

## Gut-brain axis in history and culture

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**Special issue**  
**Gut-brain axis in history and culture**

**Guest Editors - Alison M. Moore, Manon Mathias & Jørgen Valeur**

# Microbial Ecology in Health and Disease

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## Special Issue: Gut-brain axis in history and culture

Editors: Alison M. Moore, Manon Mathias & Jørgen Valeur

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### CONTENTS

#### Editorial

- Paper I Contextualising the microbiota–gut–brain axis in history and culture  
*Alison M. Moore, Manon Mathias, Jørgen Valeur*

#### Articles

- Paper II The gut–brain axis: historical reflections  
*Ian Miller*
- Paper III 'Neurasthenia gastrica' revisited: perceptions of nerve-gut interactions in nervous exhaustion, 1880–1920  
*Kristine Lillestøl*

- Paper IV Autointoxication and historical precursors of the microbiome–gut–brain axis  
*Manon Mathias*

- Paper V Coprophagy in nineteenth-century psychiatry  
*Alison M. Moore*

- Paper VI Gut thinking: the gut microbiome and mental health beyond the head  
*Grace Lucas*

- Paper VII *Mind the Gut*—displaying microbiome research through artistic collaboration  
*Adam Bencard and Louise Emma Whiteley*

## Contextualising the microbiota–gut–brain axis in history and culture

This special edition on humanistic approaches to the microbiota–gut–brain axis was inspired by two symposia organised by literary scholar Dr Manon Mathias at the University of Aberdeen in 2017 and at the University of Glasgow in 2018, both involving the participation of medical historian Dr Alison M. Moore and gastroenterological researcher Dr Jørgen Valeur, with all the contributors to this special edition having spoken at one or other symposium. Mathias and Moore are among the rare cohort of humanities scholars who approach past literary, cultural and medical concepts with the aim of contextualising current medical models and research findings, while Valeur is among the even rarer cohort of medical researchers and clinicians to see inherent value in humanistic understandings of health. It is the shared premise of all three editors that historical and cultural perspectives enrich the current understanding of microbial ecology, and the science of microbe–host interactions.

One reason it should interest all medical researchers and clinicians to read the articles in a special edition such as this, is to consider what is truly novel in current scientific models and what may be inherited from past medical concepts. Such earlier concepts may help or hinder current science, but without researchers knowing anything about them, it is most likely that their influence will not be helpful. As the American enteric nervous system researcher Michael D. Gershon noted in his 1998 book on the *Second Brain*, ‘hubris for scientists comes from inadequate knowledge and appreciation of the past’ [1]. Indeed, failures to see what is truly new in the treatment of gastroenterological disorders can be found throughout the scientific record.

The history of faecal microbial transplant (FMT) is a case in point: though often claimed as a ‘new’ therapy [2], it has existed in the form of oral administration in European medical traditions since Ancient Greece, featured in several major works of medical description of the sixteenth and seventeenth centuries [3], and has been used in Chinese medical traditions since the Don-jin dynasty (4<sup>th</sup> century CE) [4]. Rectal delivery of FMT was used by the American doctor I.O. Wilson in 1910, following the identification of changes in faecal bacterial composition among patients with functional bowel disorders [5]. Thus, FMT is anything but ‘new’ and its historical and trans-cultural ubiquity may indeed lend support to the emergent scientific model of the gut microbiome as an essential organ of the human body,

composed of organisms that have co-evolved with our own cells such that they are to some extent ‘us’. This indeed is the very argument that FMT researcher Alexander Khoruts has made for why this therapy for *Clostridium difficile* should be seen not as a ‘drug’ but as a ‘transplant’ [6]. The mounting evidence for commensal and symbiotic intestinal microbes lends itself to this interpretation, and is consistent with the acceptance of the microbial origin of our cellular mitochondria [7].

It is not hard to see then why new research on the gut microbiome should fascinate scholars in the humanities since it touches upon the very question of what it means to be human – indeed the core concern of these disciplines. Humanities scholars are richly imaginatively endowed, as both Bencard & Whiteley’s and Lucas’ creative endeavours in exhibiting and narrativising medical research on the microbiota–gut–brain axis demonstrate. They are also particularly trained in critical and contextual ways of reading concepts, a skill-set generally missing from science degrees, as Moore herself was surprised to discover when studying biomedical sciences at an Australian university between 2010 and 2013. A 2018 article involving two biomedical researchers, Katarzyna Hooks and Jan Peter Konsman, with the philosopher of microbiology Maureen O’Malley, offering a critical evaluation of microbiota–gut–brain research, is an excellent case in point [8]. The authors, while acknowledging the importance of microbiota–gut–brain axis research for understanding brain function and behaviour, show that there are frequent weaknesses in study design and conceptual modelling in the field, as well as in public communication, with pre-emptive hyperbole too often capturing popular health movements. But we might do well to remember also that medical research does not only filter out into popular cultural imaginaries, but is indeed situated within specific cultural and historical contexts. Our special edition is precisely about some of the earlier medical concepts that have helped to prime medical researchers toward posing questions about the brain by turning to the gut, and about how current medical research on the microbiota–gut–brain axis can be responsibly publicly disseminated.

The paper that engages in most depth with the question of scientific dissemination and public engagement is Bencard & Whiteley’s piece on the ‘Mind the Gut’ exhibition at the Medical Museion, Copenhagen. This exhibition was the result of intense reflection involving a range of academic researchers, artists and curators, and the article reveals the importance of this extended dialogue

that took place over two years before the exhibition itself was launched. For example, one of the outcomes of the discussions was an increased awareness of science as process, hence the decision to display projects as they progressed rather than a complete set of data. The inclusion of this article is important as makes it clear to the wider scientific community what can be achieved when different groups come together to engage in deep reflection on how to engage public audiences. The need for such endeavours is now greater than ever before in our digital age and with the emergence of popular science communicators and journalists. The public now has tremendous capacity to access – but not necessarily to understand the nuances and limits of – scientific research on health and what it may mean for individuals. Information is not all that is needed either – the humanities and creative arts can most certainly help to inspire.

While most of the papers in this volume touch upon the question of how a connection came to be made between the mind and the gut in history and culture as a precursor to the current concept of the microbiota–gut–brain axis, not all these papers show an explicit connection to questions of microbial ecology. The microbiota–gut–brain axis is indeed a quite recent innovation and is not to be found in the nineteenth-century configurations described here. As Peter Down noted in his *History of Luminal Gastroenterology in Britain*, the brain historically was most often thought to connect to the stomach rather than the colon that is most implicated in current microbiota–gut–brain research today, since the colon was generally viewed ‘as a tube that merely stored and evacuated the waste products of digestion’ [9]. In the words of one early twentieth-century British surgeon, the colon was ‘simply a sewer canal’ [10].

However, the discovery of microorganisms at the end of the nineteenth century did impact one important area of mind–gut consideration, fuelling the pre-existing concept of ‘autointoxication’ – a topic discussed in the papers by Mathias, Lillestøl and Moore in this special issue. Early configurations of this concept viewed constipation as dangerous because it was thought that toxic biproducts of digestion were absorbed into the blood, causing a systemic poisoning of the body which included the brain and the nervous system. Microbes had been found *in vitro* to putrefy animal and vegetable material, so it was assumed that they also did so in the colon, providing mechanistic support to the theory of autointoxication [6]. As Mathias’ paper in this volume shows, both German and French physicians in the late-nineteenth century indicated that microbes might be responsible for the autointoxication they ascribed to constipation, and in 1887, the French physician Charles Bouchard proposed microbial imbalance as the cause of several diseases he saw as resulting from autointoxication. Mathias also suggests why these ideas were so widespread in France, especially in relation to mental distress, and why they became discredited in twentieth-century

scientific research – in part because popular uptakes of autointoxication by purveyors of herbal remedies and enemas to relieve constipation, as well as by evangelical diet gurus such as the American John Harvey Kellogg, reduced the reputation of the theory by associating it with widespread quackery.

Autointoxication formed part of several late-nineteenth-century disease categories, from dyspepsia, discussed in Miller’s paper, to *neurasthenia gastrica*, examined in Lillestøl’s paper. Moore’s paper shows how a mind–gut connection came to support the late-nineteenth-century psychiatric description of coprophagia as both a sign of mental illness, and as a suspected cause of it. But microbes remained under-appreciated in this early body of scientific psychiatric thought, and indeed even the most recent medical investigations of institutional coprophagia have not fully explored the potential microbial interactions entailed in it.

Nineteenth-century ideas about the mind–gut connection tended to assume that the relationship was bidirectional, something discussed in the papers of Mathias, Miller, Moore, Lillestøl and Lucas. Lillestøl reveals an emerging interest for interactions between the central nervous system and the gastrointestinal tract throughout the nineteenth century; early descriptions of a field that we today would label as neurogastroenterology, and diagnoses that we now denote as functional gastrointestinal disorders. And as Miller shows, dyspepsia was considered both a disorder of the stomach and of the mind, underpinned by the concept of ‘nervous sympathy’, which pre-empted the later discovery of the enteric nervous system as a mechanism through which the viscera communicated nervous signals to the brain. Miller notes that this older holism was overturned through twentieth-century forms of anatomical, physiological and surgical scholarship which tended to isolate the stomach as more was discovered about it; but the holism is found again in the new model of the microbiota–gut–brain axis. Gershon too referred to the twentieth-century medical insistence on a one-way direction in which patients with unexplained gastroenterological symptoms were viewed as ‘hypochondriacs’, situating his own research on the enteric nervous system in both a more holistic and a more patient-centred approach [1]. Indeed, in 1977, the British psychiatrist Peter Dally insisted that all patients presenting to a gastroenterology clinic whose symptoms could not be ascribed to ‘an organic cause’ must be suffering from a psychiatric, not gastroenterological illness [9]. In this model, functional disorders were thought to be caused primarily by the patient’s psychic distress. As Lucas’s paper in this volume shows, the emerging evidence of the role of microbial ecology in mental health is a force against this one-way paradigm by providing a mechanism to explain how the gut in turn influences the brain. But as Miller argues, this holism, in and of itself, is anything but new.

Are there lessons to be gained from the past for current microbiota–gut–brain axis researchers? Perhaps these might be summarised as follows: (1) Speak not of what is ‘new’ before knowing what is old; (2) recognise the power of popular cultural uptakes of science in shaping what new generations of scientists both absorb and react against; and (3) work with the humanities and creative arts to build a more science-conscious public awareness that accurately reflects the findings of microbiota–gut–brain research.

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## The gut–brain axis: historical reflections

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### ABSTRACT

The gut–brain axis and the microbiome have recently acquired an important position in explaining a wide range of human behaviours and emotions. Researchers have typically presented developments in understandings of the microbiome as radical and new, offering huge potential for better understandings of our bodies and what it means to be human. Without refuting the value of this research, this article insists that, traditionally, doctors and patients acknowledged the complex interactions between their guts and emotions, although using alternative models often based on nerves or psychology. For example, nineteenth-century doctors and patients would have been well acquainted with the idea that their stomachs and minds were somehow connected, and that this interaction could produce positive or negative physical and mental health impacts.

To demonstrate this, this article offers a snapshot of medical and public thought on (what we currently call) the gut–brain axis in the nineteenth and twentieth centuries, using Britain as a key case study due to the prevalence of gastric problems in that country. It commences by exploring how nineteenth-century doctors and patients took for granted the intimate relations between gut and mind and used their ideas on this to debate personal health, medical theory and social and political discourse. The article then moves on to argue that various medical sub-disciplines emerged (anatomy, physiology, surgery) that threatened to reduce the stomach to a physiologically complex organ but, in doing so, inadvertently began to erase ideas of a gut–mind connection. However, these new models proved unsatisfactory, allowing more holistic ideas of the body–mind relationship to continue to carry currency in twentieth-century psychological and medical thought. In the late century, pharmacological developments once again threatened to minimise the gut–brain axis, before it once again became popular in the early twenty-first century, now debated through a new language of microbiology.

### ARTICLE HISTORY

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Over the past decade or so, research into the gut–brain axis has grown exponentially as microbiologists, neurologists and nutrition scientists have revised their understandings of how seemingly separate bodily areas interact. Our guts, brains, nervous systems and behaviour are now considered as far more interconnected than previously presumed, largely because of the influence of gut bacteria (the microbiome) on emotional well-being. In the past few years alone, numerous popular science books have hit the shelves divulging information on (what is typically presented as) a startling new discovery that gut health drives emotional and psychological well-being [1–3]. This development has even been heralded as the precursor of a paradigm shift in medicine; a medical revolution in which enhanced knowledge of microbiome behaviour will impact on clinical practice in revolutionary ways [4]. New sub-sciences have emerged, most notably those coalescing around ‘psychobiotics’, which are similarly framed as exciting, even revolutionary, advances [5].

To provide just one example, in *The Psychobiotic Revolution: Mood, Food and the New Science of the*

*Gut–Brain Connection* (2017), Scott C. Anderson, John F. Cryan and Ted Dinan (science journalist, microbiome and psychiatry experts, respectively) discuss the discovery of psychobiotics: live organisms which, when ingested in adequate amounts, benefit the health of some psychiatric patients. These bacteria produce and deliver neuroactive substances which act on the gut–brain axis, in some instances working as an anti-depressant. However, the authors also saw benefits for people outside of the clinic. On a day-to-day basis, careful manipulation of gut bacteria could improve mood, thinking, memory and emotional well-being. According to the authors, western society is currently experiencing epidemics of both depression and gut problems, issues which they see as deeply interconnected. In their words: ‘some of your deepest feelings, from your greatest joys to your darkest angst, turn out to be related to the bacteria in your gut’ [6]. It seems, then, that the ‘psychobiotic revolution’ is being framed as containing potentially enormous societal benefits. Indeed, some microbiologists see the next step as being to translate microbiome science to society [7].

Without in any way refuting the value, complexity or potential of this research, this article maintains that ideas about the intimate relationship between gut and mind has more historical precedence than has often been realised. For instance, *The Psychobiotic Revolution* provides only a paragraph-long historiographical discussion that briefly mentions eighteenth-century French anatomist Marie François Xavier Bichat's research on gut–brain connections before leaping 200 years forward to Michael Gershon's popular 1998 book on the gut as 'second brain' [7,8]. And in 2015, Perlmutter and Loberg describe 'the relationship of the gut to the brain' as 'a relatively new concept in medicine' [9]. All of this understates long-standing medical traditions of exploring interactions between gut, brain and emotions with approaches and methodologies other than the microbiological. It is not simply the case that a new holism is now challenging and replacing twentieth-century reductionist or genetic explanations of human health, as some authors have claimed [4]. Older medical models readily incorporated understandings of relations between gut, mind and emotions using the ascendant medical models of their time.

In recent years, medical historians have shown that, historically, medical communities routinely linked digestion, identity and emotional behaviour and strove to understand and interpret the impact of digestive behaviour on personality and moods (and, vice versa, the impact of mind and emotions on the gut) [10–14]. Indeed, a key point of this article is not only that the gut–brain axis has long been recognised but also that efforts by doctors and surgeons to reduce the gut to a more isolated area of the body, disconnected from everything else in the body, typically proved unsatisfactory. In light of this, throughout the nineteenth and twentieth centuries a complex interplay existed between reductionist and holistic approaches to gut and mind. Broadly speaking, nineteenth-century doctors tended to blame the gut for its effect on the mind. In the early twentieth century, psychologists were more likely to blame the mind for its effects on the guts. Nowadays, multiple pathways of communication between the digestive organs and the brain are the focus of attention. At times, fashions in medical thought highlighted the interconnectedness of gut and mind; at other times, researchers isolated and focused on areas of the gut alone [10]. But the pendulum kept swinging back and forth. And, just as now, researchers not only linked gut behaviour to the emotions, but also foresaw potential social benefits if the public maintained good gut health. Humans eat both individually and collectively and, in turn, share and understand their

gut problems communally. Historically, the gut was understood as a potential source of positive social and political health and, on that basis, was upheld as a key site of health maintenance.

## Nineteenth-century guts

Nineteenth-century doctors accorded stomachs and guts huge importance. Throughout the century, the majority of doctors worked with constitutional models of the body, examining patients as a whole rather than focusing on, say, their stomach, bowel or duodenum. Prominent doctors developed theories about how disparate parts of the body were connected via the nervous system. Notably, in 1765 Scottish physician Robert Whytt developed the concept of 'nervous sympathy' to describe the mechanisms which he believed connected the inner body organs. He observed that the gut possessed an abundant supply of nerve endings which dispensed 'nervous energy' throughout the body [15]. Constitutional medicine remained influential throughout the nineteenth century and easily accommodated the holistic concept of 'nervous sympathy'. The gut, and particularly the stomach, became hugely popular topics to write about. Numerous books were published on gut health, aimed at both the public and practitioners. Looking through these, the reader routinely encounters the stomach being described using terms such as 'the great nervous centre', the 'sensorium of organic life' and as 'the great abdominal brain'. For many nineteenth-century authors, the stomach was the most important of all organs, precisely due to its seemingly strong influence on physical and emotional well-being [16,17].

Few people were as enthusiastic about the stomach as London-based doctor John Abernethy, a highly influential St. Bartholomew's Hospital anatomy teacher. Inspired by prominent doctors such as John Hunter, Abernethy took the idea of 'nervous sympathy' to a fanatical level. He campaigned tirelessly for wider recognition of the importance of the stomach and the distressing consequences of 'gastric sympathy'. And his work was widely discussed. His 1811 book, *Surgical Observations on the Constitutional Origin and Treatment of Local Diseases*, ran into 11 editions [18]. It was followed in 1829 by a book aimed at a general audience entitled *The Abernethian Code of Health and Longevity*. In this, Abernethy traced all bodily and mental disorder back to 'gastric derangement'. The issue of nervous energy captivated Abernethy who sought to explain, for instance, why a blow to the stomach could disorder the mind or, conversely, why emotional conditions such as excessive worrying reduced appetite. For Abernethy, the only explanation seemed to be a close relationship between gut and mind linked via



the nervous system. Abernethy also emphasised how ‘vitiated digestion’ caused lowness of spirits, restlessness, disordered sleep, weariness and fatigue. His main message was that humans needed to eat simple, natural foods instead of the refined, unnatural and often adulterated foods being increasingly consumed in industrialising Britain [19].

It is notable that doctors at the forefront of medical thought and practice supported, even took for granted, this intimate relationship between guts and emotions. It was the stomach’s nerves, rather than its bacteria, that required attention to boost emotional well-being. When looked after, these nerves seemed capable of exciting pleasurable emotions in the mind. However, bad food and over-indulgence in alcohol could ‘disorder’ the nerves, exciting gloomy thoughts. As prominent doctor James Johnson, physician extraordinary to the Royal Family, wrote in 1827, ‘strange antipathies, disgusts, caprices of temper, and eccentricities, which are considered solely as obliquities of the intellect, have their source in corporeal disorder’ [20].

Organs had traditionally been attributed emotional qualities: the heart and love, for instance [21]. However, the gut seemed particularly menacing as doctors associated the region with negative or ‘morbid’ emotions which needed to be carefully suppressed. Vomiting when seeing something disgusting provides one visceral example. However, doctors regularly discussed sensations such as a ‘feeling in the pit of the stomach’. In relation to male patients, doctors were more likely to interpret dyspepsia as a consequence of poor diet or life habits which engendered symptoms such as irritability, alarm and fear. If left unchecked, male patients could develop a permanent bad temper. The stomachs of women were more likely to be viewed as naturally weak (as were women themselves) and likely to produce nervous trepidation, fear, ‘sinking’ and a fluttering heart. Although highly gendered, corresponding nineteenth-century models of the gut–brain axis clearly insisted that neglect of digestive health caused ‘diseased emotions’ [22].

### Britain and its stomachs

At the very same time that the stomach was being upheld as *the* key body organ, British doctors were expressing dismay about the extent of gastric distress which they were encountering. Britain was witnessing rapid industrialisation and urbanisation. While quantitative evidence is lacking in the historical record, it seems clear that doctors believed that stomach problems were becoming alarmingly common, a serious problem at a time when gut health was considered critically important on an individual level. Poor gut health was framed as a significant

social problem and came to serve as a metaphor for broader anxieties about socio-economic change. In 1826, the *Medico-chirurgical review* stated that ‘there is no complaint more common in this country than an imperfect condition of the stomach’ [23]. Twelve years later, the *Dublin journal of medical science* insisted that ‘stomach diseases form the national malady of Britain, and consequently the prime staple of the medical art’ [24]. In the 1840s, temperance literature warned that ‘indigestion is becoming a national disease’ adding that ‘indigestion among the labouring classes is altogether a new disease’ [25]. And in the late nineteenth century, advertisements for digestive pills and medicinal syrups warned that indigestion was the ‘prevailing evil of the human frame and the fashionable disease of the age’ and that ‘the national disease of this country is indigestion’ [26].

In the eighteenth century, gastric distress had often been associated with the wealthy: individuals with enough financial resources to eat themselves into a state of sickness. Doctors saw dyspepsia as an outcome of sedentary lifestyles and over-thinking. In a sense, stomach problems were quite fashionable, a symbol of wealth [27]. In the nineteenth century, this association persisted. One well-reported case involved Professor James M’Cullagh who died in Dublin in 1847. M’Cullagh had enjoyed good health for most of his life but was suddenly struck by chronic dyspepsia. A post-mortem enquiry revealed that he had been working particularly hard and had begun to suffer from paranoid delusions. Nonetheless, the professor refused to give up his mathematical studies. His depression was blamed on melancholy stemming from dyspepsia, which had originated from over-applying the mind to an especially difficult mathematical problem. This had encouraged M’Cullagh to neglect his bowels and over-indulge in strong green tea [28].

However, in contrast to the eighteenth century, gastric distress now seemed to be affecting all sections of society, partly due to changing food consumption patterns in the new urban areas. The gut was a useful metaphorical resource for expressing concern about the physical and emotional well-being of the nation. To provide one, somewhat dramatic, example of how the gut–brain axis was discussed, an article published in *Blackwood’s Edinburgh Review* in 1861 announced that England was not only the country most liable to gastric conditions, but also that whilst labouring under dyspeptic attacks, ‘nothing but family considerations prevented him [the Englishman] from blowing out his brains with a pistol, or effectually ridding himself of his woes by plunging into the muddy torrent of the Thames’. The author went so far as to speculate that only a fraction of the dyspeptic British had the courage to abstain from self-destruction during the gloomy months of November and December,

a period when multitudes of corpses of sufferers of crippling gastric diseases would supposedly be swept across the nation's rivers [29].

Such accounts were undoubtedly hyperbolic but resonated at a time of concern about British gut health. The mid-Victorians clearly saw an ill-kept stomach as a root cause of emotional and physical decline and invested considerable energy encouraging positive gut regulation. Doctors published a wealth of material that encouraged readers to eat moderately, digest slowly, eat at regular intervals, abstain from alcohol and consume healthy foods.

Perhaps the most intriguing, and popular, of these was published in 1853 by an obscure author named Sydney Whiting. Entitled *Memoirs of a Stomach*, the book proved immensely popular throughout the rest of the century. It ran into various editions during the next 30 years and was even translated into French. This was despite the fact that the narrator was a remarkably literate stomach, named Mr Stomach, who described the misery of his long life in great detail. Mr Stomach commenced by complaining of having been forced to digest adulterated foods, sweetmeats, oysters and tobacco smoke in his youth, foodstuffs not well suited to his delicate constitution. While at college, the organ's owner consumed long breakfasts that last until noon. It was at this point that severe dyspepsia struck for the first time.

Although his owner soon recovered, he then fell in love with a young lady, bringing on a wave of emotions that displeased Mr Stomach. The traumatised stomach began to complain bitterly of his master's new-found habit of singing loudly, lamenting that he was 'constantly being woke up in the night and found myself either walked up and down the room, the maniac repeating love ditties'. The stomach's unfortunate situation was worsened further by a honeymoon during which his master consumed endless quantities of unfamiliar continental foods. Eventually, his master secured a well-paid job. However, he chose to over-indulge in alcohol and involve himself in drunken arguments, causing a wave of 'evil passions' that disgusted Mr Stomach's sensibility. Although highly moralistic in nature, the *Memoirs* clearly outlined a complex interaction between mind, gut and the emotions. An unregulated, un-cared for stomach bore negative emotional consequences [30].

