OBJECT LESSONS

SENSORY SCIENCE EDUCATION

1830-1870

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OBJECT LESSONS: SENSORY SCIENCE EDUCATION, 1830-1870

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The Victorian nursery was filled with the potential for scientific lessons. From the bookshelves, children could listen to fairy-tales of wondrous forces and minuscule creatures; from the toy-chest, they could play with hoops and tops that demonstrated the laws of motion; at the table, they could taste and smell the chemical constituents of a cup of tea; in the garden, they could pick up a pebble and envision long-vanished lands. Through practical interactions with the objects of domestic life, imaginative stories of the wonders of nature were revealed, scientific knowledge was communicated, mental modes of rational reasoning were enhanced, and bodily skills were entrained. This dissertation analyses how such lessons on common things provided sensory introductions to the sciences in mid-nineteenth-century Britain.

The ‘object lesson’, I argue, was a crucial genre of elementary educational practice and literary representation in this period. It emphasised that children acquired knowledge directly through sensory impressions, and advocated conversation and play as effective means of developing structured skills of attention, logical reasoning, and expanded vocabularies; hence, practical scientific subjects were particularly appropriate for this style of teaching. I begin with visual education, analysing how children were trained to open their eyes in the ‘art of seeing’ the geological past; wondrous tales of forces and fairies that fired childish imaginations to rethink the commonplace objects of the world form the focus of chapter two; hands-on domestic activities appear in the third chapter, which explores household chemistry via tasting tea and smelling soap; the fourth chapter considers speech and the voices of nature through first-person narratives from trees and salt and fossils; and finally, in chapter five we will learn about the astronomical meanings artefacts could hold when held and manipulated, as boys and girls played among the stars. Mirroring this diverse array of topics, the dissertation deals with a rich collection of historic material, which spans the spectrum of Victorian childhood experience and complicates abrupt distinctions between instructional and amusing texts and pastimes: my sources include didactic tracts and manuals, gift-books and periodicals, pocket globes and chemistry sets, caricatures and terrible puns, novels and fairy-tales, foodstuffs and beverages, songs and board games.

These often fanciful, occasionally funny, usually fact-ridden expositions articulated the process of how to gain knowledge from singular, concrete, common things. Thus, they can teach us how to interrogate Victorian artefacts ourselves, with a similar sensitivity to their histories, materiality, and hidden wonders, glimpsed under their surfaces. Moreover, through their overt emphasis on the science of common things these lessons were simultaneously revelations of and arguments for the interpenetration of scientific and everyday life: the objects of the home were scientific, and men of science were domestic experts. This identification between the specialist and the quotidian supports an argument for ‘familiar science’ as a helpful analytic category when studying this period. Emphasising both the family context and the exploitation of already-known ideas and already-owned artefacts, as well as a particular mode of writing – that of the ‘familiar introduction’ – I reflect on how such a term can solve some of the acknowledged problems associated with labels such as ‘popular’ or ‘commercial’ science at this time.
This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration, except where specifically indicated in the text. Furthermore, it does not exceed the stated word limit of 80,000 words, including notes of reference but excluding the bibliography.

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"It is all very well to speak so humbly, mater," said Sydney, laughing;
"but I do not quite trust you; your 'common objects' ... lead us into
uncommon paths, and through rather difficult places."

Annie Carey, Threads of Knowledge

ACCORDING TO THE BOOKS ranged on the shelves of a Victorian child’s bedroom,
the world was full of hidden forces, tiny creatures, explosive chemicals, vanished
landscapes, and the voices of nature. Common things and familiar objects provided a
way to enter this world as the best introduction to a knowledge of and the skills to
participate in the scientific enterprise.

‘Object lessons’ formed a key genre of nineteenth-century science education.
Appearing in print in periodicals and playbooks, and in practice in classrooms and
kitchens throughout Britain, lessons on objects as diverse as water, wool, wax, and
whalebone introduced children to a deeper understanding of the world in which they
lived, and trained them in how to interrogate everyday artefacts. In this dissertation I
analyse these object lessons as sensory exercises: I ask how children’s interest and
attention was excited by hearing marvellous tales of common things, scrutinise with
what kind of eyes they were encouraged to view the world, consider how these

1 Annie Carey [1872] Threads of Knowledge, drawn from A Cambric Handkerchief; A Brussels Carpet; A Print
Dress; A Kid Glove; A Sheet of Paper (London: Cassell, Petter, & Galpin), 74.
vicarious and actual conversations furnished a scientific vocabulary, and explore how investigative and analytical habits were developed by manipulating miniature artefacts.

This dissertation provides an in-depth study of object lesson teaching to elucidate the practices of mid-nineteenth-century domestic science education, arguing that learning things was achieved through learning with things. More than this, it claims that attention to sensory practices and material culture, to processes of education and, especially, to the proposed analytic category of ‘familiar science’, has the potential to transform our understanding of scientific participation in the mid-nineteenth-century.

What was an object lesson?

An object lesson began with a singular, usually familiar, concrete artefact, explicitly present before the student: a stone retrieved from the street, a grain of coffee brought from the kitchen, or a flower picked from the garden. This object was used to focus the student’s attention, and bound the educational experience: reassuringly, it was placed in the palm of the hand. A range of information was then extracted from the chosen object, as it was interrogated in a discussion between student and teacher: as one book of lessons put it, this process would ‘question out’ its ‘particulars’.2 The conversation might begin by assessing its sensory properties: was the object smooth, cold, shiny, fragrant, or noisy? Did it change when manipulated, or subjected to closer inspection? Unfamiliar vocabulary to describe unusual properties could at this stage be introduced by the teacher, such as ‘transparent’, or ‘inflammable’. The history of the object was then traced, which might include details of the manufacture, trade, or origins of the object: how had it been made? Where had it originally come from? The uses of the object could be next elaborated: students began by listing what they knew the object to be used for, such as cooking, lighting,

washing, or writing. The teacher could supplement this list with more unfamiliar practices, including dyeing, building, or preserving. Finally, the lesson could turn to any wider associations the students might make with the object, such as well-known or historical stories connected with the given artefact, particular symbolic values of the object, and – especially when discussing natural historical specimens – religious significances to be emphasised: the greatness in small things; the adaptive design to be found in nature. The lesson often closed with reflections on the many stories even a humble object has to tell, and with an appeal to the wonders of common things.

**Figure One:** An object lesson in progress at home: the tutor holds the chosen artefacts in his hands, and discusses them with the group of boys.

The object lesson was therefore an explicitly conversational, even collaborative, process. Some books, particularly those intended to be read out in the home, or that provided models for teachers, wrote out sample lessons as idealised dialogues between an educator and childish audience. Others conversed with an
implied reader, appealed to as the listener of a fairy tale, the target audience of a periodical, or the follower of a recipe book. Writers recruited the reader into taking an active role in the educational process, by choosing objects at hand in his or her surrounding environment, and by demonstrating how these lessons could form part of existing conversational culture, and could arise naturally from everyday activities and discussions, be it making a cup of tea, or talking about what one had seen on a walk. An identification between described and repeated actions was encouraged, as a distinction between represented and actual experiences was deliberately blurred. The actual process of the object lesson was in these ways grounded in existing educational practices – oral instruction and aural learning, memorisation of words and mimicry of actions – and built on the child's existing knowledge of anything from a nursery tea to snippets of psalms.

A closer reading of one typical object lesson will further identify key features of this central nineteenth-century educational approach; the periodical article 'Remarks on a Feather' (1829) provides an illustrative example. Beginning with a claim that 'the wonders of the world of nature, will never cease to amuse and instruct both the aged and the young', the anonymous author J.C. turned his 'attention' to the plumage of a common, domestic fowl, indeed, to the very feather which he was at that moment using, and made it the 'subject of [his] present thoughts':

The feather I now hold in my hand may be considered as consisting of three parts, namely, the quill, the back or stem, and the beard. The filaments are placed in smooth, regular, and beautiful order on each side of the polished and ivory-like stem, and thus situated, they contribute much to the beauty of the bird, and furnish a covering to its body, light, warm, and durable.

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J.C. described the sensory and aesthetic qualities of the feather – it was smooth, polished, warm, beautiful – which he connected them to the activities for which it was adapted, such as walking, flying, and swimming. All this J.C. saw as evidence of divine design in nature. He went on to ‘pluck’ one of the laminae, and ‘applied it to [his] microscope’, identifying three distinct parts, which he proceeded to link to the various functions of the parts of the feather, including flapping wings, and repelling water. The sensory and extended meanings of the object were then combined in a ‘moral reflection’ as J.C. invited his readers to compare the either pleasant and downy or difficult and jarring touching of a feather – depending on whether one ran one’s finger along or against the direction of the laminae – to corresponding religious feelings: ‘Thus God has ordained, that our conscience should feel accordingly, either as we resist, or obey His will, in the gospel of Christ.’

Appearing in the *Youth's Magazine*, “Remarks on a Feather” was written according to that particular periodical’s ideology, and in dialogue with a specifically evangelical audience; as in other of its articles of the time, the social practices of reading and education were highlighted.

There are two main lessons to extract from this specific example. Firstly, object lesson teaching was thought particularly suitable for imparting knowledge about nature, and hence for scientific subjects. The use of direct sensory impressions to learn from the surrounding environment, and then a gradual leading to unfamiliar knowledge and new skills, was thought to mirror the natural mode of growth of the child’s mind and body. The educational reformer Johann Heinrich Pestalozzi and his successor, Friedrich Froebel – invoked by many teachers of object lessons as theorising the underlying philosophies employed in their lessons – both argued that education should act through direct sensation, and that it should be structured so as

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4 Ibid., 421.
to match mental development. They also prioritised learning from nature, as Froebel's invention of the 'child's garden', or Kindergarten, made explicit.6

Secondly, 'Remarks on a Feather’ highlights the way in which object lesson teaching progressed was bound by certain generic conventions, a cluster of literary devices. Particular rhetorical tropes recur in the examples on which I shall draw: they include an immediate tangibility – 'this object, which I hold in my hand'; a flip between, and complex management of, the double meaning of the verb 'to see' as both to perceive and to understand; an emphasis on attracting and maintaining the student’s attention; the exploitation of existing knowledge about the common object, what about it is ‘familiar'; a narrative dependent on a sustained reading from beginning to end, gradually leading away from this familiar knowledge into newly scientific territories; a precise situating of the reader or listener with respect to the object – where it is, how it is being moved; and an emphasis on wonder and the revelation of what is usually 'hidden' beneath the surface of nature, and of everyday life. As well as these linguistic tropes, by taking a generic perspective two other issues are highlighted: that object lessons had particular material instantiations in published works; and that they engendered certain expectations in their audience.

The object lesson fitted into a range of literary genres deployed and developed by scientific writers in the first half of the nineteenth century. In his Victorian Popularizers, Bernard Lightman has identified some of these genres as the anecdote, the calendar or life-cycle, the classification system, the journal essay, the experimental report, the speculative article, the literature review, and the ramble through nature.7 For Lightman these genres are subsumed within the higher category of 'scientific

writing'; however, the anecdote, the speculative article, and the literature review were hardly confined to writing on scientific topics. As well as being a useful tool for analysing which narrative forms writers chose to employ when communicating with their audiences, then, I believe that attention to genre can help provide an interdisciplinary perspective on the writing of this period, writing which often did not conform to, or indeed deliberately conflated, emergent categorisations.

Of the wealth of literary forms employed in nineteenth century scientific writings, a focus on the object lesson genre opens up a particularly rich array of sources for analysis: such lessons appeared in periodical articles, manuals for school teachers, fanciful fairy tales, expensive gift-books, cheap instructive miscellanies, works on cookery and household management, travel guides, and autobiographies. They covered a range of subjects: domestic economy, botany, and geology were among the most popular, but chemistry, microscopy, entomology, history, religion, geography, and astronomy were also all included. They were introduced by myriad objects ranging from a pair of scissors to a piece of honeycomb, coral to cinnamon, a sunbeam to slate, to audiences located in a schoolroom, garden or a nursery, on a beach or a heath.

Exploiting the wide scope of these publication types, scientific subjects, and familiar objects, this singular generic category hence permits me to cross disciplinary boundaries, since the object lesson approach was used for teaching a wide variety of topics, to many different audiences. Therefore, unlike much of even the best work that is still conducted in the history of science, I shall not be restricted to discussion of one scientific discipline, and, moreover, can explore how scientific knowledge could be entrained as just one facet of a wider consideration of how and what to learn about objects. By choosing the most elementary, the explicitly introductory, of these lessons, I hope to bring out the fundamental strategies at work in these practices. Elementary education is also arguably the furthest away from the scientific practice of the day, but I shall demonstrate that in this genre a wide range of levels of technicality
could also be included, as the broad framework of the object lesson could arguably exert an influence right up to the choosing of particular specimens for detailed analysis, the process of interrogating an unknown substance, fossil, or experimental result, or the writing of an expert monograph.

As well as providing a rich and influential body of works to discuss, and bringing together the history of science with considerations of literary form, material instantiation, and audience expectation, by choosing the object lesson genre as the focus of this dissertation, two historiographical issues are addressed. Firstly, that the practices of education are foregrounded as my primary historical category and analytical approach; and secondly, that this work will pay attention to material processes and things. The next two sections will consider these two separate elements in order to draw out some of the historiographical aims – and consequences – of choosing this group of works as the focus for this dissertation.

Lessons from education

In mid-nineteenth-century Britain there was an unprecedented involvement in and appetite for scientific knowledge. From fashionable conversations at dinner parties to working men’s lecture series, the most up-to-date and detailed scientific debates formed part of everyday life for many early Victorians. At home, whether laughing at the lampooning illustrations in the latest edition of *Punch*, imagining Dickens’ megalosaurus waddle along Holborn Hill, reading an account of a factory visit, using phrenological theory to vet a new servant, or wearing a brightly-hued dress in the latest aniline dye, the sciences were a visible and central part of modern life. They gave guidance when looking inward, encouraging audiences to rethink conceptions of themselves as owning a potentially mechanical mind and body, as in thrall to mesmeric forces, or in a close relation to other members of the animal kingdom. They provoked questions when interacting with the surrounding world, as
railway cuttings revealed layers of long-gone history and long-vanished creatures, or as career opportunities were curtailed by mechanisation, or opened up by the imperial infrastructure. They provided opportunities to meet the latest celebrity inhabitants of the zoological gardens, to enjoy demonstrations at the Royal and Polytechnic Institutions, to visit exhibitions great and small, or to envision the whole world at a spectacular panoramic show. And they encouraged developing the expertise to engage with men of science who were setting themselves up as authorities on anything from telling the time to telling the history of the universe, from life-preserving apparatus to life beyond the grave.

It has become increasingly clear that the designation 'popular science', or even the process of 'popularisation', does not do justice to the rich variety of activities, sites and experiences in this heterogeneous scientific culture. Many of these activities were not 'popular' occasions for mass participation, though some were pivotal in defining such an audience; many involved significant contributions to and effects on a supposedly separate elite scientific culture; many writers and lecturers did not think of themselves as popularisers, though some did attempt to forge this role; most importantly, the terms, content, and ideas of 'popular', 'science', and 'popularisation' underwent enormous discussion and change in this period. Once a useful rhetorical counterpoint to the overwhelming academic emphasis on the history of a few expert discoverers, talking about popular science before the end of the nineteenth century is increasingly regarded as unsatisfactory and, ultimately, misleading. Consequently, recent work on Science in the Marketplace has eschewed the language of popularization and popular science, choosing instead to remap the terrain of Victorian scientific

culture by an attention to varied 'sites and experiences'. Over the past twenty years academics have detailed that many of those once perceived as outside the traditional remit of the history of science were active participants in this complex scientific enterprise; expert contributors to knowledge-making, debates, spectacles, periodicals, and even music hall sing-a-longs. This emphasis on varied and embodied types of activities and contexts allows for in-depth studies that reveal the alliances forged, books published, and exhibitions visited in a network of interactions. However, by remaining in a self-consciously commercial arena, this structure risks retaining the underlying concept of a world of popular science: that scientific content has already been produced elsewhere, and remains to be packaged, marketed, bought, and sold. Popularisation has simply been replaced by commodification.

In this dissertation, I propose that the framework of education can reorient our investigations into scientific activities, and ultimately lead to a quite different picture of what it meant to be part of scientific culture in this period. At a general level, the category of 'education' might seem almost self-explanatory: the transmitting of knowledge. However, even this simple definition provides a helpful starting-point for thinking about scientific participation. It prioritises a communicative practice, the act of educating, that can encompass a rich variety of disaggregated processes including pedagogy, conversion, apprenticeship, mimicry, recruitment, training, and not only school-bound didacticism: it is both learning and teaching. Many different forms of experiences, including reading self-help literature, engaging in tea-time conversations in the nursery, or spending a seaside holiday spent knee-deep in rock-pools, can be conceived of as educational practices. Audiences picked up a book, toyed with an intriguing object, or listened to an authoritative lecturer, because they

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10 See, for example, the essays in *Ibid*.

11 For communication as the key problem for the history of science, see Secord, 'Knowledge in Transit'.
were interested, or could be made interested, in scientific subjects. Furthermore, these ways of learning operated in the opposite direction to the much-criticised model of popularisation from expert centre to lay periphery: an educational journey ran from ignorance to experience; from beginners without skills and knowledge right up to practising chemists or naturalists. Indeed, and especially as advocated through the burgeoning contemporary self-help literature, those so willing could end up with a great deal of expertise on the most taxing of, for example, moss classifications. In this way, the idea of education as a continuum of knowledge and expertise is foregrounded, rather than as part of a separate sphere of popular culture, or the specific realm of the marketplace.

By choosing elementary education, I begin at one extreme end of this spectrum, with those childish participants who had the least knowledge, and the fewest skills, and were self-consciously taking their first steps into a scientific world. In the mid-nineteenth century the place and content of, and suitable pupils for, elementary education was a hotly-debated issue, the instructional landscape a patchwork of nursery governesses, private tutors, prep schools, religious establishments for the poor, and parent-led teaching in the home. Of the wealth of possible avenues of research – for example, how common things were used in educating the working classes, or common men; the instantiation of scientific subjects into schools and universities – I focus in this dissertation on domestic education, teaching that exploited everyday activities and the common objects of the house and garden. The opening dialogue that accompanied the frontispiece to Jacob Abbott’s 1833 *The Little Philosopher* (see figure two) demonstrated how interacting with objects from the surrounding world could form the most elementary experimental education for children. In the image, ‘baby’ sat on the floor, playing with a piece of paper; as his mother told her elder son: ‘he likes to shake it about, to see how it will move; and to pull it to see how strong it is, and how easily it will tear. In that way, he is learning the nature of it.’ After shifting his attention to the ‘cricket’, the child was alarmed by its
falling over, and making a loud noise: Mother declared, however, that ‘the next time, he will not be so much surprised; he has learned something, by this lesson in Philosophy’. As the book’s introduction went on to state, the book intended to teach children ‘to think and to reason about common things’ – ‘to fix the attention, and to employ the reasoning powers, on the thousand objects around them, with which they are necessarily more or less familiar, and which are consequently the best sources of thought and reflection for them’.

**FIGURE TWO: ‘SCENE: a parlor; an infant is creeping about the floor, playing with a newspaper. Two little children, Ann and William, are trying to make the fire burn. – Enter their Mother with a copy of “The Little Philosopher” in her hand.’** Frontispiece to *The Little Philosopher.*

Historians and sociologists of education have identified the ‘science of common things’ as an important contemporary movement, and it has particularly been

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12 Jacob Abbott (1833) *The Little Philosopher, for Schools and Families: Designed to Teach Children to Think and Reason about Common Things* (Boston: Carter, Hendee, and Co.), 4.
13 Ibid., 7.
analysed as an exercise in ‘social control’. However, in this dissertation I argue that it can draw our attention more particularly to the more widespread use of domestic and quotidian artefacts in scientific education and writings, and to a wider category of ‘familiar science’ that can solve some of the problems with an emphasis on ‘popular science’ outlined above.

Common things

The middle-class Victorian home was crammed with objects: from pianos and paintings to dolls and dressers, lawnmowers and lampposts, clocks and cutlery, crinolines and Oxo cubes. To many eyes, the everyday world seemed increasingly fuller than it had ever been before: city streets teemed with commuters and carriages; shops and exhibitions displayed a dazzling array of wares; shells, scrapbooks and sheet music jostled for attention on the parlour table (see figure three). Objects were everywhere. This plenitude of things has recently been the focus of academic attention in the histories of art, science, and economics, and in literature, analysed as commodities, decorative art, signifiers of realism in novels, foci of social processes, fetishes, and even as potential biographers. Originally belonging to narratives of mass production and consumption, the many artefacts of the mid-century, both as surviving museum collections and as depicted in contemporary artistic and literary representations, are now being used to flesh out a more spectacular, noisier, smellier – indeed, fuller – conception of contemporary culture.

FIGURE THREE: A mother or governess and child sit in the object-filled Victorian parlour, at mid-century.

The object lesson tradition firmly situated itself in this thing-filled world. The starting point for each lesson was a different item taken from the surrounding environment, both natural and manufactured, which was demonstrably grasped in the student’s hand. The reality of this object was paramount, and authors went to great lengths to use readily-available things, to give directives for their collection, or to detail common, familiar processes. It was only by using real objects that the educational processes underpinning the tradition could be effected and effective, could lead from sense-impressions to enhanced understanding, skills, and powers of reasoning. For example, in an oration at the Royal Institution on the life and methods of Johann Heinrich Pestalozzi, credited with developing object lesson teaching, Charles Mayo stressed that the practices in his school at Cheam led from perception to ‘the higher intellectual faculties’ because they involved the use of ‘real objects’ from the child’s surrounding environment (see figure four):
The cultivation of the higher intellectual faculties of reasoning, taste, &c.
is preceded by the careful development [sic] of just observation and
clear intellectual conception. For this purpose, real objects are presented
to the examination of the younger pupils; the physical senses are trained
to accurate perception, and the understanding is gradually led
to generalize and classify the notices it receives through them.¹⁶

Training the physical senses by examining actual artefacts was the first object of
education, the appropriate focus of elementary instruction, and the way to a deeper
understanding of the objects themselves, their place in the world, and also how the
mind itself might come to such an understanding.

Caroline A. Halsted’s 1837 *Investigation: or, Travels in the Boudoir*, argued that
these ordinary objects underpinned the national ideal of the home, and deserved to
have their stories revealed to contemporary youth, who had been busy garnering
other accomplishments, and had neglected the potential of what lay underneath their
noses:

![Image of a child picking something up from their environment]

**FIGURE FOUR:** A child picks something up from his surrounding environment.
Note the detailed placing of the boy in a specific natural environment and his
depiction ‘in action’, holding the object.

¹⁶ Charles Mayo (1827) *Observations on the establishment and direction of infants’ schools: being the substance of a
lecture delivered at the Royal Institution, May, 1826* (London: L. B. Seeley and Sons), 27.
How many young persons, of superior understanding, who play and sing, dance and paint, with taste and execution beyond their years, - are, nevertheless, totally unacquainted with the origin, history, or progress into general use, of the most ordinary articles with which they are surrounded; so ordinary, indeed, as to be, for that very reason, disregarded, or disdained because within every body's observation: articles which, nevertheless, ...[render] an Englishman's fire-side proverbial among foreigners, and his home the pride and delight of every true Briton's heart.17

Underlying this process was a desire to demonstrate that as well as being full of objects, the surrounding world contained hidden secrets, forces, histories, and connections, that could be revealed by the trained eye, the skilful hand, the discriminating ear, and the enquiring mind. Furthermore, this hidden world, of laws and truths, pasts and futures, was the realm of the sciences. As James F.W. Johnston wrote in 1855:

The common life of man is full of wonders, Chemical and Physiological.
Most of us pass through this life without seeing or being sensible of them, though every day our existence and our comforts ought to recall them to our minds.18

Such identifications between the wonders of common things and the wonders of modern science and technology could be made with relative ease; indeed, many of the objects that furnished the nursery, that were eaten in the kitchen, or were displayed in a parlour cabinet, could quite quickly be traced back to the seashore, laboratory, or factory floor. Educators exploited this familiar knowledge to complicate the

experiences and content of these objects and impart a more sophisticated comprehension of scientific theories: why did a stone picked up on a beach feel so smooth? It was the fragment of a larger mass, worn down by friction. How did a candle wick burn? By the process of capillary attraction. Where had a piece of paper come from? It had been made in a factory, transformed from a living tree using the latest steam-driven machinery.

Whilst retaining a physical connection to their home, children pieced together the often strange stories of these objects, learning to speak novel vocabularies, to look with attentive eyes, to taste a dissolved sugar solution, to move a model earth around a model sun. They both learned through, as Mayo had emphasised, and learned to develop, a new suite of sensory skills. That object lesson teaching was overtly multisensory was emphasised by many of its proponents in the mid-nineteenth century: for example, Thomas Henry Huxley, who often used a common object approach in his lectures, introducing audiences to the stories of a piece of chalk, a lobster, a horse, and water, claimed that 'the great business of the scientific teacher is, to imprint the fundamental, irrefragable facts of his science, not only by words upon the mind, but by sensible impressions upon the eye, and ear, and touch of the student.' The chapters of this dissertation explore this claim as I investigate how and why the senses were affected, through the use of prose and artefacts: directly, vicariously, imaginatively.

This dissertation follows recent so-called 'biographical' approaches to objects in exploring what chosen artefacts can reveal about the culture in which they were invented, approved, produced, marketed, purchased, used, perhaps forgotten, and, eventually, displayed.\(^2\) Telling the stories of particular objects has even created a sub-genre of historical and popular works: Bill Brown lists 'the pencil, the zipper, the toilet, the banana, the chair, the potato, [and] the bowler hat' as topics of such works.\(^2\) How precisely to combine literary and actual representations of objects has been addressed in recent publications in literary studies, including Elaine Freedgood's *The Ideas in Things* and Brown's work on 'Thing Theory', and *A Sense of Things*.\(^3\) These texts claim there are 'no ideas but in things', tracing the 'passions and associations' of objects including curtains, furniture, and tobacco as they read their appearance in the background or foreground of novels as symbolic connections to wider narratives.

Appreciating how historical participants could have undergone this type of training in reading beyond the surfaces of things can, I detail in this dissertation, help in solving the problem of how authors and educated, middle- and upper-class, readers would have obtained the kind of multifaceted, embodied, and specific knowledge of objects' biographies, properties, resonances, manufacture and uses that is, perhaps, too often assumed when arguing in such works for the significance of tables and tail-coats.


curtains and necklaces, as they appear in literary works as background scenery, leit motifs, or critical plot points. I shall return to these considerations in the conclusion.

