lightscape' well into the twentieth century (32, p.101).

In London, electric street lighting was implemented with an attention to 'local circumstances' and to what the Liberal politician and London County Council member J. B. Firth referred to as the "'regular laws of nature'" (27, p.222,33, p.289). There was little desire to impose the conditions of day on the hours of night. Those tasked with developing the various systems of electric lighting adopted across the city installed lamps designed to achieve a standard of 'optimum perception' in densely populated areas (27, pp.224–5,30, pp.194–6). While some achieved this by setting standards for perception and regulating amounts of illumination, others did so by measuring the impact of different forms of illumination on the eye in different locations. The English electrical engineer Alexander Pelham Trotter exemplified the latter approach with his trial of different reflectors for lampposts, designed to direct light downwards, and reduce the amount of glare experienced by pedestrians (34, pp.195–6). His concern with glare, which was widely considered the most important street lighting-related challenge at the time (35, pp.73–83), motivated his interest in photometry (the science of measuring the perception of light in different conditions). His influential manual on the subject, *Illumination: Its Distribution and Measurement* (1911), positioned photometry as more than a technological pursuit. In attending to reducing eyestrain and fatigue in all lighting conditions, he suggested that photometry could provide a novel scientific approach to comprehending light's somatic impact (34, pp.190–2). For Otter, Trotter belonged to a burgeoning class of 'engineer-physiologists.' These hybrid practitioners 'did not see their responsibilities terminating where their lamps physically finished, for the radiance they produced penetrated the pupil and lens and stimulated the retina, optic nerve, and brain; it [(i.e., the radiance)] was incorporated' (27, p.204). This conception of the engineer-as-physiologist offers a possible re-

contextualisation of the narrative of artificial light's disruption within a historically contingent discourse of adaptation, integration, and augmentation. As I discuss below, this hybrid approach also coincides with the emergence of 'industrial physiology' in interwar Britain.

Reversing the charge: illuminary physiology and the introduction of the electric light

In the autumn of 1878, 20 Yablochkov lamps were installed along the Thames Embankment as part of the first trial of public electric lights in London. Shortly thereafter, the trial was extended to the Holborn Viaduct, the front of Mansion House (home to the Lord Mayor of the City of London), and a section of the Victoria Embankment between the Waterloo and Westminster bridges. By 1879, electric lighting was used in factories, offices, shops, railway stations, munitions factories, hotels, along seafronts, at private members' clubs, and in the Reading Room at the British Museum (36, p.6). The scale of adoption of the electric lighting at this time is impressive, given that many of the technological challenges associated with electric lighting had yet to be addressed or resolved. There were, for instance, no central-supply stations from which these installations could draw their power; each would have had to establish their own, isolated, generating plant. Other technological obstacles included a lack of reliable incandescent lamps and the 'battle' between direct current and alternating current systems (37, pp.22,79), but these were not unique to London. London faced a series of administrative obstacles related to concerns over the role of centralisation in urban administration as well as about the relative merits of public versus private undertakings that meant electric lighting and supply systems in the city developed in a localised, piecemeal, and pluralistic manner (37, p.229,38, p.292). Overall, these challenges account for the relatively limited uptake in electric street lighting at the time. Nevertheless, some expressed concern about the impact this new form of illumination would have on public health.

The most prominent critic of the electric light was the Scottish novelist Robert Louis Stevenson, who, in his 1878 essay 'A Plea for Gas Lamps,' described the electric light as 'a new sort of urban star [that] now shines out nightly, horrible, unearthly, obnoxious to the human eye' (39, p.231). Casting the electric light as the sort of light that 'should shine only on murders and crime, or along the corridors of lunatic asylums, a horror to heighten horror' (39, p.231), his objections to electric light were aesthetic, hygienic, and moral. By contrast, Stevenson treated gas lamps with a benign reverence, calling them 'biddable

domestic stars,' 'more practically efficacious than Jupiter himself' (39, p.228). He lauded gas lamps for advancing the 'work of Prometheus' and bringing forth 'a new age [...] for sociability and corporate pleasure-seeking'(39, p.228). Despite the nostalgia invoked by the title of his essay, Stevenson's 'A Plea' established a comparison between two technologies that were in competition with one another, not in succession. The electric light ('A lamp for a nightmare!')(39, p.231)) represented a technological development that was not only undesirable but unnatural. Subsequent scholarship suggests that Stevenson's 'plea' articulated contemporary objections to the sudden and severe transition from gas lamps to electric arc lighting in city streets (5, p.134,40, p.105,41, pp.144-5). Schivelbusch, for instance, concludes that, following the introduction of electric arc lighting, as Stevenson presaged, the 'Utopian dream of night lit up as bright as day was transformed into a nightmare of light from which there was no escape' (5, p.134). However, as Folkert Degenring points out, 'critical voices' like Stevenson's 'appear to be comparatively rare and isolated' (42, p.205). The concept of and concern with 'light' pollution only develops following an increase in the 'perception of unwanted side effects of specific lighting techniques as a form of pollution' and campaign in American astronomers for 'legislation to limit nocturnal illumination levels' in the 1960s and 1970s (42, p.206).