### Excessive tea drinking

It seems apparent that nineteenth-century doctors believed in, and placed considerable importance upon, the relation between guts and emotions. But how exactly was (what we currently call) the gut-brain axis seen to work in practice? In a period lacking access to

microbiological, or even psychological, ways of understanding bodily interactions, or technologies such as brain imaging, nerves remained central. Discussion of debates on excessive tea drinking offers insight into how gut-related diagnoses were formed and used in clinical practice. During the late Victorian period, marked by poverty and economic depression, many working-class women relied heavily upon tea and white bread. Although condemned as decadent and careless by doctors, most women survived on this diet by necessity rather than choice, opting to provide men and children with more nutritious food. Problematically, doctors viewed tea as a nervous stimulant containing little nutritional benefit. Heavy consumption (combined with the strength of Victorian tea) seemed to have exhilarating effects, encouraging doctors to frown upon excessive tea drinking as reckless behaviour (in some ways mirroring present-day discussion of caffeine addiction) [31].

Expert and public discussion on tea drinking drew heavily from medical models of nervous sympathy that emphasised the interactions between mind and gut. In 1883, the Dean of Bangor became concerned about the levels of tea being consumed in working-class communities across North Wales. He received national publicity by claiming that local communities were 'sinking' and degenerating. In his words:

Excessive tea-drinking creates a generation of nervous, hysterical, discontented people, always complaining of the existing order of the universe, scolding their neighbours, and sighing after the impossible. Good cooking of more solid substances would, I firmly believe, enable them to take far happier and more correct views of existence. In fact, I suspect that over-much tea drinking, by destroying the calmness of the nerves, is acting as a dangerous, revolutionary force amongst us. [32]

The Dean drew from contemporary nervous models to explain how stomachs, disordered by excessive tea drinking, were causing nervousness, emotional decline and an epidemic of mental health problems, an idea which he then linked to broader social and political debate. For the Dean, (what we might now term) emotional communities were forming whose passions held the potential to cause political and social revolt. Indeed, the Dean added that 'the torrents of bad tea seem to me to be swelling into a flood of radicalism. This bad housewifery is not only productive of possible revolution, but of lamentable immortality'. As evidence, he observed that the American Revolution had commenced with tea being flung into Boston Harbour and voiced his suspicions that even the French Revolution had occurred due to too much tea drinking. Despite being another hyperbolic source, the Dean's statements reveal how non-medical communities drew from medical models of nervous sympathy and saw the collective nature of gastric disorder as a social, national, even political problem [32].

On a more day-to-day basis, excessive tea drinking offered a compelling explanation for a broad range of Victorian diagnoses. More often than not, these linked the female gut to psychiatric conditions such as hysteria. In 1872, doctors treated a 32-year-old female servant who, despite having been in good health for years, had become irritable, suffering from laughing and crying fits, and had got into a 'state of great weakness'. The girl had attempted to conceal her problems from her mistress by continuing to work as usual. However, one day, while cleaning a grate, she collapsed speechless and senseless and proceeded to have several hysterical fits. It later transpired that the servant had become increasingly addicted to tea, caring for little else so long as she got her favourite substance. The doctors reported that her 'weakened stomach refused meat' [33].

Doctors typically depicted incidences of housewives gradually losing their appetite, slowly coming to loathe food and eventually finding solace in the tea cup. Once addicted, she began to prepare tea in ways that allowed her to secure as much tannin (or tannic acid) as possible to quell her intensifying cravings. Ultimately, she began to suffer from dyspepsia before developing severe nervous and mental health problems. The root of the problem was seen to rest in tea being kept stewing on the stove all day, being drunk continuously [34]. Given the intent focus on gut health prevalent in Victorian society, it is unsurprising that doctors highlighted dyspepsia caused by excessive tea drinking as a significant, and alarming, symptom and precursor of emotional distress [35].

And, like dyspepsia itself, excessive tea drinking was upheld as a major collective and social problem. Nowhere was this more evident than in the debates that took place during the 1890s about rising asylum admissions across Britain and Ireland. In Ireland, asylum admissions were increasing even though the country was witnessing a significant population decrease due to high emigration levels. The government was so concerned that it set up an official inquiry. At this, doctors and psychiatrists blamed rising levels of Irish insanity on widespread dyspepsia caused by excessive tea drinking. They firmly believed that widespread reliance on tea and white bread, particularly among women, was causing extensive mental and emotional strain, epileptic seizures, hysteria and mania [36].

### Isolating the stomach

So far, this article has presented a nineteenth-century medical cosmology that awarded the gut a privileged place within the bodily economy, emphasised its relation to mind and emotions and took for granted that the gut was not an isolated bodily region. In turn, the gut became a metaphorical resource for explaining

and managing broader social problems. Arguably, all of this provided a fairly satisfactory medical model. While most Victorian patients presumably failed to look after their stomachs to the extent desired by doctors, this model offered common-sense solutions (mainly healthy, moderate eating) that pleasingly paid attention to patients: their lifestyles, constitutions, bodies and minds.

However, the nineteenth century witnessed a turn towards medical reductionism. Expert attention moved increasingly towards organs, germs, cells, eventually, in the twentieth century, genes, rather than constitutions and the 'bigger picture' of bodily interconnectedness. While debates raged on about stomachs, tea drinking and insanity, medical activity was becoming influenced by new ways of viewing the inner body: the anatomical, physiological and surgical [37]. Each of these offered new ways of investigating and understanding the gut, albeit ones that were increasingly localised [10].

In 1828, Edinburgh physician John Abercrombie published the first full pathological description of the stomach. By examining the stomachs of corpses, Abercrombie delineated a complex range of organic diseases and stressed that problems could develop on particular walls or areas of the stomach's surface. From a diagnostic perspective, the stomach now seemed intrinsically more complex. As the anatomical approach developed, problems such as gastritis and ulcer of the stomach were isolated from the broader, catch-all diagnosis of dyspepsia. Not only that, but Abercrombie and others subsequently identified different types of ulcer, each of which could cause different symptoms and problems depending upon where it was situated within the stomach or duodenum [38,39].

Such research offered new ways of knowing the gut made possible by pathological anatomy's organ-focused approach. But this new model required little consideration of patients as a whole or their constitutions: organs simply needed to be examined upon death to reveal telling signs of illness. Anatomists dissected the stomach, literally and metaphorically, into a more clearly understood organ with well-defined areas and physical problems; an organ that was not a cohesive whole but composed of different sections and parts, all subject to their own ailments. But, amidst this localism, the organ's general relationship to the body began to be erased.

Then along came laboratory medicine. Late-century physiologists developed an active interest in digestive physiology and, in particular, gastric chemicals. New terms such as 'acid dyspepsia' came into vogue, as well as plethoric, anaemic, hepatic and renal dyspepsia. Factors such as high levels of hydrochloric acid were now hypothesised as an active cause of gastric complaints [40,41]. Physiologists developed

various new investigative technologies, including Max Einhorn's 'stomach bucket' that could be inserted into the abdomen to collect gastric chemicals [42]. Other techniques developed involved filling the stomach with liquids or gases. Stomach tubes were developed, sometimes with lamps fitted to help observe physical lesions in the gut [43]. Digestion began to be discussed using a new vocabulary of chemical terminology. Many physicians resisted the intrusion of physiologists, preferring their tried-and-tested common-sense methods. Patients too, often feared the new intrusive gastric technologies [44]. But the key point here is that laboratory interpretations of stomach behaviour also helped reduce the stomach to an isolated organ of chemicals and lesions.

The introduction of anaesthesia and aseptics brought another individual into the arena of the stomach: the abdominal surgeon. By the end of the nineteenth century, surgeons could safely open the abdominal region and surgically remove problems such as ulcers. At their most extreme, abdominal surgeons simply removed diseased stomachs and tied the intestine and oesophagus together. Patients reportedly survived such operations but did not live for too long afterwards [45]. Modern surgery opened up new possibilities for safely opening the abdomen and removing life-threatening problems, providing new prospects for cure. But, once again, in the new surgical model, there was little need to consider the constitutional problems that might have caused gut problems in the first place or the underlying emotional problems related to gastric disorder. The new 'pathology of the living' allowed surgeons, for the first time, to safely locate and observe disease in the *living* rather than *dead* body and, while the body was already opened, simply remove ulcers and other problems [46]. But this restricted the conceptual framework surrounding the gut, removing the need to consider the region's bodily interconnectedness.

### Psychologies of the stomach

By the early twentieth century, many of these reductionist approaches seemed unsatisfactory. Neither pathological examination, laboratory medicine nor abdominal surgery had truly mastered the gut or provided consistently effective treatment. What followed was a rethinking of the direction that modern gastric medicine had taken. As physician William Fenwick, wrote in 1910, chemical analysis could never explain clinical phenomena such as stomach problems arising upon feeling violent emotions or receiving depressing news. Fenwick insisted that 'many ancient empirical methods are still of the greatest value, despite the fact that experiments are supposed to have proved them to be too unscientific

in origin and useless in application'. He then quoted Abernethy who had said: 'the stomach is neither a stew-pan nor a test-tube, but a stomach' [47].

The early twentieth century emergence of new psychological sciences helped re-instate the gut-brain axis at a time when it was under threat as a concept. A new breed of psychologists, physiologists, psychoanalysts and physicians including Walter Cannon, Walter C. Alvarez and Franz Alexander insisted that the gastric patient's emotional state needed to be considered when diagnosing and treating, that digestive disorder often had psychic roots and that conditions such as ulcers had psychological aspects due to the dynamic inter-relation between mind and body [48–50]. This was in line with a renewed interest in holistic thinking which eagerly incorporated factors such as the emotions and psyche into the study and care of individuals [51]. As Michael Gershon argues in *The Second Brain*, overturning early twentieth-century views of gut problem as driven by conditions such as hypochondria was part of the development of holistic ideas that the gut has its own nervous system [8].

Subsequently, gastric problems enjoyed a period of being widely regarded as stress-related. Alexander posited that there was a certain 'ulcer type', an individual with ceaseless energy and restlessness, but who tended to suffer from fear and anxiety. Such patients passed through life happily until they experienced a stressful situation which would be expressed through gastric pain. In clinical practice, this meant that a diverse range of factors once again had to be taken into account: patient's occupation, responsibilities and social environments, not just specific lesions [52]. The emergence of stress concepts did much to help reinforce older ideas about the relation between guts and emotions [53]. The Second World War experiences seemed to confirm this model. Soldiers fighting at Dunkirk were reported as suffering from disproportionately high levels of perforating duodenal ulcers. Similar problems emerged in areas of London affected by air raids, according to contemporary reports. Stress and emotional strain provided a suitable explanatory model. The general conclusion reached was that the British had developed an array of stomach problems during the 1930s, a period of economic and emotional distress, which had remained latent until the sudden stress of world war brought them to the fore [54].

### Return to reductionism

By the mid-twentieth century, groups of competing medical sub-disciplines saw the gut as territory to be fought for. Rather than working collaboratively, physicians, anatomists, physiologists, surgeons and psychologists tended to retain their own approaches to

managing the gut and criticised each other's approaches for their ineffectiveness. Even despite the various ways of knowing the gut now in existence, the bodily region remained mysterious, almost unknowable, with the causes of conditions such as ulcers still blurry. This situation proved bewildering for both patients and doctors. As one British doctor wrote in 1956:

The surgeons think of cures by surgery. The patent medicine firms push their products. The ethical drug houses are always seeking some new and better remedy. The psychiatrists speak of individual reactions to stress and strains. The naturopaths, the osteopaths and homeopaths, and a host of other cults and quacks all make their claims. There is such a clamour of contestants for cure that the patient who really wants to know is deafened rather than enlightened. [55]

In 1951, one patient, John Parr, published a short book entitled *How I Cured my Duodenal Ulcer*. In this, Parr recounted that when he first developed an ulcer, medicines failed to work and X-Rays found no evidence of illness. Parr was informed that he was suffering from hyperchlorhydria which he described as 'a tiresomely long word to describe a condition of too much anxiety'. Surgeons then performed an operation, but no ulcer was found. A diet was imposed of milk, orange juice and steamed fish but the pains returned. In a chapter entitled 'Disillusioned', Parr mentioned that despite being informed that he could not be cured 'it was impressed upon me that I was on no account to worry, because worry was a primary cause of ulceration'. Ten years later, Parr began to lose faith in doctors. It was only when he went to fight in the Second World War that a detectable ulcer finally developed. A further decade later, he wrote:

I had now suffered, intermittently but increasingly, for over 20 years. During that time, I had been to as many doctors and had tried countless remedies. I had been advised to take exercise and to rest; to live on little else but eggs and milk; to drink only before meals; to give up smoking and alcohol; to stop worrying; to eat slowly and chew my food thoroughly; I had had one abortive operation and had been advised to have another. I had had one X-Ray after another. I had swallowed innumerable gallons of medicines.

Continuing, Parr lamented that:

I had worn an abdominal belt to 'support' the stomach and keep it warm. I had listened to friends who recommended Christian Science and Yoga exercises...I had earnestly and hopefully carried out the instructions of one doctor after another....no doctor held out any real hope of permanent cure. None of them could offer a convincing explanation of the *cause* of peptic ulcer; nor could anyone tell me why some people got it, and others didn't.

Parr concluded that he had gradually learnt from his own personal experience that 'an illness is the result of biological as well as of psychological events' and that mental strain had aggravated, if not necessarily caused, his ulcer. In his words:

I know from my own long and unhappy experience, how mental stress can and does affect the victim of a duodenal ulcer. Even the slightest anxiety, such as packing a suitcase for a weekend journey, and wondering whether there is enough time to catch one's train, is enough to precipitate an actual physical pain. [56]

But although stress-related models were widely accepted in the mid-twentieth century, later developments once again swung the pendulum back towards isolating the stomach. The development of H2 receptor antagonists in the 1970s by pharmacologist James Black helped decrease the ability of the stomach to produce certain acids. This had a striking impact on dyspepsia management [57]. And the unexpected discovery that gastric ulcers were in fact bacteriological in origin in the 1980s had a major impact on treatment as it implied a need for pharmaceutical intervention [58]. However, these developments once again minimised the role of psychological factors in producing gastric disorder. Key gastroenterological texts from the 1970s and 1980s once again emphasised causes including excess hydrochloric acid, pepsin, heredity, blood groups, tissue antigens, diet and personal habits while awarding emotion and the psyche a relatively limited role. Key among the arguments developed against the psychosomatic model was that emotional stress affects everyone, but clearly not everyone develops an ulcer [59].

## Conclusion

This article has provided a snapshot of historical thinking on the relation between gut and emotions, with a view to adding complexity to the idea that microbiome research is unique and original in calling attention to this. It seems apparent that doctors and patients have long been intrigued by ideas about interactions between the gut, brain and mental states. Throughout the nineteenth century, doctors and the public routinely referred to this interaction (then informed by theories based on constitutions and nerves) to explain a wide range of bodily and social phenomena: personal health, changing dietary patterns, suicide, asylum incarceration, even radical politics. Current microbiome research has been typically framed as a radically new development that offers a more holistic approach to the body and its ailments. However, historical analysis suggests that strands of medical thought on the gut showed tendencies to swing between thinking about the gut in either a reductionist or holistic way. At times, these

models co-existed and often competed for dominance in clinical thought. In many ways, recent microbiological research represents a swing back towards holism commenced in the 1990s when researchers began to re-question the reductionism of pharmacological gastric management and its tendencies to disregard the relationship between stomach and mind [60,61].

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## 'Neurasthenia gastrica' revisited: perceptions of nerve-gut interactions in nervous exhaustion, 1880–1920

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### ABSTRACT

In this paper, some of the medical literature on the historical disease-concept of 'neurasthenia gastrica' is reviewed. Neurasthenia gastrica was defined as a sub-unit of the wider category of neurasthenia, also referred to as nervous exhaustion or nervous weakness. Neurasthenia was a commonly used diagnostic label at the end of the nineteenth century and a few decades onwards, and was used to describe a wide variety of symptoms for which no 'organic' basis could be found. In neurasthenia gastrica, however, the gastrointestinal symptoms predominated, and there was considerable debate as to how the gut interacted with the central nervous system in the development of these ailments. Some of these discussions may be seen as historical precedents for the current debates on the brain-gut-microbiota axis, particularly in relation to the so-called functional gastrointestinal disorders.

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Neurasthenia was a widely used diagnostic label in America and most European countries at the end of the nineteenth century. The 'birth' of neurasthenia as a disease category is usually dated to 1869, when two American physicians apparently independently of each other published their first works on this condition [1–3]. Of these two, Edwin van Deusen and George Miller Beard, it was the latter who became most strongly associated with the disease label (Figure 1). Beard was a New York neurologist, chiefly attending to the upper middle class patients of the city [4]. When he presented his reflections on "Neurasthenia, or Nervous Exhaustion" for the first time, in a lecture to the New York Medical Journal Association in 1869, he opened by stating that neurasthenia, literally meaning 'want of strength in the nerve', was one of the most common causes and effects of disease at the time. He compared the condition to anaemia, arguing that 'Anæmia (...) is to the vascular system what neurasthenia is to the nervous. The one means want of blood; the other, want of nervous force' [2, p. 217]. This 'want of nervous force' and exhaustion of the nervous system could, according to Beard, lead to the development of a vast range of symptoms, including tiredness, headaches, palpitations, anxiety, depression, and sexual impotence. The general clinical examinations did, however, rarely reveal any pathological findings [5].

When it came to etiological factors of the condition, Beard was of the opinion that 'Neurasthenia may result from any causes that exhaust the nervous system'. Examples of such causes were a hereditary

disposition, as well as 'special exciting causes' such as 'the pressure of bereavement', 'business and family cares', 'sexual excesses' and 'the abuse of stimulants and narcotics' [2, p. 218]. The causal explanation he became most famous for, however, was the one he presented in a later work on *American Nervousness* (1881), in which he argued that neurasthenia was to be understood as a product of modern civilization, and the rapid societal changes and hectic American life at the end of the nineteenth century [6].

The history of neurasthenia has been widely studied during the last three decades. Historians have paid particular attention to the fact that neurasthenia was interpreted differently in different cultural and national contexts [3,7,8]. The notion that neurasthenia was a product of modernization has also been widely studied [9–12]. Since the late 1980s neurasthenia has also figured in medical debates, where it has been suggested as a historical forerunner of several contested diagnoses of our time, most notably chronic fatigue syndrome (also called myalgic encephalomyelitis/ME) [13,14].

A largely neglected part of the history of neurasthenia, however, is that neurasthenia in its heyday in many cases was perceived as a disorder which was closely associated with the gut. For instance, in 1906 the Canadian physician Hugh McCallum claimed that 'there is no known functional disease of the stomach that cannot have its cause and continuity in neurasthenia' [15, p. 1031]. Moreover, several physicians





**Figure 1.** Portrait of George Miller Beard, the ‘father’ of neurasthenia. (Wikimedia Public Domain).

reported that gastrointestinal complaints constituted a predominant part of the clinical picture in many neurasthenic patients, and some of these physicians felt the need to define a sub-entity of the wide neurasthenia diagnosis.

In the present paper, some of the major works on the sub-entity of neurasthenia called ‘neurasthenia gastrica’ will be reviewed. Drawing primarily on medical journals and textbooks from the German, British and American contexts during what is often described as the heyday of neurasthenia (ca 1880–1920), I explore the origins of this disease label. Moreover, I provide an overview of the clinical descriptions, causal explanations and therapeutic recommendations associated with this condition, with an overall aim of exploring how the nature of the relationship between the gut and the nervous system was perceived within the context of neurasthenia gastrica. As I will show, these historical medical discussions about possible nerve-gut interactions in neurasthenia contain several elements that may be seen as important historical precedents for the current debate about the brain–gut axis in functional gastrointestinal disorders.

### The origins of neurasthenia gastrica

Digestive symptoms played a part already in the earliest writings on American neurasthenia; George

Beard as well as Edwin van Deusen mentioned dyspepsia as one of the most common complaints in their first papers on this condition [1,2]. Beard’s attention towards this part of the neurasthenic picture grew throughout the following years, and in the text that came to be the first standard work on neurasthenia, *A Practical Treatise On Nervous Exhaustion* (1880), he elaborated on the topic and described ‘Nervous Dyspepsia’ (also referred to as ‘Dyspepsie Asthénique’) as one of neurasthenia’s core characteristics [5, p. 47]. According to Beard’s experience with neurasthenic patients, nervous dyspepsia was in many cases ‘the first noticeable symptom of nervous exhaustion’, and ‘the earliest sign that the body is giving way’. The way he saw it, a functionally disordered stomach could be the only sign of neurasthenia for several years, before nervous symptoms began to develop in other parts of the body. Nevertheless, he insisted that nervous dyspepsia should be seen as a part of ‘the same general pathological condition as all the orders of symptoms here noted’, and as symptoms which might ‘follow or accompany as well as lead this multitudinous army’ of other neurasthenic symptoms [5, p. 47].

The first to coin the term neurasthenia gastrica, or gastric neurasthenia, was possibly also an American physician. In a lecture to the Rhode Island Medical Society on 15 September 1880, William F. Hutchinson presented ‘Three typical cases of neurasthenia’ [16]. In one of these cases, which was presented under the headline ‘Gastric Neurasthenia’, the patient was a 47-year-old widower from New York. Among the clinical features noted, was a ‘facial expression anxious in the extreme, with dark circles around eyes’, and his general appearance was described as ‘bad’. Moreover, he was described as ‘nervous to a distressing extent’, and as a person who ‘sheds tears upon any sudden emotion, and finds it impossible to keep still a moment’. The patient’s most bothersome complaints, however, were located to the gastrointestinal tract: ‘After drinking a large quantity of lager beer, some dozen glasses or more’, the patient had been ‘attacked with severe nausea and long continued vomiting’, which later developed into a chronic ‘congestive irritation of the entire digestive apparatus, attended by obstinate constipation.’ Hutchinson concluded that this was a ‘distinct case of nerve-exhaustion dependent upon what is actually starvation, which, however, has not produced, as yet, any appreciable organic change’ [16, p. 399–400].

The following year, an abstract of Hutchinson’s paper was presented to German medical readers through the *Schmidts Jahrbücher der in- und ausländischen gesammten Medicin* [17]. The abstract – and the disease label in particular – caught the attention of Rudolph Burkart, who at the time worked as the physician-in-charge at the water cure resort (or ‘Wasserheilstalt’) of Marienberg. During this practice, Burkart had noticed

that a large number of his neurasthenic patients presented with stomach complaints as a predominant part of their clinical picture. In 1882, he published a book in which he suggested that neurasthenia gastrica might be a useful disease label in such cases. The book was called *Zur Pathologie der Neurasthenia Gastrica (Dyspepsia nervosa)*, and as it appears, it was with this text that the concept of neurasthenia gastrica first became a topic in the European medical debate [18].

Burkart's text was clearly inspired by Beard's writings on neurasthenia. Beard's monograph *A Practical Treatise On Nervous Exhaustion* had been translated into German the year before, and received much attention from members of the German medical profession [19,20]. However, Burkart's work was also a response to the writings of one of his German colleagues, Wilhelm von Leube, who a few years before had published his first paper on nervous dyspepsia [21]. According to Leube, the symptoms of nervous dyspepsia were due to a local affection of the gut; a 'direct mechanical irritation of over-sensitive nerves' [22, p. 321]. Moreover, he considered nervous dyspepsia to be an independent disorder.

As pointed out by Garland, following Leube's paper, 'there arose an active discussion as to his assumption that the syndrome described by him was due to a local affection of the gastric nerves' [22, p. 321]. His assumption that nervous dyspepsia should be understood as 'eine eigenartige, isolierte Organerkrankung' – a distinct, independent disorder – did also become a hot topic for debate in the decades to come, and in his book, Burkart made a clear stand against Leube's views [18]. According to Burkart (and also Beard), the symptoms known as nervous dyspepsia should *not* be understood and treated as a distinct disease, but rather as a part of a general neurasthenic condition. Consequently, the label neurasthenia gastrica should, in Burkart's opinion, merely be used as a specification in cases of neurasthenia where digestive problems ('einer besonderen Anomalie der Magen-Darmverdaauung') appeared to be a predominant part of the clinical picture [18].

As noted also by Arthur Bofinger, another German physician, the debate about the 'nervous' disorders of the gut intensified after the publication of Leube's legendary paper 'Über nervöse Dyspepsie' [23]. Burkart's description of neurasthenia gastrica rapidly received attention from his German colleagues, and the label was also taken into use in other European countries. However, neurasthenia gastrica was far from being the only suggested alternative to Leube's nervous dyspepsia. Other labels were also proposed, and the various names express some of the subtle differences in the authors' underlying understanding of the nature of the relationship between the disordered gut and the central nervous system [24]. For instance, as reviewed by the Norwegian physician

Johan Karl Unger Vetlesen in 1886, in the European debate there was the 'neurasthenia dyspeptica' and also 'neurasthenia vago-sympathicus' suggested by the German physician Carl Anton Ewald [24]. Rossbach, on the other hand, preferred the term 'digestive reflex neurosis', while Rosenthal suggested 'gastro-asthenia' or 'asthenic dyspepsia'. In addition, there was the 'psychogenic dyspepsia' preferred by Strümpell, and the 'maladie cerebro-gastrique' suggested by Leven [24,25]. Back on the other side of the Atlantic, Beard introduced the term 'digestive neurasthenia' as a new name for the clinical variety of neurasthenia previously known as nervous dyspepsia [19]. Notably, a change also occurred throughout this period with respect to the name nervous dyspepsia, which became far more widely used than Leube's original definition had suggested. Consequently, in a number of medical texts from the early twentieth century, the two labels – nervous dyspepsia and neurasthenia gastrica – ended up being treated more or less as synonymous terms [26–29].