Mirroring this search for the myriad stories held in surviving things, and an emphasis on the novel information and skills learnt via a sensory engagement with material culture, historians of science have conducted object lessons themselves on scientific artefacts, even referencing this terminology in their titles.24 Much of this work on objects has focused on the specialist: on instruments from astrolabes to zenith sectors; on educational, investigative, and medical tools; on wax, paper, and glass models; on the architecture of particularly important institutions; or on recreating the equipment and conditions of well-known experiments. Other studies have focussed on natural objects – naturalists’ collections from around the globe, preserved surgical specimens – or even less tangible scientific objects such as dreams, or electrons. In the introduction to Biographies of Scientific Objects, Lorraine Daston muses on the etymology of the word ‘object’. Recalling its origins as referring to the everyday things that ‘smite the senses’: walls, rain, stones, projectiles, she counterpoises the ‘quotidian’ and the ‘scientific’ object – the former are ‘rarely the objects of scientific inquiry.’25 However, the object lesson texts I look at in this thesis did precisely the opposite, conflating the everyday and the philosophical, the ‘quotidian’ and ‘scientific’. The powerful rhetoric of the texts was in part drawn from this extension and identification of the remit of science into the activities and artefacts of daily life. A properly scientific understanding could illuminate the meteorological processes of the falling rain, or the often surprising composition of a droplet of water; with a trained eye, every stone in the street told its geological history and whispered of past worlds. Hence, Daston’s fertility of scientific objects ‘in new techniques, differentiations and associations, representations, empirical and conceptual revelations’, can be claimed for common things, which for her ‘exist but

do not thicken and quicken with inquiry.' In this period in which the specialist hardware available for practising and studying science became ever-more elaborate and available, it is especially instructive to turn to common objects, advocated at precisely the same time as the most suitable introduction to the sciences.

We have become used to arguing for objects as part of complex networks of meanings, associations and uses: the creators of these lessons were all too aware of this fact — indeed, it is what they hoped to exploit in their teaching. This dissertation, then, contributes to studies of the varied meanings of Victorian objects in three ways. It details how object lesson teaching used and trained children’s senses to develop powers of observation and reasoning, and to uncover the scientific facts and forces that underpinned and made possible the world of goods and natural objects in which they lived. It demonstrates how the definition of a scientific object can be extended, and, moreover, was extended, to encompass a wide range of everyday artefacts, not just specialist equipment. Since the subjects of my thesis were not only teaching their pupils how to learn through objects — they were also articulating the process of engaging with objects themselves — it will show how, through an emphasis on sensory learning, and correspondingly through a sensory history, we can rethink ways of approaching material objects themselves, of conducting our own object lessons.

Structure of the analysis

This dissertation is structured around the senses, teasing apart different types of introductory scientific experience, and the appropriate skills for learning from those experiences, from walks in the woods and on the heath, to conversations in the nursery, spectacular kitchen experiments, and lectures on model globes. Each type of experience is associated with a particular object: the making of a cup of tea with what it meant to define a familiar activity as a scientific process; an oak tree with listening.

26 Ibid., 13.
to those Shakespearian 'tongues in trees', the voices of nature; a pebble with a meditative visualisation of vanished worlds. Emphasising the practical basis and sensory philosophies underpinning the use of these particular concrete examples demonstrates how a variety of textual and experimental strategies revealed the scientific lessons to be found at the heart of everyday life.

The texts analysed in my first chapter argued that many children wandered the world oblivious to its true sights and meanings: if they were only to open their eyes, they could truly understand, rather than merely see, the natural objects with which they were surrounded. The preeminent position of vision in the mid-nineteenth century as the superlative pedagogic sense is here reflected as visual education is the first mode of instruction that I analyse. I particularly explore the geological sciences as their subject matter was often not immediately visible, locked away in prehistoric rocks and pebbles, and the 'art of seeing' their hidden meanings had to be entrained; similarly, I analyse the complimentary skill of how children were taught to look at common objects through microscopes, uncovering what was really contained in every drop of water. Finally, I explore how visions were conjured for lecture audiences from a lobster and a piece of chalk.

Chapter two returns from the pebble-strewn stream and the chalky cliffs to the home, to consider how object lessons were given through fantastical stories told around the fireside. I draw together the overtly fact-laden and apparently fanciful presentations of common things to demonstrate how the use of fairy-tale structures of exotic princesses and sleeping beauties brought the language of wonder to bear on these potentially dry and mundane artefacts, and converted them into marvels of science themselves.

The third chapter analyses multisensory introductions to chemical knowledge, exploring first how everyday activities such as tasting and making a cup of tea were
recast as chemical processes on which men of science could proclaim themselves experts. Then, I explore how smoking wax candles and smelling cakes of soap could be co-opted into introductory experiments and home lectures that recreated authoritative presentations at the Royal Institution: the ubiquitous objects of the home were reduced to chemical components and physical processes, and were made to act in strange and even explosive ways. New artefacts of the late 1830s included dedicated youth's laboratories that brought boxed chemical knowledge to every room of the house; these began to be marketed as the best sensory introduction to the subject, but had strong continuities, I argue, with more basic household experiments.

A particular group of lessons is the focus of my fourth chapter, those given by the objects themselves in autobiographies, dramatic monologues, and in conversation with childish companions; I use these first-person narratives to consider the relationships between spirit and matter, and the spoken practice of this type of teaching. Children were urged to listen to the 'voices of nature' present in trees, flowers, and fossils: rather than this providing an unmediated access to natural knowledge, however, I read these texts in the light of their authors' heterodox religious beliefs as very particular presentations of spiritualised objects. I then reappraise why the didactic dialogue was the chosen format for many of these introductory works. Just as authors argued they had based their writings on actual conversations, so were these texts intended to be read aloud and in their turn shape the actual speech and vocabulary of learning children. Hence, I contend, they could act as appropriate preparations for an expert scientific culture characterised by debates, talk and songs.

How play was used in elementary scientific education, and how hands and speech were trained through that play is the focus of the final chapter. I investigate how astronomy could be the basis of a board game, how toy bookcases contained miniaturised scientific knowledge, how the shape of the earth could be carved into an
orange. I demonstrate that passages of instructional and entertaining language and activities were interwoven to create a structured experience that turned gaining scientific knowledge into a pleasurably rational pastime. Play, words, and plays on words were in these ways used to match natural philosophical topics to children’s minds and bodies.

This dissertation investigates how writers and lecturers used individual common objects as entry-points to the worlds of scientific investigation, and I conclude by reflecting on how my work fits with recent analyses of the ‘object matter’ of Victorian literature, and how it leads to a proposal of ‘familiar science’ as a useful analytical category for the mid-nineteenth-century historian. Educators explored a child-sized microcosm of things, both already familiar, and excitingly novel, as an introduction to the realm of scientific practice. These texts and artefacts functioned as inductions into the scientific world: its terminology, its skills, its technology, its status, its use, its amusements, its past and its future. And they functioned as introductory experiences by focussing on a single object, and by giving a lesson: training the body and the mind to apprehend and investigate the science of common things. In 1835 the Society for the Diffusion of Useful Knowledge’s Exercises for the Improvement of the Senses had exploited a double meaning in outlining the ambitions of its contents: its ‘special object’, the introduced stressed, was ‘to excite little children to examine surrounding objects correctly, so that valuable knowledge may be acquired, while the attention, memory, judgment, and invention are duly exercised.’ The objects of this dissertation also exist in two senses. They are the artefacts around which the following pages are structured: a candle, an acorn, a primrose. And they are the underlying historical ambitions to uncover how and why things mattered to elementary scientific education in the mid-nineteenth century.

1. THE ART OF SEEING

‘...he looked on objects with other eyes than mine.’

Charlotte Bronte on David Brewster

IN LATER YEARS, friends of the palaeontologist Gideon Algernon Mantell (1790-1852) remembered his beginnings in geology as being kindled by the serendipitous discovery of a fossil stone:

“While yet a mere youth, he was walking one summer evening with a friend on the banks of a stream communicating with the Ouse, when his observant eye rested upon an object that had rolled down from a marly bank which at that particular point overhangs the stream. He dragged it from the water and examined it with great attention. ‘What is it?’ was the natural inquiry of his friend. ‘I think, Warren,’ he replied, ‘that it is what they call a fossil. I have seen something like it in an old volume of the Gentleman’s Magazine.’ The ‘curiosity,’ which proved to be a fine specimen of the Ammonite, was borne home in triumph by the two friends; and from that moment young Mantell became a geologist.”


As Charlotte Bronte noted, mid-nineteenth-century men of science such as David Brewster and Mantell supposedly looked at objects through different eyes. This chapter analyses how children’s eyes were educated to see in common objects their histories, secrets, and properties, as they developed the right kind of informed and penetrative vision. I demonstrate that lessons using small, isolated objects entrained skills of observation, attention, and reasoning by miniaturising and visualising natural phenomena, rendering them accessible to audiences beginning their education in or practice of the sciences. The process of a scientific education was for many both through and of the eye: as Charles Mayo put it, ‘the first object, then, in education, must be to lead a child to observe with accuracy; the second, to express with correctness the result of his observation.’ For some, this would be achieved by astounding and inspiring the senses with spectacular panoramas; but for the writers discussed in this chapter scientific education and practice began in developing ‘observant eyes’ by examining particular objects with ‘great attention’.

In his *Thoughts on a Pebble* (1836), Mantell provided a guide to the pebble and the world from which it had travelled, employing a detailed, present-tense, personalised narration. Through this fragment of the natural world, Mantell’s close-up, detailed description of a single object brought both the subject and knowledge of geological science closer to his reader. Drawing on a combination of travel and theological traditions, Mantell fixed the reader’s gaze on a single pebble, and told its story. This magnification in size and importance of the seemingly trivial in nature was made more explicit in later additions of *Thoughts on a Pebble*, which appended ‘More Thoughts’, a microscopical investigation of the interior of the stone. Moreover, in 1846 Mantell published *Thoughts on Animalcules*, an introduction to the then-popular pursuit of microscopy. In this text he similarly subjected a series of commonplace natural objects to the scrutiny of his particular gaze, in this instance enhanced by the prosthetic of the microscope, revealing the, as he termed it, ‘invisible world’ through

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the ‘magic power’ of his optical instrument. A superficially similar work, and just one example of the burgeoning literature on microscopy at this time, Agnes Catlow’s *Drops of Water*, was published in 1851 in the same series as the eighth edition of *Thoughts on a Pebble*. An elucidation of the science of common things, Catlow transported readers into a magical realm through converting them into spirits.

My final section explores two object-lesson lectures given by Thomas Henry Huxley, one on ‘A Lobster’, in 1860, and the other ‘On a Piece of Chalk’, in 1868. His investigation of a lobster was presented to an audience of teachers, and outlined how the role of the educator was to create memorable, palpable sensory impressions. In the wonderfully oratorical ‘Chalk’, Huxley emphasised that it was through specific, sensory impressions that his audiences should learn, and then themselves teach, the rudiments of scientific knowledge. Huxley emphasised the power of a scientific perspective on the world, as he trained a new generation in ocular laboratory skills of attention and close observation, and also in the scientific perception necessary to induce scientific law from the isolated fact, the synecdochic task of the man of science.

A pebble, or object lesson as meditation

In 1836 Gideon Mantell (figure five) published *Thoughts on a Pebble; or, a First Lesson in Geology*, in which he revisited the finding of a fine fossil specimen by the banks of a river. He dedicated the work to ‘the little geologist’, his son, Reginald Neville, and hoped that from the moment of opening his book young readers would become geologists, too. The book was self-consciously an attempt to couch ‘some of the grand truths relating to the ancient physical history of our planet’ in a ‘simple and attractive guise’: using clear prose, it was set in large type, and contained quotations
from popular poems such as Byron's *Childe Harold*, later editions contained attractive coloured plates (see figure six).31

**FIGURE FIVE:** A portrait of Gideon Algernon Mantell, with an Iguanodon thigh bone – his most famous geological find – behind him.

**FIGURE SIX:** "The Pebble". The artificial construction of the pebble as an object of analysis can here be seen, with all its fossil attributes conveniently facing the reader.

Mantell was spurred to revisit this scene by an 1834 article in Leigh Hunt's
*London Journal* entitled 'On a Stone'; his response to this piece ('More Thoughts On a
Stone') would form the basis of *Thoughts on a Pebble* when it was published two years
later.\(^3\) The author (Hunt himself), culled a range of quotations from now-canonical
figures, including Keats, Wordsworth, and Shakespeare, to meditate upon the
philosophical-poetic resonances of the pebble, from babbling brook to precious
jewel. As Mantell argued when justifying his extension to the original article, 'this
misshapen mass, this mere flint, is an inexhaustible source of interest to the
contemplative mind.'\(^3\)\(^3\)

The scene set at the beginning of *Thoughts on a Pebble* bore a striking resemblance
to Mantell's own introduction to geology. After identifying the pebble as 'familiar'
flint, he continued:

The pebble I hold in my hand was picked up in the bed of the torrent
which is dashing down the side of yonder hill, and winding its way through
that beautiful valley, and over those

Huge rocks and mounds confus'dly hurl'd,
The fragments of an earlier world,
which partially filling up the chasm, and obstructing the course of the
rushing waters, give rise to those gentle murmurings that are so
inexpressibly soothing and delightful to the soul.\(^3\)\(^4\)

Mantell plunged the reader into the scene with the narrator as he directed their joint
sight by piling objects of attention on top of each other: 'yonder hill'; 'that valley';
'those rocks'. From the overwhelming torrent and confusion of the stream, however,

the pebble was removed and sheltered within his hand. On its journey through life, it had been rescued from the tumult of movement that characterised this natural world, and had become the focus of Mantell’s thoughts. Mantell’s reader therefore vicariously experienced this too: the ‘beautiful’, ‘soothing and delightful’, yet confusing melee of sensory impressions was turned away from, as nature came to rest in the object of the pebble.

Reassuringly, the pebble fitted into the palm of the narrator’s hand. Unlike the chasm and the rushing waters, it could be manipulated: handled, mastered, and known. In Alfred Tennyson’s 1869 poem ‘Flower in the crannied wall’, an natural historical objects was similarly taken from its habitat and isolated in the hand:

Flower in the crannied wall,
I pluck you out of the crannies
I hold you here, root and all, in my hand,
Little flower – but if I could understand
What you are, root and all, and all in all,
I should know what God and man is.35

Apparently inspired by a flower ‘plucked out of a wall at “Wagoners Wells,” near Haslemere’, in this verse by bringing the flower into physical human contact, and providing a human scale, the narrator emphasised the dominion of man over this humble physical specimen: compared to the poet’s hand the flower was given an adjective, ‘little’.36

Literary critics have noted the impact of Tennyson’s myopia on his poetic vision: for him the world was ‘without middle distance’, a bifurcation of the ‘detailed,

36 Quoted in an editorial note to ‘Flower in the Crannied Wall’, 372.
intimate and striking’, and the ‘unreal, ungraspable, and vague’.\textsuperscript{37} Just as Tennyson’s poetic vision has in other ways been characterised as ‘geologic’, concerned with the far reaches of time, the symbolism of particular rocks, the continuity of past and present natural forces, and the practice of going ‘geologising’, so too was this movement that counterpoised the world of close, detailed description of particular objects with musings on ultimately unknowable distant realms arguably shared with geology.\textsuperscript{38} For Valerie Pitt, Tennyson’s natural objects are so-described as to appear ‘fantastic to normal vision’.\textsuperscript{39} As this chapter will make clear, many introductory scientific works in this period stressed that what was ‘normal’ to scientific eyes, was what for many seemed miraculous. By setting limits to beginners’ visual field, and miniaturising and magnifying the phenomena in question, their introduction to these strange worlds could be eased. However, it could be argued that taking such a small and near viewpoint hinders, rather than facilitates, the gaining of knowledge: for Kerry McSweeney, the ‘close-up extreme’ of ‘Flower in the crannied wall’ clouds Tennyson’s vision by the proximity of its perspective. Rather than allowing a deeper understanding of nature, through the doubts expressed by the poetic voice (‘If he could understand) she argues that Tennyson is ‘too close to the flower for it to function as ... a metonymic symbol ... there is no continuum or whole of which it can be perceived to be a part.’\textsuperscript{40} Mantell, however, at the beginning of \textit{Pebble}, quoted the metonymic aphorism that ‘[t]here is no picking up a pebble by the brook-side, without finding all nature in connexion with it’; his excised text \textit{could}, he argued, be connected to the wholes of both the geological world, and geological knowledge.

John Ruskin expressed similar sentiments for the possibility of scaling up from the ‘more interesting’ particular rock to larger and more general natural objects,


\textsuperscript{38} See, for example, Dennis R. Dean (1985) \textit{Tennyson and Geology} (Lincoln: Tennyson Society).

\textsuperscript{39} McSweeney, \textit{Language of the Senses}, 172.

\textsuperscript{40} \textit{Ibid.}, 173.
claiming that ‘a stone, when it is examined, will be found [to be] a mountain in miniature... and taking moss for forests, and gains of crystal for crags, the surface of a stone, in by far the plurality of instances, is more interesting than the surface of an ordinary hill; more fantastic in form, and incomparably richer in colour’. Many of Ruskin’s drawings, such as *Gneiss Rock, Glenfinlas* (1853, figure seven), focused on a detailed depiction of a small segment of landscape. As Anthony Lacy Gully argues, ‘the smallest, seemingly most insignificant portion of a scene could reveal many truths to him.’

![Gneiss Rock, Glenfinlas, 1853](image)

**FIGURE SEVEN:** John Ruskin, *Study of Gneiss Rock, Glenfinlas*, 1853


42 Ibid.
Mantell did not pick just any individual object upon which to meditate. As he emphasised with a string of opening quotations, pebbles had long been freighted with cultural connotations. Indeed, their philosophical redolence had been evident since Isaac Newton's fabled encapsulation of genius' modesty, that he was 'only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary'. Henry Mayhew's 1854 biography, *The Story of the Peasant-Boy Philosopher*; Or, "A child gathering pebbles on the sea-shore", linked James Ferguson, the eighteenth-century 'shepherd-boy astronomer', with Newton and his pebbles as heroic exemplars for aspiring boys. Mantell's work also addressed the new generation, perhaps hoping to find amongst them another Newton; Mantell's own mythologised beginning in geology, similarly characterised by the margins of the water and the exceptional rock, had marked him as suitably philosophical, too.

By commencing his book with the discovery of a particularly significant stone, Hunt and Mantell might also have wished to connote William Paley's well-known *Natural Theology*, first published in 1802. Paley began his celebrated argument 'from design':

In crossing a heath, suppose I pitched my foot against a stone, and were asked how the stone came to be there; I might possibly answer, that, for any thing I knew to the contrary, it had lain there for ever; nor would it perhaps be very easy to show the absurdity of this answer. But suppose I had found a watch upon the ground... 

Compare this to the opening of Leigh Hunt's piece:

LOOKING about us during a walk to see what subject we could write upon in this our second number, that should be familiar to every body, and afford as striking a specimen as we could give, of the entertainment to be found in the commonest objects, our eyes lighted upon a stone. It was a common pebble, a flint...46

Later, in the third chapter of *Natural Theology*, Paley sought to demonstrate 'that the contrivances of nature surpass the contrivances of art, in the complexity, subtlety, and curiosity of the mechanism' by 'comparing a single thing with a single thing; an eye...with a telescope'.47 Mantell stressed the religious lesson to be learnt through his geological work as he stressed that there were 'sermons in stones': like the Shakespearian characters enamoured of their rural idyll in *As You Like It*, the reader of *Pebble* would become one who '[f]inds tongues in trees, books in the running brooks, / Sermons in stones and good in every thing'.48 A small, squat, and familiar-looking work, Mantell's book was in many ways a pebble itself, an accessible fragment of the imposing whole of geological enquiry; it was also found in 'the running brook'. In a preface to the eighth edition of the work, Mantell re-emphasised this theological purpose of the book, and linked it to the development of sensory skills: 'the more our knowledge is increased, and our powers of observation are enlarged, the more exalted will be our conception of His wondrous works'.49

After the identification of the chance pebble as something trailing allusive clouds of philosophy and theology, yet familiar, manageable and, for the moment, static, Mantell proceeded to give it his scientific attention:

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Upon examining this stone I discover that it is but the fragment of a much larger mass, and has evidently been transported from a distance, for its surface is smooth and rounded, the angles having been worn away by friction against other pebbles, produced by the agency of running water. I trace the stream to its source, half way up the hill, and find that it gushes out from a bed of gravel lying on a stratum of clay, which forms the eminence where I am standing, and is nearly 300 feet above the level of the British Channel. From this accumulation of water-worn materials the pebble must have been removed by the torrent, and carried down to the spot where it first attracted our notice; but we are still very far from having ascertained its origin. The bed of stones on the summit of this hill is clearly but a heap of transported gravel – an ancient sea-beach or shingle – formed of chalk-flints, that at some remote period were detached from their parent rock, and broken, rolled, and thrown together, by the action of the waves. ...

Though based on his own memories, Mantell’s narrator experienced the investigation again with the reader: his narrative was immediate, in the first person and present tense: ‘I trace’, ‘I am standing’; yet the reader was included: ‘our notice’, ‘we are still’. The search for the origins of the pebble was facilitated by the narrator’s precise physical journey, tracing the stream ‘to its source’ 300 feet above the British Channel. The narrator evoked the sensory experience of the reader, yet also pointed out the geological features of the surrounding landscape, and of the pebble itself, explaining, for example, how it was rounded by frictional forces. By affecting and directing the vision of the reader, an understanding of past phenomena could be reached, demonstrated at a later point in the text through the shared vocabulary of the verb ‘to see’: ‘Our flint then, we see, was once fluid, and being poured out (probably in thermal waters) into a deep ocean inhabited by myriads of beings, some of which are

50 Mantell (1836) Pebble, 6-8.
not known to exist, became consolidated and surrounded by the chalk, entangling the shells, corals, and other remains which are now embedded in it. 51

This immediate mode of describing the scene, and of narrating a physical journey through space and the text, was also employed in Mantell’s travel writings, which included, in 1846, A Day’s Ramble Around the Ancient Town of Lewes. A guide around his home town, the work commenced with a train journey, with Mantell pointing out scenes of interest on the way, and proceeded to provide a tour of the principal sights of the area. Mantell’s narration took the reader (unsurprisingly) to a site of geologist interest, and into the present moment, sharing his privileged sight:

The quarry before us, presents an instructive example of the displacements the strata have undergone. ... If we walk to the bank beyond the turnpike-gate, or to a quarry on the road-side, a few hundred yards farther, we shall find beds of grey chalk-marl underlying the white chalk; and this marl must therefore be a more ancient deposit.52

He was visiting, perhaps, the same ‘marly bank’ down which the original pebble, his fossilised ammonite, had rolled. Indeed, the location did have particular significance for the origins of Mantell’s own geological career. As he remembered, ‘[f]rom its proximity to the town, it was my principal field of research, when I began to investigate the organic remains of Sussex; and from it I obtained the first fossil fish discovered in the chalk of the South Downs.53 As well as providing beautiful views of the countryside, Mantell also took the opportunity to refer readers ‘wholly unacquainted with’ geology to Pebble, as ‘our time will not permit us to deliver on this spot a First Lesson’.54 In Wonders of Geology, Mantell had claimed that such a guided

51 Mantell (1846a) A Day’s Ramble Around the Historic Town of Lewes (London: Henry G. Bohn).
52 Ibid., 130.
53 Ibid., 128.
54 Ibid., 129.
tour, perceiving natural objects *in situ*, provided the best education, '[b]ut to those who cannot examine Nature in her secret recesses, or accompany an experienced teacher to the valleys or the mountain-tops, lectures illustrated by specimens and drawings afford, perhaps, the best substitute for the more efficient and interesting mode of instruction.' In his travel writings, then, Mantell provided a vicarious means of 'accompanying' his readers 'to the valleys or the mountain-tops', just as in his transcribed lectures, *Wonders of Geology*, and works such as *Pebble*, his authorial voice became a lecturer, and his idealised drawings substituted for actual specimens.

Mantell once again combined this role of the tour guide and scientific lecturer when he recommended *Geological Excursions around the Isle of Wight* in 1847. In its introductory section, Mantell reproduced the notes taken by his 'young friends, the Messrs. Gladstone', on a trip across the Solent the year before. Praising the Gladstones' success, he set a standard for the reader to emulate:

> These young gentlemen went unattended, and without any previous knowledge of the Isle of Wight, except what they had gathered from conversations with me, and returned home with an instructive series of the organic remains of the Island; thus affording a practical illustration of Mrs. Barbauld's admirable story of "Eyes and No Eyes."  

The tale to which Mantell referred, 'Eyes and no Eyes; or, The Art of Seeing', would have been well-known to contemporary readers as it formed the nineteenth evening's tale in John Aiken and Anna Laetitia Barbauld's best-selling miscellany *Evenings at Home, or the Juvenile Budget Opened*. First published in 1794, these volumes were reprinted, and highly influential, throughout the nineteenth century. For example, several Victorian writers of introductory scientific works, including Phoebe

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Lankester, Jane Loudon, and Charles Kingsley, remembered this story, and others, such as Charlotte M. Yonge, used the phrase ‘Eyes and No Eyes’ in their own writings.\textsuperscript{58} For Kingsley the tale had taught him that ‘mere reading of wise books will not make you wise men: you must use for yourselves the tools with which books are made wise; and that is—your eyes, and ears, and common sense … your senses and your brains.’\textsuperscript{59}

\textbf{FIGURE EIGHT:} In this illustration to ‘Eyes and No Eyes’ a boy once again finds something next to a brook.

Resonant, to most contemporary readers, of the biblical phrase ‘they have eyes but do not see’ (Psalms 115:5), ‘Eyes and No Eyes’ urged the importance of close observation of nature, arguing that though readers’ eyes might be open, they were blind to the wonders of the natural world.\textsuperscript{60} The text compared the experiences of

\begin{itemize}
\item \textsuperscript{58} Fyfe, editorial introduction to John Aiken and Anna Laetitia Barbauld (1809) \textit{Evenings at Home: Or, The Juvenile Budget Opened} (Bristol: Thoemmes Press, 2003 reprint), xxiii.
\item \textsuperscript{59} Charles Kingsley (1889) \textit{Madam How and Lady Why; Or, First Lessons in Earth Lore for Children} (London: Macmillan), vii-viii.
\end{itemize}
William (or ‘Eyes’) and Robert (‘No Eyes’) as they returned from a walk on the heath. Robert was bored by the experience, wishing for more sights of ‘men and horses’; William, however, had been fascinated by a series of natural objects (see figure eight) about which, with the help of his teacher, he proceeded to learn. For Robert, William’s journey would have been ‘so tedious, always stopping to look at this thing and that’; whereas for William it was a chance to fill his handkerchief with ‘curiosities’, spied by his observant eyes in the surrounding countryside. At the end of the story the wise teacher summed up its moral, linking the proper use of the senses to temperance, social good, and even the superiority of familiar British countryside over continental ‘Grand Tours’:

But so it is – one man walks through the world with his eyes open, and another with them shut; and upon this difference depends all the superiority of knowledge the one acquires above the other. … While many a vacant thoughtless youth is whirled throughout Europe without gaining a single idea worth crossing a street for, the observing eye and inquiring mind find matter of improvement and delight in every ramble in town or country. Do you then, William, continue to make use of your eyes; and you, Robert, learn that eyes were given you to use.61

It was this strategy that Mantell used to recruit readers into interacting with nature, urging them to seek not just sights, but knowledge and understanding. They would comprehend the detail and the richness of their surrounding landscape: the specific objects rather than the whole.