The tenor of public reaction to the trial installations in London in 1878 can be gauged more generally in letters to the editor published in *The Times*. The earliest letters, the first of which appeared in the 4 October edition, either demonstrate a greater concern with the cost and practicality of the new technology than with its dangers or they emphasise its potential and utility. In December 1878, *The Times* published a letter expressing dissatisfaction with the Embankment and Holborn Viaduct installations' use of 'opaque globes' to cover the street lights and bemoaning the installation of lights which were 'scarcely distinguishable from a good ordinary gaslight' (43, p.6). The editorial pages of *The Times* continued to feature discussions about concerns for or the improvement of the implementation of electric lighting in the subsequent years. But only some members of the general public were sufficiently opinionated to write to *The Times*. Technical experts also participated in popular, public discourse on the introduction of the electric light, but their contributions to a variety of governmental research and policy committees, particularly those interested in determining optimal illuminary conditions, had a more significant impact on electrification.

In 'The relative hygienic values of gas and electric lighting' (1908), the well-regarded inorganic chemist Samuel Rideal reported the findings of Royal Sanitary Institute's investigation of the 'direct' and 'indirect' effects of both types of light in 'ordinary domestic' settings (44, p.49). Undertaken thirty years after the introduction of the public electric light to London, this was the most extensive and expansive study on the subject to date. Studying physiological factors ranging from circulation and respiration to body temperature and weight, the researchers also considered mental fatigue, reaction times, and ophthalmic functions (44, pp.60–119). The tests conducted relating to light and fatigue, both mental and ocular, proved interesting for unexpected reasons. The researchers predicted that determining 'the effect of the light employed upon the organ which transmits it to the brain' would be 'one of the most important lines' of inquiry (44, p.116). However, testing 'visual acuity,' orbicular and ciliary muscle reactions, and retina responses in terms of gains and losses in illuminary conditions that were 'identical' across both gas and electric light, they found that while the eye was slightly less sensitive in its responses when exposed to electric light, more gains were recorded when the eye was exposed to gas light (44, pp.116–7). Overall, they concluded that 'the differences found between the two [types of] lights were so small as to be absolutely devoid of any hygienic significance' (44, p.123). Individual preference for a particular form of illumination, they extrapolated, 'belong[ed] to the domain of pathology rather than that of hygiene' (44, p.124).

In the next decade, a number of collaborative studies were undertaken by members of the electrical engineering community and by medical practitioners. This research began in earnest during the Great War, when the Health of Munitions Workers Committee (HMWC) was founded following the 'Shell Crisis' of 1915 (45, p.730). Motivated also by a 'national efficiency' drive, the HMWC, which ran until December 1917, discovered a 'direct correlation between good working conditions—especially adequate light, ventilation, washing, sanitary and safety provision, seating arrangements, and clothing—and productivity' (45, p.731). This concern for productivity extended into the interwar period and one of the results of HMWC's work was the establishment of a permanent Industrial Fatigue Research Board (IFRB) in 1918 (45, p.731). Steffan Blayney identifies 'an important shift in scientific and political discussions of fatigue at the turn of the twentieth century' from individual to 'industrial fatigue' (46, p.310). He develops the critical term 'industrial

physiology' to describe the 'new scientific conception of the body in which health was equated squarely with productive capacity' emerging out of the 'opposition between efficiency and fatigue' and culminating in 1920s and 1930s (46, pp.312–4). Appointed by the Department of Scientific and Industrial Research (part of the Home Office and adjacent to the IFRB) in 1923, the Illumination Research Committee (IRC) was responsible for studying 'illumination on general lines' (47, p.iii). Although the Departmental Committee on Factory Lighting had been in existence since 1913 and had issued three reports, 'more precise knowledge of the conditions of illumination desirable on physiological and psychological grounds' was needed (47, p.iii).