### Clinical descriptions

The clinical picture of gastric neurasthenia was frequently described as extremely variable, to the extent that this variability itself was said to be a characteristic of the condition [29–31]. Several authors also emphasized that the gastrointestinal symptoms of neurasthenia were in no way specific for this disorder [18,31]. Nevertheless, some symptoms seem to have been perceived as more common and typical for neurasthenia gastrica than others. Among these were a feeling of 'fullness' or pressure in the epigastrium (upper part of the abdomen), epigastric pain and a sense of 'burning' in the stomach, in addition to heartburn, nausea and 'eructations of inodorous and tasteless gas' [18,27,31]. These gastric symptoms were typically reported to be aggravated by intake of food [27,30], but, as a rule, they were not dependent upon the particular quality or quantity of the food ingested. As noted by – amongst others – the New York physician Anthony Bassler: 'Sometimes the most digestible foods cause distress, while the most indigestible are borne without discomfort' [31, p. 802]. However, other authors suggested that certain kinds of food generally did cause more trouble than others. For instance, in 1912 John Honeyford stated that 'In most cases of gastric neurasthenia the carbohydrate portion of the food is not sufficiently acted upon' [32, p. 17]; in other words suggesting an impaired digestion of carbohydrates. Honeyford also pointed to 'highly seasoned dishes, smoked and cured foods, sauce and condiments' as 'indigestible' foods which would aggravate symptoms [32, p. 65].

Although suggested by the name, the symptoms of neurasthenia gastrica were not limited to the stomach. Symptoms from the intestines were also

reported as quite common, constipation in particular, but also sensations of ‘fulness’ or pain in different regions of the abdomen, flatulency and variable/abnormal stools. The appetite was often described as irregular [27,31,33]. Moreover, as was noted already in the works of Beard and Burkart, a number of authors also reported that the gastrointestinal complaints of neurasthenia gastrica in many cases were accompanied by symptoms apparently ‘remote’ from the digestive tract. For instance, J. Campbell McClure pointed to tiredness, inability to concentrate, capricious memory, headaches, palpitations, sleeplessness as well as vague pain in muscles and joints, as some of the most common non-gastric symptoms associated with gastric neurasthenia [34]. Robert Coleman Kemp made particular mention of ‘a sleepy feeling, or even weakness or dizziness’, and ‘marked mental depression’ as commonly associated symptoms [27, p. 382], while Charles D. Aaron reported that ‘fulness of the head, cephalalgia, migraine, inability to work, vertigo, lassitude, insomnia, hypochondriac and melancholic illusions’ were some of the most common ‘general’ symptoms of gastric neurasthenia [29, p. 355].

Despite the many symptoms, a routine physical examination of the abdomen did usually not reveal anything abnormal, and this discrepancy between the intensity of subjective symptoms and lack of pathological findings was itself considered a core characteristic of neurasthenia gastrica [18].

### The ‘nervous’ explanations

The majority of physicians who wrote about gastric neurasthenia during this period, were in accordance with Beard’s and Burkart’s understanding of neurasthenia gastrica as a symptom-complex which was part of a general neurasthenic condition, rather than a distinct, ‘local’ disorder of the gut. Consequently, the suggested disease mechanisms and medical theories related to gastric neurasthenia were to a large extent overlapping and in line with those of neurasthenia in general. In the understanding of how general neurasthenia could develop with such a wide range of symptoms, the two most essential elements were ‘loss of nerve power’ and ‘morbid exaltation of nervous sensibility’ [35, p. 45], often condensed to ‘irritable weakness’ [36, p. 2] or, in German, ‘reizbare Schwäche’ [20]. Correspondingly, the basic understanding of the disease mechanisms of gastric neurasthenia, was that the manifold symptoms were caused by an increased irritability and marked weakness of the nerves innervating the stomach [37].

As to what kind of factors that could cause such irritable weakness in the first place, there were numerous suggestions. Several authors emphasized the importance of heredity; that a nervous disposition could be inherited and congenital, and thus be a

strong predisposing factor for the development of gastric neurasthenia later in life [18,26]. Examples of ‘certain conditions in the parent’ assumed to act as ‘predisposing factors in weakening the nervous system of the child’, were ‘mental and physical debility, alcoholic and sexual excesses, tubercle, syphilis, youthfulness or extreme age and neuroses of the parents’ [32, p. 9].

However, according to several physicians, the irritable weakness of the nerve-supply of the stomach might just as well develop ‘in a fit constitution after the excessive expenditure of nerve force’ [37, p. 336]. Some of the most commonly suggested factors suspected to drain the nervous system of energy, were overwork, worry, emotional excitement, ‘overstudy’ and other forms of mental over-exertion [26,27,30,37,38]. According to John Harvey Kellogg, medical doctor and superintendent of the Battle Creek Sanitarium, ‘overactivity or too prolonged activity of the brain, especially worry and harassment of the mind, unquestionably excite the abdominal brain to a harmful degree and lead to gastric and other visceral disturbance’ [39, p. 101].

So-called ‘sexual excesses’ and self-abuse (masturbation) were also common explanations, particularly in the case of male patients [26,27,30,37,38]. The British physician John Honeyford stressed the harmful effects of ‘over-indulgence in narcotic substances such as tea, coffee, tobacco &c., late hours and the want of sufficient sleep’ [32, p. 8]. Moreover, neurasthenia gastrica was observed to develop in the aftermath of other diseases, such as influenza, malaria or venereal disease [28,32,33]. Reflex irritation from other organs of the abdominal cavity – predominantly the uterus, was also described as a common cause [30].

In 1915, Captain J. Campbell McClure pointed to the ongoing war as a particularly common cause of gastric neurasthenia. As physician to the Red Cross Clinic for Physical Treatment of Officers in London, he had seen ‘several cases in which the foundation of a neurasthenia of a definitely gastric type was laid during the sieges of Ladysmith and Mafeking.’ He explained this by ‘the nerve-racking strain maintained for weeks, insufficient and coarse food, and the physical exhaustion of continued vigil’, and found it conceivable that the war would continue to ‘produce a large group of cases of this kind both in our navy and our army’ [34, p. 698].

As to how the different nerve centers could communicate with each other, and thus produce symptoms from several parts of the body when an ‘irritable weakness’ of the nervous system had developed, there were no definite answers, but several theories. George Beard, for instance, based his views on reflex theory: ‘The body is a bundle of reflex actions. An irritation in one part is liable to produce an irritation in some other part’ [19, pp.

41–42]. This was ‘true of all parts of the body’, he continued, but he singled out the stomach as one of the most important of the reflex centers. McClure pointed to the importance of the exhaustion of the vagus centres [40], while William van Valzah and J. Douglas Nisbet, on the other hand, assumed that the communication between the gut and the nervous system occurred primarily through the solar plexus:

The solar plexus, receiving all the impressions from the abdominal and thoracic organs, is very intimately associated with the cerebrum. Through it sensation, thought, and emotion influence digestion. Through it and the pneumogastric nerves digestion affects the activity of the brain. (...) It is the connecting link between the moral, the intellectual, and the vegetative life. (...) It is this highest and greatest assemblage of sympathetic centers which unites the nervous symptoms of neurasthenia gastrica. [37, p. 336]

The solar plexus was also in focus in the writings of J. H. Kellogg, who suggested there were actually two brains to be considered in neurasthenia, and they had the ability to mutually influence each other:

The region of the stomach is the seat of the solar plexus, the great abdominal brain which exercises a controlling influence over all the functions of digestion blood-circulation, elimination – all the automatic processes of animal life. The great sympathetic chain of ganglia is the center of the organic life of the body. Through the close association of the abdominal brain and the cerebrum there is an intimate connection between digestion and mental action. It is through this association of the cranial brain and the abdominal brain that mental states affect digestion so profoundly, and the reverse. [39, p. 98–99]

### Neurasthenia – primarily a disorder of the gut?

Although most authors who discussed the subject of neurasthenia gastrica perceived the gastric disorder to be a part of – or secondary to – the general neurasthenia, other physicians believed that it was the other way around, and that a disturbed gut was the primary problem in gastric as well as general neurasthenia. One of the physicians who raised criticism against the advocates for the most common understanding of the mechanisms of neurasthenia gastrica, was Thomas D. Savill, physician to the West-End Hospital for Diseases of the Nervous System in London. In his *Clinical Lectures on Neurasthenia* (1899), he accused the ‘observers of this school’ who were ‘in the habit of speaking of “gastric neurasthenia” for denying, or at least not adequately considering ‘the possibility of neurasthenia resulting from gastric disorder’ [41, p. 55].

Savill was, for his own part, convinced that neurasthenia in the majority of cases *was* a result of a (primary) gastric disorder, and he explained why he had come to this conclusion. After careful history-taking of 102 of his own neurasthenia patients, he had found out that as many as 74 of these patients had experienced symptoms of ‘gastric derangement’ prior to the development of other symptoms of neurasthenia. Moreover, his experience was that when patients were efficiently treated for their gastric problems, their neurasthenic symptoms faded as well.

How could this be possible? Savill’s explanation was that gastric disturbances might produce neurasthenia via an ‘autointoxic condition of the blood’, in which the ‘toxic products of digestion may have a specifically poisonous effect on nerve structures’ [41, p. 67]. He was not the only one to think along these lines. The theory of intestinal autointoxication, commonly ascribed to the French physician Charles Bouchard, was embraced by many medical doctors during the latter half of the nineteenth century, and was a commonly suggested disease mechanism for a wide range of disorders [42]. At its core was the assumption that toxic putrefactive products of digestion could cause systemic disease after being absorbed from the bowel:

The absorption of toxins from the intestinal canal – caused by changes in the digestive juices, by imperfect digestion, fermentation and by bacteria – constantly takes place, and is the chief cause in perpetuating the trouble. [43, p. 21]

The toxic products of digestion were in turn assumed to impair ‘in varying degrees the anatomical elements of the different organs and notably the nervous centres’ [36, p. 82]. Thus, by toxic attacks on the nervous system, the products of a disturbed digestive process could produce not only the local symptoms of gastric neurasthenia, such as ‘laborious digestion’, but also almost any kind of the previously mentioned ‘remote’ nervous symptoms commonly associated with the condition, such as exhaustion, headache, insomnia, palpitation and melancholia [32,36]. In 1891 the French physician Champagnac boldly claimed that autointoxication was the true ‘point of departure’ of neurasthenic disturbances [44], and two other French physicians, Gilbert Ballet and Adrien Proust, ranged it as the most important of all the modern ‘theories, which ascribe the origin of the neurasthenic conditions to disorders of the gastric functions’ [36, p. 81–82].

In neurasthenia, the process of intestinal autointoxication was often perceived as being associated with, and facilitated by, a flaccid (atonic) stomach [45]. A weakness and loss of tone in the stomach walls was assumed to lead to poor motoric function (peristalsis), with constipation as a possible consequence. This ‘intestinal stasis’ was in turn assumed to contribute greatly to an ‘imperfect’ process of

putrefaction and, consequently, intestinal auto-intoxication. Gastric atony was also reported to be associated with a dilatation of the stomach. Moreover, gastric atony was reported to be a common characteristic of the neurasthenic stomach, in its own right.

For instance, in 1917, when describing his experiences with soldiers who had developed neurasthenia during the war, J. Campbell McClure pointed to gastric atony as a condition which at the time was ‘a source of considerable trouble to those who are dealing with war neurasthenics’. He told that during the past two years, he had met

a large number of soldiers suffering from neurasthenia, either with or without a definite history of shell shock, who, in addition to the physical exhaustion and psychasthenia common in these cases, have suffered definitely from sensations referable to the abdomen, such as aching in the left hypochondrium, pain in the epigastrium, a sensation of constriction in the lower sternal region, and a general feeling of sinking referred not only to the epigastrium but perhaps to the whole abdomen. [40, p. 600]

In addition, the soldiers frequently suffered from loss of appetite and a feeling of distention of the stomach after eating, which could persist for several hours. An X-ray examination of the stomach did, according to McClure, in the majority of cases show ‘a stomach slightly more capacious than normally and rather slow to empty’. He distinguished between two classes of such cases, with slightly different underlying mechanisms:

In the former class, who recover quickly and apparently completely after suitable treatment, I believe that the gastric atony is due to over-influence of splanchnics. (...) In the latter class, whose convalescence is long and too often incomplete, it appears likely that the nervous fault which produces the gastric atony is failure of impulses due to exhaustion of the vagus centres. [40, p. 601]

As for the actual cause of gastric atony in these cases, McClure pointed particularly to the ‘emotion of fear’:

All these men have been subjected, apart from definite shell shock, to experiences which are exhausting physically and mentally trying. (...) One has to remember in dealing with such patients at the present time that in the cases of the bravest man the emotion of fear, or if we choose to call it so, of anxiety, is a contributing factor in the production of any condition of muscular and nervous weakness. [40, p. 600]

However, as was also acknowledged by McClure, a general challenge when trying to understand the role of gastric atony in neurasthenia, was to establish whether this condition was the primary problem with neurasthenia as a secondary phenomenon, ‘or whether the gastric condition is simply the emphatic expression in the stomach of a general neurosis.’ [34,

p. 697]. There were differing views. In 1903, Ballet and Proust concluded that ‘it seems certain that gastro-intestinal atony (...) [is] more often the effect than the cause of the affection’ [36, p. 3]. A few years later, however, the American surgeons MacLaren and Daugherty argued that gastric atony was ‘the original cause of neurasthenia’ [46].

Another suggested characteristic of the gut in gastric as well as general neurasthenia, was the so-called ptosis (sagging, downward displacement) of the stomach and/or intestines and other organs of the abdominal cavity, referred to as gastropptosis, enteroptosis, and visceroptosis, respectively. Ptosis could be associated with gastric atony and was also described as a possible facilitator for intestinal auto-intoxication; the latter through ‘stagnation’ of the contents of the stomach and intestines. It was also assumed that the descended organs could produce changes in the circulation of the various viscera of the abdominal cavity, with unfortunate consequences [38].

The physician who was usually credited for having been the first to describe a possible causal association between such “sinking of the viscera” and neurasthenia in the early 1880s, was the French physician Glénard [24,47,48]. During the following decades, several other physicians reported to have observed this abnormality in a number of neurasthenic patients, and some of them even went so far as to call it a ‘stigma neurasthenicum’ – a distinct sign of neurasthenia.

One of them was the Canadian physician Hugh McCallum, who in 1906 stated that he looked upon ‘ptosis of any of the abdominal viscera as a stigma of neurasthenia, and quite as pathognomonic of it as a sharp haemoptysis is of pulmonary tuberculosis’ [15, p.1032]. In a previous paper, he stated that as many as 90 percent of female cases of neurasthenia were ‘victims of visceroptosis’, and he argued that the symptoms of visceroptosis were practically the same as those of neurasthenia – ‘with or without local distress’, which suggested a direct causal link [49]. Examples of symptoms of gastric neurasthenia which were also reported in visceroptosis, were a disturbed appetite, “a sense of fullness in the epigastrium, belching, acid taste” and burning pain in the epigastrium after eating. The general nervous symptoms included ‘general weakness, changeable and depressed moods, headaches and fulness of the head, vertigo, (...) disturbance of sleep’, and a number of other ailments [38, p. 540]. Among the etiological explanations for the visceroptosis as such, were a ‘bad standing posture’, ‘badly-fitting garments’, high-heeled shoes and corsets, ‘the imperfect use of the lower zone of the thorax, the absence of fat, and the want of tonicity in the abdominal musculature leading to defective intra-abdominal pressure’ [47,49, p. 345, 50].

This enthusiasm for ptosis as a potential direct causal explanation in gastric neurasthenia was, however, not shared by every author on the subject. McCallum was instantly criticized for having ‘magnified’ the importance of visceroptosis in neurasthenics [15], and several authors argued that although enteroptosis certainly did exist in a number of neurasthenic patients, it was the exception rather than the rule [36,48]. In his thesis on neurasthenia gastrica published in 1912, John Honeyford stated that Glenard’s conclusion ‘that enteroptosis was a causative factor in the establishment of neurasthenia’ had been ‘shown to be erroneous as no symptoms of neurasthenia have been detected in many cases where both gastropptosis and enteroptosis were present.’ He concluded that instead of viewing ptosis of the viscera as the primary cause of neurasthenia, ‘the consensus of present day opinion favours the idea that gastropptosis is the result or concomitant of neurasthenia, and that once set up it frequently establishes symptoms of its own’ [32, p. 4–5]. In other words, as in the case of gastric atony and other alleged abnormalities of the neurasthenic gut, the nature and directionality of the relationship between these gastrointestinal conditions and the symptoms of gastric and general neurasthenia were in no way clear-cut matters. In 1903, Ballet and Proust made the following summary of the situation:

In short, the relations between dyspeptic states and neurasthenia may, we think, be summed up as follows: in the majority of patients suffering from nervous exhaustion the dyspepsia has merely the value of a symptom, but of an important symptom, since it may contribute largely to keeping up the neuropathic state. In certain cases – sufficiently numerous it seems – the disorder of the digestive functions has been the primary cause of neurasthenia; and it is against it that the treatment must principally be directed. [36, p. 85]

### Treatment for the nervous gut

The main principles for treatment of neurasthenia in general, and also for neurasthenia gastrica, were removal of the eliciting causes (when possible), and restoration of the nervous energy. This could be done in a number of ways. In the many cases when overwork, daily worries and other kinds of mental strain were suspected as the main causes of the nervous weakness, one way of achieving both these goals, was to ‘take a cure’ or in other ways remove oneself from one’s customary surroundings in order to rest, preferably at a quiet retreat. According to Hemmeter, this was particularly important for ‘American business men, who, with admirable energy but with little regard for their own health, persist in executing work which is too severe for their mental and physical constitution’. These men, he continued, ‘must be taught that the

prime factor in successful treatment is rest, *rest, REST!*’ [30, p. 765]

Rest and isolation were, however, controversial modes of treatment, and several authors warned against exaggerations in this respect. Thus, exercise in suitable amounts, preferably outdoors, was frequently recommended as part of the therapeutic regime: ‘Horseback riding, golf, yachting, fishing, shooting, camp life for a few weeks, a pleasure trip, all give excellent results’ [27, p. 383]. A more passive form of physical stimulation was also often encouraged: ‘There is no doubt that massage improves the nutrition of the muscles and nerves, and favors a vigorous circulation, metabolism, and regular evacuation’ [30, p. 766].

A more literal way of ‘recharging’ the nervous system could be performed through electrotherapy (Figure 2). According to George Beard, electricity was one of ‘the very best’ remedies for the nervous dyspepsia associated with neurasthenia [5]. The therapy could take many forms; it could be general and directed towards the whole nervous system, or it could be more locally targeted. One example of the latter, in the therapeutic recommendations for neurasthenia gastrica, was described by W. Fenwick:

For the stomach a constant current of 3 to 5 milliampères is passed through the epigastric for twenty minutes daily, the negative electrode being applied over the lower dorsal region and the positive one immediately below the left costal margin. [28, p. 233]

Other authors preferred ‘direct electrification of the organ by means of a metallic wire inserted into the ordinary stomach-tube’, but Fenwick found this procedure ‘unpleasant to the patient and tedious of application’. Electricity could also be used as a remedy specifically targeted to relieve constipation, based on the following procedure: ‘One pole is inserted into the rectum and the other, consisting of a large metal disc, is successively applied to the surface of the abdomen at different points along the course of the large intestine. The interrupted current is to be preferred to the constant one, and each sitting should last for about half an hour’ [28, p. 233].

The dietary advice given to patients with gastric neurasthenia varied to a great extent. As pointed out by Franz Riegel: ‘There is no particular diet for these cases. The patients must be taught what to eat and how to nourish themselves. A strengthening diet should always be given, and an irritating diet should be avoided’ [26, p. 813]. Kemp argued along the same lines: ‘The diet should be abundant, the patient avoiding highly seasoned food, alcohol, strong coffee, and excessive smoking’ [27, p. 383]. Honeyford recommended a decreased intake of carbohydrates and an increased amount of proteins (fresh meat) [32]. Occasionally a ‘fattening cure’ was



**Figure 2.** An illustration of electrotherapy (general faradization), a commonly used treatment for neurasthenia. Julius Althaus, 1873. Courtesy of the Wellcome Collection.

prescribed, particularly in severe cases associated with anorexia and weight loss [26, p. 813]. A general advice given with respect to the intake of food, was that ‘In every instance mastication must be thoroughly performed, a sufficient time be allowed for each meal, and no exercise permitted for an hour afterward.’ [28, p. 234].

Certain drugs were assumed to be strengthening and to exert a ‘tonic’ effect on the nervous system, such as arsenic and strychnine, while bromides were believed to lessen the nervous symptoms and improve sleep [27, p. 384]. Moreover, several authors, such as Riegel, emphasized the importance of so-called psychic treatment in neurasthenia gastrica:

Psychic treatment is still more important than all these methods, for the personal influence of the physician is of fundamental importance in the treatment of these cases. Only if the patient has full confidence in the physician can we expect any good results. [26, p. 813]

Hugh MacCallum, too, stressed the importance of the ‘training of the mind’ for the patients. He had experienced that this might be helped by the reading of certain books: ‘It has become my practice to reach certain patients by way of the printed page after

failing with oral instruction. Often a passage from the Bible is more impressive than volumes of secular literature.’ [15, p. 1032].

One particularly popular therapeutic regime for neurasthenics in general, which included most of these elements to a smaller or lesser extent, was the so-called ‘rest cure’ developed by the American neurologist Silas Weir-Mitchell (Figure 3) [3, pp. 25–35]. The cure typically lasted from six to eight weeks. Strict bed rest and isolation from family and friends were some of the key elements of the regime, in addition to overfeeding (a fatty diet mainly based on large quantities of milk), massage and electrotherapy. The cure also had a moral element, and the personal qualities of the doctors and nurses in charge were important for a successful result [51].

Weir-Mitchell’s rest cure was also recommended for sufferers from gastric neurasthenia, and in cases of neurasthenia gastrica associated with visceroptosis, the Weir-Mitchell cure was described as ‘the only proper treatment’ [52]. However, several authors argued that certain modifications of some of the elements had to be made. For instance, in many cases of gastric neurasthenia the long-lasting immobilization usually included in the Weir-Mitchell cure was considered to be harmful; particularly



**Figure 3.** Portrait of Silas Weir Mitchell, the man behind the famous rest cure. (Wikimedia Public Domain).

in those cases where gastric atony was assumed to be a part of the clinical picture. In these cases, immobility was thought to make matters worse and increase the gastro-intestinal atony and associated constipation, and a ‘partial rest cure’, with massage, ‘passive movements’ and faradic electricity was recommended instead [32,36]. The element of overfeeding in Mitchell’s cure was another topic for debate when it came to the gastric form of neurasthenia. As pointed out by McClure: ‘One has to remember that in all these cases there is present a stomach which has lost its tone in greater or lesser degree, which is unusually capacious, and which is very slow to empty. Rest in bed and over-feeding will not help this local condition’ [34, p. 698].