In another of Tennyson’s poems the Mantellian/‘Eyes and No Eyes’ combination of journeying through nature and looking at its small objects for inspiration can be found:

61 Aiken and Barbauld, *Evenings at Home*, ‘Eyes and No Eyes’, 111-112.
any man that walks the mead,
In bud or blade, or bloom, may find,
According as his humours lead,
A meaning suited to the mind.62

Alliteratively emphasised, was is the isolated and magnified parts of nature – buds, blades and blooms – that for Tennyson had meaning. Kingsley expressed similar sentiments in his Glincus (1855):

Seriously, if we wish rural walks to do our children any good, we must give them a love for rural sights, an object in every walk; we must teach them – and we can teach them – to find wonder in every insect,... the records of past worlds in every pebble...63

Enunciating the interaction between visual perception and mental understanding, such a travel writing ‘convention’ is concerned with the direction of sight towards and through imposing views. This direction occurred, for Mantell, Aiken and Barbauld, Kingsley and Tennyson, through the fixing of one’s attention on specific objects. Susan Stewart similarly stresses that the power of the narrative voice lies in ‘what is chosen to be related and attended to’: ‘detail in juxtaposition with pattern, the broad cliché illustrated by selected example.’64

An interesting parallel to this tale can be seen in Mantell’s response to that emblematic nineteenth-century spectacle, the 1851 Great Exhibition. One Wednesday in early autumn, he recorded in his journal details of an excursion to Hyde Park. Still struggling with the pain of spinal deformities that had resulted from an accident years

62 Tennyson, ‘The Day-Dream’.
64 Susan Stewart, On Longing, 67.
before, he negotiated the ‘tremendous’ and, to his mind, appalling, crowd of a hundred thousand vulgar visitors. He:

managed to squeeze into the back and least crowded compartments of minerals, etc., and with some difficulty ascended the gallery overlooking the transept, to look down on the sea of heads beneath. All was in motion, every one was moving on, whether they would or not: . . . to pretend that this is any proof that the splendid, marvellous, incredible exhibition of nature and art, is or can be appreciated by the ignorant mobs who frequent it, is truly absurd. I remained three hours, and returned thoroughly done up. The only new object I noticed was a splendid piece of opal, and a fine mass of quartz-rock with rich veins of gold, from California.

In a visit of three hours, Mantell noticed only two objects, both (unsurprisingly, perhaps) mineralogical specimens (see figure nine). Elsewhere, he had confessed himself ‘overwhelmed’ by the ‘multiplicity of attractive objects’ on display. Mantell’s distaste for the mass entertainment of these events was clear: more particularly, he did not care for the lack of attention given to objects: ‘every one was moving on’. Without the detailed contemplation of particular rocks, noticing qualities such as provenance, or ‘veins of gold’, knowledge of both nature and art would neither be acquired nor ‘appreciated’. In the conclusion to *The Ideas in Things*, Elaine Freedgood discusses Thomas Richards’ argument of the physical effects of the Exhibition, which produced a particularly inattentive vision: ‘visitors were virtually forced to acquire a limited attention span. Like it or not, they had to adjust themselves to the serial rhythms of the place. … [T]he Crystal Palace turned you into a dilettante’. As Freedgood comments, ‘things [had] to be understood and evaluated quickly and

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66 Richards, *Commodity Culture of Victorian Britain*, 35.
successively’; their meanings were not revealed through the ‘close inspection and consideration of their material form’ that Mantell advocated.67

FIGURE NINE: The mass of rock crystal on display in Hyde Park, as depicted in Prout Newcombe’s *Fireside Facts from the Great Exhibition*.

Mantell’s commitment to teaching through the guiding of sight with specific, small, actual objects was further revealed by his refusal to act as consultant to the display of ‘antediluvian monsters’ installed at the Crystal Palace in 1854. He had been the first palaeontologist approached to oversee the sculpting of these resurrected

creatures, which formed a geological display in the grounds of the glass palace re­erected in enlarged form at Sydenham (see figure ten). In great part relying on their size for their educational value, a dramatic impact involving, in the words of the models’ sculptor, Benjamin Waterhouse Hawkins, ‘direct teaching through the eye’, the monsters, their construction eventually overseen by Mantell’s bitter adversary, Richard Owen, were almost exactly the opposite of Mantell’s small pebble, cupped in the palm of his hand. Though an emphasis on sensory impressions and eyesight was shared, the geological spectacles sought to enthuse new audiences in different ways. Arguing against the purpose of the project, Mantell claimed that the aim of the exhibit ‘was merely to have models of extinct animals’; unlike his own displays at his Brighton museum, no actual fossil evidence would be presented to the audience. For Mantell the monsters, like the earlier Exhibition’s crowds, would be too big. He taught the reader to perceive the spectacular in the everyday: the hidden history of the world written in its stones and sand.

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Drops of water, or object lesson as instrument

In the 1842 sixth edition of *Pebble*, Mantell updated the work with a second section entitled 'More Thoughts on a Pebble': this proceeded to take the visual investigation of the pebble one step further, as it was viewed microscopically, represented in an additional coloured plate entitled 'Section of the Pebble'. Such an extension of the powers of seeing to the microscopical realms could be seen as the next level of improving one’s perception: for example, Edwin Lankester wrote in his *Half-Hours with the Microscope* (1859) that 'what eyes would be to the man who is born

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59 Dean (1998) *Gideon Algernon Mantell: A Bibliography with Supplementary Essays* (Delmar, New York: Scholars' Facsimiles & Reprints), 79. By the eighth edition of 1849 the work was substantially enlarged with supplementary notes, four coloured plates, twenty-seven woodcuts, and even a portrait of 'Dr Mantell'.
blind, the Microscope is to the man who has eyes'. The new section of the text followed the narrative conventions already established by Mantell: a strong authorial presence guided the reader through Mantell's physical activity to the inside of the pebble, as the following quotation from the eighth edition demonstrates: 'I will first strike off a small fragment, and examine it by the aid of a microscope. [woodcut] By a sharp blow of a hammer, a very thin and minute portion of the flint has been detached... I will substitute a higher power, and lo! they are seen to be distinct globular or spherical bodies beset with spines (fig.3).'

Perhaps inspired by the publishing success of Pebble, and also influenced by recent demonstrations he had witnessed of microscopical discoveries and new technologies, in 1846 Mantell wrote a companion work, Thoughts on Animalcules. Like Pebble, Animalcules was concerned with the power of scientific knowledge to bring the invisible into view, and continued the microscopic additions to the first work: Mantell taught audiences how to see the natural world, both looking at and understanding the vanished landscapes and creatures of the deep past, or the minute inhabitants who swarmed in a drop of water under a glass slide (see figure eleven). Kate Flint notes the 'slipperiness of the borderline between the visible and the invisible' for many Victorians. Like in Pebble, Mantell drew on the surrounding natural world of his local park to furnish an 'easy illustration' of the wonders revealed by the microscope: 'from some water containing aquatic plants, collected from a pond on Clapham Common, I select a small twig, to which are attached a few delicate flakes, apparently of slime or jelly; some minute fibres, standing erect here and there on the twig, are also dimly visible to the naked eye.' Each chapter of the book depicted and described a particular set of animalcules, with each plate represented as if the reader

71 Mantell, Pebble, 35-36.
73 Mantell (1846) Thoughts on Animalcules (London: John Murray), 9.
were looking down the microscope at a scene. Similarly, the illustrations to *Pebble* had been idealised representations of what one would see in the natural world, exaggerating their qualities had to be exaggerated (see figure six). Yet the writers' rhetoric stressed that *every* pebble or drop of water could yield such knowledge, if looked at in the appropriate way.

**Figure Eleven**: ‘Monads and Stentors’ glimpsed through Mantell’s microscope.

In 1851 Reeve and Benham, then publishers of Mantell’s *Pebble*, issued Agnes Catlow’s *Drops of Water* in a matching square ‘gift-book’ format: with these ‘drops’, Catlow intended to baptise the reader as a member of the scientific community. In
order to commence and facilitate their journey into the other microscopal worlds, she transformed her readers into 'spirits', and transported them into 'the new world' of a drop of water: 'And now I see your astonishment: your minds are bewildered with the variety of new beings and forms you behold...' As in Mantell's *Pebble*, Catlow guided the sight of her audience around this newly perceived world, which was at first sight 'astonishing' and 'bewildering'. Addressing herself to the drop-bound reader, she stressed the alien and yet familiar nature of an environment where animalcules were of comparable size to everyday objects, plants were ribbons, and vegetables came without roots, branches, or leaves:

Now let me direct your attention, first, to the vegetation you see around you; and remark how different it is from our own. Here is a plain covered with a plant which resembles numberless yards of green figured ribbon, in a state of entanglement. ... Here is another, much thicker, and of a different pattern. Now we come to one, which, instead of being round, like the others, is three-sided. Then look on this – have we anything to compare to it? You observe it is formed of two half-circular green masses, joined together on the straight side by a narrow band-like tube: you see it has neither root, branch, nor leaf, and yet it is a vegetable.

Catlow sought analogies she and her readers could understand ('have we anything to compare to it?'). This reassuring guiding voice also helped avoid frightened reactions: terming the sights 'vegetables' and 'ribbons' made them much less strange.

74 Agnes Catlow (1851) *Drops of Water: Their Marvellous and Beautiful Inhabitants Displayed by the Microscope* (London: Reeve and Benham), x-xi.
Catlow altered her reader to the artifice she had employed in constructing her ‘objects’, yet claimed this was ‘not unnatural’, and, indeed, facilitated the acquiring of scientific knowledge (see figure twelve:

I shall suppose four DROPS OF WATER to be under inspection at different times; and though it seldom happens that the objects I have depicted in each drop are found alone at any period, still I have thought this plan not an unnatural one, giving clearly some idea of classification, and preparing the way for more scientific works, when the subject is made a deeper study.76

She stressed the importance of identifying discrete objects on which to focus one’s attention, lest the reader be baffled by the overwhelming novel sensory impressions

76 Ibid., 54.
they experienced: 'When a drop of water, tolerably full of life, is placed under the microscope, all seems confusion to the inexperienced eye, the varied forms and rapid movements cause bewilderment in the mind of those who really wish to make a study of the names, habits, and peculiarities of these living atoms; but after some use of the glass this feeling subsides, and some one specimen attracts the attention'.

Thus, just like the commodities of manufacture or products of imperial industry, to a certain extent the objects in the natural historical works were in themselves artificial: as Catlow and Mantell constructed idealised representations of what could be seen under a microscope, or what fossils would be contained within a pebble, to isolate and exaggerate the features or creatures they discussed.

A lobster and a piece of chalk, or object lesson as lecture

In 1860 Thomas Huxley gave an object lesson on ‘A Lobster; or, the Study of Zoology’, to an audience of teachers. Expanding from a single lobster, what Huxley termed ‘some concrete living thing, some animal, the commoner the better’, he applied ‘common sense and common logic to the obvious facts it presents’, leading his audience through the parts of the lobster to wider considerations of scientific speciality, the different modes of scientific enquirer, and the purpose and means of a widespread scientific education.

Huxley exemplified the practice of scientific teaching he hoped audience-members would emulate in their own pedagogy. This practice would be based around the observation and investigation of discrete objects, teaching through direct sensory impressions, rather than vicarious reading material. Just like Mantell, Huxley sought to enthuse his audience, and his audience’s future audiences, by moving away from ‘dry definitions’ to an active investigation of an actual object. His stressing of the lowly, and widespread, origins of his chosen living thing – ‘the commoner the better’ – also resonated with his ideas about widening access to scientific education, and his lectures to working men.

77 Ibid., 182.
Through such lessons Huxley argued one could impart a deeper understanding of the natural world. He urged that the student be 'brought into immediate contact with facts... acquiring through his senses concrete images of those properties of things, which are, and always will be, but approximatively expressed in human language.' He followed this with a phenomenological manifesto for his audience to follow:

Therefore, the great business of the scientific teacher is, to imprint the fundamental, irrefragable facts of his science, not only by words upon the mind, but by sensible impressions upon the eye, and ear, and touch of the student, in so complete a matter, that every term used, or law enunciated, should afterwards call up vivid images of the particular structural, or other, facts which furnished the demonstration of the law, or the illustration of the term.

Such a desire directly to affect the senses of the student, the 'eye, and ear, and touch', resonates with Mantell's quest to open the eyes of his reader. Just as Mantell used the first-person narrative voice he would later employ in his travel writings to guide his reader to see the origin of the pebble and the geological history of the world, so too did Huxley's lecture attempt to imprint knowledge upon the reader through immediate sensory experience.

Narrated in the first person, present tense, e.g. 'I now take the fourth ring'; 'I find'; 'I turn', Huxley recapitulated the business of scientific investigation, guiding both the vision of his audience members and the vicarious sight of those who would read his lecture in its expanded version, as his 1879 textbook *The Crayfish: An*...
Huxley’s 1876 lecture tour in America on ‘Evolution’ has been characterised as ‘the combination of broad mental sweep and detail’: similar to the twin characters of ‘observant eye and enquiring mind’ of Mantell the embryonic geologist. As in Mantell’s perhaps poetic strategy of the ranging and specific vision, Huxley argued that the ‘great matter is, to make teaching real and practical, by fixing the attention of the student on particular facts; but at the same time it should be rendered broad and comprehensive, by constant reference to the generalisations of which all particular facts are illustrations.’

Huxley’s 1868 lecture ‘On a Piece of Chalk’ employed a similar strategy to ‘A Lobster’ – he used a common piece of chalk to start, and anchor, a tour of the history of the world and its inhabitants. Symbolising and substituting for both the working-class members of his audience and England itself, ‘that long line of white cliffs to which England knows her name of Albion’, Huxley’s lecture encompassed chalk in all its prosaic and stupendous manifestations: cliffs, carpenters’ writing implements, quicklime, Atlantic deep-sea mud, the ‘mutton-suggesting prettiness’ of England’s ‘inland chalk country’, the fur on the inside of a tea-kettle, and even an evolutionary chronicle of crocodiles.

With his conjuring of historic geological vistas from a humble piece of rock, Huxley revisited Mantell’s Thoughts on a Pebble. By emphasising the contemplative nature of his work, Mantell had invoked the theological tradition of meditations on particular, usually religious, objects; he used an epigraph from Charles Bonnet’s Contemplation de la Nature, translated into English and published in the 1760s. With the Evangelical revival of the early nineteenth century, the contemplative/meditational

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81 Ibid., 4.
genre had become newly popular, influencing such works as Mary Roberts’ *Conchologist’s Companion* (1825), as Donald Opitz has demonstrated. In this epistolary book, each chapter focussed on a particular object, which gave rise to a series of contemplations, following Bishop Joseph Hall’s definition of the meditative method as ‘nothing else but a bending of the mind upon some spiritual object, through divers formes of discourse, untill all our thoughts come to an issue … occasioned by outward occurrences offered to the mind … for the enkindling of our love to God’. Opitz identifies the *Companion’s* second letter on pearls, emblematised in the work’s frontispiece, as epitomising Roberts’ ‘meditative style’. As in Mantell’s book, Roberts’ central character, the Shell Collector, came across a ‘remarkably fine specimen’, in this case of *Mya margaritifera*, ‘on the banks of the Conway’ river. This shell was the inspiration for a series of musings on ‘the days of ancient times’, which it, in combination with the vista of the ancient castle, has evoked. Thus, specific objects could form an anchoring of an imaginative or poetic journey through time or space, as from seemingly prosaic remains visions of the past could be summoned.

‘On a Piece of Chalk’ began by undermining the very floor of the room Huxley and his audience occupied, as Huxley sunk a well ‘at our feet in the midst of the city of Norwich…’ Paradoxically, by this very process he sought to emphasise ‘how solid is the foundation upon which some of the most startling conclusions of physical science rest.’ Disturbing and displacing the bodies of audience-members, Huxley facilitated the journey through time and space on which he would take them, guided by the now-magical talisman of the piece of chalk. He was in control of them; as David Knight has noted, ‘he always held audiences in the palm of his hand’, like the

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87 Roberts, *Conchologist’s Companion*, 144.
piece of chalk itself. Huxley was keen to demonstrate the differing appearances of objects to different eyes:

Let us try another method of making the chalk tell us its own history. To the unassisted eye chalk looks simply like a very loose and open kind of stone. But it is possible to grind a slice of chalk down so thin that you can see through it—until it is thin enough, in fact, to be examined with any magnifying power that may be thought desirable. A thin slice of the fur of a kettle might be made in the same way. If it were examined microscopically, it would show itself to be a more or less distinctly laminated mineral substance and nothing more.

But the slice of chalk presents a totally different appearance when placed under the microscope. The general mass of it is made up of very minute granules; but, imbedded in this matrix, are innumerable bodies, some smaller and some larger, but, on a rough average, not more than a hundredth of an inch in diameter, having a well-defined shape and structure. A cubic inch of some specimens of chalk may contain hundreds of thousands of these bodies, compacted together with incalculable millions of the granules.

Much like Mantell’s subjection of the pebble to different points of view – the naked eye, the travel-guide, the microscope, Huxley demonstrated how looking at the piece of chalk, and physically investigating it, turned it into different objects: mud, a writing implement, ‘carbonate’, the fossil remains of minute organisms. From being a layer of ‘fine mud’ undersea, the chalk:

when brought to the surface, dries into a greyish white friable substance.
You can write with this on a blackboard, if you are so inclined; and, to the

eye, it is quite like very soft, greyish chalk. Examined chemically, it proves to be composed almost wholly of carbonate of lime; and if you make a section of it, … and view it with the microscope, it presents innumerable *Globigerina* embedded in a granular matrix.91

Moreover, Huxley self-consciously referred to the use of a piece of chalk when writing on a blackboard, referring both to educational practice, and to the chalk-drawn images with which he himself used to illustrate his ‘Profusely Illustrated’ lectures.92 One audience member recalled that the ‘diagrams in chalk, drawn from memory on the blackboard, often as a running accompaniment to a description, shared in the same admirable qualities as the spoken words. They were masterly performances’.93 Through talking about, and through using, a piece of chalk, Huxley could educate the sight of his listeners. Indeed, an enduring image of Huxley himself is an 1861 photograph of him next to a chalk sketch of a gorilla skull (see figure thirteen).94 Like the pebble and the drop of water, the piece of chalk, though mundane, was specifically chosen because of its existing connotations.

![Figure Thirteen: Thomas Huxley holding a piece of chalk.](image)

94 This image is reproduced, for example, on the paperback cover of Paul White’s study of Huxley: see White (2003) *Thomas Huxley: Making the “Man of Science”* (Cambridge: Cambridge University Press).
The narrative of visual education in the nineteenth century should not, however, be read as leading up to the very specific agenda of Huxley. Lesser-known texts such as Annie Carey’s *Autobiography of a Lump of Coal…* (1870) also sought to train readers in skills of observation, tolerance, and discrimination through the stories of common things, as objects from their quotidian surroundings came to life and narrated their stories to an audience of children. In the ‘Autobiography of a Grain of Salt’ Carey used the novelistic introductory paragraphs to stress objects’ altering appearances to different eyes. One grain of salt, isolated by being ‘drawn away from the rest’:

appeared to grow gradually larger and larger, till at last Lilly exclaimed, “Oh look! look, Edith! some fairy must have touched it and made it all at once so pretty and smooth, just like a small glass box, only I do not see where to open it.”

“No, little Lilly,” said a brisk, clear voice from out of the middle of the box, as the child called it, “no fairy has touched me; I am just what I was before, a grain of common salt; it is your eyes that are touched, and you see me more correctly…”

In the preface to the work Carey had stressed that ‘all true scientific training’ formed a certain ‘habit of mind’: ‘the power … of perceiving clearly, discriminating carefully, and investigating patiently’; in the text she demonstrated that by the second tale in the work Lilly’s eyes had been ‘touched’ by her education and she perceived individual natural objects in such as way as they are able to speak to her.

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95 Annie Carey [1870] *Autobiography of a Lump of Coal; A Grain of Salt; a Drop of Water; A Bit of Old Iron; A Piece of Flint* (London: Cassell, Petter, & Galpin).
96 Ibid., 26.
97 Ibid., iv.
Conclusion

By the end of *Thoughts on a Pebble*, Mantell had changed his reader’s view of the piece of flint with which he commenced. Lauding the ‘beneficial influence’ of geological investigations ‘upon the mind and character’, in later editions of the book Mantell claimed that:

In circumstances where the uninstructed and incurious eye can perceive neither novelty nor beauty, he who is imbued with a taste for natural science will everywhere discover an inexhaustible mine of pleasure and instruction, and new and stupendous proofs of the power and goodness of the Eternall! For every rock in the desert, every boulder on the plain, every pebble by the brook-side, every grain of sand on the sea-shore, is fraught with lessons of wisdom to the mind which is fitted to receive and comprehend their sublime import.98

Mantell contrasted the reader’s ‘new’ eyesight with that with which he or she had started. Having rendered his eyes ‘instructed’ and ‘curious’ by appropriately ‘fitting’ his mind, Mantell’s reader could go forth into the natural world to commence his own geological career. He had been taught the art of seeing pebbles.

The importance of eyesight, observation, and the visual imagination in nineteenth-century literature and culture has been well-documented. By allying such readings with specifically scientific texts, and the notion of the object lesson, this chapter has elucidated how a strategy of visual education was an important means by which writers and lecturers recruited new audiences to participate in the sciences. Through directing the sight of beginners to look differently at small everyday items, writers ensured that their senses would not be overwhelmed by new impressions, and developed and altered their perceptions on the world in general. Readers’ new

perception was characterised by melding a ranging and a specific vision, that has also been traced in travel writings; through this direction, use of the speculative or imaginative faculties was constrained by the detailed and attentive study of actual objects. A dual vision was entrained – the detailed description of the small and close, yet an interest in the meaningful distant.

These investigations of the small and commonplace were deemed appropriate for beginners, especially children. In part this was because their eyesight was perceived as suited to this way of seeing; for example, as Charles Dickens noted in chapter two of *David Copperfield*, entitled ‘I Observe’: ‘I believe the powers of observation in numbers of very young children to be quite wonderful for its closeness and accuracy’.

But this methodology also helped to anchor their thoughts, to prevent their sight being distracted, and to pare down the sciences to a single, apparently simple, material object. Such a focus provided a means of bounding the scope of these initial enquiries, and a familiar means through which to facilitate the communication of scientific facts, concepts, and theories. Despite the seemingly trivial origins of these objects, they were often very deliberately chosen as items already invested with a series of particular meanings, or used to tell certain kinds of stories; thus, Mantell was inspired by his own initiation into the sciences, but also invoked connotations of Newton playing with pebbles on the seashore, of Paley coming across a rock on a heath, and of a meditative religious tradition. Huxley sought to emphasise the commonplace and solid foundations on which scientific theories rested, and self-consciously referred to his own use of a piece of chalk to illustrate his lessons, and the significations of pieces of chalk in education, as well as using it as a symbol of England and her working men. Although the authors of these texts could have chosen big and strange objects to enthuse new audiences about the sciences, as did the creators of the antediluvian monsters at Sydenham, they believed mundane yet meaningful things provided a more appropriate entry-point. For Mantell

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and Tennyson, the search for the hidden stories and secrets of nature was facilitated by the taking of small, everyday objects such as isolated flowers and pebbles, miniaturising the natural phenomena in question. Moreover, by using such objects these writers and lecturers could impart scientific skills: they demonstrated that part of what it meant to be a naturalist or philosopher was to search out the small but significant details, even when dealing with large creatures, or distant planets. The scientific, just like the poetic, vision dealt not only with over-arching vistas and grand sweeps, but also with the commonplace.

The influential children’s tale ‘Eyes and No Eyes’ informed much of this rhetoric of nineteenth-century writers who revealed the wonders of the natural world to its hitherto unseeing inhabitants. Like the teacher in the tale, many emphasised the importance of the twin characteristics of ‘observing eye and inquiring mind’. As in ‘Eyes and No Eyes’, more than simply communicating scientific knowledge to their audiences, these writings and lectures encouraged an active engagement with and education in the natural sciences. Through their emphasis on the experiences undergone by those who investigated the natural world, these popularisers sought to engage new audiences with the sciences: to enthuse them with amazing tales but also to impart practical skills: close observation, attention to detail, clear perception, reasoning, concentration, discernment, and patient investigation. This notion of the ‘art of seeing’ would also become associated with figures such as Ruskin, and Gerard Curtis argues that it appropriately describes ‘the Victorian approach to observation and a Victorian passion for refining the skills of looking’.100

I have focused in this chapter on the specifically visual skills imparted by object lesson texts. Some of the texts achieved this by a first person, present tense narration, as the reader was taken step-by-step with the author or lecturer through the different parts of a lobster or pebble. The texts emphasised sensory impressions, even if

vicarious: pebbles, flowers, twigs, lobsters and pieces of chalk were held like books in authors’ hands, and closely scrutinised. As Huxley argued in his promotion of scientific over solely literary education, an interaction with things provided a more direct access to knowledge about nature, imparting understanding, rather than merely superficial ‘seeing’, and bookish ‘learning’. Though many of these texts were themselves having to teach through words, they chose language that emphasised or reproduced as closely as possible first-hand encounters with natural objects, the sensory experiences of investigating particular things oneself: grinding up a piece of chalk; holding a smooth pebble in one’s hand; the initially astounding sights glimpsed through a microscope; picking up a twig from a nearby pond. Through discussing these objects, therefore, these texts demonstrated how it was possible to render visible to a non-specialist audience seemingly invisible parts of nature, either because they lie beyond the limits of our perception, or because they usually lie beyond our notice. With ‘seeing’ eyes, they could be perceived.
2. FANCIFUL FACTS

‘Oh, now all common things become uncommon and enchanted to me.’

Charles Dickens, after reading the Arabian Nights

This thesis is full of common things. From pebble to primrose, candle to cup of tea, they were often used as entry-points to the sciences in the mid-nineteenth century. By teaching their magical properties, wondrous powers, and hidden histories, the objects of everyday life were rendered unfamiliar and strange, uncommon and enchanted. The language of myth and magic was often employed in introductory scientific writings to accomplish what for Charles Dickens had been achieved by reading The Arabian Nights: facts and forces could have the same effect as fantasies, could be written as fairy tales, and could be identified with fairies themselves. In this chapter I will explore the contested, competing and conflated issues of ‘fact’ and ‘fancy’ in the middle decades of the nineteenth century, particularly in relation to knowledge about specific common objects. I shall focus on a series of examples, including insects, a horse, drops of water, and a primrose, and on contemporary concerns with fairies and fairy tales, to argue that such narratives were not perceived as necessarily opposed to the object lesson philosophy; indeed, for many authors they could fruitfully be combined, as the didactic fantastic transported readers to a modern wonderland of science.