In 1926, the IRC produced a joint report with the IFRB on the 'fine work' involved in 'hand-composing in letterpress printing' (47, p.iii). As in Rideal's report, the most significant findings relate to the topic of 'fatigue': first, that '[i]nadequate illumination may be expected not only to diminish the rate of production, but also to increase the fatigue experienced by the worker' and, second, that 'maximum fatigue was experienced by both subjects when the minimum illumination was provided' (47, p.8). The report concluded that there was little risk of increased 'ocular fatigue' with the reasonable use of adequate artificial light,' but it also observed that, in certain settings, where 'the work has to be done continuously in artificial light, as in newspaper offices,' increased illumination was 'essential, if the efficiency of a night shift is to approach that of a day shift' (47, p.11). No concern was expressed for the impact of the night shift on either productivity or the workers' health, nor did the study account for the 'vague sense of oppression which seems to be induced by the nearness of a powerful light source' felt by compositors participating in the study when they were exposed to excessive illumination (47, pp.10–1). What is clear from this study, and from more general research on artificial lighting in industrial or other occupational settings, is that artificial lighting was used in a limited capacity and that it was treated as supplementary to daylight. Dis-ease with the increased illumination of public and private spaces manifested much later in the twentieth century in relation to the emergence of the concept of 'light pollution.' Although throughout the late nineteenth and early twentieth centuries there was a sense of resignation to or acceptance of this increased, some concerns were expressed much earlier in the nineteenth century—when gas lights were introduced into city streets, work places, public institutions, and households.

Critics of the social and cultural repercussions of industrialisation and urbanisation found the increased use of artificial light in industrial workplaces in the mid-1800s concerning. The French historian Jules Michelet's description of factories 'flooded by brilliant light' in *Le Peuple* (1846), exposed the impact modernisation was having on those who had quit the country for manufacturing and textile work in the city. Idealising pre-industrial life, Michelet decried how '[t]he vast, white-washed, new-looking rooms of the mill, flooded with light, hurt the eye accustomed to the shadows of a lowly roof' and lamented the loss of the 'deep obscure [of the humble, rural abodes] into which the thoughts can plunge,' of the 'sombre corner where the fancy can build up its dreams,' and of the 'possible illusion when surrounded by a broad daylight which permits escape from the harshness of reality' (48, p.51). Here, expectations of increased productivity through improved public hygiene and working conditions and the corresponding lack of individual autonomy, privacy, and agency proved a greater threat to the individual than the increased illumination, although this increase facilitated the threat. Not only were workers expected to produce more, but they were more visible and thus more exploitable by their employers.

Artificial light's impact on the body's 'natural rhythms' at the end of the nineteenth century and beginning of the twentieth century was more nuanced than it is often portrayed when considered in the context of the origins of 24-hour culture. As I establish above, there was variance in concern expressed over artificial light's impact on public health varied across the late nineteenth and early twentieth centuries. And it is important to reconsider the relationship between electric light, sleep, and the body in a way that acknowledges its resistance to the convenient and constructed narratives of innovation, disruption, and ascendancy often associated with modernity in studies of the history of technology. However, despite the care taken in adopting the electric light in city streets and the attention given to optimal levels of illumination, the proliferation of artificial light in industrial and other occupational spaces facilitated an expansion of the exploitation of the worker under capitalism. One possible consequence of this expansion of illumination, and thus of working into private life, was the disruption in sleep. In dystopian fiction's portrayal of fully-electrified future cities and authoritarian societies, this expansion enacts a reconfiguration of the body's relationship with nature, on one level, as well as the individual's relationships with the state, society, and the self, on another level. As I will set out below, the disruption

of sleep is only one way in which this co-option of increased and total illumination by social and political forces affects individuals—at its most extreme, it results in the annihilation of the self.

'The Battle of the Darkness' and Wells's power / power dynamic

In *The Sleeper Awakes*, Wells employs the narratological device of the extended slumber to allow readers to experience an unfamiliar future from the perspective of someone who is closer to their own time. Graham, the eponymous Sleeper, has been in a cataleptic trance since shortly before Queen Victoria's Diamond Jubilee in 1897. He awakes in 2100 to discover that he has amassed great wealth and has become the owner of the entire world. A Council has been ruling in his stead and acting in his (and their) financial interests. From his private room atop the city, Graham's 'first impression' of this future London is of its 'overwhelming architecture,' with its 'aisle of Titanic buildings,' and 'mighty cantilevers,' 'gigantic globes of cool white light,' and 'gossamer suspension bridge[s]' (49, p.42). His awakening, however, disrupts the world order that has coalesced around him and riots break out across London. While new technologies meant to improve standards of living disrupt the body's biological rhythms, these disruptions effect a more sinister distortion of the individual's perceptual experiences that perpetuates the authoritarian *status quo*, as Graham himself experiences in 'The Battle of the Darkness.' During the rebellion which Ostrog leads under the pretext of freeing the Sleeper, the Council use their total control of the electric supply utilities to disrupt the skirmishes occurring across the city, throwing combatants into a chaos of intermittent darkness and unreliable illumination. Graham joins Ostrog's rebel forces to defeat the Council, but rather than reforming society's ills, Ostrog continues to exert power over the disenfranchised working class using Graham as a figurehead.