In those cases where some kind of abnormality of the gastrointestinal tract was understood as the cause of gastric (and general) neurasthenia, the therapeutic advice given was somewhat different. For instance, when intestinal autointoxication was considered to be the primary problem, the aim of the treatment was to remove the source of toxemia. This could be done by improving the ‘elimination’ and reducing the often-associated constipation, by the means of drugs (‘emesis or lavage’) or so-called ‘colonic flushings’ [53]. Moreover, yoghurt was assumed to inhibit the toxic putrefactive processes of the intestines [54]. In some cases, a more radical and invasive mode of treatment option was suggested. As pointed out by Campbell McClure:

In a certain small proportion of cases it may be even necessary, on account of long-continued and severe gastro-intestinal toxæmia which resists any other form of treatment, to remove the colon and implant the ileum into the sigmoid, as recommended by Sir Arbuthnot Lane. [34, p. 699]

Sir Arbuthnot Lane was a British surgeon who became particularly associated with surgical treatment of intestinal autointoxication (‘alimentary toxæmia’), and he also recommended this treatment for neurasthenics [55]. However, McClure emphasized that such operations should not be undertaken lightly; they should ‘not be resorted to until every other known means of treatment of these cases has been proved, after careful and long-continued trial, to be a failure.’ [34, p. 699]

Surgery was also sometimes recommended in cases where gastric atony or ptosis of one of the abdominal organs was perceived as a main cause of the neurasthenic symptoms [47,56]. For instance, the American surgeon John F. Sheldon argued that in cases where the neurasthenia could be seen as secondary to gastric atony and associated complications, a ‘gastro-enterostomy, with closure of the pylorus’ would give the patients ‘complete and permanent relief, not only from the stomach symptoms, but also from the neurasthenia and constipation’ [57, p. 36]. In the cases of ptosis, George N. Kreider was of the opinion that ‘hundreds – yes, thousands – of women have been condemned to a miserable existence as hysterics or neurasthenics, who could be relieved if their abdominal ptosis were considered and relieved by bandages or operation’ [47, p. 2036]. Other physicians were far more critical and warned strongly against the use of surgical treatment in such cases, arguing that ‘no operation will take away the muscular atony but will rather aggravate it’ [46, p. 310].

The general impression left by the majority of physicians who were engaged in the medical debate about neurasthenia gastrica is that this was a challenging condition which was hard to combat. The prognosis was frequently described as poor, in the sense that the condition would often become chronic and relapse after brief intermissions of improvement. As summed up by Riegel, it was considered ‘impossible to formulate any general rules; the only way to treat these cases correctly is to individualize and to weigh carefully all the conditions in each case’ [26, p. 813].

### **The end of neurasthenia gastrica?**

In summary, the present study shows that neurasthenia gastrica as it was perceived by Western physicians around 1900, was a many-faceted condition and disease concept. The clinical picture was characterized as highly variable, and although gastrointestinal complaints were presented as the core manifestations of the condition, the definitions also included ‘remote’



nervous symptoms, such as fatigue, anxiety and depression. In this respect, many of the clinical descriptions of gastric neurasthenia show a great resemblance to those of the conditions we now know under the name of functional gastrointestinal disorders [58–61]. Parallels between the past and the present may also be drawn when it comes to some of the possible causes for ‘nervous’ disorders of the gut; infectious disease, emotional/mental strain and hereditary factors are among the suggested contributing factors in the development of functional gastrointestinal disorders today, as they were for neurasthenia gastrica more than a hundred years ago [60].

The historical texts studied in the present paper also clearly show that the physicians who dealt with neurasthenia gastrica around 1900 raised and struggled with many of the same questions as clinicians and researchers do today, when it comes to trying to understand the true nature of the pathways of communication between the gut and the central nervous system in functional gastrointestinal disorders. Although our current concept of a brain–gut axis was not explicitly used in the writings on neurasthenia gastrica, the reasoning around these issues nevertheless went along some of the same lines then as it does today, although in different shapes. For instance, one interesting parallel is the understanding of the vagus nerve as having a crucial role in the brain–gut communication; a theory which is acknowledged today [62,63], which was also (although more vaguely) suggested by some of the authors writing about neurasthenia gastrica. Moreover, the notion that we have an ‘abdominal brain’ which is interacting with our other brain, as was suggested in the debate about neurasthenia gastrica, would fit very well with the language in the current debate, where the enteric nervous system is frequently referred to as our ‘second brain’ [64]. Intriguingly, with the causal theory of intestinal autointoxication, the history of gastric neurasthenia also contains an element which may be seen as a historical forerunner of the present-day interest in the potential role of the microbes of the gut in the development of functional gastrointestinal (and other) disorders (the microbiome-gut-brain axis) [62,63].

It has been stated by many that the ‘golden age’ of the diagnosis of neurasthenia ended around 1920 in America and most European countries [7,13]. Apparently, and probably as a consequence, this was also the case for the label neurasthenia gastrica. Nevertheless, the debates surrounding this historical condition are still highly relevant, and should serve as an important backdrop for our current attempts to reach a more complete understanding of how the brain, gut and microbiota interact in (gut) health and disease.

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# Autointoxication and historical precursors of the microbiome–gut–brain axis

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## ABSTRACT

This article focuses on autointoxication, a discredited medical theory from the late nineteenth century that provides important points of reflection for today's research on the role of microbes in the human gut for mental health. It considers how the theory of autointoxication, which came into great prominence amongst physicians and the general public worldwide, fell from grace by the middle of the twentieth century, and briefly asks why studies of the human microbiome are now back in vogue. It departs from earlier articles on the topic firstly by arguing that autointoxication theory was especially prevalent in France, and secondly by focusing on the application of this theory to mental health. Bringing to light medical treatises and theses from this period which have so far remained unexamined, it shows that examining the development and reception of medical theories from the past can help us today in understanding both the pitfalls and promise of research in this area.

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## Introduction

As recently as 2005, the suggestion that bacteria in the human gut could be a factor in mental health was highly speculative, even contentious [1]. Even in 2011, it was still located in the hypothetical realm [2]. Almost a decade later, more clinical trials are needed on humans, as is pointed out in recent reviews [3,4], and the precise nature of the process is still not known. But numerous studies have demonstrated clear links between intestinal microbiota and mood, behaviour, and cognitive impairment [5–8] and such findings could have radical implications for the treatment of neuropsychiatric disorders. However, the idea that bacteria in the human gut could play role in mental health is not revolutionary, and this article argues that the prehistory of this area provides important context for present-day research. Specifically, it will be shown that the heightened interest in ‘autointoxication theory’ in nineteenth-century France provides important points of reflection for contemporary work on the gut–brain–microbiome connection. The article provides an important corrective to common views of autointoxication as a mere quack theory grounded in nineteenth-century obsessions with constipation. It shows instead that many of the physicians who wrote about autointoxication were in fact interested in microbe–mind interactions, whilst those associated with debunking autointoxication were the most resistant to recognising the potential role of intestinal bacteria in mental health.

## Autointoxication theory takes off

Following on from Louis Pasteur's discoveries in the sphere now termed bacteriology, researchers in the 1880s and 1890s became highly interested in the significance of microbes located in the digestive system. Specifically, European physicians pondered about the influence of these microbes on human health through the internal processes of ‘putrefaction’ [9]. There were several claims to precedence in this area. For example, some have referred to Dr Robert Bell as an early developer of what came to be known as autointoxication theory, since he claimed that putrid ‘fluid’ absorbed from the large intestine led to a form of blood-poisoning [10]. But as Robert Hudson notes, Bell did not indict bacterial toxins specifically [11].

Much of the early groundwork for the theory was laid out by German physicians. The Prussian specialist in internal medicine, Hermann Senator, speculated in a brief article of 1868 that ‘self-infection’ through bacteria in the intestines could lead to disease [12]. The work carried out by German physician and medical writer Ludwig Brieger on ‘ptomaines’ also proved influential: in his three-volume *Über Ptomaine* (1885–1886), Brieger analysed the chemical processes that occurred during the ‘putrefaction’ of proteins within the human intestine. He referred to the basic products formed during this process as ‘ptomaines’ (from the ancient Greek *πτῶμα* for fallen body, or corpse) [13] and argued that their absorption was harmful to the human body [14,15].

But it was French physician Charles Bouchard's theory of 'auto-intoxication' which did the most to stimulate research on the role of intestinal microbes in health. Bouchard noted in his famous *Lectures on Auto-intoxication in Disease* (1887) that 'man is inhabited, most considerably in his digestive tract, by lower organisms', and if these organisms were not properly eliminated, or if too many of them were produced, they could cause what he termed internal 'poisoning', leading to disease. Thus 'man [...] carries within himself the cause of many illnesses', he stated [16]. Bouchard's theory was notoriously vague, but it was to have remarkably wide currency, particularly in France and Germany, and also in the US, largely spearheaded by French and German-trained physicians [17].

The American health reformer, John Harvey Kellogg, for example, popularized the theory in his bestselling *Auto-intoxication or Intestinal Toxemia* (1919) where he referred to the concept as that of 'the French school'. Some still swear by these theories, as seen in the republication of Kellogg's text in 2006 [18]. Kellogg claimed in 1919 that 'at the present time there are few up-to-date medical men, who do not recognize the close relation between intestinal stasis [...] and a long list of chronic disorders' [19]. His volume enthusiastically describes methods for dealing with 'cases requiring change of the intestinal flora', methods that he claimed to have 'successfully employed' to treat thousands of patients at his Battle Creek Sanitarium. Such is his interest in the topic, he devotes further attention to auto-intoxication in his next publication, *The Itinerary of a Breakfast* (1920), where he asserts that 'intestinal toxæmia or auto-intoxication is the most universal of all maladies, and the source of auto-intoxication is the colon with its seething mass of putrefying food residues', outlined in a coloured illustration (Figure 1).

### Auto-intoxication: a swift fall from grace

Despite the intense medical and popular interest in auto-intoxication at the turn of the century, however, serious research on the topic was short-lived, and it largely fell out of favour amongst scientists and most practitioners by the 1930s. There are numerous reasons behind this dramatic decline, and many have stressed the problems and failings of the model [11,17,20–22]. One of the reasons that auto-intoxication became discredited, for example, was that certain established physicians took up the theory in the early twentieth century as a basis for extreme and unnecessary treatments. The most famous example is that of Scottish physician, Sir William Arbuthnot Lane (Figure 2), who regularly performed colectomies as a way of treating cases of intestinal stasis [23]. Lane's purported success motivated further surgeons, such as Henry Cotton and John

Draper in the US, to perform risky, invasive procedures based on little evidence and leading to little respite and at times, death [24]. Such radical approaches further undermined serious interest in intestinal bacteria.

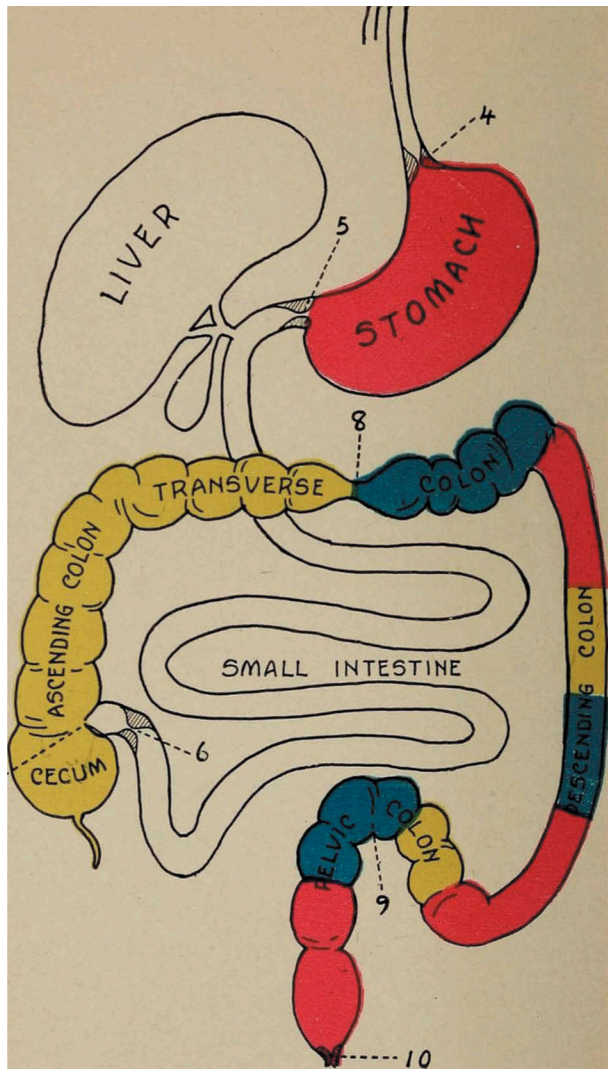
However, it is rarely pointed out that Lane was mostly interested in problematic abdominal positioning rather than the role of microbes in the gut. Lane believed that the upright biped position of human beings was harmful for the digestive system, as it placed stress on the colon and thus harmed both its form and function [25,26]. It was not Lane's adherence to auto-intoxication theory that led to opposition, but rather his doubtful ideas about the positioning of the bowels and his repeated removal of patients' colons as an extreme response to what he saw as the resulting problems.

This presents one of the other reasons behind auto-intoxication's fall from grace: the fact that it was regularly conflated with other conditions and theories, including infarctus (impacted faeces, a theory associated with Johann Kampf, 20), constipation, distention, and visceroptosis. Charles Bouchard's early interest in abdominal distention, for example, was one of the reasons behind his opponents' initial dismissal of his broader theory of auto-intoxication [27]. Auto-intoxication theory was also (and still is) often confused with visceroptosis, a condition associated with physician Frantz Glénard which broadly referred to the displacement or prolapse of the bowels [28]. Baron and Sonnenfeld's 2002 article, for example, examines visceroptosis and auto-intoxication concomitantly and dismisses both as 'nonexistent disease entities' [17].

A further reason behind auto-intoxication theory's decline was that it quickly became associated with quackery. Alongside the legitimate scientific interest in the effects of intestinal bacteria on health, alternative practitioners and charlatans were alert to the financial possibilities offered by the idea that cleaning out the colon could instantly improve wellbeing [22]. Opportunistic entrepreneurs appropriated the theory in order to sell dubious therapies based on unfounded claims. Charles A. Tyrrell's syringe enema, 'the Cascade', for example, purported to cure a host of maladies, all of which Tyrrell attributed to so-called intestinal poisoning [22] (Figure 3).

### Auto-intoxication and its links with today's research

It is not surprising that unscrupulous individuals regularly used hyperbolic language to discuss cures for auto-intoxication as a means of selling their ultimately useless products. In his *The Royal Road to Health* (1894), for instance, Tyrrell claimed that the cause of all disease was 'the retention of waste matters in the system', and thus 'the average colon is a fertile breeding ground for all kinds of poisonous germs' [29].



**Figure 1.** Kellogg, John Harvey, *The Itinerary of a Breakfast; a Popular Account of the Travels of a Breakfast Through the Food Tube And of the Ten Gates and Several Stations through which it Passes, Also of the Obstacles which It Sometimes Meets* (1920) by Kellogg, John Harvey, 1852–1943 [No restrictions], via Wikimedia Commons <https://archive.org/stream/itineraryofbre00kell/itineraryofbre00kell#page/n139/mode/1up>.

Luckily, he could offer a method of treatment which he ‘unhesitatingly’ affirmed would be found ‘so simple, so inexpensive and so obviously based on common sense and true hygienic principles, that the thoughtful reader cannot fail to give it his unqualified endorsement, and will be lost in wonder that any one should fail to adopt it, when made acquainted with its simplicity and its marvellous results.’ This wondrous instrument was the ‘J.B. L. Cascade’, a mechanical appliance named after the words ‘Joy, Beauty, Life, which aptly indicate its purpose and effects, for we confidently claim that its use will infallibly confer these three great blessings, it being the one safe and sanative method of regaining and preserving health.’ Tyrrell’s overly self-assured phrasing (‘unhesitatingly’, ‘unqualified’, ‘confidently’, ‘infallibly’) and quasi-religious language (‘wonder’, ‘marvellous’, ‘blessing’) are signals of his misleading purposes.

But exaggerated claims were not confined to charlatans. On a broader level, the vague nature of auto-intoxication theory made it amenable to all forms of conditions and it was particularly useful as a diagnosis for the myriad unexplained and poorly understood symptoms of ‘hypochondria’, ‘neurasthenia’ or ‘melancholia’, which would today be catalogued as comorbid gastrointestinal and anxiety-related disorders. Auto-intoxication thus met a need to explain such symptoms with no identifiable source, and it became a catch-all diagnosis.

This sense that auto-intoxication could be seen as the cause of all disease was not considered problematic but instead made it highly attractive: its lure can for instance be detected in French psychiatrist Emmanuel Régis’s allusion to experimentation in this area as ‘seductive and full of promise of immediate scientific success’ (30. added emphasis). Referring to the psychic symptoms which often accompanied gastrointestinal illness, Régis claimed that Charles Bouchard had ‘shone new light on these symptoms’ [31].

Such comments remind us of today’s excitement surrounding the human microbiota: although most researchers scrupulously qualify their findings and acknowledge the preliminary nature of work in this area, the notion of the gut as the key to health is proving to be highly attractive. For Emeran Mayer, ensuring that our gut–microbiota–brain interactions are ‘functioning at peak effectiveness’ can help us achieve ‘optimal health’ [32]. A recent article in *Frontiers in Genetics* argues that ‘the human microbiome has emerged as the crucial moderator in the interactions between food and our body’, and thus research in this area has moved from a marginalised position to become ‘a beacon of hope with great potential and many possibilities’ [33]. Once again the image of light cast over shadows suggests that we have finally reached an explanation for hitherto mysterious maladies.

A potential explanation behind the enthusiasm surrounding the microbiome–gut–brain axis today, in contrast with the scorn poured on such connections in the early twentieth century, is the shift in attitude towards the environment and the rise of ‘green studies’, as argued by Funke Iyabo Sangodeyi [34]. This point is also raised by Nitin and Amisha Ahuja, who comment on the ecological metaphors regularly used to describe the human microbiome [35]. Ed Yong’s *I Contain Multitudes* (2017), for example, refers to the ‘ecosystems’ inside us [36], and many researchers now refer to the human body in such ecological terms [37,38]. Since we are now much more aware of the inextricable bonds between human, animal and mineral life, the notion that we also have a symbiotic relationship with non-human elements within our own bodies is becoming increasingly logical.



**Figure 2.** Autographed portrait of Sir W. Arbutnot Lane, from an original photograph by Harrods. Lent by the director, Wellcome Medical Museum. Wellcome Collection.

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**Figure 3.** An advertisement for the J.B.L. Cascade, *Health: a Home Magazine dedicated to Physical Culture and Hygiene*, December 1905 issue. <https://archive.org/stream/healthahomemaga00unkngoog/page/n492/mode/2up> Copyright expired, originally printed prior to 1923 in the US.

On one hand, current use of such ecological frameworks and an emphasis on 'traditional' or 'natural' lifestyles to discuss the functioning human microbiome (seen as out of sync with twenty-first-century living) is an apt and logical progression from the early theory of autointoxication, which was also associated with the dangers of modern, industrialised society such as pollution, chaotic eating habits, and psychological and digestive disorder [35,39]. But on the other hand, there are major differences between these two research areas today, not least on the level of development, since gut-brain-microbiome research is still at an early stage, whereas environmental science is highly advanced, and the evidence for climate change and the effects of human lifestyles on the planet is vast. Moreover, we need to consider the specificity of gut-brain research in the context of mental health, which is where autointoxication theory proves most noteworthy of our interest.

### Autointoxication theory and mental health

It has often been claimed that the theory of autointoxication was definitively 'disproven' [22] by American physicians Walter Alvarez and Arthur Donaldson in the 1920s. Chen and Chen, for example, affirm that these

physicians' 'decisive experiments' [20] invalidated intestinal autointoxication, and others also make similar affirmations [40]. Edzard Ernst, for example, referring to Donaldson's work, also claims that 'rigorous scientific investigation into the theory of autointoxication' meant that 'the hypothesis was soon found to be wrong' [21]. Alvarez and Donaldson's research showed that typical symptoms of autointoxication – loss of appetite, mental sluggishness, headaches and depression – were caused by constipation rather than chemical forces such as the absorption of poisons. They therefore challenged the importance of intestinal microbes in these symptoms.

As Bested et al. have recently shown, however, the notion that Alvarez and Donaldson's research was both rigorous and decisive is a 'modern myth' [24]. Most importantly for this article, Alvarez and Donaldson focused on constipation rather than autointoxication itself: their experiments were carried out on patients suffering from chronic constipation; healthy individuals who were made to refrain from defecating for several hours; or individuals whose rectums were packed with cotton [22,24]. What they showed was that the symptoms were caused by 'mechanical distention and irritation of the lower bowel by fecal masses' rather than 'poisoning' through bacteria [22]. The hypothesis that bacteria in the human intestines could have an impact on mental health, on the other hand, was never disproven, since it was not subjected to rigorous trials. Therefore, these two physicians, who are routinely considered to have invalidated autointoxication, were unwilling to acknowledge or even to consider the potential role of intestinal bacteria in mental health.

The assumption that autointoxication theory can be dismissed wholesale, however, due to its presumed association with other complaints, continues: Micaela Sullivan-Fowler, for example, conflates autointoxication with constipation and colonic irregularity in general [22], and Ernst presents it as 'a triumph of ignorance over science' by equating it with extreme treatments such as colonic irrigation [21]. J. L. Smith also asserts that 'chronic intestinal stasis was a pseudodisease, an aberration of medical progress' [40]. James C. Whorton's excellent work on the social and cultural importance of 'inner hygiene' repeatedly conflates autointoxication with constipation [41]: he affirms, for example, that 'the constipated person, French physician Charles Bouchard declared, "is always working toward his own destruction; he makes continual attempts at suicide by intoxication."' [39]. Although Bouchard did indeed make this comment about man working towards his own destruction (through the organisms in his gut), the comment was not made in relation to constipation. Rather, Bouchard affirmed that constipation could be a form of protection against autointoxication, since constipation assumes that everything that can be absorbed has been absorbed, and whereas

there is a risk of intoxication in the first stage of constipation, by the second stage, intoxication is no longer in operation [16].

Such examples give an indication of the early reasons behind the discrediting of microbes' importance for mental health research, and suggest pitfalls for researchers to avoid: conflation with broader conditions and symptoms; recruitment by individuals and organisations driven by commercial interests; misappropriation of the theory to sell products based on unfounded claims; and exaggerated, overhyped promises. Such factors enabled commentators in the first half of the twentieth century to dismiss the potential links between gut bacteria and the mind before sufficient human evidence could even be established.

But if we look at the early research that specifically explored the role of intestinal bacteria in psychiatric conditions, auto-intoxication emerges as a fruitful area of inquiry. Bouchard's lectures tied in with the findings of many physicians across the Western world regarding the role of bacteria in causing disease. But his theory of auto-intoxication took particular hold in France, specifically in relation to mental health. It is beyond the scope of this article to consider the compelling cultural factors behind France's strong involvement with this theory (unlike in Britain where take-up was lower) [17]. But we can note that, within the realm of medical history, France had a particularly strong tradition of linking the state of the digestive system with psychiatric health or what was termed 'la santé morale'.

Philosopher and physiologist Pierre-Jean-Georges Cabanis (1757–1808), for example, argued that moral life (or the life of the mind) was not only affected by impressions received by the senses but also by those received from the viscera. He stressed the stomach's influence on the nervous system, and especially its immediate impact on the brain [42]. The military physician, François-Joseph-Victor Broussais, famously argued that all passions and mental states are caused by visceral sensation, and in his epigastric theory, hypochondria and similar conditions such as neurasthenia and melancholia were all located in the viscera [43]. Philippe Pinel, often seen as the 'father of psychiatry' in France [44], also argued that the seat of mental illness was to be found in what he termed the 'epigastric region', and he saw symptoms such as constipation or the tightening of the stomach as early symptoms of mania [45]. Mental illness was therefore partly visceral in origin [44]. Pinel's student, the highly influential psychiatrist, Esquirol, also emphasised visceral lesions in cases of insanity in his thesis of 1805 [46].