Attacking 'that cursed Barbauld crew' at the beginning of the century, Charles Lamb claimed that for fact-filled instructive works knowledge 'must come to the child in the shape of knowledge'. The question at the heart of this chapter is this generic one: how the rewriting of fairy tales as conveyors of scientific facts, the presentation of a lecture as a trip to fairyland, and the avoidance of taking either a fanciful or factual 'extreme', played with the 'shapes' in which knowledge was communicated to children. Rather than a fixed 'pigeon hole' view of categorising educational scientific writing, in which a text was fitted into the genre of either a textbook or a fairy tale, a didactic dialogue or travel guide, a more supple use of genre is more helpful, thought of as akin to family resemblances or centres of attraction, what Ralph O'Connor calls 'sets of broadly-agreed norms'. With this looser sense of genre, instructive and amusing — fact-filled and fanciful — works do not have to be rigidly separated, and Gradgrind can meet the fairies. Moreover, this has implications for my use of the object lesson as a genre: rather than simply a distinct pigeon hole it is, rather, a sense of resemblance, the combination of rhetorical tropes and ways of explaining and engaging with the material and natural world I outlined in my introduction.

This chapter addresses this generic question through the listening ears of middle class children, and with the stories that led children to marvel and wonder at their surrounding domestic and natural environments, full of enchanted common objects. I explore how educational writers enticed their young readers and listeners to learn about nature by employing imaginative narrative strategies, fables, and metaphors, and by dressing introductory explanations in the garb of fairy-land. The 'magic' of these tales, such as John Cargill Brough's Fairy-Tales of Science (1859) and Arabella Buckley's The Fairy-Land of Science (1879), I contend, resided in the

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103 For the limitations of a ‘pigeon hole’ view of genre, see O'Connor, Earth on Show, 228-230; ‘broadly-agreed norms’ on 229.
juxtaposition of everyday humdrum reality and fantastical forces, creatures, and stories, and in the play with what was familiar and unfamiliar to their childish audience. The fairy-tale actions of physical forces and biological processes were not the inhabitants of a far-off realm, but were unveiled in one's everyday surroundings, as Buckley affirmed in her introduction: 'the fire in the grate, the lamp by the bedside, the water in the tumbler, the fly on the ceiling above, the flower in the vase on the table, anything, everything, has its history, and can reveal to us nature's fairies.'

Such specificity of directed vision, and the precise location of the reader in a room with a bed, a fire, a tumbler, vase, and table, was continued in the chapters of the book, which often asked readers actually to hold such small objects as a segment of orange, or an almond, to grasp both mentally and physically the concepts about which they were being told.

Providing a new perspective on the 'fact and fancy' educational debate of the period, the object lesson tradition — presented by Dickens in *Hard Times* (1854) as potentially the worst form of dryly factual instruction — can in these ways be reconceived as an often lively way of writing, which sought to engage both the imaginations and real-world experiences of beginners. Countering Dickens’ admittedly satirical presentation of the disastrous results of wholly separating fact from fancy, this chapter shows that many of these writers used the language of wonder to elevate what could be dismissed as the boring artefacts of quotidian life to the status of marvels and prodigies: it was by combining the physically-existing and fact-filled object, such as a lump of coal, with a fanciful tale or bizarre personality that this was achieved. I demonstrate how through this more narrative object lesson teaching the everyday became wondrous: insect fairies could be found fluttering their wings at the bottom of the garden, and the seeds of every flower contained a sleeping beauty waiting to be awoken by a sunlit kiss. The very raindrops that fell from the sky were competing suitors for the hand of an exotic Princess, and plum puddings and

104 Arabella Buckley (1879) *The Fairy-Laud of Science* (Bristol: Thoemmes Press, 2003), 13,
cricket bats grew on trees. By enchanting objects, facts were made fanciful, and children were welcomed into the fairy-land of Victorian science.

Enchanted horses and drops of water, or object lessons as fact and fancy

In autumn 1837, the statistical section, C, of a scientific society opened its session with a curious presentation. The speaker reported that the group had latterly devoted its energies to the topic of ‘infant education among the middle classes of London’, in which a survey had revealed the following books in circulation:

<table>
<thead>
<tr>
<th>Title</th>
<th>Circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jack the Giant-killer</td>
<td>7,943</td>
</tr>
<tr>
<td>Ditto and Beanstalk</td>
<td>8,621</td>
</tr>
<tr>
<td>Ditto and Eleven Brothers</td>
<td>2,845</td>
</tr>
<tr>
<td>Ditto and Jill</td>
<td>1,998</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21,407</strong></td>
</tr>
</tbody>
</table>

This preponderance of fantastical works had had dire consequences, the report continued, resulting in ‘lamentable’ ‘ignorance’. As the professor detailed: ‘One child, on being asked whether he would rather be Saint George of England or a respectable tallow-chandler, instantly replied, “Taint George of Ingling.” Another, a little boy of eight years old, was found to be firmly impressed with a belief in the existence of dragons, and openly stated that it was his intention when he grew up, to rush forth sword in hand for the deliverance of captive princesses, and the promiscuous slaughter of giants. … They had not the slightest conception of the commonest principles of mathematics, and considered Sinbad the Sailor the most enterprising voyager that the world had ever produced.’\(^{106}\) The professor regretfully concluded that this was the result of teaching with faulty, untrue stories. A lively discussion ensued – for example, could Jack and Jill be exempted from criticism, on the grounds

\(^{106}\) Ibid.
that it encouraged industry, in the form of walking up hills to fetch pails of water? — in which '[s]everal other Members … dwelt upon the immense and urgent necessity of storing the minds of children with nothing but facts and figures; which process the President very forcibly remarked, had made them (the section) the men they were.'

Of course, this report was not of an actual meeting of an organisation such as the British Association for the Advancement of Science (founded 1831), rather of its satirical counterpart the Mudfog Association for the Advancement of Everything, a lampoon from the pen of Dickens. Its delegates more concerned with competing for bottles of mulled port, combating seasickness, gossiping about fellow professors Snore, Doze, Wheezy and Slug, and conducting secretive experiments on mistakenly purloined puppies, the society was a thinly-veiled caricature of the meetings of these societies. Yet the conclusion of this section report — that minds should be stored with 'nothing but facts and figures' — betrays a criticism often levelled at scientific education at this time. Most famously, Dickens himself began his 1854 *Hard Times* with an attack on extreme utilitarian object lesson teaching, in which Thomas Gradgrind urged that ‘facts alone are wanted in life’:

> "Now, what I want is, Facts. Teach these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts: nothing else will ever be of any service to them. … Stick to Facts, Sir!"

In a parody of teaching through singular classes of objects, the children were asked to detail what they knew about one particular animal: in this case, facts about the horse. It was, a boy named Bitzer claimed, a:

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“Quadruped. Graminivorous. Forty teeth, namely, twenty-four grinders, four eye-teeth, and twelve incisive. Sheds coat in the spring; in marshy countries, sheds hoofs, too. Hoofs hard, but requiring to be shod with iron. Age known by marks in mouth.” Thus (and much more) Bitzer.\textsuperscript{109} 

This presentation of an information-laden horse satirised the stereotype of the overtly factual object lesson: a list of the qualities, uses, properties and origins of a common thing, to be elaborated with the aid of a teacher, and memorized by the pupil. The Mayos’ \textit{Lessons on Objects} (1831), which detailed the sensory teaching they had introduced in their school at Cheam, was indeed overtly list-like (see figure fourteen). Works such as Richard Phillips’ \textit{A Million of Facts} (1832) were repositories of more advanced knowledge, but based around the same list-like format, and grouped by particular object or subject of interest. The astounding onslaught of information the reader met upon opening this book (as Phillips claimed in a preface, it should really have been termed a ‘million and a half’ of facts) covered topics including modern history and many sciences. Turning to the section on the animal kingdom, readers would encounter facts including the following:

A horse has 24 grinders, 4 tushes, or single teeth, and 12 front teeth. At five the colts’ teeth are shed, and the tushes appear; at six they are grown, and at eight the black marks disappear, and the horse is called aged.\textsuperscript{110} 

As well as dental details, readers also learnt the difference between a mule and a hinny, that Arab horses ‘sleep standing and rocking’, and a series of comparisons between the speeds and endurance of various named horses: how far, how fast, and carrying what.

\textsuperscript{109} \textit{Ibid.}, 4.  
\textsuperscript{110} Richard Phillips, (1832) \textit{A Million of Facts and Correct Data in the Entire Circle of the Sciences} (London: Darton and Clark), 123.
LESSON XIII.
A GRAIN OF COFFEE.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>The surfaces.</td>
<td>If roasted it is brown.</td>
</tr>
<tr>
<td>curved surfaces.</td>
<td>hard.</td>
</tr>
<tr>
<td>flat surface.</td>
<td>crisp.</td>
</tr>
<tr>
<td>groove.</td>
<td>sapid.</td>
</tr>
<tr>
<td>edge.</td>
<td>aromatic.</td>
</tr>
<tr>
<td></td>
<td>stimulating.</td>
</tr>
<tr>
<td></td>
<td>agreeable to the taste.</td>
</tr>
<tr>
<td></td>
<td>pulverable,</td>
</tr>
<tr>
<td></td>
<td>or may be turned into</td>
</tr>
<tr>
<td></td>
<td>powder.</td>
</tr>
<tr>
<td></td>
<td>solid.</td>
</tr>
<tr>
<td>If unroasted,</td>
<td>dingy yellow.</td>
</tr>
<tr>
<td></td>
<td>inodorous,</td>
</tr>
<tr>
<td></td>
<td>without smell.</td>
</tr>
<tr>
<td></td>
<td>disagreeable to the taste</td>
</tr>
</tbody>
</table>

Use.—To make a beverage, or drink.

LESSON XIV.
A PAIR OF SCISSARS.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>The limbs.</td>
<td>It is steel.</td>
</tr>
<tr>
<td>bows.</td>
<td>bright.</td>
</tr>
<tr>
<td>blades.</td>
<td>reflective.</td>
</tr>
</tbody>
</table>

FIGURE FOURTEEN: A typical page of object lessons, here on 'a grain of coffee' and 'a pair of scissors', which presented a list of attributes to be learned.

Beginning with the lengthy and pedantically accurate zoological language of 'quadruped' and 'graminivorous', Bitzer's catalogue of horsiness was designed to resemble these lists of numbers, names, and authoritative declarations, and indeed bears a striking similarity to the passage from Phillips' book (including the references to 'grinding'). However, it can be argued that by representing what one would perhaps find in an informational book Dickens did not give a fair sense what an object lesson itself would have been like. It would, rather, have been an engaging conversation, or story, told by the teacher to his pupils, woven with and around an object in his or her hand and the facts contained in the book, as reproduced in the Mayos' Lessons on Objects as idealised classroom conversations. Harry Hieover's Things
worth knowing about horses (1859), perhaps the place to look for equine information, was itself far from a dry catalogue, encompassing subjects including driving out in a carriage, stabling, and treatments for 'ailing horses', as well as peculiarities of shape, habits, and form (from curby-hocked to ewe-necked) in the creatures. Moreover, the book was informal and conversational in tone, as Hieover introduced illustrative characters where appropriate, or supposedly responded to readers’ letters.

Even Phillips’ Million of Facts was not simply intended as a storehouse of information, but as a stimulus and aid to conversation ‘in the closet and the active world’; with quotations from Burke and Bacon on the title page referencing the usefulness of facts in rendering a companion ‘agreeable’, or when writing, speaking, or meditating with ‘understanding’. Moreover, read in the light of his radical politics, Phillips’ work became much more that a dry list of information: his millions of facts were addressed to millions of men, published cheaply to reach and energise a wide audience; as Phillips claimed in his preface, providing a thousand facts per penny. The sheer quantity of information contained in this and similar texts was intended to wonder and amaze: books such as The Arcana of Science and Art; or, One Thousand Popular Inventions and Improvements (1828); and Dionysius Lardner’s One Thousand and Ten Things Worth Knowing (1856) themselves echoed in their titles the Thousand and One Nights of Arabian story-telling.

A conversion of the objects and stories of childhood into instructive pastimes underpinned Dickens’ later criticism of Mr Barlow, Thomas Day’s tutor character from the influential Sandford and Merton (first published 1783), who saw in every event an educational opportunity: he ‘didactically improved all sorts of occasions, from the

112 Phillips, Million of Facts, title page.
consumption of a plate of cherries to the contemplation of a starlight night’, or even the *Thousand and One Nights* themselves:

What right had [Mr. Barlow] to bore his way into my Arabian Nights? Yet he did. He was always hinting doubts of the veracity of Sindbad the Sailor. If he could have got hold of the Wonderful Lamp, I knew he would have trimmed it and lighted it, and delivered a lecture over it on the qualities of sperm-oil, with a glance at the whale fisheries. He would so soon have found out – on mechanical principles – the peg in the neck of the Enchanted Horse, and would have turned it the right way in so workmanlike a manner, that the horse could never have got any height into the air, and the story couldn’t have been.114

Dickens feared Mr Barlow would extend this programme of didactic improvement even to fairy-tales, and by converting their stories into factual exemplars would destroy their magic. Such writings have been read as emblematising Dicken’s antipathy towards factual writings and the educational cramming of young children. However, he satirised object facts by giving one extreme version of what a lesson could have been like: it is the possible quantity of unleavened information that attracted Dickens’ ire, and the barb of his wit, as revealed in the eloquent ‘(and much more)’ which followed Bitzer’s response. As the narrator commented after listing the array of knowledge boasted of by M’Choakumchild: ‘Ah, rather overdone, M’Choakumchild. If he had only learnt a little less, how infinitely better he might have taught much more!’115 Indeed, one of the titles Dickens had considered for the book was *Extremes Meet*.116 A criticism of taking a scientific interest or pursuit to an extreme, particularly on the part of women, had been expressed twenty years earlier

in the form of comic composite caricatures, in which the bodies of those of 'scientific habits' became transformed into their objects of inquiry, from books to bugs.\(^{117}\) Dickens' descriptions of some of his characters invoked the idea of becoming your interest: Gradgrind had gone to such a factual extreme that his very body turned into a dry, square storehouse of information:

> The emphasis was helped by the speaker's square wall of a forehead, which had his eyebrows for its base, while his eyes found commodious cellars in two dark caves, overshadowed by the wall. ... The emphasis was helped by the speaker's hair, which bristled on the skirts of his bald head, a plantation of firs to keep the wind from its shining surface, all covered with knobs, like the crust of a plum pie, as if the head had scarcely warehouse-room for the hard facts stored inside. The speaker's obstinate carriage, square coat, square legs, square shoulders, ... all helped the emphasis.\(^{118}\)

Later on, this was paralleled in a description of Gradgrind's house: 'A great square house, with a heavy portico darkening the principal windows, as its master's heavy brows overshadowed his eyes.'\(^{119}\) In 1833 the Comic Offering had used just this analogy to humorous effect (see figure fifteen):


\(^{118}\) Dickens, *Hard Times*, 1.

FIGURE FIFTEEN: This caricature of Hamlet of Denmark punned on the dual meaning of 'Hamlet' as a small town and Shakespearian hero; like Dickens' book, it identified a person with a square building, windows with eyes, etc.

One of Dickens' best-known articles, and for some commentators evidence for Dickens' preference for 'more fancy ... less fact', 'Frauds on the Fairies' appeared in Household Words in 1853.120 A direct response to George Cruikshank's re-writing of Cinderella as a temperance tract, in this Dickens argued for a separation of didacticism from fantasy. However, another article from the same periodical, Henry Morley's 'The Water Drops: a Fairy Tale' had been precisely this meld of didactic fact and fairy fancy: it discussed problems of polluted water, particularly in poor areas of London, in the guise of the adventures of the Cloud Country People, each particular drop of water becoming a distinct fairy.121 The framing narrative featured a familiar trope: a contest between the suitors Nebulus, Nubis, and Nephelo, subjects of the Prince of

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120 Dickens to Angela Burdett Coutts, quoted in Stone, Dickens and the Invisible World, 16; [Dickens] (1853) 'Frauds on the Fairies', Household Words VIII (October 1st), 97-100.
Nimbus, for the hand of Princess Cirrha, daughter of King Cumulus. For those who already had some meteorological knowledge, the names of these characters (and the supposedly offensive vernacular ‘mackerel’, ‘ball of cotton’ and ‘cat’s tail’ alternatives) would act as puns on cloud classification; but for those without they would be more like the exotic words found in Dickens’ favoured *Arabian Nights*.122

The story began by contrasting scientific and fairyland descriptions of a place not in the east, but ‘far in the west’. Its appearance was usually ‘accounted for’ by principles of Meteorology’, but ‘it is well known in many nurseries, that the bright land we speak of, is a world inhabited by fairies.’123 The purely scientific explanation for the colours of the sunset was deemed not sufficient or suitable for the nursery, where it was ‘well known’ that fairies were the better explanation for meteorological phenomena. From fairyland, the tale descended along with the various suitors, to the streets and sewers and kettles of London, following the path along which each drop flowed. The truth of the story was affirmed by bracketed references to the sources of the information spoken by the travelling fairy-drops: intruding on the narrative they pierced the fairy tale veneer and reminded readers they were learning about actual events:

“How many people have to drink out of this butt?” asked Nubis. “Really I cannot tell you,” said a neighbor Drop. “Once I was in a butt in Bethnal Green, twenty-one inches across, and a foot deep, which was to supply forty-eight families. (Report of Dr. Gavin).124

The conviction that through fanciful fable concrete and true realities could be imparted, from the corpses of cats floating in fetid metropolitan waters to the

122 [Morley], ‘Water-Drops’, 482-485.
123 Ibid., 482.
124 Ibid. 484.
types of discussions about water and sanitary reform ongoing in well-to-do houses, was central to the success of this story.

As we have seen in chapter one, literary object lessons on drops of water were very popular throughout the nineteenth century, included in Buckley's *Fairy-Land of Science*, Annie Carey's *Autobiographies of a Lamp of Coal* (1870), and forming the focus for Agnes Catlow’s *Drops of Water* (1851). Hans Christian Andersen's fairy tale entitled 'The Drop of Water' (1848) also compared the microscopic view of the teeming and violent world of a water-drop to the bustle of a great city such as Paris.\(^{125}\) Rather than 'Water-Drops’ use of components of clouds, in a poem prefaced to Catlow’s book the tiny animalcules glimpsed within the droplet were converted into gems, flowers, and wondrous beings:

```
creatures beautiful and bright,  
Disporting 'midst its liquid light. 
Some, like to rare and clustering gems;  
Like lilies some, with silver stems,  
Waving in graceful motion, slow,  
(Like measured cadence) to and fro;  
Others like fairy bells appear,  
Ringing their chimes in fancy's ear;  
And there are serpent-forms, that glide  
'Midst tiny banks of moss…
```

Illuminating the hidden inhabitants of a drop of water became something of a commonplace itself in the mid-century, linked to contemporary campaigns of sanitation and water reform, advocated by such prominent figures as Dickens, Henry

Mayhew and Michael Faraday. Satirical publications such as *Punch* exploited their audience's familiarity with microscopical images to portray 'The Wonders of a London Water Drop': rather than the positive associations of glimpsing this hitherto unnoticed world, however, *Punch* wryly inverted the contemporary representations of lurking organisms who caused disease: instead of pathogenic animalcules they became chimerical pathogenic aldermen, the real cause of the sanitary problems (see figure sixteen). Horrified, not edifying, reactions to the opening of eyes was depicted in several nineteenth-century images enlarging the drop of water: being able to see the true face of nature was not necessarily a good thing. As Kate Flint puts it, 'it is impossible to ignore the fact that for many Victorians, that which was not visible did not so much inspire as frighten.' Writers have noted that much of the significance of mundane domestic objects and products such as gas and dust for Victorians, was their 'capacity to suggest the vastness of imaginative conjecture that may lie behind and beyond the most apparently mundane: the invisible behind the visible.' Indeed, microscopic visions of abundant life and supernatural creatures, such as that in 'Monster soup' (see figure seventeen), have been read as having a profound influence on the format, scale, and subject-matter of mid-nineteenth-century fairy paintings.

126 Curtis, *Visual Words*, 70.
127 For the use of these microscopical images magnifying the polluted contents of London water in water filter advertisements, see *Ibid.*, 70.
128 Ibid., *Visual Imagination*, 34.
129 Ibid., 63.
FIGURE SIXTEEN: 'Monster soup commonly called Thames water, being a correct representation of that precious stuff doled out to us!!!'

FIGURE SEVENTEEN: 'The Wonders of a London Water Drop'.

Whilst the main body of Catlow’s text contained a description of various microscopic forms, in its introductory section she continued this language of ‘wizard
Science', 'by some magic spell' revealed, identifying both her readers and science with spirits, and transporting them through a magic portal:

My readers must fancy themselves spirits, capable of living in a medium different from our atmosphere, and so pass with me through a wonderful brazen tunnel, with crystal doors at the entrance. These doors are bright, circular, and thick, of very peculiar construction, having taken much time and labour to bring to perfection. A spirit named Science opens them to all who seek her, and feel induced to enter her domains.\textsuperscript{131}

The next section goes on to show another fanciful strategy for engaging readers with scientific facts: that the visible fairies at the bottom of the garden could be used to teach scientific and moral lessons.

**Insects, or object lessons from fairies**

The frontispiece to A.L.O.E.'s *Fairy Know-a-bit* (1866) introduced both Philibert Philimore and Sidney Pierce, its child heroes, and the actual reader of the book to its eponymous main character, a book-dwelling fairy lecturer (see figure eighteen):

a tiny figure, not six inches high, dressed like a student, in cap and gown, with wee dots of spectacles on his nose, and a grand beard, nearly an inch in length, which reached his little girdle! The figure had as a pen behind his ear a quill from a humming-bird's wing, and at his girdle hung an ink-bottle about the size of an elder-berry. His eyes, not quite so large as those of a robin, but a good deal brighter and merrier, twinkled

\textsuperscript{131} Catlow, *Drops of Water*, x-xi.
through the tiny spectacles, which looked like diamond dew-drops set in a single thread of gold! 132

Figure Eighteen: Sidney’s Introduction to the Fairy'. This frontispiece brought the children and the fairy together in a richly-furnished library, where Fairy Know-a-bit lived amongst the books.

A.L.O.E., or Charlotte Maria Tucker, a prolific author of children’s books on subjects from mining and rats to needles and India, had converted the didactic voice of her text into a fairy lecturer suitable for Victoria’s Britain. As he argued:

Times have changed — and so have I. A railway now runs right through the valley which was our favourite haunt — there are engine-lights instead of the glow-worm’s, and the scream of the whistle drowns the song of the bird! Education is now all the fashion, and fairies, like bigger people, are sent to learn lessons at school.133

The fairies had been chased away from their traditional home by the steam engine, and recast as model citizens for contemporary society. As another separate group from ‘bigger people’ — in this case, adults — children were encouraged to identify with the fairies, as they were educated through the text. The main body of the text repeated the object lessons Fairy Know-a-bit gave to Philibert (and, later, Sidney), as he used his magic wand to uncover the origins of household commodities, starting with foodstuffs:

Know-a-bit touched the warm pheasant with his wand, and in an instant the dish was empty! The fairy turned and pointed with his wand towards the window; Philibert, looking through it, saw a large handsome bird with a long tail running across the lawn.134

The fairy lecturer explained that this visualising, enlivening process was used as an educational strategy since ‘what we see with our eyes is apt to make more impression on the mind than what we hear with our ears’.135 The many illustrations in the work (see figure nineteen) reproduced the images Know-a-bit conjured in the story with the aid of a magic mirror:

133 Ibid., 13
134 Ibid., 14
135 Ibid.
Kn­ow-a-bit gently touched with his wand the bottle of oil: the bottle was instantly empty. To the no small surprise of Philibert, a tree, not very large in size, appeared to be reflected in the mirror, though nothing like it was in the room. Its narrow leaves, about two inches and a half long, were of a bright green on the upper side, a duller whitish green on the lower. Small white flowers were on the olive—such was the name of the tree. These flowers, while Philibert looked on in wonder, changed into fruit of a yellowish-green, which darkened as they ripened before his eyes, being about the size and shape of damsons.

“It is from these olives,” observed the fairy, “that oil is obtained by pressing.”

FIGURE NINETEEN: Fairy Know-a-bit’s object lesson on an olive, reproducing a Mediterranean vision conjured by the fairy in a mirror.

In the book’s sequel, Fairy Frisket (1874), Know-a-bit’s sister named the book, and visited her brother at Fairydell Hall, where the books were set. Together, the two fairies introduced the children in the story to the worlds and types of insects in the surrounding garden and woodland (see figure twenty). This time, the magical power of the garden fairy was encapsulated not in a wand and mirror, but in a substance that would enable the boys to be transformed into insects, and thereby enter an ant hill, and go to a butterfly’s ball (their human forms safely sleeping back in the bedroom):
"Through the charm of that fancy pomatum, the boys whom you love to teach may buzz through a hive as bees, or roam through underground passages as ants, or bury themselves like beetles, or fly through the air as gnats." When A.L.O.E.'s fairies moved, they were compared to insects, a grasshopper in the case of Know-a-bit, and a butterfly in the case of Frisket: 'on catching sight of his long-lost sister, he made a bound like a cricket towards her, while she flew like a butterfly towards him'; so too were the children encouraged to learn more about insects by inhabiting their bodies, and mimicking their sensory impressions. As Nicola Bown has pointed out, fairies were often linked to insects through a metonymic extension of their wings: through associations of the small size of their bodies, and quick, darting movements, fairies were converted into common creatures of wood and garden. Supernatural beings could be part of same classificatory hierarchy as natural creatures, and the nineteenth century saw a rise in popularity of euhemeristic explanations for fairy lore and peoples, the idea that such tales were based on real-world pygmies or disappeared races, or actual occurrences now forgotten.

137 A.L.O.E. Fairy Frisket, 12.
FIGURE TWENTY: The two fairies converse amongst the paraphernalia of the library: whilst Fairy Know-a-bit, on the right, resembled a miniature lecturer in a cap and gown, his sister, Fairy Frisket, looked more obviously like a stereotypical representation of a fairy, with her butterfly wings.