After breaking from Ostrog, Graham sets out to ascertain the true conditions of this future world only to learn that London's modern marvels and luxuries come at the expense of exploited workers living in suburbs, slums, and gargantuan workshops on the periphery of the city. Everywhere, individuals are denied their autonomy and agency in exchange for oppressive political stability and superficial entertainments. The subterranean 'working places' staffed by 'men and women and children in pale-blue canvas, with their thin yellow faces and full eyes' ensure the city dwellers above ground are supplied with food, goods,

and electricity (49, pp.161–2). When Graham himself visits, he finds the working conditions appalling even by late-Victorian standards (49, pp.193–5). The ‘factories that were not working were sparsely lighted’ and ‘their shrouded aisles of giant machines seemed plunged in gloom, and even where work was going on the illumination was far less brilliant than upon the public ways’ above ground (49, p.194). Despite claiming to have ‘abolished destitution’ (49, pp.161–2), the working conditions overseen by the ‘Labour Department’ are abject. Graham’s time in the subterranean workhouses leave him with the impression that a present (or, indeed, a future) in which ‘the city had swallowed up humanity’ (49, p.128) was, in fact, a nightmare from which he could not awake. His promise to relinquish his proprietary power over the world to its people remains unfulfilled at the novel’s close; the narrative ends as he is about to face the black troops from Africa sent by Ostrog to destroy him.

In *The Sleeper Awakes*, increased productivity wrought by increased illumination ultimately serves to disenfranchise and deprive the working class of the goods, services, and utilities they produce. And yet the city-dwelling elite are subservient to the plutocratic state through their continual consumption of opulent food and luxurious goods. In this way, Wells returns to a theme he explored in his earlier novel, *The Time Machine* (1895), where he followed the trajectories of contemporary capitalist tendencies to their extreme conclusions and used the trope of the future city to exacerbate the disparity between the ‘Haves’ and the ‘Have-nots,’ between the sites of production beneath the city and those of consumption above it (50, p. 48). But the darkly dystopic world of *The Sleeper Awakes*, in which science, technology, and society have gone wrong, manifests in a Foucauldian power / power dynamic in which electric power is collocated with political power. As one of Wells’s ‘negative Utopias,’ notable for their ‘glaring shadowless light’ (5, p.124), the novel provides a most effective example of Schivelbusch’s ‘nightmare of total illumination’ (5, p.134, n.121).

The ‘Battle of the Darkness’ chapter is marked by an unsettling uncertainty about the future of electric light unique to Wells’s lifetime which manifests in the intermittent flickering of the electric current during the skirmishes that take place across the city in the name of liberating the Sleeper and his people. At its outset, the scale of the conflict can only be apprehended from a great height, but even this aerial view lacks distinction: ‘Far away, high up, seemed the mouth of a huge passage full of struggling humanity. The whole

multitude was swaying in congested masses. Individual figures sprang out of the tumult, impressed [Graham] momentarily, and lost definition again' (49, p.81). The image of an 'individual figure' emerging from a 'congested mass' only to suddenly disappear recurs throughout the passage, is repeated, distorted, and unresolved. For Graham, '[a]ll his impressions were vague save the massive emotion of that trampling [sic] song. The multitude were beating time with their feet—marking time, tramp, tramp, tramp, tramp. The green weapons waved, flashed, and slanted' (49, p.81). Here, the repetitive 'tramp, tramp,' like the image of the emerging and retreating figure, demarcates the long passages of sensory descriptions (49, pp.80–3). When the battle begins and a quick succession of flares are set off one after the other, the flickering of these 'blinding stars' replaces the resonance of the 'tramp, tramp, tramp, tramp' and ensures the ensuing clashes unfold without visual coherence.

Before the battle erupts, the city is marked by consistency of its illumination, its artificial daylight. But, in order to shore up its control of the city, the Council thrusts the masses into a sudden, pervasive darkness. Graham experiences this plunge as 'a curious emotion—throbbing—very fast' (49, p.83). He begins to realise, however, that the throbbing 'had something to do with the lights':

At first it seemed to him a thing that affected the lights simply, an isolated phenomenon having no bearing on the things below. Each huge globe of blinding whiteness was as it were clutched, compressed in a systole that was followed by a transitory diastole, and again a systole like a tightening grip, darkness, light, darkness, in rapid alternation (49, p.84).