### Early pioneers: auto-intoxication and psychiatric disorders

Physicians from the early nineteenth century often focused on the nerves as the key connection between

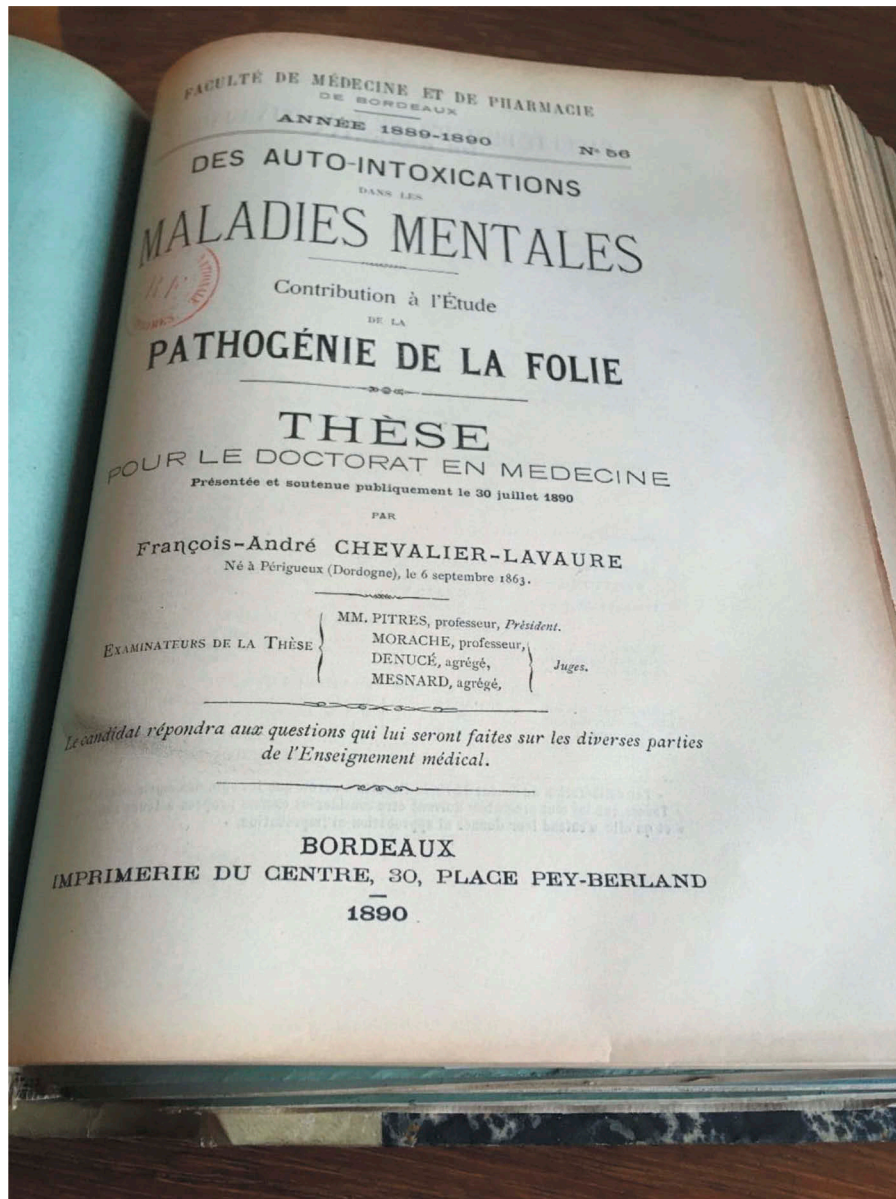
the gut and the brain, and portrayed the connection as a form of 'sympathy' [47] between the two regions or a process of 'irradiation' from stomach to brain [48]. This is in contrast with many scientists and practitioners from the end of the century who focused on bacteria in the gut as the essential factor. Emmanuel Régis was a pioneer in this regard. Régis became particularly interested in the potential of this connection in the 1880s through his observations of psychiatric patients. He noticed that their condition improved after they had received treatment for gastric symptoms, which suggested to him that the bacteria in their intestines might be intervening in their mental balance. He himself did not publish on this until 1893, but before that point he encouraged other researchers to investigate.

Bested et al. have highlighted auto-intoxication as an antecedent for current gut-brain-microbiome research, but the first original paper on auto-intoxication and melancholia that they refer to is physician Daniel R. Brower's article in the *Journal of the American Medical Association* in 1898 [24,49]. The first publication suggesting a link between auto-intoxication and mental health in fact seems to have been *de l'influence Des phénomènes d'auto-intoxication et de La dilatation de l'estomac dans les formes dépressives et mélancoliques* of 1891, an extract of a presentation given by physician António Mario de Bettencourt Rodrigues at a mental health congress in Paris, August 1889. Rodrigues was a Portuguese physician, but he was based at the Faculty of Medicine in Paris and he trained under French psychologist Georges Dumas.

Rodrigues argued that one of the main factors that could trigger mental disorders was gastrointestinal auto-intoxication, particularly in the case of depression and melancholia. He cited Emmanuel Régis and Charles Bouchard as his key inspirations in this regard [50]. Given his many experiences of mental patients improving after a change in diet combined with the elimination of toxins in the gut, Rodrigues argued that there was all the reason to believe that auto-intoxication was the cause of the psychiatric disorders in these patients. Rodrigues admitted to having little proof to support his claims – the task of compiling such evidence would fall to François-André Chevalier-Lavaure, 'the first experimental scientist to apply Bouchard's ideas to the realm of mental pathology', according to a later medical practitioner [51].

Chevalier-Lavaure, in his doctoral thesis of 1890 (Figure 4), explained that there are always bacteria in the human organism, but digestive problems sometimes lead to an augmentation in the level of bacteria and a qualitative and quantitative change in their toxicity [52]. Insufficient elimination of these toxic products means that they can make their way into the patient's blood and, in this way, affect the brain. Although we now know that this argumentation in





**Figure 4.** Medical thesis by Chevalier-Lavaure, Bibliotheque Nationale de France, picture taken Manon Mathias, 2 July 2018. Copyright expired.

itself is false, Chevalier-Lavaure did note an improvement in psychiatric patients after the treatment of digestive conditions. He posited that this was due to the fact that harmful bacteria had been prevented from forming, but experiments were needed to prove this.

Chevalier-Lavaure provides a list of case studies involving patients suffering from psychiatric conditions. His experiments showed that digestive problems preceded their psychiatric disturbances, and when these problems were treated, the mental disturbance disappeared. He acknowledged the important role played by heredity in the development of such conditions, but he affirmed that a trigger was needed to set off this predisposition, ‘and this trigger is autointoxication.’ Mental disturbance, he stated, is caused by ‘the effects produced on the brain by the poisons released by an unhealthy organ in which the

nutritive process is disturbed.’ Chevalier-Lavaure admitted that he had little means of confirming the so-called ‘toxicity’ of the contents of the bowel, but he could measure what came out: he thus used patient’s urine as a means of ascertaining the level of ‘toxins’ in the patients’ system [52].

Chevalier-Lavaure did not claim to have offered definitive proof, and some of his suggestions have proved to be erroneous. But his central aim, inspired by the suggestions made by Régis and Bettencourt Rodigues, of drawing attention to the relations between mental disorders and ‘toxins’ in the digestive system (not digestive problems in general, but ‘the most important factor: autointoxication’), was highly prescient. His work thus shows that not all of auto-intoxication was mere quackery, and instead some of the earliest researchers took a serious and careful interest in microbe–mind interactions.

As recently as 2003, Ann Dally considered auto-intoxication as no more than a ‘fashionable’ but discredited theory. Focusing on the resulting treatments, she presents it as a theory which supports the ‘modern’ model of the ‘body as machine with working parts, quite separate from the mind’ [53]. But as this paper has shown, researchers in France at the end of the nineteenth century were, on the contrary, applying ideas about the role of gut bacteria in health and disease to rethink the disorders of the mind. Such was the interest in this area of research in France that the 1893 French Congress of Psychological Medicine held in La Rochelle featured a panel session dedicated to the topic of intestinal auto-intoxication in mental health.

## Treatment

In terms of treatment, Chevalier-Lavaure suggested that in future, patients’ faecal matter should be examined in order to find out its toxicity, and the harmful bacteria could then be addressed either through antibacterial measures or through ordinary nutritive methods. Some later researchers suggested alternative methods of addressing auto-intoxication: rather than eliminating the harmful ‘organisms’, it might be possible to counteract them with the effects of beneficial bacteria.

What we would now call ‘bacteriotherapy’ is most famously associated with Elie Metchnikoff, a Ukrainian zoologist and microbiologist who was particularly interested in factors that could contribute to human longevity. Influenced by Bouchard’s auto-intoxication theory, Metchnikoff believed that ailments associated with the aging body, including dementia and neurasthenia, were caused by fermentations and putrefactions produced by colonic microbes, and he saw the colon as a highly problematic, even expendable, part of the human body [54]. He observed, however, that Bulgarian villagers who regularly drank fermented dairy products lived longer than others, and, aware of Pasteur’s work on the effect of lactic acid fermentation in preventing bacterial growth, Metchnikoff theorized that rather than removing the colon or attacking its content, people could instead consume lactic acid as a means of addressing the dangers of putrefactive intestinal bacteria. His views about the role of the intestinal microbiota in longevity and health were published in 1907, and his views on intestinal bacteria in 1910 [55]. His specific comments on ‘fighting microbes with microbes’ were made in 1912 [56]. But he had also made suggestions about ‘introducing useful microbes into the body’ in the form of kefir or soured milk in an earlier book, *The Nature of Man*, in 1903 [57].

Metchnikoff was again working in the context of French medicine: he was positioned at the Pasteur

Institute in Paris where he had worked from 1888, and his suggestions were taken up by a broad audience in France. Medical student A. Le Play, for example, in his thesis on ‘Intestinal Poisons’ in 1906, raised the prospect of ‘modifying the intestine’s chemical organisation’ [58]. Journalist Emile Gautier also referred more explicitly in 1907 to the need to combat intestinal poisoning with ‘a police force composed of good microbes’ [59]. He exclaimed that ‘these defensive microbes exist! they are lactic ferments which explain the phenomenal vigour and longevity of Bulgarians: these people, as everyone knows, feed themselves almost exclusively on yoghurt, i.e. soured milk.’

Gautier specifically refers to a French ‘savant’, a Monsieur Chevretin, who isolated the most active of these ferments, the lactic ferment or ‘lactozyme’ B, and dried it before incorporating it into ‘a pastille composed of nutritive substances’. According to Gautier, Chevretin created tablets out of these pastilles ‘which one simply chews with a glass of sugared water to ensure definitive internal health.’ Chevretin’s pastilles are also mentioned in *le Figaro* in 1908 as a means of addressing intestinal intoxication [60] and lactic acid tablets are discussed in the *Gazette médicale de Paris: journal de médecine et Des sciences accessoires* in 1910 [61]. There was therefore a growing sense of excitement in France at this point about the impact of auto-intoxication on health and the potential means of addressing it.

## Gut microbes reshaping psychiatry

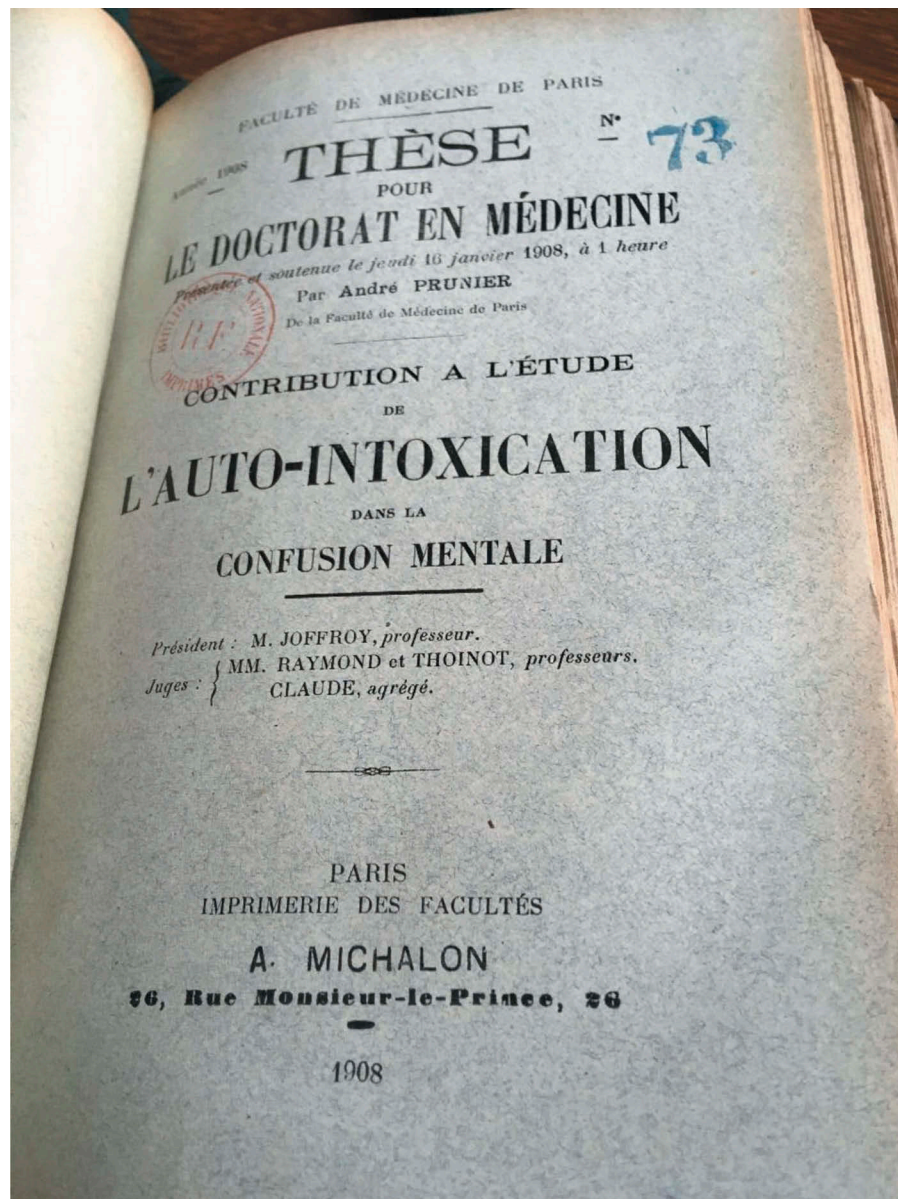
What is most noticeable in the French publications on this area of research in the late nineteenth century is the suggestion that auto-intoxication is the key concept that will unlock the potential of psychiatry and enable it to move from conjecture and speculation into the realm of facts and science. Chevalier-Lavaure, for example, writing in 1890, acknowledged earlier work in this area but noted that although it would have been possible to group previous findings together, it would not have been possible to form a synthesis, ‘due to the lack of a common basis’. This basis, however, ‘has now been provided by the work of professor Bouchard’, he affirmed [52]. Régis also stated in 1893 that whereas the link between mental disorders and the viscera had long been described by French physicians using the notion of sympathy and other ‘mysterious, scientifically unexplainable causes’, the link could now be explained through auto-intoxication, that is, ‘the poisoning of the organism and subsequently the brain either by microbes or their secreted outputs, or by toxic substances resulting from the excessive formation of or insufficient elimination of the body’s normal poisons’ [62].

Régis's first major work on psychiatry, the *Manuel pratique de médecine mentale*, was published in 1884, but his third edition of 1906 was renamed *Précis de Psychiatrie* and was entirely reworked to reflect the changes that had taken place in his discipline. Whereas in 1884, he stated, 'psychiatry was still an isolated subsection within the medical sciences, existing almost without any change since the clinical discoveries of the first half of the nineteenth century', after 1892 things had started to change, and since 1893 this medical specialism had been 'completely transformed' [31]. Régis was of the opinion that it was 'the great modern theories of infection and autointoxication' which had led to the regeneration of psychiatry and brought it into closer contact with medical pathology [31].

In a further example, Dr André Prunier, in his 1908 thesis on autointoxication and mental confusion (Figure 5), also described how psychiatry had been

'transformed' over the course of the nineteenth century, now becoming a part of medical science: 'revivified by the application of the fruitful and modern theories of autointoxication and infection', psychiatry had ceased to exist as 'a mere chapter within philosophy' to become, by entering into the fold of general pathology, 'one of the units within biology' [51]. He referred to the influence of autointoxication on his field, for instance, by noting the numerous publications which were appearing on the relations between psychosis and nutritional problems. The idea that mental disturbance could be caused by gastro-intestinal problems was, according to Prunier in 1908, 'no longer in need of demonstration' [51].

There was therefore a strong sense at the turn of the last century that autointoxication was of serious scientific interest. That psychiatric disturbance that might be caused by intestinal bacteria was considered a crucial



**Figure 5.** Medical thesis by André Prunier, Bibliothèque interuniversitaire de Santé, Paris, picture taken Manon Mathias, 4 July 2018. Copyright expired.

factor in bringing psychiatry away from conjecture, hypothesis, and theory into the realm of modern medicine, and concomitantly it was believed that mental conditions could now be understood through biological and physical explanations. Such optimism is palpable today in the proposed applications of microbiome research to the understanding of numerous psychiatric disorders. Basted et al. suggest that one of the reasons behind the discrediting of research into the role of microbes in mental health from the early twentieth century onwards was the influence of Freudian theories about the mind and the growing dominance of psycho-analytical approaches to mental health. Whether one agrees with such a position or not, it is clear that we still have few answers when it comes to successfully treating individuals suffering from conditions such as anxiety, depression, and bipolar disorder, and the situation is becoming increasingly urgent [63]. This is one of the reasons why human gut microbiome studies are stirring such excitement, due to their perceived ability to offer new explanations for the causes of mental health problems and, potentially, new forms of therapy.

As is recognised by many of those now leading the research in this field, caution must be exercised in terms of managing expectations, and few affirm that probiotics are a straightforward method of treatment or that they alone can improve mental health outcomes [64]. Nevertheless, the suggestion made by the major French psychiatrist, Maurice de Fleury, in 1898, that ‘the way forward is now flung open’ and that ‘therapeutic interventions in to ailments of the soul through the action of the physical on the moral is no longer a laughable idea’, might now finally be brought to fruition [65]. By examining the ways in which the theory of auto-intoxication was beginning to yield fresh understandings of ‘melancholia’ and its treatment at the turn of the last century, we can appreciate the risks, pitfalls, and scepticism involved in undertaking microbial-mental health research, but also the great promise that it holds.

## Disclosure statement


No potential conflict of interest was reported by the author.

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## Coprophagy in nineteenth-century psychiatry

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### ABSTRACT

This paper shows how Austrian psychiatrists of the 1870s developed the first pathological accounts of institutional coprophagia, examining how they related the behaviour to mental illness and dementia. These ideas about coprophagia contrasted dramatically to the long European pharmacological tradition of using excrement for the treatment of a wide range of health conditions. Recent medical scholarship on institutional coprophagia is also reviewed here, with a novel hypothesis proposed about why some patients in long-term care resort to the behaviour in institutions where there is little opportunity for healthy human–microbe interactions.

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### KEYWORDS

Coprophilia; history of coprophilia; history of scatological behaviour; history of excrement as medicine

Among the perverse and pathological behaviours catalogued by European psychiatrists in the second half of the nineteenth century, we find a new concern with the misuse (smearing or eating) of excrement, which came to be taken as a sign of psychopathology. This practice was now designated by several neological terms: ‘coprophagy’, ‘coprophilia’, or the German term ‘*Skatophagie*’ (scatophagia) proposed by a group of Austrian psychiatrists in the 1870s who were collectively fascinated by the problem. In the first part of the paper, I consider the new nineteenth-century view of excrement that helped to produce the modern psychiatric category of psychopathological coprophagia. In the second part, I contrast these developments to the long historical tradition of what the seventeenth-century German physician Christian Paullini (Figure 3) called *Dreck Apotheke* – Filth Pharmacy [1]. Coprophagic and coprophilic behaviours among psychiatric patients attract a continuing scholarly inquiry in our own time, and a considerable body of scientific hypothesis has been suggested along the lines of an intuitive self-medicating motivation. In the final part of this paper, I review several of these hypotheses, as well as offering some additional possibilities worth investigating in light of the emerging models of the role of intestinal bacteria in regulating neurotransmitter balance, mood, and well-being. There is little indication of such a category of behaviour defined in medical sources prior to the 1870s. This is probably not because madness never produced excremental behaviours of this kind. In fact, the early-modern Dutch physician Jan Baptise Van

Helmont described a painter in Brussels who had gone mad and thereafter ate his own excrement [2]. The question then is why did this only result in a meaningful medical category of behaviour from the late nineteenth century onwards?

The answer proposed here is that from the end of the nineteenth century, European medical understanding entered a radically new period defined by an important rupture in ideas about the meaning of excrement. From the time of the ancient Egyptians (circa 1550 BCE) until the late eighteenth century, faecal remedies had been common in European pharmacology, with excrements of different animals, including humans, blended with other agents to produce medications that featured in all the standard apothecary lists [3]. There was simply no place to consider the eating of excrement as, per se, a sign of madness in a context in which excrement was widely agreed to have a pharmacological value. Nineteenth-century doctors were certainly aware of these long and ancient traditions, but with help of new ethnographic colonial imaginaries and their uptake in the theorisation of Freudian psychoanalysis, and with the help of the new fashion for theories of intestinal auto-intoxication, a reframing of their meaning occurred: Early-modern excremental pharmacology was now simply viewed as the remnant of primitive cultures that had failed to differentiate muck from what mattered. They were of no interest to doctors in the new scientific era of the nineteenth century, and indeed the eating of excrement could now only be taken as a sign of civilisation’s discontents: the insane.

## Austrian psychiatric ideas about coprophagia before Freud

By the time the first psychiatrists working in insane asylums began to observe the coprophagic behaviour of a small number of patients, they were so distanced from the notion of excrement having any potential pharmacological value, that this possibility of behavioural explanation did not even appear to occur to them. Instead, they worried that the eating of excrement might itself cause mental illness. These psychiatrists included Professor Lang who was director of the *Landes-Irrenanstalt* (Lunatic Asylum) in Graz; the senior German psychiatrist Adolf Albrecht Erlenmeyer, who authored a major work on syphilitic psychosis [4]; Heinrich Obersteiner (Figure 1), a reputable Jewish psychiatrist in whose Vienna clinic the young Sigmund Freud had worked around 1888, following his apprenticeship in Paris under Jean-Marie Charcot in the early 1880s [5]; and a Dr Maresch who was editor in chief of *Psychiatrisches Centralblatt*, a new Austrian medical journal founded in 1871, in which all the others named here published articles on coprophagia.

Because of Freud's connection with Obersteiner, it is worth inquiring if the ideas about coprophagia generated by this group of Austrian psychiatrists formed part of the genealogy of the Freudian concepts of defecatory sublimation in childhood as necessary for adult psycho-development. Freud, among all the psychoanalytic and psychiatric thinkers of the late nineteenth and early twentieth centuries, particularly privileged defecation in psychosexual development, positioning the anal-sadistic phase as the most primitive instinctive moment of struggle in the development of the child psyche in modern civilisation. His ideas about this, as I have previously described, were deeply idiosyncratic and profoundly teleological in situating defecatory behaviour within a vision of 'recapitulation' of the child through earlier stages of civilisational development [6]. I have, in earlier work, shown how Freud's ideas about anal primitivity engaged with late-nineteenth-century ethnographic observations about excremental practices in diverse cultures, particularly the 1888 *Compilation of Notes and Memoranda Bearing Upon the Use of Human Ordure and Human*



**Figure 1.** A signed photograph of the Viennese psychiatrist Heinrich Obersteiner taken around 1900. Wikimedia Public Domain.

*Urine in Rites of a Religious or Semi-Religious Character Among Various Nations* by the US cavalryman John G. Bourke [7] (Figure 2). The current paper considers the earlier body of Austrian psychiatric thought on the relationship between coprophagia and mental illness which most likely also helped Freud's ideas about excrement and primitivity to cohere.