A Primrose, or object lesson as fairy tale

‘How are you to enter the fairy-land of science?’ In 1879 Arabella Buckley opened her children’s book with this appeal to her audience. In so doing, she revealed questions of paramount importance for Victorian writers eager to recruit children to an active study of nature: what was the most appropriate way of beginning to learn about scientific subjects? Indeed, what were the most appropriate beginners’ subjects themselves? Buckley’s own answer was definitive:

There is but one way. Like the knight or peasant in the fairy tales, you must open your eyes. There is no lack of objects, everything around you will tell some history if touched with the fairy wand of imagination…¹⁴⁰

For Buckley, children could learn about science through stories, told with and about the plenitude of illustrative objects at hand in the Victorian home and garden: a piece of coal, a drop of water, a sunbeam, a bee, or a primrose. It was a primrose on which John Ruskin chose to focus his attention when discussing the pathetic fallacy in Modern Painters (1856):

So, then, we have three ranks: the man who perceives rightly, because he does not feel, and to whom the primrose is very accurately the primrose,

because he does not love it. Then, secondly, the man who perceives wrongly, because he feels, and to whom the primrose is anything else than a primrose: a star, or a sun, or a fairy’s shield, or a forsaken maiden. And then, lastly, there is the man who perceives rightly in spite of his feelings, and to whom the primrose is for ever nothing else than itself — a little flower, apprehended in the plain and leafy fact of it, whatever and how many soever the associations and passions may be, that crowd around it.¹⁴¹

In this passage Ruskin addressed the central problem of this chapter, the central concern of Dickens’ argument, and indeed of the object lesson philosophy itself. The texts I study in this dissertation relied upon the ‘associations and passions’ that ‘crowded around’ these apparently simple objects. They aimed to inculcate a way of viewing the world that would result in ‘right’ and ‘accurate’ perceptions; but this did not entail a dissociation from nature, a lack of love or feeling. On the contrary, an emotive engagement with one’s pursuit of natural knowledge was crucial, and appeals for the appropriateness of wider inclusion in and understanding of scientific subjects often relied upon such personal benefits. The object lesson employed and traded in associations and passions just as in facts: writers walked a line between the extremes of ‘plain and leafy fact’ and ‘fairy’s shield’ as understandings of the primrose.

The seventh of ten lectures delivered in the spring of 1878 to an audience of children in St. John’s Wood, London, and compiled in book-form as The Fairy-Land of Science the following year, ‘The Life of a Primrose’ asked Buckley’s audience to ‘fix’ their ‘attention on one little plant, and [inquire] into its history’, to learn about growth

¹⁴¹ Ruskin, Modern Painters III (1856), quoted in Bown, Fairies, 122.
processes in plants.\textsuperscript{142} It certainly began by following its author’s mandate to exploit the plenitude of illustrative objects at hand in the Victorian home:

You were asked last week to bring with you today a primrose-flower, or a whole plant if possible, in order the better to follow out with me the “Life of a Primrose.” (*To enjoy this lecture, the child ought to have, if possible, a primrose-flower, an almond soaked for a few minutes in hot water, and a piece of orange.\textsuperscript{143}"

Buckley used objects that could easily be procured, observed and analysed by the audience at first-hand. The familiar objects would stand for a greater class of natural things, and for phenomena difficult to perceive by the unaided senses, they were mediated by the substitution of another common object, as she guided her listeners between the particular case of the primrose, active investigations with familiar objects, and general scientific principles:

I have here a packet of primrose-seeds, but they are so small that we cannot examine them; so I have also had given to each one of you an almond kernel, which is the seed of the almond tree, and which has been soaked, so that it splits in half easily. From this we can learn about seeds in general, and then apply it to the primrose.\textsuperscript{144}

Knowledge of ‘seeds in general’ would be learnt, applied to the primrose, and then converted back into general principles. The active investigation of the object in hand was conducted in tandem with references to the wider fairy-land of science into which Buckley sought to transport her readers, in a twin assault of educational strategies, most explicitly in the following passage, in which a dissection of the

\textsuperscript{142} Buckley, \textit{Fairy-Land of Science}, 152.
\textsuperscript{143} Ibid., 151.
\textsuperscript{144} Ibid., 152.
almond, representing the primrose, was followed by a fairytale analogy to the sleeping beauty of the dormant seed:

If you peel the two skins off your almond-seed (the thick, brown, outside skin, and the thin, transparent one under it), the two halves of the almond will slip apart quite easily. One of these halves will have a small dent at the pointed end, while in the other half you will see a little lump, which fitted into the dent when the two halves were joined. This little lump (a b, Fig. 37) is a young plant ...

When a seed falls into the ground, so long as the earth is cold and dry, it lies like a person in a trance, as if it were dead; but as soon as the warm, damp spring comes, and the busy little sun-waves pierce down into the earth, they wake up the plantlet, and made it bestir itself.145

For the pupils, the plantlet thus became both a physical 'little lump' with which they were themselves in contact and also 'a person in a trance', a character often encountered in fairy tales, in the conflation of science and myth that guided Buckley's text.

Throughout 'The Life of a Primrose', Buckley used active investigations of a range of plants to illustrate the biological processes at work in her flower. Some of these were hypothetical experiments, in which she exhorted her reader to listen to what nature could say when placed in an artificial situation:

If you will take some fresh laurel-leaves and put them into a tumbler of water turned upside down in a saucer of water, and set the tumbler in the sunshine, you will soon see little bright bubbles rising up and clinging to the glass. These are bubbles of oxygen gas, and they tell you that they have

145 Ibid., 153.
been set free by the green cells which have torn from them the carbon of the carbonic acid in the water.\textsuperscript{146}

Again using an imaginative presentation alongside the observation of an active process, she converted the bubbles of oxygen into animated creatures, as the reader imagined the small round bodies ‘clinging’ to the experimental apparatus, after they had been ‘set free’ from their ‘cells’. They were also given burbling underwater voices. In these ways questions raised by the subject of the primrose, including how it grows, and what causes this, could be answered by looking at different natural objects, including the piece of orange that the children had brought along.

These illustrative experiments taught through familiarising strategies, making analogies with other everyday substances; for instance, the following possible but hypothetical example demonstrated how water was transported into and through the plant:

If you tie a piece of bladder over a glass tube, half fill the tube with treacle, and then let the covered end rest in a bottle of water, in a few hours the water will get in to the treacle and the mixture will rise up in the tube till it flows over the top.\textsuperscript{147}

Some such experiments had been performed in front of her original audience in St John’s Wood, as reflected in direct instructions to the listener to observe the results, here to illustrate the presence of carbon in leaves and flowers, something ‘difficult at first to picture’:

I have here a plate with a heap of white sugar in it. I pour upon it first some hot water to melt and warm it, and then some strong sulphuric acid.

\textsuperscript{146} Ibid., 158-159. 
\textsuperscript{147} Ibid., 157.
This acid does nothing more than simply draw the hydrogen and oxygen out. See! in a few moments a black mass of carbon begins to rise, all of which has come out of the white sugar you saw just now.* You see, then, that from the whitest substance in plants we can get this black carbon; and in truth, one-half of the dry part of every plant is composed of it.

Now look at my plant again, and tell me if we have not already found a curious history?148 (159-160)

Here she fulfilled the promise of the introductory lecture, quoted at the beginning of this section: with a series of visual directions ('See!', 'You see', 'Now look') she opened her pupils' eyes to the surrounding scientific fairy-land of objects. However, this fairy-land was not explicitly invoked through describing the process of drawing out the oxygen and hydrogen as magical, or akin to a fairytale transformation, but with an emphasis on the 'curious history' of the supposedly everyday plant: what children had thought they knew about was made strange and alien. Though she had emphasised the 'commonness' of the loaf sugar with which she had begun, however, the written instructions contained a note to the reader:

*The common dilute sulphuric acid of commerce is not strong enough for this experiment, and any child who wants to get pure sulphuric acid must take some elder person with him, otherwise the chemist will not sell it to him. Great care must be taken in using it, as it burns everything it touches.149

Throughout these examples, such as with considerations of the strength of acids, Buckley was perhaps far away from fairy tales. Towards the end of the lecture Buckley returned to the question and language of fairies, pulling focus from the primrose to discuss wider forces of nature, as she asked 'what fairies are they which

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148 Ibid., 159-60.
149 Ibid., 159.
have been at work here?'. Her answer was that fairies were the invisible forces of nature: 'Life', and 'the sun-waves'. They left open the possibility for quasi-magical ultimate explanations for the phenomena of the natural world, what Bown termed an 'unintended consequence' but what can be illuminated by Bernie Lightman's recent discussion of Buckley's 'fascination with spiritualism. Whilst working on *Fairy-Land*, she had been attending a series of spiritualistic meetings, at first in an attempt to cure writer's block, but later out of a genuine interest in spiritualistic phenomena. Indeed, in the same year she wrote an article on spiritualism, in which she used the analogy of the growth of a flowers to demonstrate a spiritually-driven evolutionary process: "If this life-principle, or "spirit," exists, Buckley argued, "we must suppose, on the theory of evolution, that it is passed on from flower to seed, ... from parent to child". However, on the cover of the book Buckley's fairies were far from invisible, rendered as gilt pixies and angels enacting a series of processes and holding natural objects (see figure twenty-one). She closed by using the language of myth and mystery to assert the religious lessons to be drawn from a primrose:

And the life of the plant? What is it, and why is this protoplasm always active and busy? I cannot tell you. Study as we may, the life of the tiny plant is as much a mystery as your life and mine. It came, like all things, from the bosom of the Great Father, but we cannot tell how it came nor what it is.

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150 Ibid., 169.
151 For Bown this is an 'unintended consequence' of Buckley's project, implying that 'scientific ideas are a form of magical thinking'; Bown, *Fairies*, 108. Lightman writes: 'Buckley was working on her *Fairy-Land of Science* 246 at the same time that she wrote this article. Although the analogy she draws between invisible natural forces and fairies in this book can be interpreted as a device to entice children to become interested in the wondrous world of nature while retaining a naturalistic perspective, it could also reflect her fascination with spiritualism.' (Lightman, *Victorian Popularizers*, 245-246).
Thus, Buckley's fairy-land references were used as framing devices, entry- and exit-points, just as she hoped the wider fairy-land of science would for the world of science as a whole. This is how she managed the transitions from actual observation to general principle; from nature to fantasy; from garden to fairy-land.

![The Fairy-Land of Science cover](image)

**Figure Twenty-One:** The decorated cover of *The Fairy-Land of Science* depicted impish figures holding everyday objects such as lanterns, shells, or vases of water.

These transitions did not involve large changes: as Buckley had explained in her first lecture, the closeness of her audience to the subjects they were to be taught was paramount:
this land is not some distant country to which we can never hope to travel. It is here in the midst of us, only our eyes must be opened or we cannot see it. Ariel and Puck did not live in some unknown region. On the contrary, Ariel’s song is

“Where the bee sucks, there such I;
In a cowslip’s bell I lie;
There I couch when owls do cry.
On the bat’s back I do fly,
After summer, merrily.”

In this way Buckley connected her writing to a much longer tradition of the fairy-land of nature, and in particular to the Elizabethan fairies of Shakespearean song. A.L.O.E. had also connected her fairy guides to this other time of fabled fairy popularity: Fairy Know-a-bit had been living in the library of Fairydell Hall for four hundred years; indeed, he had not ‘spread his wings since the death of Queen Bess’; and part of his argument for the value and virtues of man, as opposed to his sister’s championing of nature, relied on the fairies’ valuing of Shakespearean song. Moreover, the primrose itself had traditionally been seen as a fairy flower: as Katherine Briggs details, primroses were involved in a range of localised fairy lore and rituals, from being scattered in front of Irish houses to keep away fairies, to a Somerset tale of a child who had become lost whilst picking primroses – after accidentally touching a fairy rock with the flowers she was given presents and shown the way home – and in wider associations of yellow flowers with the Devil.

Buckley hoped and claimed to go beyond the stories of old: her descriptions of fairy forces were ‘ten thousand times more wonderful, more magical, and more

154 As quoted in Ibid., 5.
156 Briggs, Fairies in Tradition and Literature, 84.
beautiful in their work, than those of the old fairy tales. An important way in which these tales would supersede their older counterparts would be in their truthfulness, since scientific knowledge was perceived as an uncovering of the truths about nature. In the mid-nineteenth century concerns over the inherently mendacious character of fairy tales and fantastical writings more generally led to a discouragement of children reading fanciful works, and to a corresponding promotion of factual education. Works such as Buckley’s used the truthful ideology of the sciences and the (as was admitted) engaging world of fairy-land to help solve this problem in the form of true fantasy:

I thoroughly believe myself, and hope to prove to you, that science is full of beautiful pictures, of real poetry, and of wonder-working fairies; and what is more, I promise you they shall be true fairies, whom you will love just as much when you are old and greyheaded as when you are young; for you will be able to call them up wherever you wander by land or sea, through meadow or through wood, through water or through air.

Barbara Gates has identified Buckley’s combination of scientific fact and fancy as an exploitation of the post-Darwinian possibilities for going beyond objective language in scientific writings. Read in the context of the history of children’s books and explicitly educational writings, however, rather than just that of Darwinian and expert literature, Buckley’s work seems less of a ‘transgression’ of scientific borders than one of a series of explorations of how best to communicate ideas, a sense of active investigation of the natural world, and of possibilities for that investigation, to young audiences. An overt use of narrative or comparison with other genres was one

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157 Buckley, Fairy-Land of Science, 6.
159 Buckley, Fairy-Land of Science, 2.
way in which this could be achieved; animism, animation and imagination were perceived as crucial.

For example, in 1859 John Cargill Brough had published the *Fairy Tales of Science*, a similar attempt to write imaginatively about technical scientific knowledge in *a Book for Youth*, as he subtitled his miscellany. He took scientific subjects geological, entomological, astronomical, chemical, and botanical in turn, and converted and compared them to fairy tales. In his botanical tale, ‘Wonderful Plants’, Brough dealt in exotic plants from far-flung lands. In his story, he used a fanciful cartoon and the object lesson of a plum pudding as a launching platform for his discussion (also see figure twenty two; and figure twenty three for another humorous presentation of strange objects growing on a tree):

The wonderful plants portrayed by our artist are scarcely more wonderful than some of the vegetable productions of this bounteous earth. The little boy may well be astonished to see such a wonderful crop of good things; but if he will only stop and think a little he will find that plum-puddings, mince-pies, and wearing apparel do really grow, or, more strictly speaking, they spring from the wonderful plants which actually exist. Consider the composition of that famous pudding which crowns the fanciful group on the preceding page. The currants and raisins, the sugar, almonds, and candied lemon-peel which are its principal ingredients, are all vegetable productions; and the suet and eggs may be described as animalized grass and barley, for they are formed out of the vegetable food of the ox and the hen. The plum-pudding tree is not half so preposterous a conception as it appears to be at the first glance.\(^{160}\)

Object lessons on the plum pudding really did exist, and might have been known to Brough's readers: 'Ingredients for a plum pudding' formed object lesson LIII in the miscellaneous final section of W. J. Lake's *The book of object lessons: a teacher's manual* (1857) (see figure twenty-four).  

**FIGURE TWENTY-TWO:** A young boy is knocked backwards, astounded by the 'Wonderful Plant', on which grows dolls and soldiers, shoes, shirts and trousers, bottles and candles, shuttlecocks and cricket bats, and — in the middle at the top — a plum pudding.

FIGURE TWENTY THREE: 'The Reform Bill' of 1832, 'French Revolution' of 1789, 'Great Comet' of 1680, and the 'Comic Offering' itself grew on the leaves of 'A Date Tree!'

LESSON LIIL — INGREDIENTS FOR A PLUM PUDDING.

I. DRAW from the children, and write upon the black-board, the names of the various articles used in making a "Christmas Pudding;" e. g.:—

(a) Flour.  (b) Eggs.  (c) Milk.  (d) Suet.  (f) Bread-crumbs.  (g) Salt.  (h) Cinnamon.  (i) Ginger.  (j) Orange, lemon, and citron peel.

(b) Nutmeg.  (c) Cinnamon.  (d) Suet.  (e) Ginger.  (f) Raisins.

II. Elicit a description of each article in detail, and give a few particulars respecting its cultivation, preparation, and production.

a. Flour.—Trace it from the field to the mill, and through its various stages. Large quantities required by our population; partly supplied from abroad; imported from Russia, Prussia, Germany, and America.

FIGURE TWENTY FOUR: In this festive object lesson, children reduced a 'Christmas Pudding' to its ingredients, and then 'traced' each constituent part to its origins and means of production.
Conclusion

After reading the *Arabian Nights*, Charles Dickens was in a new world: ‘Oh, now all common things’, he declared, ‘become uncommon and enchanted to me. All lamps are wonderful; all rings are talismans. Common flower-pots are full of treasure.’ Almost ‘every object’ he recognised, including trees, beef-steaks, tarts, dates, olives, rice, apples, and dogs, was transformed, bathed in ‘fairy light’. As this chapter has demonstrated, works of natural history claimed the same power to transform everyday artefacts and experiences; but they also claimed a higher status: that their enchantment revealed the true wonders of nature.

Therefore, object lesson teaching was not simply the Gradgrindian recitation of facts that defined a particular artefact or animal, but an imaginative presentation of the natural world through fable and fairies, allusion and wonder. By sitting and listening to these tales, by reading and hearing these glimpses of the wonders of nature, elementary scientific education was much more than a dry catalogue of information. Moreover, and for the argument of this thesis, more importantly, in books such as Buckley’s *Fairy-Land of Science* these marvellous stories were woven with and around the prosaic objects of a flower, an almond, or a segment of orange. The tales thus depended on readers’ and listeners’ familiarity: with the metamorphoses of garden insects; with the four legs of a horse; with the life of a flower; with rain-clouds and water-buttts. Their very ‘uncommonness’ worked because it was set against the quotidian. This was the tales’ power of enchantment.

This chapter has explored fact, fancy, fable and familiarity to demonstrate how these fairy tales of science were employed in debates over what kind of knowledge should be taught to children, and in what way, the generic ‘shape’ in which they were couched. References to and uses of myths and stories were diverse, and often

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conveyed subtle and specific allusions: to the oriental *Arabian Nights*, to British Puckian traditions. In these ways, fairy tales could be used to connect scientific learning and experience to potentially conflicting interpretations: the more detailed comprehension of local objects, or the exotic distant. These elementary works made explicit concerns with the close relationships and blurred boundaries between the natural and supernatural and remind us of the importance of such considerations to research chemists and physicists themselves, and to the nascent scientific studies of fairies and folklore.

For some scientific writers fairies solved the problem of invisibility: in conjunction with visible and tangible objects, they brought into the scope of understanding and vision things just outside our grasp — supposedly invisible, magical, or slipping away. For Buckley, it was invisible forces, of heat, cohesion, or life, that were converted into fairies, intermediaries between matter and the ultimately spiritualised world of nature. For Morley in *Household Words*, the invisible individual water drops of different types of clouds became distinct fairies, the appropriate scientific language used to describe them modified to resemble the exotic Eastern names of fairy tale Princes and Princesses. For others it was the hitherto hidden and magical scientific content of objects — their facts — that could be revealed and communicated. Rather than being seen as the destroyer of supernatural stories about the world, through these fairy tales the sciences were presented as being the way to understand both contemporary society and the invisible recesses of nature. They were a way of revealing the hidden magic of both the sciences and everyday life.

Throughout these blurrings of the natural and supernatural, the spiritual and material, an appeal to the truth of science and, more specifically, scientific stories was paramount. Fairy tales of science were advocated as conveyors both of accurate information about the natural world and also of engaging characters, magical transformations, and powerful forces. Their writers participated in a debate over what
was suitable literature for children, and whether fanciful works would encourage habits of lying in children. It was argued that works in which the fantastical elements were representations of true natural laws would not predispose children to lie and, rather, would prepare children for an increasingly scientific and industrialised world.

Therefore, though these were didactic works, it was not just lists of facts they sought to teach. The stories were communicators of morals and religion; of inquisitiveness, of wonder and imagination; of the conditions of working-class London; of practical household experiments on sugar or laurel leaves; they were also the latest incarnation of an oral folkloric tradition, suitable for a progressive age. In these ways, an important argument of this chapter has been to reconnect factual and fictional children’s literature. Academic work has tended to stress the fictional, particularly leading up to the ‘Golden Age’ of imaginative literature in the second half of the nineteenth and early twentieth centuries. However, by analysing, for example, the way in which sewerage reform was written as a fairy tale we can see that fact and fancy were not the exclusive preserve of two rigidly distinct genres. Rather, they shared an interest in wonder, in narrative, in morals, and the physicality of being told; the idea of fanciful facts helps support a more flexible use of genre in the history of science, with genres rather as centres of attraction than fixed categories.

When looking for fairy tales of science, works of natural history would perhaps be expected to be the clearest scientific discipline in which this type of writing can be found, as insects and flowers were anthropomorphised and ‘fairyised’; but for many in Victorian Britain it was the still-marvellous and the invisible forces of the physical and chemical sciences, such as light and electricity, that were most suitable for converting into modern fairies, sprites, imps and genies, as fairies were brought together with new technological objects of the home. At the end of the century, something as overtly concrete and technological as a Meccano set could be thought of as an evening’s entertainment akin to a fabulous tale: on 5th November 1901.
Professor Hele-Shaw of University College, Liverpool, wrote to Frank Hornby, inventor of the sets:

Thank you very much for the Photographs of your clever and useful form of Toy. When it is on the market I shall certainly buy a set for my little boy, and feel sure it will afford many hours of enjoyment both to father and son. With a little ingenuity and exercise of the imagination, it should be as good as a fairy story, and what can one say more!\(^3\)

3. **HOUSEHOLD CHEMISTRY**

'**the kitchen is a chemical laboratory'**

Friedrich Accum, *Culinary Chemistry*

THE MIDDLE-CLASS VICTORIAN HOME was furnished with many artefacts thought suitable for guiding an introductory scientific education. Everyday domestic activities of eating breakfast, taking afternoon tea, washing clothes, or reading by candle-light became opportunities for lectures adumbrating and experiments exploring the properties and histories of particular common commodities. This chapter will draw lessons about the affecting of the senses through exploring the practices of home experimentation, and that pre-eminently smelly, noisy, messy, colourful, and dextrous of disciplines, chemistry. My exploration of household chemistry will centre on three common objects in Victorian homes – a cup of tea, a cake of soap, and wax candles – as well as a slightly different type of artefact, Robert Best Ede’s ‘Youth’s Laboratory’, one of the first home chemical cabinets.

Rather than demonstrating the hidden, wonder-working fairies that underscored the burning of a fire or the growth of a flower, or dwelled in a drop of water, the texts analysed in this chapter argued for the technical and chemical constituents of the kitchen table and wash-tub, and for their connections to industry, empire, and contemporary scientific practice. I analyse their dynamic role as both demonstrations that even the commonest object could be the basis of a practical

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scientific education as well as arguments for the authority of men of science as capable domestic experts. Claiming the territory of the kitchen through redefining everyday activities and familiar experiences as chemical processes was one way in which this authoritative position could be achieved: by learning more precise details of the underlying scientific concepts at work, practices such as cookery could also arguably be improved.

As well as already known activities to be engaged in with common objects, I shall also show how lessons on new ways of manipulating commodities could lead to unfamiliar combinations and locations: the chemicals in soap that would react violently with water, the spectacular world of the soap and candle factory. Michael Faraday’s *Chemical History of a Candle* (published 1861), perhaps the most famous object lesson text of the nineteenth century, is here discussed; however, by using a rewritten version of Faraday’s lectures that appeared in *Household Words* with a boyish protagonist, I demonstrate how children could conceivably become home lecturers themselves, exploiting the objects of their surrounding environment to introduce unfamiliar material.

The new, specially-created chemical laboratories that were marketed from the late 1830s for childish domestic experimentation formed a continuous part of this household culture of chemistry. With the aid of Robert Best Ede’s ‘Youth’s Laboratory’ (c.1836-1845), a typical example of an early Victorian chemical cabinet, I investigate how those using a portable home laboratory for the first time could make sense of their set, analysing its contents alongside the dedicated literary guide to performing its experiments, John Ward’s *Footsteps to Experimental Chemistry* (1837). I reveal how close many of its experiments were to those that could be performed with everyday objects, employing the same substances and using the same apparatus, such as glasses and tea-cups. Both argued for the essentially embodied nature of chemical
education – but the pre-preparation of these sets was criticised for taking away the very practical expertise they sought to inculcate.

A cup of tea, or object lesson as everyday activity

We begin this chapter by returning to the end of the eighteenth century, for ‘a tea lecture’ one *Evening at Home* (see figure twenty five).

![Figure Twenty Five: 'A Tea Lecture' given in the home. Note the teapot in the hand of the tutor, the cup in front of him, and the open book in front of the pupil.](image)

Laying aside his book, a young pupil was asked by his tutor to talk about the operation of tea-making:

*Pup.* An operation of cookery – is it not?

*Tut.* You may call it so; but it is properly an operation of *chemistry*.

*Pup.* Of chemistry! I thought that had been a very deep sort of a business.
Tut. Oh – there are many things in common life that belong to the deepest of sciences. Making tea is the chemical operation called *infusion*, which is, when a hot liquor is poured upon a substance, in order to extract something from it. The water, you see, extracts from the tea-leaves their colour, taste, and flavour.¹⁶⁵

By identifying the processes of cookery and chemistry, the tutor converted the making of the cup of tea itself into an instructive experiment. Appeasing the fears of his young pupil, the receptacle demonstrably did not contain a ‘very deep’ subject: it was small enough to hold in one’s hand, reassuringly tangible and unthreatening. The pupil was encouraged to think more carefully about what happened during everyday activities which, as it was demonstrated, were also chemical operations with technical names such as ‘infusion’. An explication of a chemical phenomena was thus illustrated by, with and through the cup of tea. For example, the process of solution was introduced along with a lump of sugar:

*Solution* is when a solid put into a fluid entirely disappears in it, leaving the liquor clear. Thus, when I throw this lump of sugar into my tea, you see it gradually wastes away till it is all gone, and then I can taste it in every single drop of my tea; but the tea is as clear as before.¹⁶⁶

The contrasting experiences of the tutor and pupil, highlighted by the dialogue form in which the lecture was presented, helped the reader to identify with the pupil through a series of sensory mediations. The tutor actively demonstrated the process of solution, by ‘throwing’ the lump of sugar into the tea, and then ‘tasting’ it. The pupil, however, could only ‘see’ these actions occur, observing that the tea, along with his knowledge on the subject of solution, became clear. One stage back, the reader watched and empathised with the seeing pupil, and his own understanding

¹⁶⁶ Ibid., 144.
clarified. With such newly-acquired knowledge, the pupil could then answer questions on hypothetical experiments, and become introduced to unfamiliar chemical processes: 'suppose you had a mixture of sugar, salt, chalk, and tea-leaves, and were to throw it into water, either hot or cold – what would be the effect?'167

The close of the conversation mirrored the opening statements, as the tutor affirmed the scientific status of the object lesson, and his pupil’s fears about the difficulty of the subject were quelled:

*Tut.* But our tea is done; so we will now put an end to our chemical lecture.

*Pup.* But is this real chemistry?

*Tut.* Yes, it is.