As the disruption to the electric current and, consequently, the city's lights, continues, its effects worsen. The lights 'flickered faster and faster, fluttered between light and extinction, ceased to flicker and became mere fading specks of glowing red in vast obscurity' until a 'roaring darkness, a black monstrosity' emerged, 'suddenly swallow[ing] up those glittering myriads of men' (49, p.84). Order is eventually restored to the city when Ostrog takes control of the wind-vanes and, consequently, the city's power supply. But Graham's impressions of the battle remain fragmented and dreamlike (49, p.92). This flickering and breakdown of the lights affects his vision, so, to reconcile what he witnessed with his reckoning of the events, he must reassure himself that 'the awakening, the shouting

multitudes, the darkness and fighting' were 'a phantasmagoria, a new and more vivid sort of dream' (49, p.92). What else could explain why 'it was so inconsecutive, so reasonless' (49, p.93)? And yet, it was 'no dream' (49, p.93). The Council uses the future city's illuminary technologies to create an artificial daylight that disrupts the natural oscillation of night and day and then abuses them to plunge the uprising masses into a night that must seem both chaotic and unnatural. However, while the unexpected awakening of the titular Sleeper disturbs the political order which exploits the labouring classes to ensure the luxurious living conditions of the elite, the novel ends without Graham fulfilling his promise to restore the balance of power to the people.

Huxley's dystopian rhythms: biological conditioning and the extinction of night

Starting in the hatchery incubators (artificial gestation units) with a process known as 'bokanovskification' (51, p.3), individuals in *Brave New World* are constantly conditioned through their environment. In Huxley's future world, all babies are 'decanted' (born) outside the human womb, after which individuals are conditioned differently according to their castes (Alpha, Beta ... double Epsilon) (51, pp.3-5). The effects of this conditioning are explained using the analogy of developing a photographic negative, a process which initially relies on exposure to light to capture images and on chemicals for its development. Mr Forester, the director of the Central Hatchery and Conditioning Centre, explains to his new students that "'Embryos are like photographic film [...] They can only stand red lights'" (51, p.8). In this way, Forester configures the illuminary atmosphere as fundamental to the development process (whether of a person or of negatives) and it is worth exploring the commonalities between embryos and photographic film beyond their sensitivity to particular wavelengths of light to expose Huxley's philosophy of environmental and social conditioning.

The concept of film as a negative waiting to be developed is reminiscent of Locke's philosophy of the *tabula rasa*, according to which all individuals are conceived to be the same, diverging from this innocent beginning as they grow up under the influence of their families and society. Outside of the womb, the individual's development can be manipulated, just as that of the photographic film can be in the development chamber or laboratory. The analogy of embryo-as-negative encapsulates the importance of light to behavioural conditioning in the novel. While 'sleep-teaching, or hypnopaedia' (51, p.20), is

less well-developed in the novel than the 'bokanovskification' process, it provides another example of conditioning to which individuals are exposed post-decantation. An experimental practice developed in the early days of the novel's society, hypnopaedia was discontinued when researchers discovered that it did not alter behaviour but resulted in rote learning; it had limited 'moral' applications (51, p.21). Yet, while conditioning happens in conscious and unconscious states in the novel, the most effective conditioning is that which is continually and consciously reinforced. The 'bokanovskification' process represents technology at its most disruptive, not only because of the intense stratification of society it begets, which is presented as useful *and* natural, but also due to the dependence on technology and other consumer goods it inculcates. The mantra that 'even epsilons are useful' conceals the reality that the continuation and happiness of such a society rests not only on the exploitation of the lowest castes but on their reproduction (51, pp.10–1,63–4). The embryo-as-negative also anticipates the way in which the screen of sky-signs that block out the darkness of the sky later in the novel naturalise and reinforce an ignorance of night (51, p.67).

Powerful illumination and strategic darkness collocate in the novel to reinforce established habits of consumption. At the 'feelies' (a cinematic advance from the 'talkies'), when the audience is plunged into 'complete darkness,' the 'stereoscopic images' on the screen become 'dazzling and incomparably more solid-looking than they would have seemed in actual flesh and blood, far more real than reality' (51, p.146). Here, the artificial is supplanting the natural. The convenience and pleasures of the novel's 'electric city' are a consequence of the disconnection from the natural world created by biological and behavioural conditioning of individuals. The extent of this correlation between artifice and enjoyment is evident when Henry and Lenina attend a show at the Westminster Abbey Cabaret. There, one sacrilege—a nightclub in a former place of worship—accompanies another profanation: irreverence towards nature. The 'electric sky-signs' advertising the performance of 'CALVIN STOPES AND HIS SIXTEEN SEXOPHONISTS,' or 'LONDON'S FINEST SCENT AND COLOUR ORGAN' with 'ALL THE LATEST SYNTHETIC MUSIC,' 'effectively shut out the darkness' and Lenina and Henry are immune to the beauty of night (51, p.65). Huxley's narrator is most disconcerted by their lack of awareness of this 'whole depressing fact' (51, p.65). Their disconnection from the natural world is complete: '[t]he

depressing stars had travelled quite some way across the heavens. But though the separating screen of the sky-signs had now to a great extent dissolved, the two young people still retained their happy ignorance of the night' (51, p.67). In this dystopia, night's darkness is thus not only unnatural but also unnoticed and unappreciated. Moments of sensual overload like these reveal a fundamental incompatibility between the pursuit of individual happiness and freedom within the realms of pleasure and leisure, on the one hand, and a state of mind in which individuals can question or challenge their society's power structures, on the other.