Freud himself does not appear to have engaged explicitly with the work of Lang, Maresch, Erlenmeyer, and Obersteiner in relation to excremental questions, though it seems likely that he would have been exposed to their ideas as an intern in Obersteiner's clinic. He also most certainly read Bourke, who in turn cited Obersteiner [7]. Freud appears to have read some scholarship on the notion of scatological behaviour as sign of psychopathology: His 1917 paper 'On Transformation of Instinct as Exemplified in Anal Erotism' referred to

'obsessional neurotics' in whom 'regressive debasement' towards faeces was observed, though without citing his source for this observation [8]. In 1912, the American Freudian psychoanalyst Ernest Jones had signalled a direct genealogical link between Freudian ideas of excrement as a mark of primitivity and the earlier Austrian psychiatric scholarship on coprophagia as a form of mental illness. Jones wrote: 'That it is not very rare for insane persons to eat their own excrement is of course well known', footnoting Obersteiner's data cited in the 1871 article in the *Psychiatrisches Centralblatt* which referred to the figure of 1% of patients exhibiting the behaviour [9]. Prior to this passage in the same text, Jones had cited the work of John G. Bourke on the practice of excremental rituals and remedies in 'primitive' cultures, adding a digression on the matter of

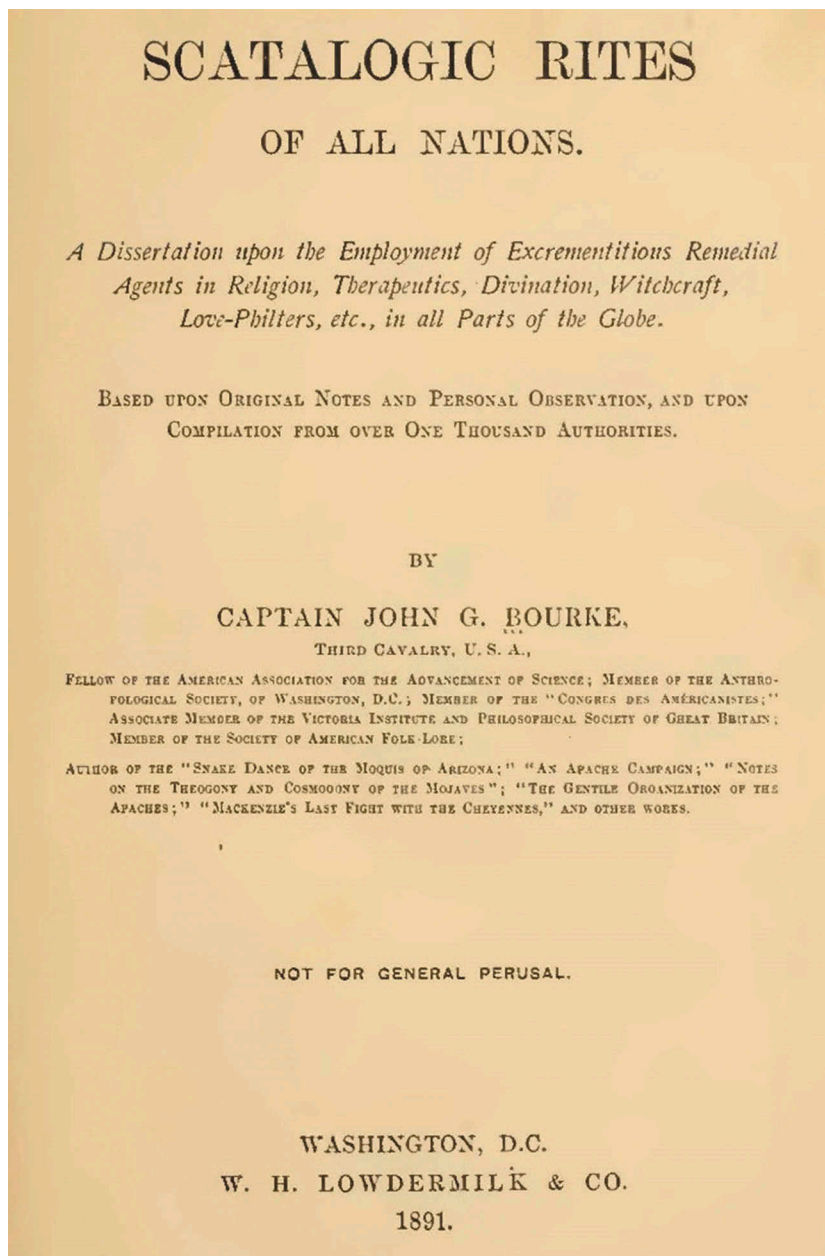


Figure 2. The title page of the 1891 edition of John G. Bourke's compendium. Courtesy of Archive.org. Public Domain.





**Figure 3.** Portrait of the early-modern German physician Franz Christian Paullini, author of *Heilsame Dreck Apotheke (Therapeutic Filth Pharmacy)* of 1696. Courtesy of the Wellcome Collection.

the association between food as taken into the body and food as it is given out, two ideas which are by no means so remote from each other in the primitive mind, including that of the child, as they usually are in that of the civilised adult. [9]

For Freud and for Jones, the psychiatric patient displaying coprophagic tendencies was regressing to childhood, with childhood itself representing a recapitulation of earlier 'primitive' social-evolutionary stages. The insane, toddlers, and primitive humans all shared a coprophagic disposition.

Having established with some degree of likelihood that Freud was influenced by the earlier Austrian psychiatric literature on coprophagia and mental

illness, we might then inquire if these earlier discussions had viewed the behaviour as a sort of regression to childhood, or as a primitive practice in the mode of later Freudian thought. But at no point did Lang, Erlenmeyer, Maresch, or Obersteiner appear to entertain such ideas. This was clearly Freud's original line of reasoning about the meaning of coprophagy and coprophilia. In 1896, he had written to his mentor Wilhelm Fleiss asking, 'in connection with the eating of excrement' if there was ever a phase in a child's development when disgust in such things was not yet developed, adding that 'the answer would be of theoretical interest' [10]. He clearly found his answer to this question, as indicated in later statements to the

effect that ‘the excreta arouse no disgust in children ... and seem valuable to them as being part of their own body which has come away from it.’ [11]. As psychologist Nick Haslam notes, the lack of early childhood disgust towards excrement was verified in the 1986 study of Rozin et al. in which most of the 2-year old test-subjects, when offered what appeared to be a dog turd on a plate (actually a simulacra made of smelly cheese and peanut butter), voluntarily put it in their mouths [12,13].

For Freud, the disgust towards excrement and the culturally appropriate abjection of it were products of the first and second phases of erotogenic sublimation in childhood that later encompassed perverse and incestuous sexual desires – the various oral, anal, and genital phases [6]. His observation of coprophagic or scatologic behaviour in adults then situated it as a form of regression or infantilisation. This idea was exciting for Freud because it fitted his emergent vision of childhood development as evolutionary recapitulation, in which infantile drives had to be overcome in the individual in the same way that primitive humans were thought to evolve towards civilisation [14]. This was a kind of cultural application of Ernest Haeckel’s notion of biological developmental recapitulation in which the human embryo passes through previous stages of animal evolution, developing pharyngeal gill slits and a post-anal tail in the eighth week of gestation. Freud thought that the civilised child in the development to adulthood had to learn to sublimate excrement just as primitive humans of the European past must once have done [6]. Adult neurosis was a regression to those infantile/primitive drives.

It was in the decade prior Freud’s work under Obersteiner when the latter was most engaged, along with Lang, Maresch, and Erlenmeyer, with the problem of aberrant excremental behaviours among inhabitants of insane asylums. They all agreed that it was not a common problem exactly, though clearly nonetheless a disturbing one for asylum medical staff and for other patients. One of the problems that these early psychiatrists faced in defining their object was the diversity of types of individuals who were ‘scatophagic’ – ranging from those with severe delusional illnesses, to those with a conscious sexual fetish for excrement (such as that described by the Marquis de Sade). That distinction probably made less sense to nineteenth-century psychiatrists than it might today since sexual perversions at this time were widely considered to constitute a form of psychopathology and were seen as signs of genetic ‘taints’, according to the thesis of ‘degeneration’ [15]. But the Austrian psychiatrists’ case studies all appeared to concern those who had never exhibited any such desires before but who at a certain age – and in institutional contexts – developed behaviours of eating or smearing their own or other patients’ excrement.

The first inspiration for the debate about *Skatophagie* appears to have been an oral paper delivered in Graz by Professor Lang in 1871, entitled ‘Über Skatophagie bei Irren’ (On Scatophagia in Madmen), which appeared in written form in the first volume of the *Psychiatrisches Centralblatt* of 1872 [16]. Lang presented several case studies of scatologic patients, which included both a 26-year-old army cadet who was clearly delusional and insisted on using his own excrement as a sort of clay from which he modelled furniture for his room. Another was an educated and intelligent alcoholic man in his fifties who suffered brain damage from a fall (hitting his head) while drunk, and thereafter developed coprophagic behaviour along with other drastic changes to his personality [16]. Lang considered the eating of excrement potentially very damaging to his patients’ physiology and considered that it might even have been part of the causation of derangement, or at least part of the reason for the men’s mental deterioration over time. Was coprophagia merely an inconvenient symptom of madness that institutional staff had to manage? He doubted this, considering it might play a more sinister causative role, worthy of scientific investigation.

Erlenmeyer made a response to this paper in the *Psychiatrisches Centralblatt* of 1873, in which he repeated Obersteiner’s reported statistical account of the prevalence of coprophilic patients in asylums – 1 in 100 patients most of whom were male – and insisted that, in his own experience, it was not a masturbatory behaviour, and nor could any ‘injurious influence of the diet’ be seen [17]. In this same volume, a longer article by the journal’s editor-in-chief, doctor Maresch summarised a discussion of psychiatrists in a meeting on the matter, which included Maresch himself, Lang, Obersteiner, as well as Professor Beer and doctors Flechner and Leidesdorf. Here, Maresch noted Lang’s observation that those with less education were more likely to exhibit the behaviour and added that it was most common among those in ‘chronic maniacal states’ and in those whose mental deterioration had descended to the expression of complete nonsense. Maresch claimed that the application of a ‘constant current’ of electrotherapy effectively ceased the behaviour (perhaps along with many other behaviours!) [18]. Though it is worth noting that would have most likely been a weak current as per the customary use of electricity in late-nineteenth-century psychiatry.

But Maresch’s summary of his own and his colleagues thinking on the matter claimed that sexual fetishists indeed constituted a large percentage of those exhibiting coprophilic behaviour, and contra Erlenmeyer, insisted on it as primarily a masturbatory activity, as evidenced by the observed enthusiasm and enjoyment that coprophages showed

when observed consuming excrement, both their own and that of other patients. The ingestion of the fecal matter must surely be damaging too he insisted, since the brain requires the right amounts of nutrients to function, and with excrement making up a large part of the diet of coprophagic patients, their blood must surely be improperly constituted: ‘the defective metabolism thus produced alters all functions, and causes all sorts of ruin to organic life’. By way of illustration, he described a depressed and anxious patient who had resorted to eating his own excrement in the apparent desperation to become well again but had shown a marked deterioration into a more severe form of mental derangement after adopting this unusual diet, and thereafter became permanently coprophagic, believing that it was the only food that might fuel his recovery. Consequently, he considered ‘scatophagia to be one of the most pernicious disease states ... because of its highly injurious effect’ caused by ‘the production of certain agents added to the blood’, such that ‘the activities of organic life are incessantly prepared of an inappropriate admixture’. [18] By way of support, he cited an essay by the early-nineteenth-century alienist Carl Ideler entitled ‘*Verbrechen und Wahnsinn*’ (Crime and Insanity), in which the latter attributed ‘the mood of melancholy patients to the hydrogen sulphide gases which have developed from stagnant excremental substances that have passed into the blood’ [19].

### The nineteenth-century rupture with historical ‘Filth Pharmacy’

The Austrian psychiatrists’ insistence on the nefarious effects of excrement-eating represented an important rupture in medical thought viewed over long historical perspective. Most commonly, early-modern medical texts, in fact, referred to it as a variously useful pharmacological remedy. Several important and much-cited works of early-modern pharmacy include extensive discussion of the use of excremental remedies to be ingested orally or applied topically for the treatment of many diseases, including Johan David Ruland’s *Pharmacopoea Nova* of 1644 [20], Michael Etmüller’s *Opera Omnia* of 1690 [21], Franz Christian Paullini’s *Dreck Apotheke (Filth Pharmacy)* of 1696 [1], and Martin Schurig’s *Chylologia* of 1725 [22], all which, as of 2018, remain untranslated into any modern languages. In some cases, the idea of excrement as a pharmacological remedy appeared as a form of critique of irrational remedies of other kinds. For instance, the early-eighteenth-century natural philosopher Robert Boyle had noted sceptically that ‘a despised common sample, nay an infect or an excrement may in some cases prove nobler medicines than an extract, elixir, or a quintessence’ [23]. But

he also prescribed ‘Paracelsus’ *zebethum occidentale*, (viz. human dung) of a good colour and consistence’ be used as a dried powder, blown into the eyes of one suffering blurry vision [24]. Though, it was important, Boyle had noted, not to use the excrements of the mad for any remedy, lest one become mad oneself [25]. Such a remark indeed may now be seen as a remarkable intuition of current scientific models of the effect of intestinal bacteria on mental health, as will be discussed in the last section of this paper.

This is not to say that all premodern views of excrement unequivocally celebrated its value. As the work of numerous medieval and early-modern literary scholars has shown, excrement came to be associated with devil, with humiliation and urban disorder in a range of texts from the fifteenth to eighteenth centuries [26–28]. Early-modern excremental medical remedies were certainly not without critics in their own time too. The English physician Nicholas Culpeper’s *Pharmacopoeia Londinensis* (London Dispensatory) of 1652 mocked the fact that the College of Physicians ‘give the apothecaries a catalogue of what part of living creatures and excrements they must keep in their shops’ [29]. In all cases though, early-modern texts certainly make no mention of coprophagic behaviour as a sign of mental illness.

The ancient to early-modern excremental pharmacy traditions were clearly known to many doctors and psychiatrists in the nineteenth century through anthologies such as that of John G. Bourke as well as an earlier French work of 1849 entitled *Bibliotheca Scatologica*, by Auguste Veinant, Pierre Jannet, and Jean-François Payen which described the works of Schurig and Paullini in some detail [30]. Other similar bibliographies included the *Anthologie scatologique* by Pierre-Gustave Brunet of 1861 [31], and the *Bibliographie Des ouvrages relatifs À l’amour, aux femmes, au mariage et Des livres facétieux, scatologiques satyriques, etc.* ... (Bibliography of works about love, women, marriage and facetious, scatological and satirical books, etc...) by the editor and socialist Jules Gay, first self-published in 1861 and reprinted in several editions throughout last decades of the nineteenth century [32]. These works represented a curious intermediary stage in the divide between early-modern uses of excrement as a pharmacological agent, and the later nineteenth-century theories of coprophagia as psychopathological, infantile, or primitive. They combined scatological humour with a sort of titillated curiosity in the early-modern medical practices, jocularly naming the physicians who prescribed *stercora* (manure) ‘stercoral doctors’. They found a utility in celebrating the filth-medicine tradition, enlisting it as an ally in their atheistic critique of benevolent Christian views they claimed denied the reality of unseemly things [30]. The *Bibliotheca Scatologica*’s first edition listed its

publication details as: 'Scatopolis (Paris): chez les marchands d'aniterges, l'année scatogène 5850 [i.e. 1849]': 'Scatopolis (Paris): by the toilet-paper merchants, in the scatogenic year 5850 [i.e. 1849]' [30] (Figure 4). Their works listed flatulence verses and scatological jokes alongside serious medical texts of the past detailing the use of excremental remedies. However, these works belonged to a quite peculiarly French context ideological opposition of atheist materialism towards Catholic faith. It is quite possible that the Austrian group of psychiatrists would have been ignorant of these works in French, and it does not appear that any similar anthologies were published on this topic in German during the nineteenth century. Both Freud and Jones certainly

knew of them via John G. Bourke's citations, but there is no evidence that they followed-up in examining the texts to which Bourke himself referred, nor is it clear how much of the early-modern medical texts Bourke himself actually read with his at-best rudimentary school-boy Latin.

We might expect to find that the major cause of the shift in the 1870s discussion of coprophagia would refer to the new bacteriological model of disease that had begun to displace the miasma model of Galenic medicine in the period between 1850s and the 1880s, following the work of Louis Pasteur in the 1850s, as well as the 1849 essay by John Snow *On the Mode of Communication of Cholera* which made

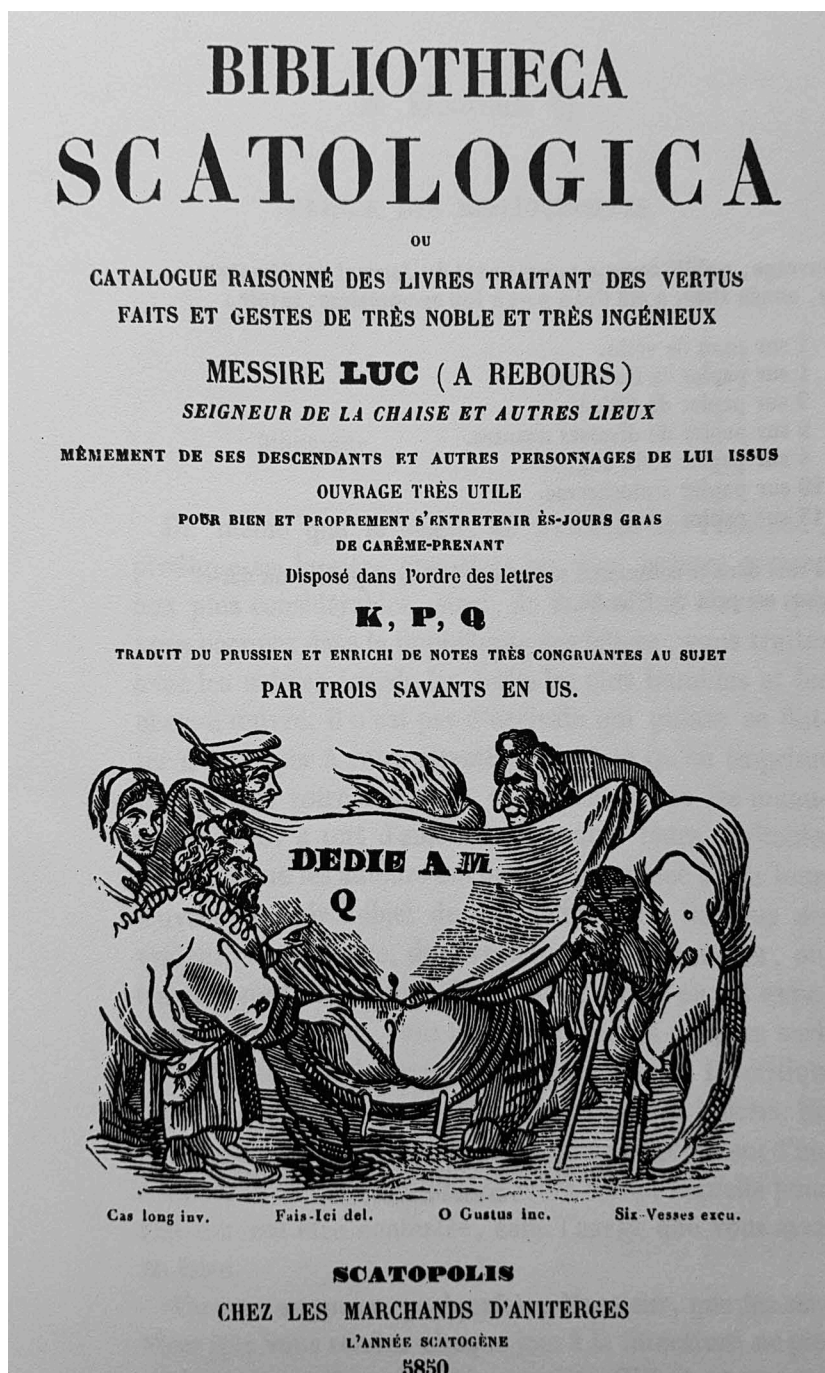


Figure 4. The title page of the 1849 *Bibliotheca scatologica* by Veinnant, Jannet and Payen. Author's own photograph.

a substantive case for the view of this highly prevalent disease as faecally transmitted [33]. But surprisingly, the Austrian doctors writing in the *Psychiatrisches Centralblatt* made no mention of any concerns about infection and located the negative effects of excrement-eating in a far more hygiene-based model of disease as the product of improper diet – hygiene understood here in the nineteenth-century sense of the term, as described by James C. Whorton – referring to the management of the body through diet and bodily functions [34]. Germ theory was clearly not the cause of the novel Austrian psychiatric pathologisation of coprophagia. It seems the mechanism by which they considered coprophagia to aggravate mental illness was via a notion that became popular in nineteenth-century medical thought and in quack remedies for constipation: auto-intoxication [34]. The Austrian psychiatrists did not use this exact term, but they did appear to be gesturing towards a similar idea: that excrement itself could poison the blood and consequently derange the mind. The idea had been current throughout German-speaking Europe, as well as in France, from the mid-nineteenth century until the 1920s, and is most associated with the work of the French pathologist Charles Jacques Bouchard [35]. Much of the most significant work on auto-intoxication occurred after the period in which the Austrian psychiatrists were writing on coprophagia. But the notion was clearly circulating in their time as well: From 1868, the Prussian physician Hermann Senator had referred to the role of intestinal putrefaction and the development of diseases, using the term *Selbstinfection* (self-infection) [36]. In his later work, he theorised about it as the cause of delirium [37]. The Berlin physician Ludwig Brieger's work on auto-intoxication in the 1880s made an explicit connection between intestinal microbes (specifically anaerobes) and the generation of toxic by-products, but earlier theories of auto-intoxication on which much of the late-nineteenth-century fixation with enemas rested referred only vaguely to the 'putrefaction' that faecal retention was thought to generate [38]. Excrement itself was already considered poisonous in the mid-nineteenth-century medical imaginary, and germ theory merely served to provide a further layer of mechanistic explanation.

The *Psychiatrisches Centralblatt* writings on *Skatophagie* appear to have remained fairly obscure – they are not cited, for instance, by the great Austrian psychiatrist Richard von Krafft-Ebing in his description of excremental sexual fantasies in the *Psychopathia Sexualis* of 1886. Krafft-Ebing's 'corprolagnic' case studies all refer to erotic fetishes of high-functioning individuals in which the defilement with excrement or ingestion of it featured as a dramatised act of sexual submission and humiliation, e.g. cases 79, 80, 82 [39]. However, it seems likely that the 1870s accounts of

coprophagic asylum patients as masturbatory in their enjoyment helped to produce the view of it as primarily a form of sexual perversion in the account of Krafft-Ebing and others in the 1880s and 1890s. That view, in turn, was probably also a stimulus for the later Freudian account of childhood coprophilia as a key component of psycho-sexual development.

### Institutional coprophagia today

Since the 1980s, there has again developed a clinical literature on coprophagia in varied patient populations, including children with gastrointestinal problems, children and adults with mental handicaps, elderly adults with advanced dementia, and adults with dissociative psychoses, beginning with the 1987 paper by the two psychiatrists Nissan and Haggag, which described episodic coprophagia in a female sufferer of Major Affective Disorder (DMS-III bipolar mixed type), and hypothesised a 'reversion of the normal process whereby experience and ideation give rise to affect' in the amygdala [40]. A number of clinicians between 1989 and 2017 published case reports, some indicating anecdotal success in reducing coprophagic and scatologic incidents through the use of various drugs and behavioural protocols in adults and children with mental handicaps [41], in a schizophrenic adult [42], and in children brought to a gastroenterology clinic because of constipation and encopresis [43]. Other studies have hypothesised about the causes of scatological behaviours in relation to obsessive-compulsive disorder [44], in relation to dementia [45], in the geriatric mentally ill [46], in relation to developmental handicaps [47], and as sexual fantasy reported by patients in psychotherapy [48]. A 2016 study by researchers at the Mayo Clinic falsely asserted the earliest publication on coprophilia in mental asylums was that of Theodor Kellogg in 1897, in a medical textbook written some 16 years after the Austrian scholarship identified in the current paper [49]. Kellogg's brief mention appears to be the first in the English language, after which a long hiatus is probably explained by the solution Kellogg indicated to be widely used in US asylums at the turn of the century and most probably throughout the twentieth century as well: compulsory, repeated administration of enemas so that such patients never had anything to play with! [50] (Figure 5)

As the authors of a 2016 Greek study on the problem note, coprophagic behaviour in institutional settings causes significant loss of quality of life for patients who display it as it tends to result in them being isolated in special wards, avoided by nursing staff and other patients, and can result in physical restraint and severe limitations of freedom of movement in the attempt to prevent them engaging in the



**Figure 5.** A French drawing of a nurse administering an enema to a bed-ridden patient, circa 1800. Courtesy of the Wellcome Collection.

behaviour [51]. Gerontology researcher Joan Ostaszkiwicz has suggested that urinary and faecal incontinence alone may be a risk-factor for elder abuse and can be subject to chastisement and shaming on the part of some carers [52]. Some current scholarship clearly too carries the legacy of psychoanalytic thinking about coprophilia as evidenced in the remarks about the behaviour representing a regression to infancy or to ‘primitive, primordial instincts’ found in certain publications [51]. It is possible that coprophagic patients in many cases are not being respectfully cared for and are harshly judged by institutional staff on account of the powerful conditioning of disgust towards excrement that has become generalised in modern cultures.

On the other hand, the use of excrement as a legitimate therapeutic remedy has returned in modern medicine in the form of faecal microbial transplant

for *Clostridium difficile* infection, at an efficacy rate that far exceeds competing antibiotic remedies [53,54]. It also shows promise as a treatment for persistent Crohn’s disease and ulcerative colitis [55,56]. When we consider this alongside the recognition that throughout the history of medicine, there have been uses of excrement as a pharmacological remedy for various conditions, it is most certainly worth considering whether institutional forms of coprophagia may be caused by an intuitive self-medicating motivation. It is now known that a wide variety of animals display zoopharmacognosy, or the ability to intuitively self-medicate, either by learnt behaviours in intelligent primates (such as the chimpanzee use of antiparasitic herbs), or through innate adaptive mechanisms and without the need for high intelligence, explaining its occurrence in ants, moths, and fruit flies [57–59]. Some researchers have indeed considered a potential

self-medicating explanation for human coprophagia, noting its use by different animals (rabbits, gorillas) to meet nutritional deficiencies such as for the B vitamin thiamine [60]. However, no consistent vitamin or mineral deficiencies have been identified in human excrement-eaters to date. On the other hand, one study found success in reducing coprophagic incidents in a man with profound retardation and autism through the provision of highly spiced foods *ad libidum* [61].