*Pup.* Why, I understand it all, without any difficulty.

*Tut.* I intended you should.168

The end of the short dialogue, and of the tea-making, returned to the question of fearing the ‘very deep’ subject of chemistry set up at the outset: the tutor affirmed that this was ‘real chemistry’; the pupil was amazed this could be understood ‘without any difficulty’. An important reason for the use of common objects as entry-points into the sciences at this time was to assuage these fears about novel subjects, as they identified the scientific processes at work in phenomena observed or activities engaged in every day.

Such identifications relied upon constructions of the home as a refuge: a shelter from fear. In his analysis of *Victorian Things* Asa Briggs cited John Ruskin’s declaration of ‘the true nature of home’ as ‘the place of Peace, the shelter, not only from all injury, but from all terror, doubt and division... a sacred place, a vestal temple, a temple of the hearth watched over by Household Gods.' Fear of chemists and of chemistry could take many forms. For evangelical educationalist Mrs Sarah Trimmer, reviewing ‘A Tea Lecture’ in her *Guardian of Education* periodical, it was not suitable as a subject about which children should be taught: ‘it is a fascinating thing, likely to occupy their thoughts and attention to the exclusion of more important subjects, and to put them upon dangerous experiments.’ It was the identification made between cookery and chemistry, however, that would become the locus of debates over the safety of the science. Ruskin’s ‘sacred place’ was not free from fears about foods; indeed, the constituent parts of a cup of tea were amongst the household products most at danger of contamination and adulteration. Accum

himself claimed that the adulteration of tea 'has been practised in this country to an enormous extent'. Similarly, the 'enemy of fraud and villainy' who wrote *Deadly Adulteration and Slow Poisoning* in 1830 claimed that '[n]o article of consumption is more subject to adulteration than the pleasant one which forms the principal ingredient of the tea-table.' Fears over adulterated foodstuffs could be overcome by learning the chemistry of cookery, particularly a series of simple domestic tests that greatly resembled the kind of elementary identification experiments elaborated in introductory treatises. For instance, *Deadly Adulteration* gave several practical tests whereby the reader at home could detect any spurious substances in their tea: adding grains of vitriol and watching for a particular colour change; noting the precise shape of the tea leaves; and by taste: 'The liquor drawn off, which should be smooth and balsamic to the palate, tastes rougher and harsher than the genuine tea does.' This genre of writing thus taught readers how to be chemical detectives by using their senses to detect adulterated foodstuffs.

**FIGURE TWENTY SEVEN:** Sketch from Accum’s *Adulteration*, demonstrating the shape and properties of genuine tea-leaves, to aid in their identification.

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172 [Anon.] [1830] *Deadly Adulteration and Slow Poisoning*, 83. Note that in Sarah Freeman *Mutton and Oysters: The Victorians and Their Food* it is pointed out that relatively little tea was adulterated at this time.


174 [Anon.] *Deadly Adulteration*, 89-92; 90.
Writers such as Derbyshire chemical lecturer Albert Bernays attempted to reassure readers that appreciating the proper chemical nature of everyday foodstuffs led to their being ‘good and wholesome’, not artificially tampered-with: though chemists were arguably the cause of adulterated foodstuffs, they could also be the solution to this problem. A discourse of purity had underpinned the opening of Freidrich Accum’s 1821 *Culinary Chemistry*, which convinced readers that by preparing meals they were already chemists: ‘the art of preparing *good and wholesome* food is, undoubtedly, a branch of chemistry; the kitchen is a chemical laboratory’. As with the earlier ‘tea lecture’, the identification of cookery and chemistry was just the beginning of the educational process: extending one’s knowledge through learning more precise details about these connections would provide an enhanced perspective on the world, as well as sparing waste and labour, and providing more nutritious food. The perceived wholesome and temperate properties of tea itself, though certainly not a unanimous position, its suitability as a beverage for children, and its increasing position as central to afternoon domestic and nursery life, helped reinforce these arguments.

A more advanced work than ‘A Tea Lecture’, Bernays’ *Household Chemistry* used a series of easy experiments to demonstrate the chemical contents and nutritive properties of tea, an example of his ‘Chemistry of the Breakfast-Table’: tea could be transformed into thein and tannin. Other writers presented such facts and statistics in tables, impressing readers with their reduction of each cup of tea to precise chemical components. The motivation for learning this chemical information was, as Accum had stated, to improve the quality of the tea one produced oneself, rendering it ‘good and wholesome’. Therefore, Bernays immediately followed his chemical identification with recommendations for tea-drinkers everywhere: that a ‘volatile oil’ meant that ‘the longer the tea is allowed to draw, the less pleasant becomes the taste’;

177 Albert Bernays (1853) *Household Chemistry* (London: Samson Low & Son), 63-64.
he also reported that some authorities recommend: 'heating the tea in a dry tea-pot, before the hot water is added.' Bernays therefore gave a purpose for understanding the chemical composition of tea, about which his readers were tested with a series of questions at the end of each chapter:

Is hard or soft water best for making tea?... How much woody fibre is contained in tea? What is tannin? What are its properties? What is meant by extractive? What is thein? How may it be prepared? Of what is it composed?  

Accum's *Culinary Chemistry* also included 'singular effects of different kinds of teapots, on the infusion of tea': he was concerned with explaining how the taste of the tea could be affected by the conductivity of the material out of which the teapot had been made. Charles Foote Gower's *Scientific Phenomena of Domestic Life* (1847) even demonstrated how best to put a lump of sugar into one's tea, no stirring required: holding it in a spoon at the surface of the cup, made the most of circulating currents so that the sugar was 'constantly in contact with a fresh portion of unsweetened tea'. Sensory considerations were key, and were the chemical technology used to differentiate results. Thus, these chemical guidebooks not only revealed the chemical nature of tea, but argued that men of science were those who had the authority and demonstrated expertise to advise on household activities, from corroborating your produce as genuine to the best way of making a cup of tea, as they could explain the scientific laws at work therein.

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178 Ibid., 64-65.
180 Accum, *Culinary Chemistry*, 299-300.
But different phenomena could be introduced through making a cup of tea: the 'kettle boiling on the fire was 'a familiar illustration of the process of evaporation', which could lead not to the chemical laboratory, but to the steam engine.\(^{182}\)

If we hold a cold tumbler near the spout of a boiling kettle so as to receive the steam, we shall immediately perceive it condensing in small drops on the sides of the tumbler, and running down in a miniature shower.\(^{183}\)

By making these connections, and detailing experiments his reader could enact along with the narrator ('if we hold a cold tumbler... we shall immediately perceive'), Gower also implicitly relied on mythologised stories of the young James Watt and his observation of the boiling kettle (see figure twenty eight), which was said to have inspired his ideas about steam power and was the most famous contemporary example of how thinking clearly and scientifically about everyday occurrences could lead to insights into the laws of nature.\(^{184}\) Mention of Watt returned in a short story on the ‘Mysteries of a Tea-Kettle’, published in *Household Words*, the periodical ‘conducted’ by Charles Dickens, and after which Bernays claimed to have named his *Household Chemistry*, in 1850.\(^{185}\) A discussion that began with defining whether or not a kettle which had been brought into the room by a servant was boiling led to talk of steam, and, eventually, to the inevitable pun:

> “For all which,” remarked Mr. Bagges, “we have principally to thank what’s his name.”

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\(^{184}\) See David Philip Miller (2004) ‘True myths: James Watt’s kettle, his condenser, and his chemistry’, *History of Science* **42**, 332-360, for how this story originated and was used to assert Watt’s expertise. Though now used to emphasise Watt’s insights into steam power, Miller argues that the story could be (and indeed was) used to demonstrate his thinking on the properties of steam, and on the chemical composition of water itself.

\(^{185}\) See Bernays, *Household Chemistry*, vii. He calls *Household Words* ‘a serial worthy of the attention of young and old’. 
“Watt was his name, I believe, uncle. . . ."\textsuperscript{186}

More important than its supposedly comedic asides, however, is that in this story the child, Henry Wilkinson, became the knowledgeable lecturer, introducing his mother and buffoon of an uncle to what he had learned at the Royal Institution.\textsuperscript{187} Just as with a tea-set children could preside over a playful dolls' tea party in the nursery, they could also get to play at giving chemical lectures. Moreover, it was as a boy that Watt had supposedly had his eureka kettle moment: children could identify through these stories and tales both with someone who knows a lot about this kind of knowledge, and also with someone like Watt, who would go on to use that knowledge.

\textbf{FIGURE TWENTY EIGHT:} The young James Watt contemplates a kettle, with tea-pot, cup and saucer on the table nearby.

Not all of the works in this genre used their tea lectures as an opportunity to advocate experimentation: others used these interdisciplinary objects to teach about a

\textsuperscript{186} [Percival Leigh] (1850) 'The Mysteries of a Tea-Kettle', \textit{Household Words} 179.
\textsuperscript{187} The next section will deal with Henry Wilkinson's version of Faraday's \textit{Chemical History of a Candle} lectures, which also appeared in \textit{Household Words} in 1850.
range of other subjects. For example J.F.W. Johnston’s *Chemistry of Common Life* (1855) explored ‘the beverages we infuse’ by taking an amazingly global perspective: tea-drinkers from Central America, Labrador, Georgia, the West Indies, Spain, Italy, Sweden, Turkey, Arabia, China, Tartary and Thibet, Siberia, and Sumatra were referenced to demonstrate its ‘extensive use’, before details of the tea-plant were given. For Accum, too, rather than simply an opportunity to entrain knowledge of chemical processes of infusion, solution and evaporation, the tea leaves became owners of an exotic and global history: from Dutch adventurers trading sage to Linnaean natural history and Japanese tea ceremonies. Indeed, before he had given details of the chemical composition of tea, Bernays had also begun his description of tea by telling his readers about the tea-plant’s history and natural history. Other works focused on the china of the cup rather than the tea itself to connect the household with the world: Halsted’s *Travels in the Boudoir* (1847) talked of both Oriental china and European Porcelain. Through making such connections, history, magic, mystique, and exoticism, were stirred into the reader’s drink along with tea-leaves and sugar. Satirical composite caricatures of the 1830s had punned on these, representing China as a cup and saucer on a map of ‘Figurative Geography’, alongside a turkey-shaped Turkey; and constructing a Chinese man out of porcelain objects (see figure twenty nine.

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190 Caroline A. Halsted (1837) *Travels in the Boudoir*
The tradition of such literary tea lectures continued throughout the nineteenth century as an appealing way of introducing young audiences to scientific subjects. By the time of high imperialism, talking about tea provided an opportunity to affirm the global reach of the Victorian home. The pre-eminent example of this can be found in *Aunt Martha’s Corner Cupboard* (1875), authored by Mary and her sister Elizabeth.
Kirby. This moralising tale about how to inspire idle boys with a thirst for knowledge and a sense of industry, revealed how Aunt Martha determined to commence her nephews’ education with the histories of the commonplace items of the tea-table: ‘It seemed to Aunt Martha – for she was a lady of a lively imagination – as if everything in that cupboard, - her china, her tea, her coffee, her sugar, even her needle, - had a story to tell, and a most entertaining one too.’\textsuperscript{191} Through the exemplars of each discrete object, whose history was narrated in turn at successive tea-times, Aunt Martha stressed the labour that had gone into producing the everyday things of life: ‘The tea-cup seems a simple thing, and you use and handle it very often, and drink your tea out of it every afternoon. But perhaps you have never been told its whole history “from beginning to end,” as the story-books say, and do not know that it takes a vast amount of labour, and sets numbers of persons to work, before it can become a cup at all.’\textsuperscript{192} That epitome of Victorian society, the emphasis on ‘setting numbers of persons to work’, was thus embodied in its everyday artefacts. Moreover, \textit{Aunt Martha’s Corner Cupboard} underscored the importance of the imperial sphere: through telling these stories of far-off places and people the authors demonstrated how even, and perhaps especially, the ‘common’ things of life were dependent on, and helped forge, the British Empire.

This section has demonstrated how written lectures on making tea offered a familiar way of introducing young readers to the sciences of chemistry and physics. The actual observation of the boiling tea-kettle, infusing liquid, and melting sugar-lump, either at first-hand or in memory, was crucial to the success of these presentations. The widespread contemporary fears over adulterated foodstuffs, of which tea and sugar were prime examples, allowed chemists to assert the authority of their knowledge of the kitchen. And the global tea story allowed some writers to travel from the breakfast-room or boudoir to the farthest corners of the empire. But

\textsuperscript{191} Mary and Elizabeth Kirby (1875) \textit{Aunt Martha’s Corner Cupboard} (Bristol: Thoemmes Press reprint, 2004), 13-14.
\textsuperscript{192} \textit{Ibid.}, 18.
in other ways there was only so far a cup of tea could take you; only certain chemical and physical processes about which you could learn.

Soap and candles, or object lesson as experiment

Michael Faraday’s well-known Royal Institution lectures, published in 1861 as *The Chemical History of a Candle*, used this common household commodity to introduce the sciences: as he claimed, ‘there is not a law under which any part of this universe is governed which does not come into play and is touched upon in these phenomena. There is no better, there is no more open door by which you can enter into the study of natural philosophy, than by considering the physical phenomena of a candle.’ By grabbing hold of a candle, his juvenile audience could be connected to a scientific understanding of the entire cosmos, all of which was ‘touched upon’. Faraday began his lectures with an analysis of the different substances of which candles are made, introducing his ‘boys and girls’ to:

> candles as they are in commerce. Here are a couple of candles commonly called dips. They are made of lengths of cotton cut off, hung up by a loop, dipped into melted tallow, taken out again and cooled, then re-dipped, until there is an accumulation of tallow round the cotton. In order that you may have an idea of the various characters of these candles, you see these which I hold in my hand – they are very small and very curious.

A crucial part of the introductory process was the fact that Faraday held these ‘small’ and ‘curious’ objects in his hand. His actual experimenting with these candles, and the possibility of his audiences’ experimentation, continued throughout the lectures;

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for example, he asked the listening children to 'go home and take a spoon that has been in the cold air and hold it over a candle — not so as to soot it, — you will find that it becomes dim just as that jar is dim.'

At the end of his Royal Institution lectures, Faraday wished that his audience would 'be fit to compare to a candle; that you may, like it, shine as lights to those about you.' This plea was taken up in an article for Dickens’ *Household Words*, the first of many of such expositions modelled on Faraday’s lectures; quite literally in the case of this article, which was written from notes taken at these events by Percival Leigh. In ‘the chemistry of a candle’, which appeared in the issue for 3rd August, 1850, information about the household object was imparted not to the child, but by the child, Harry Wilkinson, a “bright youth”, whom we met earlier in this chapter making jokes about James ‘Watt’s his name’. By altering the source of information from the Royal Institution’s stage to its audience-members, it was demonstrated that children could attend these lectures and learn their content, to the degree that they could themselves reproduce them. As Harry’s mother observed, “he attended Professor Faraday’s lectures there on the chemical history of a candle, and has been full of it ever since.”

Whilst in the story Harry had to be prompted by his father for some of the more scientific vocabulary (his mention of “cap-something” is corrected to “Capillary attraction”), he remembered and recounted most of Faraday’s everyday analogies and examples from the presentations. With his uncle again providing humorous relief (as he terms it, a “comical chemical history”), the article demonstrated that from youthful “dips and rushlights” to older candle “moulds”, “seniors may learn something from a juvenile lecture”. As a reward for his learning, and a spur to further

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195 Ibid., 53.
196 Ibid., 171.
198 Ibid., 439.
199 Ibid., 440.
study, at the end of the story Harry was promised a "Galvanic Battery on [his] next birthday". 200

Just as young Master Wilkinson went home from the Royal Institution to give his own chemical lecture, then, these written books were intended as enticements to active practical investigations; for instance, Bernays' *Household Chemistry* concluded with 'a number of useful and simple experiments, many of which may be understood and performed by a child of eight years old.' 201 The first series of these experiments required 'no apparatus beyond what is to be found in every household', and began with observing what happened when a candle was lit:

1. Take a fresh candle and light it. Mark the carbonization or apparent blackening of the wick, the melting of the tallow, its rise into the wick, the form of the flame, and the division of the wick into the part which consumes away and that which is simply soaked in tallow.

Then the reader was encouraged to start manipulating the object, and doing strange things with it, noticing how it changed:

2. Move the candle quickly through the air, and note carefully the results, as regards smell, smoke, &c. Hold a dry plate immediately over the flame – carbon is deposited; - some distance above it – the plate is not soiled.

The lessons drawn from these investigations were then extended by being compared to what happened when the experiment was conducted with an oil-lamp, rather than a candle:

3. Try at what distance immediately above the flame it ceases to light or even charr a piece of paper. – Repeat the experiment with a lighted camphine or oil-lamp, and find out why the paper will inflame at a much greater distance from the flame than a candle not surrounded by a lamp-glass.\textsuperscript{202}

Another example included in these experiments using everyday objects at the end of the book was an exploration of what happened to grains of soap in different types of water:

Dissolve a few grains of hard soap in clean rain-water, and add a few drops of this solution to hard-water. You will find the soap curdle. The lime of the water forms, with the fatty acids of the soap, a greasy insoluble lime-soap, while the soda of the hard soap combines with the sulphuric acid with which the lime of the hard water is usually associated. Until, therefore, the lime is thrown down from the hard water, the soap will not begin to act as a cleansing agent.\textsuperscript{203}

This was an experimental version the ablutionary observations made by Gower in \textit{The Scientific Phenomena of Domestic Life}, a text that stalked the daily activities of its reader, and talked of what happened when soap and water were mixed in one of the ‘phenomena of [the] bed-chamber’:

In performing our morning ablutions we shall probably be led to remark the difference between hard and soft water, as they are commonly termed, and the difference of their actions upon soap. Hard or spring water, though originally rain, has, by filtering through the earth for a considerable time, imbibed many impurities, by having come into contact with various

\textsuperscript{202} \textit{Ibid.}, 245-246.
\textsuperscript{203} \textit{Ibid.}, 250-251.
earthly and mineral substances through which it has passed. These impurities, when using soap with hard water, have the effect of decomposing the soap, and preventing its solution with the water, on which the washing properties of the soap depend.\textsuperscript{204}

For more advanced students, and those willing to spend ‘a few shillings’ on specialist apparatus to augment the contents of the kitchen cupboards, one of Bernays’ next series of more complex experiments detailed the spectacular properties of potassium, which, as he informed his reader, was the basis of potash, and found in soft soap and glass. This was one of the more sensually-exciting of the experiences he outlined, creating burning substances and tastes:

A small piece of the metal thrown into a few drops of water in a saucer, bursts into flame, is carried rapidly about, and is quickly dissolved. The water is decomposed; its oxygen unites with the potassium and dissolves, whilst its hydrogen is inflamed by the heat of the combustion, and burns with a violet flame – the color being due to admixture with a little volatilized potash. The remaining water will be found on examination to possess a caustic (burning) taste, and to blue reddened litmus paper.\textsuperscript{205}

Thus, these experiments began to take the reader far away from their everyday experiences of soap, and demonstrate the hidden alien natures of these commodities.

As Bernays introduced his chapter on ‘the chemistry of soap’, this product connected the home to the factory to the chemical laboratory: ‘in a chemical point of view, the manufacture of soap is extremely interesting, and forming as it does one of the most important articles of domestic use, a short account of its composition, and the process of its manufacture, should not be omitted in a work professing to

\textsuperscript{204} Gower, \textit{Scientific Phenomena}, 19-20.
\textsuperscript{205} Bernays, \textit{Household Chemistry}, 264-265.
illustrate household chemistry. Soap and candles were often made together in industrial manufactories. George Dodd’s account of ‘A Day at a Soap and Candle Factory’ emphasised the ironically smelly and dirty experience of soap’s manufacture (see figure thirty):

Near the frame-room is a range of ware-rooms, in which the slabs of soap are cut up into bars, and then piled up in tiers, like bricks in a wall. If “cleanliness is next to godliness,” according to the old adage, we ought to have very pleasant thoughts while passing between these walls of soap — here ‘mottled’ — there ‘yellow’ — in another part ‘curd,’ and so on; but the truth is, that the odour from such a mass of soap, and the unavoidable absence of cleanliness in the manufacture, somewhat disturb the pleasure of contemplating the ulterior purpose to which the soap is to be applied.

![Figure Thirty: The fumes of the soap and candle factory.](image)

206 Ibid., 185.
In his *Chemistry of Common Life* Johnston included a section on smells produced by such factories, which, he argued: ‘materially affect, at times, the comforts of common life.’ Advocating a ban on the ‘intentional discharge’ of ‘injurious substances’, he referenced the ‘soap and candle makers’ in particular, who ‘[dissipated] into the air the volatile fetid substances which naturally exist in long-kept and rancid fats. As a result of some of these processes, also, they produce and send forth vapours of the irritating and unpleasant acrolein’.208

This section has demonstrated how two emblematic early Victorian commodities were used by writers to introduce a range of scientific phenomena to young audiences. Rather than just thinking more about practices already engaged in at home, these works demonstrated unfamiliar processes, and could take readers on imaginative journeys to the sites of these processes: Faraday’s candle could open the doors to the factory, as well as to the Royal Institution. Moreover, as *Household Words*’ recasting of *Chemical History* reveals, children could be set-up as knowledgeable lecturers, and that they were believed capable of remembering the majority of the information imparted in such venues. If such lectures were based on common objects, then they could particularly easily be recreated in the home, alongside elementary experiments.

**A Youth’s Laboratory, or object lesson as commodity**

Of course, not all chemical experiments could be illustrated with objects found around the house: at some point specialist equipment would be required to interrogate particular phenomena. From early in the nineteenth century several chemists, including Accum, and chemical outfitters had produced sets with which elementary experiments could be conducted in a small space in the home, claiming such apparatus was a vital accompaniment to the many introductory treatises on the

subject: as I have been arguing in this chapter, it was only through physical
engagement with objects that beginners could really learn about chemistry. Robert
Best Ede's 'No.1 Youth's Laboratory, or Chemical Amusement Box' first appeared
around 1836-1837 and sold for a price of 16 shillings. It was advertised as 'containing
more than 40 Chemical preparations and appropriate apparatus, for enabling the
enquiring youth ... to perform above 100 Amusing and Interesting Experiments with
perfect ease and free from danger.' This introductory set included a range of
equipment, from Funnel, and Test Tube, to Spirit Lamp, Retort Stand, Two Watch
Glasses, and Litmus Paper, alongside various chemicals, all labelled according to
Ede's standardised system. The company's acclaimed earlier portable laboratories,
marketed from 1835, had been designed to accompany the 1834 7th edition of John
Joseph Griffin's best-selling Chemical Recreations, but the Youth's Laboratory had its
own dedicated guide: 'the [supposedly] plain and simple instructions' of Ward's
Companion; or Footsteps to Experimental Chemistry. This textual accompaniment, a 36-
page pamphlet written by Ede's London agent, was from the beginning conceived of
as essential to the Laboratory's success. After Griffin's book went out of print in
1837, Ede himself produced Practical Facts in Chemistry: as he phrased it, a 'key' with
which to unlock his larger cabinets. This section explores Ede's set and Ward's
Companion.

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209 See Brian Gee (1989) 'Amusement Chests and Portable Laboratories: Practical Alternatives to the
Regular Laboratory', in Frank A. J. L. James (ed.) The Development of the Laboratory: Essays on the Place of
Experiment in Industrial Civilisation (Macmillan Press), 37-59, and David Knight (1993) 'Pictures,
Diagrams and Symbols: Visual Language in Nineteenth-Century Chemistry', in Reanto G. Mazzolini
210 Robert Best Ede (1837) Practical Facts in Chemistry (London: Thomas Tegg; Simkin, Marshall and
211 Ibid.; J. J. Griffin (1834, 7th ed.) Chemical Recreations. Incidentally, to obtain a locked Youth’s
Laboratory you would have had to have paid £2 2s 0d for the No. 3 version.
FIGURE THIRTY ONE: Close-up of R.B. Ede's Youth's Laboratory, from its depiction on the title-page to Ward's Companion.

FIGURE THIRTY TWO: Ede's Chemical Cabinet.

Note how this more advanced cabinet contains more apparatus and more reagents than the Youth's Laboratory, and that it has a lock. The inscription on the lid reads: 'Render the Study of Chemistry So Fascinating'.
Despite his readers presumably having purchased a 'Youth's Laboratory' alongside their guidebook, an image of which was engraved as his frontispiece image (see figure thirty one), the first of Ward's experiments did not use the contents of the chemical box at all, rather the everyday domestic items of water, sugar, and a tea-spoon, as he detailed exactly the same kind of elementary household experiment outlined by Bernays, and even the *Evenings at Home* tea lecture:

**EXPERIMENT I**

To discover whether any substance is soluble in water, is easily ascertained by suspending it in the fluid. For instance, by holding a lump of sugar fastened by a thread, or in a tea-spoon, in a glass of clear water; if it be soluble, you will observe a stream of bubbles continually descend until it is all gradually dissolved or melted away; and so, you will no longer be able to perceive its presence in the fluid, nor discover it, except by taste, or by some other means by which you may detect its presence: to do this you must employ some re-agent which shall exhibit its existence in the solution.212

A nice pun on the supposed purpose of these texts to 'sweeten the lip of the cup of knowledge', by beginning with a sugar solution Ward revealed that the act of tasting was itself an art of testing, one of Lissa Roberts' 'sensuous technologies'.213 More importantly, however, Ward decided not to start his book with a spectacular demonstration of something strange and new and wonderful: instead he chose the mundane dissolving of a lump of sugar. He thereby created a bridge to the kind of household experiments previously discussed in this chapter — experiments with which his young readers might well have been familiar.

Many introductory chemical works in this period used this middling combination of household and specially-purchased equipment: Samuel Parkes' *Elementary Treatise* contained many such directions, of which the following are illustrative: in the first, the reader combined the tea-cup (everyday) with the bell-glass (chemical) to perform that reversed miracle of turning wine into water; in the second, the colour of a rose (everyday) was changed by suspending it in a gas jar (chemical) and exposing it to the fumes of a match (everyday):

**EXPERIMENT**

Put a little alcohol in a tea-cup, set it on the fire, and invert a large bell-glass over it. In a short time an aqueous vapour will be seen to condense upon the inside of the bell, which by means of a dry sponge may be collected, and will be found to be pure water.

**EXPERIMENT**

Suspend a red rose within a glass jar similar to that in the annexed engraving, and in that situation expose it to the confined fumes of a brimstone match. This will soon produce a change in its colour, and at length the flower will become quite white.²¹⁴

Therefore, we can see that there was no clear divide between the kind of experiments that could be conducted with everyday commodities and with the contents of the chemical cabinet.