Huxley approaches the possibility of using artifice to entice consumers from a different perspective in his novel. Explaining to a group of trainee nurses why Gammas, Deltas, and Epsilons had once been conditioned to 'like flowers—flowers in particular and wild nature in general [...] to compel them to consume [(i.e., make use of)] transport,' the Director of Hatcheries and Conditioning reveals that the purchase and use of products, services, and resources was the factor motivating all conditioning. But, since '[a] love of nature keeps no factories busy,' authorities decided to 'condition the masses to hate the country' but to 'love country sports' and, thus, compel people to 'consume manufactured articles as well as transport' (51, pp.18–9). These ersatz preferences are further reinforced by the administration of 'electrical shocks' (51, p.19) reminiscent of those delivered to real-life participants in Patrick and Gilbert's sleep deprivation study. Alphas, like Lenina and Henry, operate on the assumption that they, unlike the lower classes, are not conditioned and that they alone live in a natural and unconditioned state. This cognitive dissonance is a product of their position in the hierarchy, facilitated by their access to knowledge not permitted to the other castes. But freedom and individuality are concepts constructed in opposition to the restrictions imposed on and conformism of the labouring masses; inhabitants of the World State have been conditioned to think in these binary terms: a thing is either natural or unnatural, civilised or uncivilised, individual or mass. This thinking is evident in Lenina's association of continuity with the absence of civilisation when confronted with the realisation that those inhabiting the Reservation in New Mexico live in the same manner as their distant ancestors ("“they've been doing it for the last five or six thousand years [...] they aren't civilized”" (51, p.94). The implication here is that what is civilised is whatever is the newest or most discontinuous with the past.

The 'Newspeak' vocabularies and concept of *doublethink* which Orwell introduces in *Nineteenth Eighty-Four* can help to account for the consequences of such binary thinking exhibited in *Brave New World*; at its extreme, binary thinking can be positively dystopian. 'Newspeak' vocabularies were 'designed not to extend but to *diminish* the range of thought' through both a 'reduction of vocabulary' and through a morphological strategy in which any binary terms (i.e., 'two words [that] formed a natural pair of opposites') were elided by suppressing one of the two terms (52, p.346, italics in original). The example Orwell provides is that '*Dark* [...] could be replaced by *unlight*, or *light* by *undark*, according to preference' (52, p.346, italics in original). Although he indicates no preference for either pair of terms here—light and 'unlight' or dark and 'undark'—elsewhere in the novel Orwell describes an abundance of illumination in terms of an absence of darkness, the implications of which I will address in my subsequent discussion of *Nineteen Eighty-Four*.

Doublethink, defined as 'the power of holding two contradictory beliefs in one's mind simultaneously, and accepting both of them' (52, p.244), emerges through a concomitant narrowing of linguistic expression and comprehension of complex concepts or experiences; it reduces this complexity to binary, oppositional terms. In the novel, this elision of linguistic and conceptual binaries inculcates a widespread state wherein the power / knowledge paradigm identified by the French literary theorist Michel Foucault (53, pp.98–9) is reconfigured as the aphorism 'IGNORANCE IS STRENGTH' (52, p.6). The disruptive effects of total illumination that the novel's protagonist, Winston Smith, experiences in Room 101, attempt to effect this elision through the annihilation or extinction of darkness. And yet, while either darkness or light can be completely extinguished, and one can also diminish the other, they cannot exist, simultaneously, in their extremes. So long as light and dark remain nuanced and distinct, it is possible to resist the full force of *doublethink*. The disruptive effects of total illumination on the body, when combined with sleep deprivation, have a deleterious effect on intellectual and emotional capabilities, effectively decreasing the individual's resistance to *doublethink*. As I discuss in detail below, for Orwell, the state's use of total illumination to reduce the individual's autonomy and subjectivity alongside the diminishing effects of Newspeak on both thought and expression explicitly enacts a superintendence of technology over the body. In this way, Orwell's elision of the light / dark binary belongs to a larger threat posed by the authoritarian state's exertion of total control over the individual

that has both physical and ideological consequences. For Huxley, this manifests in a de-naturalisation of night. The threat of total illumination does not take the form of a 'nightmare,' as Schivelbusch suggests, but the alienation of the individual from the natural world. The consequences of this alienation are not primarily physical, in that they do not overtly disrupt sleep, but ideological.