Since current research on institutional coprophagia has already approached it through the rubric of possible self-medication approaches, it is surprising that none of these studies have considered that coprophagia may, in some instances, be motivated by an intuitive quest for commensal intestinal microbes. Clinicians dealing with this challenge may wish to consider the growing evidence of the importance microbial ecology in human mental and general health, particularly in relation to microbes that: (a) generate the neuroprotective short-chain fatty acids n-butyrate, acetate, and propionate as by-products of their own metabolism [62]; (b) synthesise Menaquinones (vitamin K2) which play an important role in bone remineralisation and calcium regulation – of particular relevance to osteopenia in the elderly [63]; (c) produce indoles such as indolamine-2,3-dioxygenase, which act as catalysing enzymes in tryptophan synthesis, with corresponding beneficial effects on the gut epithelium, but also on serotonin synthesis [64,65]. They might also wish to consider the bacterial species that have been found to upregulate neurotransmitters and neurotransmitter precursors, including GABA, Dopamine, 5HT, and acetylcholine – of particular relevance to mental illness and to neurodegenerative diseases such as Alzheimer's and Parkinson's [66].

There is now a considerable body of scientific evidence of the role of intestinal microbiota in regulating a wide range of animal physiological functions, and an emerging paradigmatic shift towards a view of it in humans as an organ of the body that has co-evolved with us from our earliest multicellular beginnings – as much a part of 'us' as the microbes from which our own cellular mitochondria are thought to have evolved [67–69]. The evidence accumulating of a role of the intestinal microbiota in mental health, in particular, might then prove of interest to carers both of the mentally ill and of those suffering depression or neurodegenerative diseases in aged care towards a revision of the nutritional and ecological environment provided to those in institutional and in-home settings [70–73].

There is evidence from a number of difference cultures indicating that diets provided to inhabitants of long-term care facilities tend to be low in fermentable polysaccharides of the kind that would promote

the growth of commensal intestinal bacteria [74–76]. Considering the long history of the use of excremental remedies in the medical traditions of numerous human cultures, it would seem a fruitful line of inquiry to consider whether self-medicating drives towards coprophagia might be located in the abundance of microbiota present in excrement, which are, otherwise, lacking in the intestinal tracts of those in institutionalised medical settings. Long-term care institutions, whether nursing homes for the elderly, care facilities for the mentally handicapped, or psychiatric hospitals, are all frequently (though not ubiquitously) characterised by a lack of microbial-ecological consideration in meal planning, with the need for greater nutritional variety that includes both copious prebiotic (soluble) fibre in the form of fresh vegetables and pulses, as well as probiotic foods (such as fermented vegetables, grains, and dairy products). Many institutions frequently disinfect tactile interior surfaces, keep residents indoors most, if not all, of the time, without access to pets, without physical intimacy with other humans, and with limited opportunity to make physical contact with the natural environment – all of which are important sources of microbial inoculation in humans. It would seem worth experimenting in clinical settings to see if coprophagic patients fed a diet aimed at creating a more diverse and robust intestinal microbiome, which includes palatable probiotic and prebiotic foods given *ad libidum*, and permitted access to gardening, pets, or lying on grass lawns might be less inclined to seek microbial support from faeces.

## Disclosure statement

No potential conflict of interest was reported by the author.

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## Gut thinking: the gut microbiome and mental health beyond the head

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### ABSTRACT

**Background:** In recent decades, dominant models of mental illness have become increasingly focused on the head, with mental disorders being figured as brain disorders. However, research into the active role that the microbiome-gut-brain axis plays in affecting mood and behaviour may lead to the conclusion that mental health is more than an internalised problem of individual brains.

**Objective:** This article explores the implications of shifting understandings about mental health that have come about through research into links between the gut microbiome and mental health problems such as depression and anxiety. It aims to analyse the different ways that the lines between mind and body and mental and physical health are re-shaped by this research, which is starting to inform clinical and public understanding.

**Design:** As mental health has become a pressing issue of political and public concern it has become increasingly constructed in socio-cultural and personal terms beyond clinical spaces, requiring a conceptual response that exceeds biomedical inquiry. This article argues that an interdisciplinary critical medical humanities approach is well positioned to analyse the impact of microbiome-gut-brain research on conceptions of mind.

**Results:** The entanglement of mind and matter evinced by microbiome-gut-brain axis research potentially provides a different way to conceptualise the physical and social concomitants of mental distress.

**Conclusion:** Mental health is not narrowly located in the head but is assimilated by the physical body and intermingled with the natural world, requiring different methods of research to unfold the meanings and implications of gut thinking for conceptions of human selfhood.

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## Background

### Gut thinking

Diagnosable mental health problems are said to affect one in four people in any given year [1], they are a leading source of disability globally, and new strategies for prevention and treatment are vital [2]. But the boundaries of these problems sit on shifting sands. Since the anti-psychiatry movement of the 1960s [3] and the analysis from critical psychiatry that has followed [4], debates have continued about what is constitutive of mental illness or mental disorder, especially given the changing nature of psychiatric diagnostic manuals over time [5]. Neuro-explanations of mental health have dominated the last decades of mental health research with mental disorders being re-cast as brain disorders [6], but often on shaky evidential ground and widely contested, especially by social psychiatrists [7].

Whilst there has been disagreement and controversy over the past century, mental health has predominantly been understood as related to the head. Biological psychiatry's paradigm of brain disorder provides mental illness with a clear physicalized location there [6], whilst a Cartesian dualist model of the immaterial mind

contrasts the intangible realm of mental thoughts with the body and physical health [8]. If the body below the head has been involved in understanding mental health, it has often been viewed as a 'dustbin' expressing symptoms of illness from above [9]. However, in recent years, research into the microbiome-gut-brain axis has foregrounded the impact of the gut microbiome on mental health [10], inverting these dominant top-down models of mental illness. This emerging evidence, which shows observable links between gut dysbiosis and some mental health conditions, suggests that mental health is not all about the head, after all, leading to some paradigm shifting interpretations and conclusions about what is actually meant by 'mental' health, and how it should be treated [12].

Evidence connecting microbiome-gut-brain communication to psychiatric illness might seem to relegate dualistic mind-body thinking to the past, but a Cartesian divide between mental and physical health runs down the middle of healthcare systems (the NHS in the UK is divided in this way despite an increasing focus on the provision of integrated care) [13]. This divide is underpinned by language, which both supports and constructs clinical and non-

specialist understandings of the mind and the mental as separate from the body and the physical. As psychiatrist Edward Bullmore argues, a Cartesian ‘blind spot’ [14] intervenes every time mental health is redefined as our language separates out the mental from physical life.

Whilst research into the microbiome–gut–brain axis turns its attention from the brain to the gut and back again, it arguably lacks the conceptual tools to investigate the broader (social, cultural, linguistic) implications of these shifts on the meaning of mental health. In particular, there is a critical imperative in analysing how language is employed. This is because psychiatric diagnostics frame mental health problems, and psychiatry’s vocabularies and definitions are passed onto patients. As philosopher Havi Carel argues, patients are then ‘quick to mimic the medical discourse’ as they rearticulate and explain their conditions to others [15]. Mental health is thus shaped and defined not only within medical settings but also outside of the clinic. The deinstitutionalisation of mental health problems like depression, as argued by feminist scholar Elizabeth A. Wilson, means that they are now ‘extensively entangled with everyday life’ requiring an analysis that extends beyond biomedicine to examine social, cultural and individual constructs [16] (p. 10). Brain or neuro-explanations for mental disorders have disseminated rapidly into popular understanding [17]. Indeed, it is the dominant frameworks of what physical cultures scholar, Simone Fullagar describes as, ‘neuroscience and psy-expertise’ [18] (p. 42) that have provided a structure through which those with mental health problems have sought to understand their experiences in recent decades.

Interest in the microbiome–gut–brain axis has already led to the publication of a range of popular books on the topic [19–21] which argue, in different ways, how communication between the brain, gut, and microbiome may be responsible for a range of health problems including depression and anxiety thereby challenging brain-shaped understandings of mental health. Indeed, if, as Wilson argues, the gut is ‘an organ of mind’ (p. 5) [16] then critical questions are raised: What and where exactly is our ‘mental’ health? How can this research contribute to an improved understanding of selfhood beyond the head? What kind of research is needed to investigate the broader meanings and implications for understanding human mental and physical life?

In this paper, I argue that an interdisciplinary critical medical humanities framework [22] can attend to such ‘ontological questions’ [23] raised by this idea of the gut as an active part of the mind. I take a feminist new materialist approach to argue that – as feminist theorist Karen Barad writes – ‘matter matters’ and that human subjectivity is always ‘entangled’ in the world [24], in opposition to models that theorise the power of ‘mind over body’ [25]. I propose that knowledge about the gut microbiome’s

effect on behaviour complicates understandings of mental life and selfhood as contained within the narrating, thinking brain. I build on research into disciplinary entanglements developed in medical humanities scholarship [26] to help contextualise the broad impact of questions around the mind and mental health, calling attention to the way in which research into the microbiome–gut–brain axis illuminates the interplay between biological, psychological and social constructions of mental illness. Finally, I use this critical framework to ask how research into the gut microbiome relates to understandings about selfhood, the way matter is conceptualized, and how embodiment is theorised.

## Mental health is in the head

### *All in the mind*

Dualism, in philosophy of mind, is the theory that the mind or the mental is different to the body and the physical. This theory has lineage in ancient philosophical thought. Plato thought that the soul, although united to the body, existed beyond it [27]. Philosopher, Rene Descartes (1596–1650) like Plato, also held to these beliefs, but his dualism specifically separated out the ‘mind’ from the body [28]. Descartes’ shaping of the palpable physical body as separable from the intangible mind laid the ground for medicine to claim the physical body as its domain [29]. By the nineteenth century – as psychiatrist R.E. Kendell argues – Cartesian thinking was supported by findings from medical dissection, which showed that patients diagnosed with forms of madness did not show ‘the obvious pathological changes’ that were physically located in other diseases [30]. However, this period saw a diverse range of opinions about the origins of mental illness and – as psychiatry as a discipline began to evolve – other traditions linking the gut and the mind in more holistic conceptions of mind-body interactions were also being re-explored and studied [31]. Indeed, as historian Elizabeth A. Williams argues, the work of the founder of French psychiatry, Philippe Pinel, considered ‘mental and nervous ills’ to be ‘inextricable blends of physical and moral components’ influencing how French physicians approached neuroses and some cases of mental illness [32]. But, as the nineteenth century wore on, some of the theories on the links between gastric and mental illnesses were rejected [33], emerging materialist psychiatric models, which posited that mental illnesses were brain-based ‘cerebral illnesses’ [34] were also challenged [35] and Cartesian influences took hold. Functional illnesses, as opposed to organic disorders, were thought of as being ‘all in the mind’ and therefore not real [36]. Psychogenic (non-physical, non-substance-like) causes for mental disorders underpinned influential theories and techniques of psychoanalysis and psychiatric models into the twentieth century.

### **Mental disorders: brain disorders**

Although Cartesian understanding set the language of mental against physical illness, in recent decades, images of the brain have been used to depict mental health, bringing a physical location back to understandings of the mind. As Nikolas Rose and Joelle M. Abi-Rached argue – in their critical examination of the ‘new brain sciences’ – for a public highly engaged with brain culture, ‘mind seems visible in the brain itself’ [17] (p. 5). The American National Institute of Mental Health (NIMH) has stated that ‘mental disorders are disorders of the brain’ [6] and The Brain & Behavior Research Foundation uses the term ‘brain and behavior disorders’, arguably taking the word ‘mental’ out of the equation [37].

### **All in the mind or brain: the problems**

Whether mental disorders are brain illnesses or a matter of immaterial thoughts, there has been a clear focus for mental health as conceptualised within the head. Two recently launched UK charities designed to support mental health, Heads Together [38] and Headcase [39], and the meditation mental health app, Headspace [40], underline this commonly articulated emphasis. Indeed, ‘headclutcher’ imagery, depicting a person holding their head in their hands, is commonly used to accompany articles about mental illness [41].

If medical and public understanding predominantly locates mental health in the head, a question may follow about why this is a problem. Mental health is certainly at a critical point (in terms of economic, societal, and personal costs) and existing research has struggled to move forward the field [42]. Dualist formulations of mental health separate people into parts and prop up stigmatising beliefs about mental health as an individual’s fault – either seen as not real or possible to control from above by thought management. Furthermore, they complicate understanding of the profound physical effects of mental health issues. Indeed, whilst depression and anxiety are defined as mental health problems, the palpable physical symptoms attached to them uncomfortably cross the medical divide [43]. Brain disorder models are equally problematic, as philosopher Natalie F. Banner argues, they operate at a reductionist ‘biological, subperson’ level and often exclude broad-based social, emotional and psychological factors creating internalised models of mental illness [36].

### **Getting out of the head: guts and mental health**

Research into the gut microbiome has started to unsettle the narrow focus for mental health above the neckline. The observed links between disturbance

of the gut microbiome (dysbiosis) and stress, anxiety, and depression have shifted the research ground for mental disorder [12,44,45]. In response to these emerging findings, probiotics and dietary approaches have been explored in terms of their ability to modulate microbiota and address symptoms [46]. Arguably, gut microbiome research starts to move mental health out of the rule of the cognitive head and provides evidence that the gut is storing, remembering, feeling and thinking in itself. However, how this research speaks to the questions around definitions of mind and the mental needs to be addressed.

In examining how the gut microbiome might affect states of mind in relation to the biology of microbiome–gut–brain communication, a question is raised as to what understanding of mental health and minded states is being foregrounded. If microbiome–gut–brain axis research is in alignment with an expanded brain disorder model of mental health – including the assumptions that go along with that model (mental states are brain states) – then the same social psychiatry counter arguments around the displacement of psycho-social human reasons in understanding mental health may also hold true. Furthermore, if it is under the individual’s control to manage their microbiome, and this is what affects mood and mental health, then the implication is that it is the job of the individual to fix it when that mood is low. Indeed, mainstream publishers have been keen to emphasise this particular facet of dietary change in gut health, building on the multi-billion dollar diet industry to sell books from early scientific findings [47,48]. The idea that some people will be enabled to beat or outwit gut bacteria with the right access to the right foods or supplements, feeds into a new gut consumer culture wherein some people will be enabled and others disadvantaged. Recovery solutions move sideways from the self-management therapeutic strategies of the cognitive model to ones based in the gut. These potential alignments with existing understandings of mental wellbeing require careful analysis and exploration.

## **A critical medical humanities intervention**

### **Disciplinary entanglements**

The questions pertaining to the shifting boundaries of mind and the mental which are raised by evidence about the gut microbiota on mental health cannot be solved by biomedicine alone. In setting out the project of a critical medical humanities focused on disciplinary entanglement rather than the integration of separate silos of investigation, Des Fitzgerald and Felicity Callard suggest that it is necessary to, ‘understand how practices of making, breaking and shifting boundaries constitute illness and healing’. This analysis of shifting boundaries has resonance for the analysis of gut

thinking. In the re-assertion of the importance of matter and physicality (beyond the brain) in research into the gut microbiome's effects on mental wellbeing, traditional healthcare distinctions between mental and physical health falter. Further boundaries are also called into question, in terms of what constitutes human and non-human, inside and out, and where the lines of health and illness are placed. These lines do not exist separately in different disciplinary spaces but speak to what Fitzgerald and Callard discuss as the 'deep entanglements of subjectivity, experience, pathology, incorporation, and so on, which cut *across* the ways in which we understand both the human and her medicine today' [26]. The questions raised by these entanglements are as resonant for biomedicine as they are for humanities scholars and suggest the need for both new methods and vocabularies that outmanoeuvre that Cartesian 'blind spot' [14].

### **'Matter matters'**

Critical theorisation in humanities and social sciences in the 'turn towards the body' – or 'the material turn' – is entangled with the questions raised by microbiome–gut–brain axis research into mental health [49]. Affect theory [50], new materialism [51], feminism [52] and phenomenology [53] have, in different ways, sought to undo the devaluing of the body as unthinking matter. The material turn in humanities scholarship has asked questions about the problematic idea of mind over matter both in individual terms and in relation to the environment. As Stacy Alaimo and Susan Hekman argue, in their scholarship on feminist new materialism, the 'denigration of nature and the disregard for materiality cannot be entirely disaggregated' [52]. The dualist conception of mind over matter does more than to denigrate the body; it also positions the human subject as separate from – and superior to – the natural world. Barad's work, drawn upon by Fitzgerald and Callard [26], helps to redress this, arguing that 'being is threaded through with mattering' and, therefore, the nature of materiality itself 'is an entanglement' [54]. The challenge from emerging evidence from the gut microbiome counters the mind over matter assumptions of Cartesian medicine, with bodies re-framed as active and relational and comprised of many different genomes of microorganisms, uprooting psych-orientated, individualist, brain-dominant models of behaviour.

### **Methods for gut thinking**

The concept of the thinking gut may require both biomedicine and humanities disciplines to consider new methods of research. Language tells us that the gut has always been associated with 'feeling states' [11] – the

notion of 'gut instinct' and 'trusting the gut' remains present in everyday English language. However, as feminist writer Sara Ahmed explains in her book, *The Cultural Politics of Emotion*, emotional states have also been stratified. Visceral, gut feelings have been characterised as bodily sensations [55]. In healthcare, unreliable bodies have awaited interpretation by the superior, objective, rational mind endorsed by a positivist biomedical epistemology. Subjective and experiential evidence is usually downgraded versus the objective and empirical in terms of medicine's evidence hierarchies [56]. Healthcare's bodies do not know, they are to be known. Objectivity is understood to relate to reason and logic, but if the gut is an organ of the mind and the body is involved in thinking, what does this mean for this hierarchy and privileging of mind over body? How might subjective and individual bodies offer insights into minds and guts? Indeed, might what Barad terms as the 'material practice' of knowing necessitate an epistemological shift? [57].

If the gut is thinking, it also demands a methodological response from humanities disciplines. Medical humanities as interdisciplinary scholarship has developed a strong focus on applying narrative to questions of medical practice and to the experience of illness [58]. However, 'embodied methodologies' [59] that actively look to incorporate body sensation into research may provide scope to connect more specifically with bodies and the sensory nature of 'mental' experience and feeling from the gut. These methodologies may range from paying attention to bodies of researchers rather than side-lining them in 'attempts to eliminate bias' [60, p. 7], using sensory, physical materials in qualitative interviews with participants, and using bodies in the production or communication of research (walking interviews [61], body mapping [62] or representation in dance, for example) [63]. The gut engages all the senses – from the sound and feel of digestion, to the physical response to the smell, taste or the sight of certain foods or experiences and, as such, requires a sensory, bodily approach to connect with these aspects.

In the final part of this paper, I turn to how the concept of embodiment helps frame evidence from the gut microbiome, moving mental health away from the head and towards bodies intra-acting and entangled with the world, asking what the implications of this are for future research.

### **Entangled meanings: what the microbiome–gut–brain axis can contribute to improving understanding about mental health**

#### ***Biopsychosocial: horizontal entanglement***

Mental health is often framed within a biopsychosocial paradigm [64] – this very definition, despite its emphasis on an integration of perspectives, speaks to disciplinary

boundaries of biology, psychology, and social sciences, each taking a vertical disciplinary cut through the mental health conundrum. However, I suggest that the gut microbiome's evidential links to mood and mental health ask for a much more of a horizontal slice through this biopsychosocial construct. Research into the gut microbiome may be easily divided into the biological research looking at bacteria in the laboratory, with social scientists asking how the social and environmental are related to this new method of internalising mental illness away from social determinants, and psy-disciplines trying to wrestle back selfhood to the head or drawing maps against models of embodied cognition [65]. However, I suggest that it is possible to take a horizontal perspective. This does not mean the eradication of disciplinary boundaries and methodologies but offers an invocation to look differently at the 'entanglements' [26] that problematize the vertical linearity from head to body as much as they do the disciplinary silos.

The microbiome–gut–brain axis brings forward a biological basis for mental health problems and gestures towards the social and psychological, not as separate factors, but as enmeshed with the biological. Stress and environmental influences – things that happen to us and shape our lives (even before birth) cause biological changes and responses, and direct expectations of and reactions to future events – not just in terms of thinking from the head, but from within the gut microbiota via 'long-term modulation of stress-related physiology and behaviour' [66]. Gut bacteria may be different depending on environment and culture [67] suggesting that cultural and environmental factors are intermingled with bodies, not separate to them. The social is not an externalised force that contributes separately to the bio- and psych-elements, the three are intertwined with one another through the body, and in the world. This way of thinking arguably problematizes the notion of neoliberal selfhood [68] wherein health behaviours (including attempts to improve mental health and wellbeing) are part of a project of self-improvement and empowerment directed from the head [69].

### ***Gut selfhood: beyond narrative***

Research into the microbiome–gut–brain axis has foregrounded an expanded model of selfhood that recognises the influence that intestinal microbes have on cognition and mood. This poses a challenge to what sociologist Rose describes as the 'regime of the self', constructed within the 'psy' sphere, wherein the physical body is to be known and interpreted by the psyche-brain self in the head [70] (p.3) Furthermore, not only does the gut microbiome's effect on mood and mental health suggest an undoing of the head over body – mind over matter – understandings about cognition, it has also been argued that it challenges dominant Western philosophical ideas

of the bounded self. Human microbiome research unsettles the idea that human bodies are intact containers, guarding against external invader germs; thus reconceptualising that which may have been previously understood as the non-human, as a part of the human. In a paper on this challenge to selfhood, Rees et al. [71] suggest that evidence showing that microorganisms are a part of human bodies (and the interaction of human and microbial cells) challenges the humanities to re-think what it is to be human away from the 'untenable' idea that they might be 'mere nature'. They argue that a 'microbial humanities' is needed to re-think these 'more than human' aspects of humanity. This position perhaps risks ignoring the value of existing scholarship that is working to undo nature–culture dualism [26]. However, it does speak to the way in which research on the psychological side of the Cartesian divide has been privileged in medical humanities scholarship on mental health, which has built an emphasis on linguistic and representational issues [72]. Arguably, this is because mental health remains on the side of the Cartesian divide that is linked to speech and language.

The microbiome–gut–brain connection suggests a radical cut through Cartesian boundaries; shifting the emphasis onto the corporeal and challenging the discipline of medical humanities to conceptualise the meaning of matter in relation to mental health. Wilson demonstrates this kind of approach as she argues that in the eating disorder, bulimia nervosa, 'distress, anger, need, depression, comfort and attachment have become primarily organic' in nature, such that the division between mood and gut is collapsed [16] (p. 63). The gut responds, conveys and unfolds mood. It is not merely a narrative representation or a metaphor or a secondary somatic response to cognitive thinking. As such, it raises the question of what it means not only to have a body but to be a body, especially when that body is deeply enmeshed with that of microorganisms considered to be non-human.

To move beyond narrative representational enquiry, scholarship on embodiment can be brought towards understanding mental health. In line with phenomenological principles of 'being in the world' [53], embodiment goes beyond 'the body'. As opposed to the static object body (which is managed by the mind), I draw from an interdisciplinary perspective to theorise embodied experience as both proprioceptive (the sense of the relative position of one's own parts of the body in space) [73] and as that which is always relational, as embodiment scholar Laura L. Ellingson puts it, as 'mutually constitutive with the world' [61] (p.3).

### **Conclusions: embodied mental health**

Mental health is problematic for medicine because it cannot always be seen and shown; organically

identified. A model of mental health related to gut dysbiosis moves closer towards medicine's preferred methods of visual identification. The microbiome-gut-brain axis, like the brain disorder model, seeks to provide a physical, biological location for mental disorder. The very fact that this model has gathered so much attention and interest – with a wave of books and media articles being published since the revival of interest in gut-mind connections and the characterisation of the 'second brain' [74] – arguably speaks to the discomfort of conditions that can't be identified under the microscope of biomedical research. Conditions that rest on subjective feeling are labelled unexplained, functional, or a matter of the intangible mind and, resultantly, are left in an area of problematic stigmatisation. Proponents of alternative models of health may reach to microbiome-gut-brain research to validate why it is necessary to think holistically about health, but data connecting the gut to mood, behaviour and mental health does not provide a neat answer. Additionally, the fact that biomedical evidence frameworks and epistemologies control and constitute what is real (organic) or not – and thereby arguably contribute to stigma – mean that the possibility of such a holistic view is challenged.