The way in which these texts were written differed considerably from the more narrative styles employed by authors such as Gower. The clearest example of how a series of elaborate instructions detailing how to perform a particular chemical

²¹⁴ Samuel Parkes (1839) *An Elementary Treatise on Chemistry, upon the Basis of the Chemical Catechism* (London: E. Palmer), 50; 121.
manipulation were first outlined, then encoded in a handier and singular imperative, can be seen in experiments II and III of Ward’s text: experiment II provided a lengthy articulation of how to evaporate a substance:

EXPERIMENT II

Take a few grains of the superoxalate of potass, and dissolve in a teaspoonful of water; then having fixed the brass rod and triangle, (as shewn in woodcut,) put the solution into a watch-glass, and place it on the triangle; then light the spirit-lamp, and very gently and gradually apply heat to the watch-glass, to prevent its cracking by a too sudden expansion, and continue it until the water rises in the form of vapour; and after a time a thin film will appear on the surface; then gradually lessen the heat, and take away the watch-glass, and put it in some place where it will not be disturbed. In a very short time you will find the crystals of the superoxalate of potass reformed; but if the water has not been sufficiently evaporated, the crystals will not be formed, and it will be necessary to repeat the process, and continue it a little longer, and then again put it aside to crystallise.

After the crystals are formed there is usually a little water remaining, which is called the mother-water, and in simple crystallisations of this nature may be thrown away. The crystals are to be thrown on a piece of blotting-paper, so that any moisture adhering to them may be absorbed, and the perfect crystals obtained dry.215

The detailed instructions gave quantities (a tea-spoonful of water); showed how to set up the appropriate apparatus (by directions and the woodcut); warned of potential dangers (cracking the watch-glass); and directed the repetition of the process should

the desired result not be obtained. Terminology not introduced in the earlier
‘theoretical’ sections, such as ‘mother-water’, was explained.

By the following experiments, all these processes of experimentation could be
themselves boiled down to one sentence:

EXPERIMENT III
Take a solution of the bi-chromate of potass, evaporate, and crystals of a
beautiful garnet colour will be formed.

EXPERIMENT IV
Evaporate a solution of the prussiate of potass, and lemon-coloured
crystals will be produced.\textsuperscript{216}

The emphasis on gestural control (gently heating), on what equipment to use, even
on quantities, had disappeared, as had the figure of the experimenter. Rather than a
potentially fallible process, the experiments became certain and passive
demonstrations of fact: ‘lemon-coloured crystals \textit{will be} produced.’ There was no
longer any room to go wrong.

I have chosen these experiments of evaporation partly because they were
supposedly some of the first experiments children would have attempted to perform;
but also because the processes they described neatly provide suitable language to
describe the ‘difficult’, as Ward found, operations of writing out experimental
instruction. This was itself a process of reductive concentration, as Ede revealed in
the preface to his \textit{Practical Facts in Chemistry}. Within its pages the reader would find
‘the technical phraseology, in which the sciences are too often obscured, \textit{reduced} to the

\textsuperscript{216} Ibid., 15.
most familiar and simple form consistent with the dignity of Chemistry'.217 The sets themselves were an exercise in reduction: the Times applauded how Ede had ‘managed to condense into as small a form as possible a considerable number of chymical tests, and re-agents’; 218 Ede reported in his advertisements that the (admittedly less influential) Bury and Suffolk Herald declared that: ‘the concentration, in so small and elegant a form, of all that is requisite for practical experiments, cannot fail to be duly appreciated by all interested in the study’.219

However, more importantly, such linguistic processes rendered the experiments transcendent, as these advertisements brought out: like the small (and supposedly affordable) boxes, the sugar or tea, the experimental instructions could travel between many different places, and bring these types of chemistry to new audiences. Not everything was conserved in this distillation, however: the reductive prose did not include the rich digressions on etymology, history, and industry that were included in more descriptive works, and which for some were just as important parts of learning about chemistry.

An ability to move between rooms, like volatile compounds wafting through the air, was important for Ede’s other projects: the firm was a renowned purveyor of a series of perfumes, advertised alongside the chemical cabinets. 220 The scent of his ‘odoriferous compound, or Persian Sweet Bags,’ (which apparently sold over 80,000 packets), was pronounced ‘delectable’ by the Literary Gazette, whilst the World of Fashion recommended that ‘No Lady’s Toilet should be without it.’221 Ede’s Hedyosmia was even patronised by the Duchess of Kent and Princess Victoria:

217 Ede, Practical Facts, ix. My emphasis.
218 Ibid., endpapers, 7. My emphasis.
219 Ede, endpapers, 8.
220 It appears that the idea and practicality of turning a perfumery into a chemical toyshop occurred more than once: William Edward Statham, who began trading in rival chemical cabinets in 1839, was originally a wholesaler in perfumes (Gee, ‘Amusement Chests’, 57, footnote 4).
221 Ede, endpapers, 36.
Combining all the fragrant properties of the CELEBRATED ODORIFEROUS COMPOUND, being extracted in a pure and colourless form from that greatly-extolled and highly-popular Perfume, ... this Essence is considered by FAMILIES OF THE FIRST DISTINCTION, as the purest and most elegant article for the ASSEMBLY, or the BOUDOIR, and being quite colourless, and derived from the *far famed exotics of Foreign and British Cultivation*, is justly calculated as the finest Esprit for the HANDKERCHIEF, the TOILET, or the DRAWING ROOM.222

The two commercial concerns could be linked together: the *Leicester Herald* echoed the language of this advert when reviewing Ede's Portable Laboratories, stressing elegance, refinement, and the suitability of the product for many different rooms of the house:

"we have concentrated in an elegant and ornamented Cabinet, adapted equally for the Library of the man of Science, the Studio of the Chemist, or the Boudoir of the Lady amateur, an organized collection of the best contrived modern apparatus, adapted to render the exhibition of refined experiments even in the *drawing room* at once easy and satisfactory."223

Yet the differences between these spaces were asserted by Ede: despite the professed aim of these chemical cabinets to provide a sense of what it was like to be a research chemist, he reminded the purchaser of his laboratory not to expect to be able to (re-)enact all experiments which he encountered in his readings:

When it is said, that a Portable Laboratory is presented to the student in the compass of a *small box*, let him clearly understand in what sense this is

222 Ede, endpapers, 37.
223 Quoted in Ede, endpapers, 8, italics as emphasised by Ede.
meant. We do not pretend to say, that either one size or the other will enable him to put every fact he may meet with in reading to the proof of experiment, very few Chemists indeed are in a condition to do this, but they are amply sufficient to unfold to his view the phenomena of nature, by making him familiar with a great number of useful and entertaining facts, and giving him such expertness in manipulation, as will render it easy for him hereafter to widen the sphere of his operations, should he judge it necessary so to do.224

In his autobiography, the engineer James Nasmyth likewise emphasised the limitations rather than opportunities created by the pre-packaging of commercial chemical sets. Contrasting the mid-Victorian present with the days before Ede’s laboratories, he remembered how, growing up in the 1810s, he and his friend:

made it a rule ... that, so far as was possible, we ourselves should actually make the acids and other substances used in our experiments. We were not to buy them ready made ... Hence, though often baffled, we eventually produced perfect specimens of nitrous, nitric, and muriatic acids. We distilled alcohol from duly fermented sugar and water, and rectified the resultant spirit from fusel oil by passing the alcoholic vapour through animal charcoal before it entered the worm of the still. We converted part of the alcohol into sulphuric ether. We produced phosphorus from bones, and elaborated many of the mysteries of chemistry. ... I feel certain that there is no better method of rooting chemical or any other instruction, deeply in our minds.225

Nasmyth lamented that with the production of commercial chemical cabinets such as Ede’s, later generations had little experience of real ‘technical handiness or head

224 Ibid., 2.
work!': ‘Everything is bought ready made to their hands; and hence there is no call for individual ingenuity. . . . the result, for the most part, of too free a supply of pocket money.’ Thus, the production of these sets, despite all their rhetoric of providing the means to do experiments, in fact often worked against the wider dissemination of certain kinds of skills, and turned the replication of chemical experiments into a simple matter of combining prepared substances. Users might have imagined they could now have an insight into and experience of what it meant to do chemistry, but in reality they had learnt few practical skills, and chemical instruction had not been ‘rooted’ in their minds. They were effectively boxed in by the contents of the sets, which did not really encourage the independent use of their products; rather, the sets distanced you from learning certain things about chemistry.

Dodd had opened *Days at the Factories* with a reflection on the contemporary distancing of individuals from the means of production of everyday commodities:

> THE bulk of the inhabitants of a great city, such as London, have very indistinct notions of the means whereby the necessaries, the comforts, or the luxuries of life are furnished. The simple fact, that he who has money can command every variety of exchangeable produce, seems to act as a veil which hides the producer from the consumer.

Many of the texts I have studied argued in the opposite way, however, and revealed how their audiences were made aware of how objects had been produced – where they had come from, what they were made of: indeed, it was this appetite for such stories hidden in the artefacts of everyday life that created the market for Dodd’s ‘factory tourism’ itself. *Aunt Martha’s Corner Cupboard* particularly emphasised how these commodities revealed labour by setting vast numbers to work, and not least by setting their readers to work on active engagements with these subjects themselves.

226 Ibid., 96.
227 Dodd, *Days at the Factories*, 1.
Conclusion

In his best-selling memoir, *Uncle Tungsten*, neurologist Oliver Sacks remembered that when a youthful experimenter his ‘first taste was for the spectacular – the frothings, the incandescences, the stinks and the bangs, which almost define a first entry into chemistry.’ A century earlier, several of Francis Galton’s *English Men of Science* also claimed their ‘first taste for chemistry date[d] from the possession of a chemical box, when I was a little boy;’ or from ‘the lectures I attended as a boy, and to the permission to carry on little experiments at home in a room set apart for the purpose. I was encouraged in my tastes at home.’ This chapter has explored how mid-nineteenth century children acquired their first tastes for chemistry through such experiences of home experimentation, frothings, bangs, stinks, and boxes. Moreover, I have taken their chosen metaphor of ‘taste’ quite literally, and argued for the sensory nature of elementary science, and its appeal to beginning audiences. By sipping sugary tea, charring the wicks of candles, smelling perfumed soap, and enacting exciting experiments, they could engage with the chemical world in which they lived.

When introducing the series of experiments that appended *Household Chemistry*, Bernays affirmed the importance of actual experiences in converting common objects into conveyors of scientific facts:

CHEMISTRY is a science so dependent on experiment, that it may be averred that a man may spend a life-time in reading about it, without attaining to any satisfactory knowledge on the subject. We may read about

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228 Oliver Sacks (2001) *Uncle Tungsten: Memoirs of a Chemical Boyhood* (London: Picador), 71. In this passage, Sacks goes on to say that he used a copy of Griffin’s *Chemical Recreations* to guide these youthful experiments.

229 Francis Galton (1874) *English Men of Science* (London: Macmillan), 158. Admittedly these responses were given to a rather leading question!
the changes which the air undergoes in the processes of respiration and combustion – we may hear that a burning candle gives off water and carbonic acid – we may see a blue-bell on the solitary heath become red during a thunder-storm: – but how much more do these become facts to our minds, when we can prove these results to be constant and ever-recurring under similar circumstances. I need, therefore, offer no apology for suggesting a series of experiments on the subjects treated of in this little volume.230

Edwin Lankester echoed these comments when reviewing Johnston’s *Chemistry of Common Life* in the *Athenaeum*, connecting the ‘operations of the senses’ to learning facts:

> it is a great mistake to suppose that chemistry, or any of the natural sciences, can be taught, or that they can become methods of education, by mere reading. The laws of natural science are derived from observation and experiment, and a correct knowledge of the import and value of these laws can only be imparted through the operations of the senses on the facts they embrace. It is useless to expect to teach natural science without museums, apparatus, experiments, and specimens.231

As Johnston’s book did not contain any directions for specific experimentation, readers relied on the everyday activities he described to provide such sensory experiences, ‘apparatus, experiments, and specimens’ that could readily be found around the home.

Like many a scientific education, therefore, this chapter commenced with a
discussion of quotidian chemistry. In particular, it began with that household ritual
often converted into an illuminating illustration of scientific phenomena: the
chemistry and physics of the teapot. As the tea leaves infused, the young reader was
enthused with ideas of learning about the sciences, and chemistry became his ‘cup of
tea’ in more senses than one. Theories of evaporation, solution, infusion, and even
steam power could be imparted through a closer examination with eyes, nose, hand
and tongue of familiar activities, helped along by a knowledgeable guide. An
important function of identifying these household experiments as chemistry was to
connect the potentially unreachable realms of science with the eminently attainable
home: in these ways, contemporary conceptions of the home as a shelter or refuge
could be used to overcome fears about learning the sciences. However, the cup of tea
was a doubly appropriate vehicle for these lessons, as it was the constituent parts of
tea, sugar and water themselves of which early Victorian drinkers could be afraid, due
to widely-propagated scares about adulterated foodstuffs and fluvial pollution.
Learning about chemistry was promoted as one way of overcoming these fears, and
many of the elementary tests for adulterated commodities resembled introductory
scientific experiments, as I have shown. Once safely ensconced in the domestic
environment, the further reaches of the globe could be traversed through telling the
story of the cup of tea, from leaves to exotic lands, and china to China. Rather than
the relationship outlined in chapter one of this thesis, in which the sciences were
rendered exotic, mythic and fairy-tale, the converse applied, as experimental
orientalisms became everyday objects.

For many children at this time, the factory could be almost as remote a
location as the far-off tea-fields of China. The next section of this chapter
demonstrated how experimenting with soap and candles provided one way of visiting
the sites of industrial manufacture. With these objects Victorian children moved
beyond the simple recapitulation of household activities to elucidate scientific
theories, and could begin to experience the unfamiliar effects produced through new
types of chemical manipulation. By following the experimental directions detailed by
lecturers, or appended to introductory texts, they began to enact new types of
experiments with increasingly novel objects. They could thus comprehend and
manage the spectacular in the everyday, such as the explosive properties of
potassium, or Dodd's overwhelming spectacle of the factory. An emphasis on the
senses was again appropriate: the ironically smelly and dirty soap and candle factories
were seen to be the objects whose productions most deleteriously affected the bodies
of nearby inhabitants. Just as with tea, these highly symbolic objects were already at
once commonplace and also redolent of many other events and practices: candles
and enlightenment, soap and cleanliness. Drawing on such notions, Faraday hoped
that his young listeners would themselves become fit to compare to a candle.

Many writers on elementary chemistry, from Parkes to Faraday himself,
incorporated these types of household experiments into their writings. Yet certain
phenomena could only be illustrated with specialised equipment, reactants, and
practices. Pre-packed chemical cabinets such as Ede's 'Youth's Laboratory', and its
dedicated literary companions, were created to sell to these markets: rather than
making the reader or commodity capable of transcending the spaces of the home,
empire, factory or laboratory, the laboratory itself became portable. However, these
boxes had permeable sides, being intimately linked to more common household
products and places, including their equipment and replicating their processes. I
demonstrated how the literary strategies of the prose in accompanying textbooks
reduced language to its elements, hiding location, quantities, failure, and the body of
the experimenter, and thus also transcending the household and identifying the
practices engaged in at home with those of the laboratory. However, there were
criticisms of portable laboratories such as Ede's, couched in bodily language, which
argued that pre-prepared sets gloved the hand of the experimenter: they therefore
created barriers to knowledge rather than opened doors; distanced rather than engaged their audiences with chemistry.

This chapter has taken a geographical approach to these topics, mimicking some of the authors I have studied, and accompanying readers and experimenters as they travelled around the house and world. I have discussed how these writers placed the sciences in general, and chemistry in particular, at the heart of everyday life. A powerful argument for the authority and importance of the sciences, and for men of science as capable domestic experts, such a location revealed conceptions of who was thought able to practice and understand these disciplines. Like chemistry itself, these objects of tea, candle, soap, and cabinet connected the kitchen to the chemical laboratory, to the factory, the boudoir, and the world, all under the gaze, nose, and hands of the man of science. This was achieved by the conflation of household and scientific activities, though: however insightful the science, it was, like the use of fairy tale or poetry in my first chapter, irretrievably dependent on either traditional narratives or mundane tasks and objects for its success; and it was also couched in the rhetoric of expanding knowledge of these subjects and practices.

Thus this chapter can be read in the light of debates over who could participate in the sciences at this time. Symbolised in the artefact of the sliding scale, and underscoring contemporary rhetoric, were ideas of an egalitarian chemical community, in which all could contribute to ongoing research. In the 1820s, a correspondent wrote to *The Chemist* to applaud its aims of promoting a community in which all could participate with very little equipment: he outlined, in a reference to Wollaston, how “the profoundest of the English chemists discards the fopperies of apparatus, and keeps his laboratory within the compass of a tea-tray; a few glass tubes, a blowpipe, some twenty little phials, and three or four wine glasses, suffice for his experiments.” The periodical also referenced Franklin, Priestley, and Watt to
demonstrate how great discoveries could be made with mainly household objects. Did these metonymic extensions from the candle to laws of nature imply it was just a matter of degree or quantity which separated these activities? Or were there fundamental differences in the type of activity engaged in in the specialist laboratory, the factory, and the kitchen? If what beginners were doing was like what specialists were doing, then they were still making sensuous judgements, even if mention of them disappeared from expert discourse. In these ways, far from ‘dying’ at the turn of the nineteenth century, the sensuous chemist could be immortal.

These introductions to chemistry welcomed early Victorian children into a household and world in which even the commonest object was full of wonder and magic. But more than this, they grounded chemistry in smelly, tasty, and reassuringly tangible experiences: the perfumed whiff of an exotic origin, the taste of a sugary solution, the heat of a candle flame, the weight of everyday commodities as they rested in the hand. New ideas were impressed on the mind through those ‘gateways to knowledge’, the senses: thus, these lessons on the science of common things were not just designed to get children to think about things in new ways: they were supposed to perceive, taste, touch, and smell differently, too. Whether with a dedicated ‘Youth’s Laboratory’, a few cheap gas jars, or simply a candle, a bar of soap, or a cup of tea, through these sensory object lessons the beginnings of an interest in the sciences was inculcated in nineteenth-century children as they experienced household chemistry.

233 See L. Roberts, ‘The Death of the Sensuous Chemist’.
4. VOICES OF NATURE

‘Nature was a companion speaking in a thousand voices.’
Charles Kingsley’s funeral sermon

THE ROLE OF THE SCIENTIFIC EDUCATOR in the mid-nineteenth century has been conceived of as an interpreter of the ‘voices of nature’. From the cacophonous ‘thousand voices’ that could potentially overwhelm the beginner, in the texts I shall analyse in this chapter one specific source of speech and scientific information was isolated, and located in a particular object: a tree, a fossil ammonite, and a grain of salt. Communicating knowledge was in this way achieved through making things speak to their audiences, engaging with readers via first-person narrations. Drawing on traditional pedagogical and folkloric devices of animal and object personification, texts argued from the perspective of the object in question, revealing scientific facts through the familiar forms of autobiography and dialogue. This chapter demonstrates how the use of these literary techniques did not solely communicate natural knowledge, but trained readers in how they should talk about the sciences, giving them their own scientific voice. More than this, it addresses the varied religious beliefs of these writers in relation to conceptions of voices and things, spirit and matter, and turns for the first time to consider in detail the specifically conversational practice of object lesson teaching.

Charles Kingsley’s funeral sermon, quoted in Life and Letters

See, especially, Lightman, ‘Voices of Nature’, in Victorian Science in Context. On 207 Lightman briefly discusses how these books were intended to be ‘voices of nature’ themselves.
The fourth chapter therefore takes a step back from experimental hands-on investigations, to revisit the idea of telling and listening to stories about particular objects; to considerations of voices, of biography, and of the wondrous natural world. In particular, I analyse one particular of educational narrative, what could be termed 'subject lessons': the autobiographies of mouthy objects who lectured readers themselves. In the preface to his 1861 edition of Michael Faraday's *Chemical History of a Candle*, William Crookes claimed that:

The fluid bitumen of the far East, blazing in rude vessels of baked earth; the Etruscan lamp, exquisite in form, yet ill adapted to its office; the whale, seal, or bear fat, filling the hut of the Esquimeaux or Lap with odour rather than light; the huge wax candle on the glittering altar; the range of gas lamps in our streets, - all have their stories to tell. All, if they could speak (and after their own manner they can), might warm our hearts in telling, how they have ministered to man's comfort, love of home, toil, and devotion.236

Bringing objects to life to tell their autobiographical adventures had appeared in a range of works from the eighteenth-century; these so-called 'it-narrative' tales from earlier decades had similarly animated the natural world.237 These often took a small common object as their focus — coins, and were quite explicit about the fictional strategies they employed. Medical and scientific subjects could be addressed in this manner, as well as the objects of childhood, and even books themselves: for example, respectively, *Memoirs of a Stomach* (by 'A Minister of the Interior'); J. E. Taylor's *Geological Stories* (1873); R. H. Horne's 1846 *Memoirs of a London Doll, Written by Herself*, and Annie Carey's *History of a Book* [1873], are just some examples of this rich body of

236 William Crookes, preface to Faraday, *Chemical History.*
material. As L.M. Budgen declared in Live Coals (1868), converting objects into subjects of their own memoirs or adventures was often undertaken in an attempt to reach new audiences: ‘[v]iewed as objects, they have long attracted our notice. Now we make them subjects, with a view to their notice by other people.’ Of course, anthropomorphised objects and animals were a staple of children’s literature from Aesop to Andersen, but, as this chapter demonstrates, they had a particular relationship with the practice of specific object teaching, in relation to telling biographies, and also with the sciences, in relation to ideas of the voices of nature. More generally, by exploring this topic the notion that objects can ‘speak for themselves’ can be critiqued, and the predominantly oral nature of educational practice at this time can be asserted.

One of a series of Mary Roberts’ transcriptions of Voices from the Woodlands (1850), I begin by analysing how an oak tree told the reader of its life history, botanical properties, arboreal companions, and surrounding setting. I show how Roberts used echoes of other voices within her work, from brief poetic quotations to the stories of alternative specimens, and even the voice of ‘Chemistry’ itself. However, it is the echoes of Roberts’ Quaker upbringing, and her later heterodox belief in the possibility of ‘speaking in tongues’ that, I argue, reveal how particular religious meanings underpinned what could be dismissed as a standard natural theological presentation of botany.

A consideration of the Swedenborgian philosophy advocated by John Mill also illuminates his progressive and providential presentation of geology as fossils inhabited by successive spirits. I go on to use the reincarnatory series of creatures

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239 L. M. Budgen (1868) Live Coals, or, Faces from the Fire, x.
whose experiences narrate the history of geological time in Mill's *Fossil Spirit: A Boy's Dream of Geology* (1854) to connect ideas about the voices of nature to contemporary cultures of spoken geology. I demonstrate how the education of the reading child was mapped onto this tale, as increasingly complex geological ideas and, crucially, vocabulary, were introduced, from the pictorial education of the opening pages to the index of technical terminology with which the book concluded. Having modified his speech through a range of voices from poems and archaic spirits to sesquipedalian categorisations, the aspiring boy could go on to participate in a geological enterprise characterised by oral presentation, debate, and conversation, by dinner-parties and songs.

Finally, this chapter turns to the voices of children themselves, in conversation with a talkative grain of salt, one of Annie Carey’s series of *Autobiographies* (1870). A variant on the didactic dialogues and conversational works which was the overwhelmingly favoured format for children’s scientific literature in the century, this work highlighted how boys and girls at differing stages of their education could talk with, as well as on, scientific subjects. The object lesson approach to teaching was itself based on a directed conversation: a structured series of questions and answers guided by a teacher, which sought to use sensory impressions and existing language to lead to new associations, and novel vocabulary. Sometimes such conversations were written-out in teachers’ manuals as idealised dialogues; at other times as lists of impressions to be noted, and words to be introduced. I conclude by bringing together this discursive practice of object lesson teaching with an analysis of the conversation depicted between the grain of salt and four children, to suggest ways in which the historical use of actual conversations to train children’s actual voices can be drawn out.

**An oak, or object lesson as voice from nature**
We have seen how geological writers alluded to the Shakespearean quotation "sermons in stones" to legitimise the lessons contained in natural objects. Whilst a sermon required a suitably trained minister to impart its teachings, the first part of the line, taken from *As You Like It*, emphasised a direct communication with nature: there were, it claimed, "tongues in trees". Mary Roberts’ 1850 *Voices from the Woodlands* took this notion literally, and ventriloquised a series of plants encountered on a shady forest stroll, from smallest lichen to mightiest oak. Talking in the first person, the trees assumed various appropriate characters to narrate their botanical structures, chemical properties, uses, histories, and associations to the implied rambler. This section explores the use of the oak in *Voices*, and other of Roberts’ writings, to demonstrate how the voices of nature were recruited to teach object lessons. It argues that talking trees held a particular religious significance for Roberts, raised a Quaker but later a follower of the millennialist evangelical preacher Edward Irving. Rather than a homogenised natural theology, then, sophisticated spiritual reasoning underpinned Roberts’ authorial choice of imparting voices to trees, from a meditative communion with nature and the enhanced sensory perception of the ‘Inner Light’ to a conviction of the reality of ‘speaking in tongues’.

Mary Roberts wrote a range of introductory books on topics in natural history, from the *Conchologist’s Companion* (1824) to *Domesticated Animals* (1833) and *Flowers of the Matin and Even Song* (1845), as well as works on Christianity, including *The Progress of Creation* (1823). Throughout these texts, she argued for the educational and religious value and pleasure that could be teased out from a closer examination of and meditation on natural artefacts: that ‘the acquisition of science opens a continual

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240 See, for example, the title page to *Thoughts on a Pebble*. Amongst others, Hugh Miller also referenced this quotation (O’Connor, *Earth on Show*, 5).

241 *As You Like It*, II.1. The Spectator reviewer of Charles Lyell’s *Principles* emphasised this need for interpretation: ‘There are sermons in stones [...] but they want an interpreter: that interpreter is the enlightened geologist. Such a man is MR. LYELL.’ (quoted in O’Connor 2007, p. 184).

242 *The Conchologist’s Companion* is discussed in more detail in chapter 2. Roberts appears to have begun her writing career to provide an income after the death of her father, Quaker merchant Daniel Roberts, in 1811. See Lightman, *Victorian Popularizers*, 110; Opitz 2004.
source of delight to the well-conducted mind’. On the title page to one of her earliest works, *The Wonders of the Vegetable Kingdom Displayed* (1822), she likened each discrete and common part of nature to the literary work that her readers had just picked up:

Not a tree,
A plant, a leaf, a blossom, but contains
A folio volume. We may read and read,
And read again, and still find something new,
Something to please, and something to instruct.

In her *Sea-Side Companion* (1835) she again employed the well-known natural theological analogy of the book of nature to laud the seemingly trivial as containers full of wisdom: ‘[e]very shell is like an open book; every painted sea-/weed has a lesson written on its leaves.’ Elsewhere, actual objects as common as ‘the red currant, which grows in every cottage garden’, provided hidden wonders and useful knowledge to those with a ‘botanical eye’: a trained viewer would understand why the plant’s berries were edible. With the appropriate training and vision, the parts of nature could be seen from more than one perspective, and could reveal their lessons.