'The place where there is no darkness' (52, p.29)

Orwell's own dystopian fiction served as a platform for his criticisms of utopian fiction's tendency to idealise the relationship between technology and the future city. According to Emmanuel Goldstein's 'The Theory and Practice of Oligarchical Collectivism' — a subversive metatextual treatise read by the protagonist of *Nineteen Eighty-Four* — utopias were ubiquitous at the beginning of the twentieth century (52, p.218). They represented 'the vision of a future society unbelievably rich, leisured, orderly and efficient' that, while at odds with contemporary urban experiences, built on the assumption that science and technology would progress with 'prodigious speed' (52, p.218). In Orwell's future, these utopias failed to materialise in part 'because scientific and technical progress depend on the empirical habit of thought, which would not survive in a strictly regimented society' (52, p.218). And, while science and technology exist in the authoritarian state that arose in Winston's world, because 'ideology controls technology' (52, p.55), they are static and reinforce the oppressive *status quo*.

The novel's protagonist, Winston Smith, lives in Airstrip One, the 'third most populous of the provinces of Oceania,' of which London is the capital (52, p.5). This future city is a most cruel and brutal dystopia through which Orwell could explore post-war, anti-communist anxieties. While individuals appear equal, a self-oppressing surveillance society reinforces an egalitarian façade. Political power is ostensibly centralised and located in the individual authority of 'Big Brother' but is facilitated through the support of his party members. Inhabitants live in an urban consumer culture, but are perpetually subjugated to an orchestrated scarcity of resources. These contradictions are explicit from the novel's opening chapter, when the reader learns that 'the electric current was cut off during daylight hours' as 'part of the economy drive in preparation for Hate Week' (52, p.3). Rationing is not practical but ideological. In the case of electric power for heating and lighting, the intermittent rationing was both involuntary, in that it was achieved through coercion, and

unnecessary, in that there was no real scarcity. In fact, as Winston later discovers there was an abundance of power elsewhere, as in the Ministry of Love's Room 101, where an excess of light, amongst other forms of psychological and behavioural conditioning, is used to punish and torture political dissidents. This conditioning has a deleterious effect on individuals' intellectual and emotional capabilities, thus reducing their ability to resist the elision of the light / dark binary and to retain their autonomy and subjectivity.

As I proposed above, this superintendence of technology over the body is part of a larger threat posed by the authoritarian state's exertion of total control over the individual. Significantly, Orwell's treatment of the light / dark binary in *Nineteen Eighty-Four* builds on representations of artificial light and the trope of increased illumination established in the earlier dystopian fictions of *The Sleeper Awakes* and *Brave New World*. Wells's novel imagines the widespread use of electric street lighting controlled by a plutocratic city Council at a time in history when electric lighting technologies were in their infancy, central power stations were uncommon, and the idea of a publicly owned utility was limited at best. Huxley's novel conceived a post-Fordian world in which the city's constant illumination facilitated the chemical and behavioural conditioning of the individual, inspired by developments in public lighting that took place in London following the Great War. Orwell's representation of artificial light in *Nineteen Eighty-Four* is less straightforward, which is understandable, given the novel's proximity to the 'blackouts' of WWII and the rationing and shortages of post-war Britain.

In *Nineteen Eighty-Four*, Winston dreams of 'the place where there is no darkness' (52, p.29). A place defined solely by the absence of darkness is difficult to imagine, but its portentousness fills him with a pervasive anxiety. When he is later apprehended for his thoughtcrimes and seditious actions, he is taken to a room where the lighting is unrelenting: the 'humming sound and the unvarying white light induced a sort of faintness, an empty feeling inside his head' (52, p.278). There, he feels ill and not only is he disconnected from the world outside the Ministry of Love but he loses his temporal awareness (52, p.260). Ampleforth, a colleague from the Ministry of Truth imprisoned alongside Winston, laments the lack of "'difference between light and day'" and his inability to "'calculate the time'" (52, p.266). This atemporality is merely one of the many disconcerting conditions of imprisonment that are meant to intimidate and degrade prisoners of the state. As the

narrator explains, 'the aim of this was to simply humiliate him and destroy his power of arguing and reason' (52, p.277). For, although Winston had managed to establish privacy and quietude in the darkness of his room in the Victory Apartments—a space where he thought, mistakenly, he could rebel against the Party and its ideals—this is gradually annihilated. Indeed, '[s]ince the moment when they arrested him he had not seen darkness or daylight' and, as a result, 'his memories were not continuous' (52, p.275). If the darkness and quiet of his own bed had earlier enabled him to 'think continuously,' the discontinuity of his mental processes is here exacerbated and amplified by the constant illumination which troubles his sleep (52, p.125). Here he has 'memories of another kind,' the kind that 'stood out in his mind disconnected, like pictures with blackness all round them' (52, p.278).