Research that suggests the importance of gut health for mental health does not solve the Cartesian traps, especially given the stronghold that language has in shaping perception. However, it does call attention to the possibilities for a model of 'embodied mental health' [75], one that recognises that mental health is not a separate entity from physical health and explores the entanglements within a horizontal bio-psychosocial framework. This model reimagines mental health untied from its dualistic roots and unrestricted to the head. It interrogates psychologically driven, individualist constructions of health and wellbeing and demands humanities scholars to think beyond narrative means, to work in much more embodied terms.

For people trying to make sense of mental health problems within ever-shifting models of causation – moving from immaterial thoughts to neuroscience's brain disorder, to social psychiatry's focus on social determinants – research into the gut may seem like just another layer of complex explanation. However, such a reversal of head-down, mind over matter culture potentially shifts the focus when it comes to interpreting and making sense of whole-bodied experiences. In an article about anxiety, author, Anna Spargo-Ryan, writes:

It lurches from my throat like a wave of black tar and  
I choke on it and the world caves in around me and  
I am drowning. [76]

This is anxiety felt in the 'very self' of her body; it is violent and physical and leads to a sense of suffocating enclosure and sensory shutdown. Anxiety is visceral,

digestive, figured as surging up, lurching and choking. Anxiety can equally rise from the ground up, from interaction and experience that accumulates and shapes the sense of being a body in the world. Research into the relationship between the gut and the mind does not prove or validate that mental health is beyond the head, but it does entangle the biological, social and psychological. It explores the inseparability of mind and matter and enables a different conceptualisation of mind and the mental to be opened up.

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## Mind the Gut—displaying microbiome research through artistic collaboration

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### ABSTRACT

This paper presents the *Mind the Gut* exhibition, opened in 2017 at the Medical Museion, the University of Copenhagen's museum for the culture and history of medicine. It is an experimental exhibition combining science, art, and history in an examination of the relationship between mind and gut, including the trillions of microbes that inhabits them. *Mind the Gut* was the result of a 2-year-long research and curatorial process, which began in 2015 when Museion was awarded the Bikuben Foundation Vision Award. The exhibition brings together the long history of attempts to understand and intervene in the relationship between mind and gut, between emotions and digestion with cutting-edge biomedical research, and includes the perspectives of science, medicine, and personal experience, via a combination of artworks, historical objects from the Medical Museion collections, items from laboratories, and individual stories. The exhibition is organized around different ways the body has been handled in order to intervene in interactions between mind, gut, and bacteria, including imaging, electrifying, feeding, drugging, and opening surgically. This paper outlines some of the thoughts on science communication that motivated the exhibition, discussing why the displays emphasize the exploratory over the explanatory. Also discussed are several artistic collaborations that formed part of the displays. Ultimately, *Mind the Gut* is created to be a public space that encourages reflection and curiosity, by showing how biomedicine fits into social, cultural, historical, and directly personal contexts. The exhibition does not aim to provide answers about what food the visitors should eat or what the truth of how gut and brain interactions might be. Rather, it emphasizes process over result, hopefully encouraging the visitors to ask their own questions of the relationship between mind and gut, between body and microbes.

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In October 2017, the *Mind the Gut* exhibition opened at Medical Museion, offering glimpses into the strange history of our attempts to understand and treat the relationship between brain and belly (see [Figure 1](#), [Figure 2](#)). Medical Museion is the University of Copenhagen's museum for the culture and history of medicine, integrated with an interdisciplinary research group and housing the 'Metabolism in Culture' program of the Novo Nordisk Foundation Center for Basic Metabolic Research.

*Mind the Gut* was the result of a 2-year-long experimental research and curatorial process, which began in 2015 when Museion was awarded the Bikuben Foundation Vision Award. The Vision Award is, unlike most exhibition awards, not given retrospectively to an already completed exhibition, but is given to a promising and experimental exhibition *concept*. The winning institution is granted 3 mill DKK to realize the concept, turning it from an idea into a finished exhibition. The time and means provided by the award allowed us to engage in a properly experimental curation process, and an exhibition that

cut across science, art, and history. This paper outlines some of the ideas that went into its making, including thoughts on science communication and the relationship between art and science, with a focus on the unique challenges presented by attempts to display the microbial realm and its relationship to our human-sized experience.

As the title suggests, *Mind the Gut* examines the relationship between mind and gut, between brain and bowels including the trillions of microbes that inhabit them. From a public engagement and museum perspective, this was in some ways an easy choice; it is a 'hot topic' and an interesting case study of a complex, unsettled research field with potentially profound implications for both medicine and culture. Yet gut-brain-microbiome (GBM) interaction is a complex relationship, as difficult to display as it is to study; contemporary scientific research struggles to disentangle inputs and outputs, conditions and effects. As we discovered, some of our contemporary concerns and scientific challenges have a long history. Doctors and scientists have long been intrigued by both local questions of disease and discontent, and the implications

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**Figure 1.** View from inside the *Mind the Gut* exhibition. The exhibition is located in the basement of the Medical Museum, a space filled with wiring and ventilation. These spatial qualities resonate with the themes of complexity and connectedness at the heart of the exhibition, and are also echoed in the exhibition design. Copyright Medical Museumion.



**Figure 2.** *Mind the Gut* is organized in a series of themes, each showing a type of view upon or intervention in the relationship between mind and gut. Seen here is the theme 'cultivate', which features five people who in various ways have tried to manipulate their gut microbes. In the back are a series of Winogradsky columns, living microbial ecosystems with distinct aesthetic qualities.

for how we understand the human organism. And throughout history people have worked on mind-gut connections in their daily lives, changing what they eat, how they sleep and exercise, taking supplements, fermenting foods, having enemas, purchasing commercial brain stimulation kits, and so on. The exhibition brings together this history with cutting edge research, and brings together the perspectives of science, medicine, and personal experience, via

a combination of artworks, historical objects from the Medical Museumion collections, items from laboratories, and individual stories. The exhibition is organized around different ways the body has been handled in order to intervene in interactions between mind, gut, and bacteria, including imaging, electrifying, feeding, drugging, and opening surgically.

Microbiome-gut-brain (MGB) research promises to have profound implications for a number of the

pathologies and health problems that characterize our post-industrial societies—and while these promises are yet to be fulfilled, public culture and medical practice are already responding to their possible implications. It is thus a tempting case for anyone interested in science-society relations—they are evolving fast and in public. Fermentation workshops and other bacterially driven food practices are everywhere, DIY fecal transplant videos can be found online, open science projects are selling personal microbiome sampling kits, probiotics are becoming more mainstream, there are a steady stream of TED talks and media reports, best-selling science journalism books, microbiome cookbooks, microbially based makeup products, and much more. Alongside the more practical health implications of mind-gut-microbiome research, it also seems to offer a fundamentally different perspective on long-held views on human development (Pradeu [1], Gilbert [2]), our sense of self (Hird [3], Bencard [4]), and our connection to our environments (McFall-Ngai et al. [5]). It engages a complex, environmentally entangled body, whose very existence is interwoven with nonhuman life—can we therefore talk of our bodies as simply human? How should we conceptualize the kinds of relationship we have to the microscopic organisms that live on and in us? Does our emotional state belong solely to us? Thus we engaged the research as a study of how science and culture is interwoven and plays into deeply individual and existentially resonant experiences. All this makes for a profoundly messy and entangled field, and a rich and engaging topic for on-going experiments at the museum in science communication and public engagement.

### **An interdisciplinary process for an interdisciplinary topic**

The concept behind *Mind the Gut* was built on a merger of an experimental content—the rapidly developing research field of MGB interaction—with an experimental form: an open-ended cocuratorial process which involved scientists and artists from the start, as well as historical curators. In other words, we wanted to see what would happen if we invited scientists and artists to be part of handling the ‘total medium’ of the exhibition, rather than just using scientists as sources or simply commissioning artists to produce works based on the exhibition themes. We wanted to make them part of a shared discussion and a longer-term process, aimed at breaking down disciplinary boundaries. We wanted to avoid making an exhibition that had a science section, an art section, and a history section, but rather look for questions that arose at the overlaps of—or even out of interactions between—those practices. This was in part a reaction to more traditional

approaches to involving artists and scientists in museums of science, technology, engineering, and medicine, which can tend to instrumentalise their expertise toward an (often unnegotiated) communicative goal (e.g., Born and Berry [6]).

We started with an open call for collaborators, in which we asked for ‘four curious, inventive collaborators interested in crossing disciplinary boundaries to join our team’. Successful applicants were expected to join 12 workshops over an 18-month period, as well as participating in a 2-day international conference following the conclusion of the project; they would contribute to the exhibition content in a manner to be agreed during the process; and participate in three research interviews about the project conducted during and after the process. We received 155 applications from a wide range of people—artists, scientists, chefs, philosophers, art curators, cultural historians, speculative designers, and science communicators. With the help of a jury, we ended up choosing five cocurators; three artists; and two scientists. The team then embarked on the year-long journey until the exhibition was opened to the public. Part of the reasoning behind this process was to create data for our own academic research on cocuration and transdisciplinary collaboration; in essence, embedding a research project within the exhibition project.

In setting up this process, we were inspired by scholars Dez Fitzgerald and Felicity Callard, and their work as part of the first interdisciplinary residency at The Hub at Wellcome Collection in London. Their project was entitled *Hubbub*, and was dedicated to exploring the dynamics of rest, noise, and work. It consisted of a 50-strong international collective of social scientists, artists, humanities researchers, scientists, broadcasters, public engagement professionals, and mental health experts. Through this experimental program, Fitzgerald and Callard developed the concept of ‘experimental entanglements’ as a way to go beyond traditional disciplinary boundaries, and as a way of creating what they call an awkward intradisciplinarity—awkward because there is no set structure, and intra- rather than inter-, because it is set up to go beyond an exchange between different disciplines and hopefully become a process in which the members of the working group impact each other and the object studied and produced. They argue that this approach is a way, as they write, to ‘to help scholars circumvent a burgeoning, but bloodless and sterile, literature on “interdisciplinarity” between the social sciences and the life sciences’ (Callard and Fitzgerald [7])

Applying an experimental, cocuratorial approach to produce an exhibition about biomedical science also built on a decade of museological research and practical experimentation at Medical Museion, which has grasped the challenge of communicating

contemporary biomedical research, which can often be complex, opaque, and intangible—not the natural choice for museums that like to exhibit medium-sized, easily interpretable objects (see Söderqvist et al. [8], Whiteley et al. [9]). *Mind the Gut* represented another step in this journey, via an unusually lengthy and open process that aimed to predetermine as little as possible about the roles each participant should play. *Mind the Gut* was thus set up as a science communication experiment in how to use the exhibition medium to display, investigate, and invite audiences to engage in GBM interaction research *as process*, and driven by the hypothesis that ‘experimentally entangled’ cocuration might help us to do so.

Our commitment was to showing science *in* and *as* process, and as culturally embedded, relevant, and resonant, leads to an emphasis on the exploratory over the explanatory. In other words, we wanted to show science as an on-going and open-ended exploration, rather than a progressive fact-based process of explanation. For example, we followed three scientific research projects, two of which were still ongoing at the time, not to put the results on display but rather to show what they look like in practice. We filmed the day-to-day work of the scientists, we collected equipment and animal specimens used in the research, and we worked with the scientists to create publicly digestible diagrams of their experimental setups and hypotheses. The exhibition emphasizes the detective-like aspect of this work, portraying it as something at once incredibly detailed, sophisticated and high tech, as well as open, intuitive, and occasionally downright strange. There has been a general tendency in museums of science to push against traditional modes of only representing science as a slow, steady, objective march toward truth; instead, its open-ended nature is emphasized, communicating about the processual nature of scientific work as much as its results. With *Mind the Gut* this felt particularly pertinent, due to the unsettled nature of GBM interaction research—overselling results and making overly strong claims about causal relationships between microbes, moods, and mental states is a real danger.

### Art and the microbiome

An important aspect of the cocuration approach to exhibiting complex science as process was collaboration with artists. In recent decades, it has been increasingly popular for scientific institutions and science museums to collaborate with artists. Regina Born and Mathew Berry categorized art-science collaboration as being driven by logics of *accountability*, *innovation*, or *ontology*. The logic of accountability is perhaps the most well-known and practiced. Here,

artists are asked to communicate science in more interesting, approachable, or aesthetically pleasing ways. They are also often delegated responsibility for asking critical or ethical questions, in a way that increases the apparent accountability of scientific institutions whilst keeping these debates at arm’s length. The logic of innovation is mostly associated with industry where, e.g. IT companies have involved artists in product development (Born and Berry [6]). However, we were primarily interested in what Born and Berry term the logic of ontology. The aim here is to find collaborative structures that are more equal—or at least equally awkward—ideally leading to transfers of knowledge and practices across disciplinary boundaries. Artists are not merely involved as an instrument of science, but rather as an equal collaborator with alternative perspectives and approaches. According to Born and Berry this has the potential to change our understanding of science and of the world itself, by offering encounters with multiple alternative ontologies. This experience of different ways of thinking about what kinds of things make up the world can provide a framework for a more open-ended interaction between science and the public.

Artists working with microbes and the problems of microbial entanglement have been growing in numbers in the past decades, alongside the growth of both scientific and cultural engagement with microbes as something other than our enemies. Our engagement with microbes could be argued to be shifting from a dominant narrative of control to one of promise (Paxson and Helmreich [10]). Artists are increasingly using microbes as media and as tools to construct artistic conceptions of a complex, ecosystemic nature in which the boundaries demarcating animals, plants, humans, and a swarming, lively microbial biosphere are continuously breached (Hauser [11]).

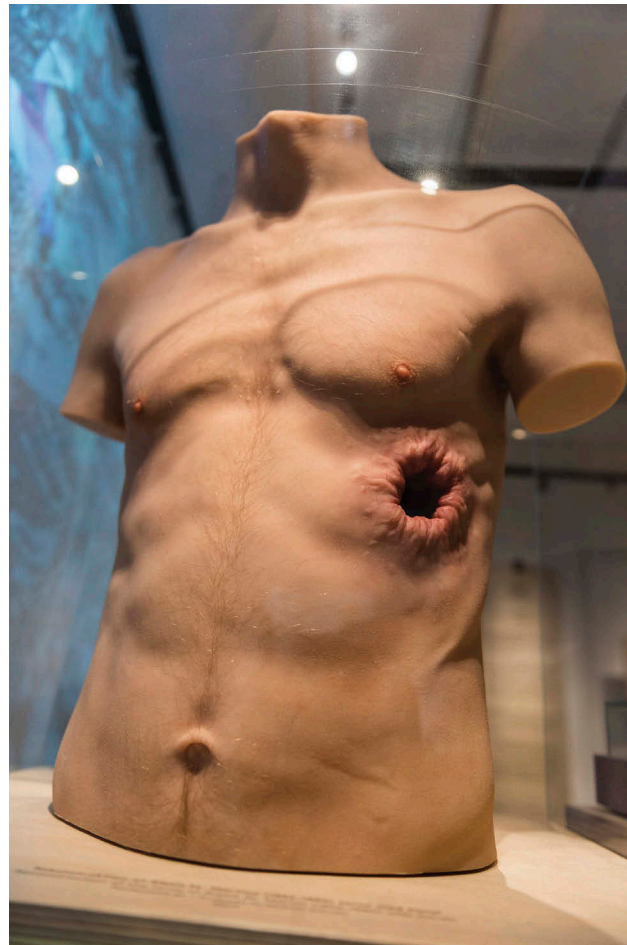
Including such artistic interventions into microbiome research into *Mind the Gut* was an easy choice for us, as it aligned with the experimental nature of the exhibition, as well as the more open-ended approach to science communication founded partly on the logic of ontology as outlined above. We included a number of such art works and collaborations. One such example is the work of the artist Kathy High, whose practice lies at the intersection of art, science, and the personal, engaging both ethical dilemmas, speculative futures and existential concerns of biomedicine and biotechnology. We featured three objects from her work around fecal matter transplants (FMT), which she has a personal interest in because of her personal experience of having Crohn’s disease. The first object is a speculative prototype of a DIY stool bank, consisting of a glass container filled with honey and ceramic excrement. The piece belongs to a series ‘The Bank of Abject Objects’ which responds to the notion that healthy

feces might become a valuable commodity in the near future. As our internal microbiomes continue to become more unbalanced, mirroring the shifts in our larger ecological sphere, feces might transform from a dangerous waste product that must be cleansed and made invisible into a possible source of ecological intervention.

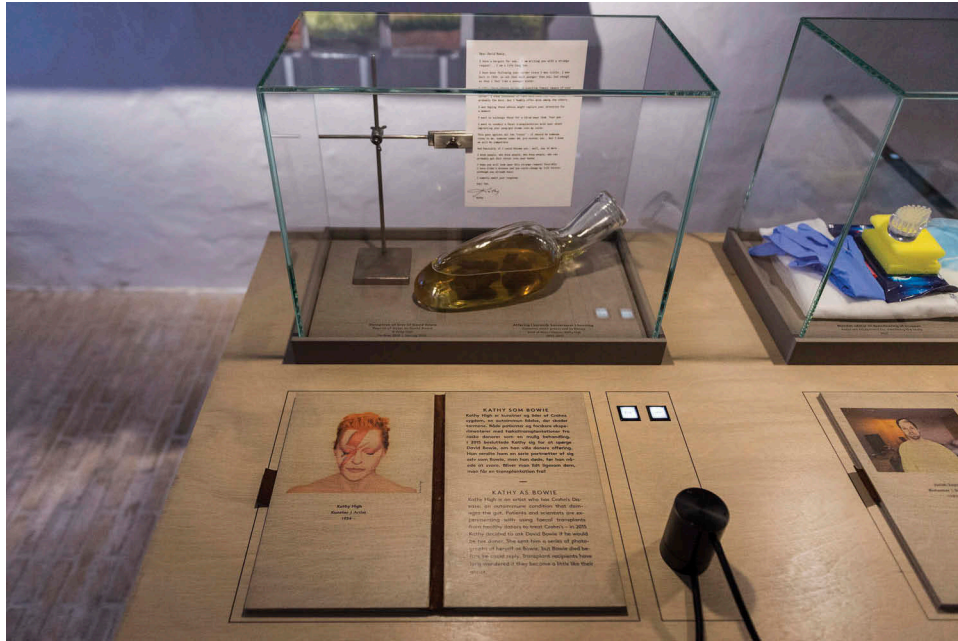
While High was investigating FMT, a friend asked whose stool *she* would want to use—in a sense, asking which other person she might want to take in. She settled on David Bowie, being a lifelong fan, and decided to make a series of photos of herself costumed as famous images of him. She sent the photographs to Bowie along with a letter asking for an unusual exchange: Whether he would send some of his feces in return. The exchange never happened, as Bowie unbeknownst to the artist was battling cancer at the time. In our exhibition, we display both the letter and one of the images of *Kathy as Bowie* (see [Figure 3](#)). These works bind together patient perspectives—the hopes, fears, frustrations, and anxieties connected to suffering from a chronic medical condition that the medical establishment is still trying to figure out—with an artistic, playful reflection upon our entanglement in

the microbial biosphere inside and outside of us. Like other potential transplant recipients, the artist wonders what exactly is being exchanged when organic matter is moved from one body to another, something that is further complicated by the possibility of the commensal microbes possibly impacting the mental state and moods of the recipient. High's work also invites us to ask broader cultural questions of FMT, such as how we might rethink our relationship to feces, why we often are ashamed of our bodily functions, and where this shame came from culturally and historically.

A second collaboration was made with the Canadian scientist and bioartist Francois-Joseph Lapointe. Lapointe is professor of evolutionary ecology at the University of Montreal, and also holds a PhD in dance. His artistic practice revolves around what he terms performance experiments, in which he modifies and studies his own microbes in different ways, using his body as a laboratory and a seismic register of how our microbial constituents shifts through different actions and environments. In *Mind the Gut*, we featured his project *Becoming Batman*, undertaken during a research trip to New



**Figure 3.** Silicone torso made to resemble Alexis St. Martin, a young man who in 1822 survived a gunshot wound to the stomach but developed a permanent fistula. He was treated by the physician William Beaumont, who later experimented on him by tying food on silk strings and inserting them into the stomach through the fistula. Beaumont's pivotal observations were published in 1838, in the book *Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*. Copyright Medical Museion.



**Figure 4.** The work of artist Kathy High as featured in the exhibition. In the display case is a copy of the letter she wrote to David Bowie, as well as a glass vessel containing ceramic stool in honey, from her series *The Bank of Abject Objects*. The audience can also listen to an interview with High about her work. Copyright Medical Museion.

Guinea in 2016. While studying the local bat population, Lapointe noticed the locals eating the bats, and decided that he would do the same (along with other local species), while sampling his oral microbiome before and after the meal, to see how consuming the animal changed his microbial population, and in turn, himself. From the data produced by this and similar performance experiments, Lapointe produces what he calls ‘microbiome selfies’, artistically modified data visualizations. He has conducted a number of such selfie projects, including the project *1000 Handshakes* which Lapointe conducted in collaboration with Medical Museion in 2014, where he visited the medical faculty at the University of Copenhagen and shook a 1000 people’s hands; his palm microbiome was then sampled after every 50 handshakes, to see how the contact with other people changed him. The selfies were then exhibited at the Medical Museion in an exhibition entitled *Hello Bacteria!*

Alongside *Becoming Batman*, we also collaborated with Lapointe to produce a series of microbial portraits of a family living in the same house in Montreal, consisting of a baby, a young child, a mother, and a grandmother. Fecal samples from the four family members were collected and sequenced by Lapointe and his team, and then visualized as four slowly turning microbial ‘planets’, whose networked surfaces consisted of dots representing microbial species, and the relative size of the dots the abundance of the given species. The planets show how microbial diversity shifts over the lifetime of the organism: the baby’s microbiome is the least diverse, and diversity then increases through the young child and the mother,

and then decreases again in the grandmother. The microbial planets provide a useful talking point for our guided tours as well as an artistic representation of the complicated and interwoven nature of our microbial relations. They communicate directly and easily, but also prompt discussion amongst scientifically trained visitors in how the visualizations were possible and what rhetorical functions they play.

Engaging with artists in the making of the exhibition is a way to highlight how microbes, both in scientific and artistic fields, increasingly are becoming ‘model organisms’, that is, organisms that are made to signify larger biological worlds and imagined futures. More specifically, we have been interested in microbiomes being used as ‘model ecologies’, that is, models for thinking about coexistence and human and nonhuman entanglement (Ankeny and Leonelli [12]). In this light, the work of Kathy High emphasizes a new mode of ecological thinking about intervention, where fecal transplants is both a medical and an existential procedure, transferring qualities from one collective to another. And similarly, the performance experiments of Lapointe points to ecosystemic entanglement in everyday actions, from shaking hands to eating. His artistic practice thus highlights the implications of bacteria as model ecologies, pointing tensions about complexity, reductionism versus holism, and of scales and possibilities of intervention.

## Conclusion

*Mind the Gut* deals with a topic that is public, and which belong to culture and society in several ways: Both

because it speaks to fundamental somatic aspects of what it means to be human, and because scientific developments are being reported and brought to the public as they happen, long before basic scientific issues are settled. This makes GBM research both vital and vulnerable to overinterpretation. As microbiome interventions are relatively cheap and accessible, it is also a potentially creative but undisciplined source of personal understanding and treatment, and a potential ‘wild west’ for commercial interests. *Mind the Gut* is a public space that aimed to encourage reflection and curiosity, by showing how biomedicine fits into social, cultural, historical, and directly personal contexts. The exhibition does not aim to provide answers about what food the visitors should eat or what the truth of how gut and brain interactions might be. We emphasize process over result, hopefully encouraging the visitors to ask their own questions of the relationship between mind and gut, between body and microbes.

The exhibition ultimately rests on a series of existential and philosophical questions that have piqued our interest over the last years, but which are only just beginning to be explored. What are we to make of microbial entanglements creeping into the traditional confines of the ‘human experience’? What might it be taken to imply for our self-understanding, both individually and as a community? What sort of social practices and cultural patterns emerge if we see bacteria as foundational to our humanity, and what does it mean for technological and scientific intervention in our distributed environment? And what are the implications for how we philosophically define the human subject, as a thinking, conscious being?

*Mind the Gut* offers no answer to these questions, but rather aims at the more modest goal of starting a conversation about them, the first step in broaching what is likely one of the biggest set of questions in the coming decades: What does it mean to both be and be a part of an ecosystem? How might such questions shift the complex boundaries between mind, body, and environment? Whatever the answers to these questions might become, our work with *Mind the Gut* has emphasized the need for interdisciplinary engagement across art and science.

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