Individuals in Orwell's novel are most vulnerable to the authoritarian state and least autonomous in 'the place where there is no darkness.' Winston is kept 'in a cell which might have been either dark or light [...] he could see nothing except a pair of eyes' (52, p.278). Recalling the synecdochial eyes of Big Brother which seemed to followed him from the poster in the hallway to his flat earlier in the novel, here they haunt his sleep, his most private and unconscious moments. Big Brother eradicates all capacity for resistance through this invasive conditioning so that, when Winston emerges from the Ministry of Love, he is no longer himself, nor can he reckon this. Sleeping consistently and dreaming coherently for the first time in his memory, he feels reassured that he has kept his individuality and evaded what he most feared: becoming a true acolyte of Big Brother (52, p.316). He experiences some residual nostalgia without the associated pain; he is able to drift listlessly through his daily routine without his former angst and apathy. And, until the novel's denouement, when he learns to love Big Brother, Winston remains wilfully ignorant of the ways in which his experiences of total illumination in the Ministry of Love have reprogrammed him. While this is an extreme instance of artificial light's impact on the body, it demonstrates that the greatest threat the use of artificial light by the totalitarian state (or individuals) poses is not merely to disrupt sleep, but to reduce and, in some cases, annihilate individual autonomy.

Conclusion

When contrasted with Wells's, Huxley's, and Orwell's dystopian treatments of increased artificial illumination, Manaceïne's observation, that '[t]he importance of light for the conscious intellectual life is so great that [...] a better illumination of our houses by windows

and good illuminants, and a perfected system of street lighting, should distinctly favour the growth of social life' (9, p.172), has a distinctly utopian undertone. Her belief that improvements to illumination and optimisation of vision would naturally result in the increased well-being of society aligns with contemporary responses. Dystopian fictions, however, expose the fallacy of technology-as-progress, whereby technologies actually perpetuate the *status quo*. Whether in the capitalist system of late-nineteenth or early-twentieth century Britain or in the authoritarian states dystopian fictions depict, this fallacy serves to entrench the exploitation of the working class, as Graham learns in *The Sleeper Awakes*. Combining what Gordon Beauchamp identified as 'the fear of utopia,' which manifests 'a fear of stasis and perfection,' and 'the fear of technology,' these novels enable an examination of the very 'nature of technology' not possible in realist fiction or non-fictional writing (54, pp.52–7).

Returning to the present threat of total illumination we are facing in the twenty-first century, there is a critical consensus that our sleep is affected by a '24-hour society' in which we live, with its '24-hour news coverage, all-night supermarkets, continuous internet availability' (2, p.119). Crary is clear that '24/7 steadily undermines distinctions between day and night, between light and dark, and between actions and repose' (4, p.17). And, as Huxley's depiction of the chemical and behavioural conditioning of individuals alongside the supersession of the natural world by the artificial, 'electric city' in *Brave New World* demonstrates, this '24/7' can be ideological and psychological as well as physical. In the extreme case of *Nineteen Eighty-Four*, there is no 'natural' oscillation between night and day, sleeping and waking. When compared with the forceful exposure to continual illumination in the Ministry of Love to destroy rational subjectivity and re-condition political dissidents, the enforced regimen of brownouts or rationing experienced by party members seems mild. Both tactics, however, rely on the state's ability to create and control optimal illuminary conditions.

Better self-regulation that, in turn, improves the harmonisation of bodily rhythms with those of a 'natural' nature results only in a limited resistance to the 'nightmare of total illumination' within a 24/7 culture outside dystopian fiction. An attentive reading of how increased artificial illumination reconfigures the body's relationship with the natural world,

in dystopian fiction reveals the continual risk of being subjugated to the increasing demands of light, pleasure, distraction, and productivity on our waking hours. It is only through a radical resistance to the encroachment of capitalism and the illusion of autonomy and subjectivity it provides that we can overcome these demands. Those concerned with the psychosomatic impact of the 24/7 are right to insist on the need to protect our sleeping hours. But, to do so, we need a better understanding of the complex, historically contingent factors and forces that impinge on sleep. I argue that, just as chronobiology revealed complex ‘circadian networks’ interacting with exogenous factors, of which the most important is light, so a careful and close reading of the treatment of artificial light in dystopian fiction can uncover the equally complex social and political forces that impinge on these exogenous factors to transform the ‘nightmare of total illumination’ into the ‘place where there is no darkness.’

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