In *Voices*, Roberts argued for the central precept of object lesson teaching – the many meanings held in every singular artefact – and claimed a special prismatic resonance for the oak-tree. ‘The prism’, she wrote, ‘has many sides, and the rainbow its many colours. All natural objects have their numerous associations, and none, it

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243 Mary Roberts, *Progress of Creation*, 18. Don Opitz has particularly discussed the meditative strategies of Roberts’ writings – see his introduction to *Conchologist’s Companion*.

244 Quoted on the title-page to [Mary Roberts], *The Wonders of the Vegetable Kingdom Displayed* (1822), and attributed to *The Village Curate*.

245 Mary Roberts, (1835) *The Sea-Side Companion* (London: Whittaker), 12-13. This formed a prelude to a lengthy discussion of sponges as ‘forms of vegetable beauty’ ‘deserving of attention’.

may be, more than forest trees, - the oak especially'.247 Throughout Roberts’ writings, the oak had appeared as a particularly symbolic object, being, for example, the first ‘noble’ tree to ‘suddenly spring forth’ on divine command during the third day of The Progress of Creation, her version of Genesis; and supplying the focus for many of her historical tales of Ruins and Old Trees (1849).248 Indeed, in the first epistolary instalment of Wonders of the Vegetable Kingdom, Roberts had opened the central educational conversation by contrasting the narrator’s botanical expertise with the historic (and ‘pagan’) ‘associations’ her interlocutor, Lælius, had made with an oak:

As we were walking, Lælius, through the groves of Hagley, you pointed out a stately oak, and reverted, with all the glow of youthful and poetic feeling, to the piety of ancient times. 

Your associations with the monarch of the forest were those of classic feeling; mine were derived from the charms of nature, and the love of botany. Which of them, my Lælius, are productive of the purest pleasure? What did your imagination present to you, but pagan rites and senseless superstitions? Listen to me, and I will endeavour to point your attention to better things than these.249

Barraging Lælius with rhetorical questions, Roberts exhorted him to ‘listen’ to her as she voiced and communicated ‘the charms of nature’, far superior to ‘classic feeling’ (appropriate, after all, to his Latinate name) on the subject of the oak. The purely imaginative response to seeing a natural object was allied with ‘pagan rites and senseless superstitions’; and had its ‘purity’ questioned: botany was ‘better’. The educational process of the letter continued to be structured by rhetorical questioning:

248 Roberts, Progress of Creation 11; Roberts [1843] Ruins and Old Trees Associated with Remarkable Events in English History (London: Harvey and Darton). Renowned oak-trees featured in Ruins included The Queen's Oak; The Oak of Salcey; Hatfield Oak; The Oak of Chertsey; Glendour's Oak; The Oak of Howel Sele; The Blasted Oak; Wallace's Oak; and The Parliament Oak.
The oak rises from an acorn: its roots imbibe the moisture of the earth: its leaves are watered with the dew of heaven. Can you tell me through what conduits that moisture is conveyed, or how the drops of rain refresh the stately tree?  

At this point, the reader could not answer such a question; by the end of *Wonders*, however, he would have learned along with Lælius of the microscopic structure of leaves and trunks.

![Oak](image)

**FIGURE THIRTY THREE: The Oak, frontispiece image to *Voices from the Woodlands***

In *Voices From the Woodlands* a different voiced strategy was used to draw the reader in: the Oak drew attention to itself and its properties, rather than being pointed out by Roberts’ self in the persona of narrator: ‘BEHOLD in me’, it

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declamed in 'stately' tones, exhorting the rambler to look more closely at its body, rather than strolling by, unnoticing. The chatty Oak's tale characterised the world as filled with similarly enlivened inhabitants, from 'the quiet yet unwearyed labours of a small sisterhood of lichens and bright mosses' to the 'friendly gas' oxygen; frost became the bearer of a 'magic wand', which 'garnished' 'every shivering blade of grass and fern, till the coarsest herbage glittered to the wintry sunbeams, as if gemmed with diamonds'. By using such imaginative strategies in her descriptive prose, Roberts continued her quest to bring the subject of botany to life.

After detailing how the acorn had begun to grow, the Oak then gave an object lesson on its 'outward form', on which the reader was supposed to gaze, whilst listening to details of its 'inward mechanisms'. In effect, this re-enacted what would have occurred in a contemporary nursery or classroom, where 'a piece of bark of the oak tree' was one popular subject for lessons: children would have been given the natural object to 'consider', and then enjoined to 'hear' what their teacher had to say about it. Roberts' lesson began as follows:

Consider my outward form, and hear concerning the inward mechanism by which that form progressed to perfection and is still sustained. First is the cuticle, or bark, smooth in youth, furrowed as years pass on, and furnished with pores through which both air and light may pass, in order to perform their active ministry. To this succeeds a green substance, called the cellular integument; next, the inner bark; and, lastly, the wood, diversified with a variety of concentric circles, each the growth of a single year, and designating, by consequence, my age.

The internal or true wood is hard, and often darkly coloured; the outer differs in appearance, and through this ascends innumerable vessels,

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251 Roberts, *Voices*, 61. I am capitalising the Oak (as Roberts does when the tree is first introduced) to emphasise that this is one particular arboreal character.

252 Ibid., 61-63.
which, becoming spiral in the leaf-stalks, ramify between the pulpy
substance of the leaves. These vessels act as conduits for the moisture of
the earth, which, being absorbed by the roots, rise through them into the
leaves, and, after undergoing a chemical change through the agency of air
and light, is brought back by another set of vessels down the leaf-stalks
into the wood, where it deposits the principal secretions in all trees.  

The educational process was structured as a logical journey into the centre of the tree,
and through its vessels from root to leaf (and back again). The same subject – that of
how water travels through a plant – was addressed to that tackled at the beginning of
Wonders, but this time it was spoken in a definite, detailed, and authoritative tone: the
reader was not asked questions nor to venture an opinion; rather, he or she was told
absolutes: ‘is brought’, ‘is hard’; and was introduced to a more technical vocabulary:

As with a more traditionally-presented object lesson, after this consideration of
botanical properties the Oak then related its sensory ‘qualities’ to a range of different
uses; repeating the word ‘hence’ it tethered the lesson, which had the potential to
stray too far into myriad topics – fragmenting, in Roberts’ analogy, like light through
a prism – to its own body:

Hence it is, that to my bark and roots, my leaves and acorns, different
qualities are assigned; that my wood, though hard and tough, is flexible,
adapted also for wainscotting and furniture, and that the highest praise
which can be given to men of dauntless expertise and valour, is to say that
they have “hearts of oak.” Hence, also, the chemist owes to me oak
vinegar, with which to facilitate his experiments; the dyer, bark for
tanning; the gardener, beds for producing artificial heat in pineries; and

while every variety of drab and shade of brown is afforded by my wood or bark, the scribe derives from such excrescences as grow upon my leaves, the blackest and most lasting ink.254

As well as demonstrating the importance of oak-trees to a range of contemporary workers — chemists, dyers, writers, carpenters — the Oak drew moral lessons from its properties: its ‘stately voice’ was now found to emanate from a character ‘of dauntless expertise and valour’. An equation between the life of the tree and the people who strolled beneath its branches ran throughout the lesson; for example, the Oak had detailed how its skin was ‘smooth in youth, furrowed as years pass on’. This both fleshed out the tree as a more human character, but also brought its audience closer to identifying with the expert, authoritative, and definitive knowledge spoken by the Oak.

One way in which poetry was used in object lessons was as an authoritative voice, marshalled to instil moral responsibility in those reading the lesson: they too could resemble Roberts’ wise Oak. Children in particular were encouraged to identify with the potential inherent in the acorn, a child-sized artefact which, though little, would go on to achieve great things. The message of the Oak’s story, from ‘my acorn cradle’ onwards, reinforced a progression from playful child to stately and noble adult:255

Small, therefore, was my origin, nurtured by viewless elements, - an acorn - a cup for babes to play with; but now a monarch of the forest, rising with umbrageous majesty among my tributary trees.256

254 Ibid., 65.
255 Ibid., 62.
256 Ibid., 63.
Returning to the prismatic nature of the objects she discussed, Roberts included the stories of more than one oak tree in *Voices*, highlighting the many possible stories of oaks. The different characters presented related to the individuated histories of any particular tree: though these were typical objects, standing in for oaks in general, they were also given their own voice. Therefore, at the close of the first oak's narration, another specimen picked up the thread of the tale:

The strong oak ceased; and presently another voice/ sounded feebly from a time-worn and hollow trunk, grey with pendent lichens.

*Centuries have come and gone, the weak voice said...* 257

The voices of the oaks were matched to their physical properties, as they conversed amongst themselves as well as between tree and man. Roberts let her own authorial voice enter the narrative at one point, pointing up the equivalence of these conversations – the analogy between humans reading the work and the talking trees themselves – to wish that her fictive device were in fact true:

Old men like to converse with one another. You may see them in sunny weather, beneath the shelter of some aged tree ... Would that the old memorial oaks of Britain could thus meet together, each with his word of wisdom or narratives... 258

There were more voices speaking in *Voices from the Woodlands* than just those of the trees: as well as an authorial presence, Roberts layered and complicated the speech she used. For example, at one point ‘Chemistry’ (a capitalised personification, if not deification, of the discipline) burst onto the scene and addressed the reader:

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Suddenly, and as if with a magic wand bringing hidden things to light, Chemistry appeared, and, touching the royal fern, thus spake: -

What see you, Stranger? A group of ferns waving in the summer breeze, and reflecting the rays of light; - much, too, of sylvan beauty, for the spot in which they grow is wildly picturesque. Men often stop in passing to admire. “Yonder group of ferns,” they say, “are beautiful, thrown off in light and shadow from the old grey rock;” and thus speaking they pass on...

As well as bringing trees to life. Roberts also gave the very disciplines of the sciences and forces of nature personalities (here, rather an archaic one – signified by the choice of ‘spake’, ‘sylvan’, ‘yonder’, etc.); the human readers themselves also had words attributed to them, as well as a rather dilettante nature, prone as they were to ‘passing on’.260 Roberts had dedicated the ‘volume’ to ‘the admirers of woodland scenery’ such as the men who appeared as characters in this passage, and claimed its purpose was to prevent this rapid ‘passing on’ after remarking on the beauty and ‘picturesque’ nature of a natural scene: Voices was ‘designed to awaken the sympathies of those who may have passed hitherto amid the beautiful solitudes of nature unmindful that every tree hath its own history.’261

An introductory work, the book was designed to appeal to beginning audiences, ‘awakening’ their ‘sympathies’ for the subject, as well as those who might not have read a more dryly didactic work; this could be one reason for the imaginative way in which it was written. In a self-aware passage right at the beginning of the book, Roberts addressed her choice of literary style in a prefatory disclaimer, in which she herself feigned hearing a voice:

259 Ibid., 56-57.
260 Compare the discussion of the dilettante experience of visiting the Great Exhibition in chapter 1.
261 Roberts, Voices, dedication.
Methinks I hear some one say, Why are things inanimate thus fabled to speak? Why not rather tell concerning their properties and uses, and the places of their growth, without having recourse to fiction?

To counter suspicion of the fantastical fictional device of giving her trees the faculty of speech, or, as she phrased it, to avoid ‘chafing’ a reader’s scientific sensibilities, she invoked Biblical precedent and authority:

Be not chafed, courteous Reader, but remember, that poets in all ages have preferred to instruct mankind after the same manner; that even the Sacred Volume offers a precedent which cannot be objected to; when Jotham, desiring to reprove the treachery of the men of Shechem, went to the top of Mount Gerizim, and put forth a parable concerning the trees, who sought for a king to rule over them.262

This Biblical ‘sanction’ (a parable from Judges 9 which featured talking olive and fig trees, amongst others) was what ‘above all’ had ‘encouraged’ Roberts as she ‘ventured to assign both speech and memory, with the love of poetry and nature, to many an aged tree or sapling, fern or way-side moss; trusting that some who read, will go forth into the woods, and learn to gladden their solitary walks with associations of engrossing interest.’263

Roberts’ emphasis on a practical communion with nature can be illuminated by considering the Quaker faith in which she had originally been raised, before she broke with the church in 1826. Quaker theology advocated practical interactions with the natural world as a suitable part of religious behaviour; faith was founded on and

in the service of actions, from the most profound to the most mundane. Certain practices were favoured above others, and Sunday afternoon nature walks through the countryside were one such activity deemed a suitably inspiring pursuit: 'A country walk, asserted one Quaker, results in our feelings being 'soothed and comforted, our [religious] faith a little strengthened.' It was this enhanced experience of both deriving spiritual succour and botanical knowledge from the woods that Roberts sought for her readers: what could be seen on one level as a general natural theological desire to unite nature study and religion was given a more particular denominational cast.

For Roberts, studying botany had from the first been as much a religious as a scientific practice, which she made clear in her explicitly theological writings. In such works, Roberts advocated meditation, natural science, and self-improvement through education: she concluded her Sequel to an Unfinished Manuscript of Henry Kirke White (1823) with 'Rules for the Conduct of Life' culled from 'the writings of several eminent persons'. This manifesto for an appropriately devout life (which would ensure that its readers ended up on the correct side of the 'Christian' and 'Infidel' divide into which she split the depictions of death-bed scenes that formed the body of the work) included praise for the sciences as an appropriate pastime, especially astronomy and natural history, which as empirical rather than rational pursuits were the disciplines engaged in most frequently by Quakers:

Fetch down some knowledge from the clouds, the sun, the moon, and the revolutions of the planets. Draw up some valuable meditations from the depth of the earth, and search for them through the vast oceans of water. Extract some intellectual improvement from the minerals and metals;

265 Ibid., 235.
266 Ibid., 232.
from the wonders of nature among the vegetables and herbs, trees and flowers. Learn some lessons from the birds, the beasts, and the meanest insects. Read the wisdom of God, and his admirable contrivance in them all: read his almighty power, his rich and varied goodness in all the works of his hands.267

Later in the same section, Roberts again emphasised that it was through engaging the body that her readers would ‘honour’ their ‘Maker’: employing ‘sensation, judgment, memory, feet, hands, &c.,’ would benefit others around them, as well as lead to their ‘own best interest and happiness’.268

Quaker doctrine held that within the body of each believer shone what was termed the ‘Inner Light’. This Light affected all actions and all sense-perception. For example, as Geoffrey Cantor puts it, ‘when a flower is observed, perception is not restricted to seeing the physical properties of the flower, such as its shape and colour, but the observer also appreciates its beauty, and is thereby led to a consciousness of its Creator … raising the experience of a physical object to a more spiritual plane’.269 This elevation of experience to a doubly sensory and spiritual process was what Roberts sought to achieve in her writings, ultimately developing in her readers the kind of all-encompassing sensation of the Inner Light, informing all actions: as she claimed in The Sea-Side Companion, ‘God is in every place; he speaks in every sound we hear; he is seen in all that our eyes behold!’270

The senses developed through following Roberts’ educational process and reading her books – through stopping and meditating – would therefore give students something akin to an Inner Light of their own, but this inspiration would be

268 Ibid., 142.
269 Cantor, Quakers, Jews, and Science, 235-236.
scientific. For example, the ‘botanic eye’ with which she claimed one could look at a redcurrant bush in *The Progress of Creation* was one manifestation of this prosthetic sensory enhancement – looking was not simply ‘looking’ any more. Also in that 1823 work, she posited the possibility of enhanced hearing, that, in an echo of Milton ‘the whole creation might then break forth into singing’.

Indeed, in *Voices*, she wrote that not only can one stop and listen to trees, but also to the wind, sun, and rain:

> Seek such knowledge, not from books, but in the places of our growth.
> Listen to what the winds may tell you, warm sunbeams, and passing showers, for all minister alike, and shed a blessing as they pass.

In the preface to *Flowers of the Matin and Even Song*, Roberts termed this religious and scientific ability to hear what nature had to say ‘the ear of reason’:

> EVERY flower telleth its own tale to the ear of reason; yet men pass by unheeding. Women too, and young children, who love flowers, and ask questions concerning them, seem alike regardless of the small voices which speak from out the brakes and hedgerows, the gaily decked meadows, and daisied commons.
> I have listened to those voices, heightening the delight of every country walk, and I have desired that others should profit likewise. Amid those mingled voices, therefore, I have sought to embody a few of the most interesting...

In later life, Roberts became a follower of evangelical preacher Edward Irving, at whose services she would have listened to the ‘mingled voices’ of spiritual utterances.

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271 Roberts, *Progress of Creation*, 219. The relevant section from *Paradise Lost* had been quoted a few pages earlier.
272 Roberts, *Voices*, 56.
273 Roberts, (1845) *Flowers of the Matin and Even Song* (London: Grant and Griffith), [v]-vi
which erupted via inspired members of his congregation as apparent ‘gifts of the Spirit’. In her *Life of Edward Irving* Mrs Oliphant evoked the differing reactions to such supposedly unmediated spiritual sounds:

To some the ecstatic exclamations, with their rolling syllables and mighty voice, were imposing and awful; to others it was merely gibberish shouted from stentorian lungs; to others an uneasy wonder, which it was a relief to find passing into English.

In an analogous way, Roberts converted the potential ‘gibberish’ heard from the natural world – speaking to her from flowers and hedgerows – into ‘English’ for her young audience, couching potentially ‘imposing’ botanical knowledge in appealing autobiographies.

Upon a first encounter, the talking trees of *Voices from the Woodland* seemed to speak both directly for nature, and directly for themselves. Through a first-person narration of their life-stories and memories they seemed to avoid problems of interpretation, communicating knowledge of botanical structures, historical fables, and wondrous chemical processes immediately to their audiences. However, by reading Roberts’ body of works in the context of her changing religious beliefs, a particular conception of natural theology has been emphasised, as she combined spirit and matter. Based around a series of meditations on specific natural objects, be it shells, trees, or flowers, her writings advocated the pleasure and rational and religious benefits to be derived from learning, actively, about scientific topics. This spur to action was crucial: she sought to affect her readers’ habits of communing with

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nature, teaching them to stop and think about what they encountered at the sea-side, in the garden, or on a woodland stroll. She encouraged a meditative process of reasoning, through which the student travelled from the original whole object to its parts and uses, meanings and history, that was to be enacted with actual specimens, in nature itself. Quaker beliefs about the importance of the *vita activa*—of worship through actions—and of the ‘Inner Light’ which rendered every experience a spiritual act, lending the believer superior ways of interacting with the surrounding world, underpinned this message. Such augmented senses appeared throughout Roberts’ writings, as the ‘botanical eye’ which can assess how and why a redcurrant is edible, or as the ‘ear of reason’ which can hear the tale told by every flower: the inner knowledge provided by scientific training, she argued, enhanced perception in analogous ways to religious inspiration.

In these ways, the less conventional spiritual beliefs Roberts came to hold as a follower of Edward Irving help illuminate her choice of first-person narration for the trees in *Voices from the Woodland*: for Roberts, the use of ‘tongues in trees’ was, I have argued, closely related to the conviction of ‘speaking in tongues’ that was a founding tenet of Irving’s circle. For a more orthodox readership, Roberts had initially invoked Biblical precedent when asking her readers to accept her narrative conceit of talking trees, but she also drew on the particularly Irvingite importance, central to the group’s rather flamboyant services of worship, of ‘utterances’ in supposedly spiritual or natural languages, direct from a supernatural source. Paying attention to how voices were given to trees in her book—to the language in which they were presented as speaking—elucidates how she expected her readers to listen to nature. The aural experience of listening to *Voices* or to *Flowers of the Matin and Even Song*, which also made extensive use of poetic quotations, resembled the measured approach of her visual education through meditative reasoning: the changing tone and breaking-in of different voices necessitated a sustained attention to the shifting prose to make sense of the potential cacophony. Just as in her personal life, Roberts overlaid these ideas of

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a privileged access to the secret languages of nature onto her pre-existing Quaker convictions of the importance of an active pursuit of empirical science, and of all experience as enlightened religious practice. In these ways, the process of meditation itself, espoused in her earlier works and analysed in chapter one, can thus be reconceived as an act of listening to nature, in which privileged hearers received information in their ‘ears of reason’.

Through a focus on John Mill, another unorthodox religious figure – in this case a follower of Swedenborgian mysticism – and his children’s book *The Fossil Spirit*, the next section demonstrates that conceptions of voices of nature formed both part of a heterogeneous natural theology as well as of practical education that prepared children for entrance into the oral culture of scientific practice.

**An ammonite, or object lesson as spirit**

John Mill’s *The Fossil Spirit; A Boy’s Dream of Geology* (1854) narrated the geological history of the globe through a succession of reanimated fossil forms, as remembered by the serial reincarnations of a mystical fakir. An ‘ingenious idea’, as the *Athenaeum* commented.276 Voices were given to a succession of extinct animal forms, including ammonites, plesiosaurs, dodos and orang-utans, to form a rich and allusive text that drew on its author’s wide-ranging interests, from phrenology and technical education to clairvoyance and the mystical philosophy of Emanuel Swedenborg. This section first considers how voices were used in the text to resurrect the subject matter of geology via first-person narratives, particularly in relation to Mill’s own heterodox views on the transferral of spirits and persistence of matter. It then traces how such voices were appropriate for future participation in a geological culture of conversation and song.

Unlike many other contemporary geological texts, which gave an account narrated by a disembodied, omniscient narrator, Mill explicitly located the voice and personality of scientific knowledge in the fossil creature itself. As neither a geological lecturer, nor well-known for his own work on the topic, Mill used these animal and spiritual characters rather than his own personality to impart authoritative information. The fossils were given voices that readers could emulate in their own artificially contrived, but seemingly ‘natural’ geological speech. With his speaking creatures, Mill invoked traditions of fabular and natural historical anthropomorphism. More closely, his reincarnatory narrative resembled the short tale ‘The Transmigrations of Indur’, from Barbauld and Aiken’s *Evenings at Home*. This similarly couched natural historical pedagogy in the guise of an Eastern tale: in this case a third person account of what happened to a Fakir who tangled with a fairy:

Instantly he found himself in a green valley, by the side of a clear stream, grazing amidst a herd of antelopes. He admired his elegant shape, sleek spotted skin, and polished spiral horns; and drank with delight of the cool rivulet, cropped the juicy herb, and sported with his companions.... When the struggle of death was over, Indur was equally surprised and pleased on finding himself soaring high in the air, as one of a flight of Wild Geese, in their annual migration... Indur, awaking as it were from a trance, found himself again in the happy region he had formerly inhabited...

Mill took this idea of a Fakir who had ‘cherished the memory of his transmigrations, and handed them down to posterity’ and applied it to an historical, geological sequence, rather than the series of living creatures inhabited by Indur. The well-known and extraordinary ‘dreamland’ sequence of Charles Kingsley’s *Alton Locke* (1849) was another contemporary experiment in how to write about changing forms

of life: its first-person narrative, surreal frame and successive inhabitations would all be echoed in *Fossil Spirit*:

And I was a soft crab, under a stone on the seashore. With infinite starvation, and struggling, and kicking, I had got rid of my armour, shield by shield, and joint by joint, and cowered, naked and pitiable, in the dark, among dead shells and ooze. . . . my cousin, as he turned away, thrust the stone back with his foot, and squelched me flat. 280

For example, a characteristic passage of the early part of *Fossil Spirit* chronicled what happened when the Fakir lived in the primeval sea:

I soon after became a sea reptile of the most strange and wonderful kind that ever existed. Here is my likeness. I was a Plesiosaurus. I had a small head and a very long neck. The neck of the swan or the giraffe are but feeble imitations of mine; it was as long as all the rest of my body, tail included. My neck was small except it were near the body, but the bones and muscles were so beautifully arranged that I had great strength in it. My head was small, but mouth large and strong; my paddles were not good for walking, so I never came on land except when it was necessary to deposit my eggs, where in the warm sun my young were brought forth. I had above a hundred teeth, all sharp and strong. 281

In his different fossil forms, the Fakir inhabited different characters; as he recalled, “I have been a dull, stupid, and indolent booby, confined to one rock or creek, and a lively navigator of the air, passing from one country to another, like the crane and swallow.” 282 Mill tailored his voice to convey appropriate information, for example

282 Ibid., 64.
using Pliny the Younger's memories to detail events at Pompeii, and demonstrate the geological importance of earthquakes the Fakir turns into the figure of a time-travelling historian. Each of these creatures was intended to provide a living lesson in palaeontology: rather than lengthy scientific words they were beings with their own voices and characters.

A brief comparison with another Victorian geological work, William Buckland's 1836 Bridgewater Treatise, *Geology and Mineralogy Considered with Reference to Natural Theology*, brings out Mill's different scientific voice; here, Buckland discusses the planned creation of coal:

Thus, from the wreck of forests that waved upon the surface of the primeval lands, and from ferruginous mud that was lodged at the bottom of the primeval waters, we derive our chief supplies of coal and iron; those two fundamental elements of art and industry, which contribute

more than any other mineral production of the earth, to increase the riches, and multiply the comfort, and ameliorate the condition of mankind.284

Fossil Spirit to some extent conformed with the content of other geological works – for example, the illustration of the vegetation of the coal period was exactly the same as the frontispiece to David Ansted’s Ancient World, evidently where Mill got the image from; however, Mill’s mode of presentation and choice of language showed considerable differences.285 In treating of the same subject of coal, for example, he introduced a new character, the ‘spirit of nature’:

“The spirit of nature spoke once again, and said, ‘call up in thy mind, the plants which once flourished more than a thousand feet beneath the surface whereon thou now standest … behold how carefully they are laid under layers of rocks; buried, but not lost, it shall yet come forth to a glorious resurrection, shall be a household god to millions of families, shielding them from cold and want.’”286

We can see Mill’s careful layering of voices in this passage: Mill has the Fakir, now reporting the voice of nature, emphasise the benevolence and love of the deity, who ‘carefully’ deposited vegetation in the carboniferous era in order that mankind’s existence should be ‘shielded from cold and want’. The religious tenor of many contemporary works is here made explicit, with the coal itself regarded as something divine: a ‘household god’. Moreover, mankind’s use of coal is also linked to the book’s central concept of resurrection involved in bringing the fossil forms back to life. Mill’s revivification of fossils by imbuing them with spirit is therefore regarded as

286 Mill, Fossil Spirit, 156.
something that is daily achieved through the power of modern industry and science: comparative anatomy becomes the coal mine.

![Vegetation of England during the Coal period.](image)

**FIGURE THIRTY FIVE:** Mill’s illustration of Vegetation of England during the Coal period, which was taken from the frontispiece to Ansted’s *Ancient World.*

Mill’s emphasis on how one spirit travelled through these diverse fossils, and his introduction of other spiritual characters, is illuminated by a series of lectures, or ‘Orations’, he gave in the winter of 1857, on the life and mystical philosophy of Emanuel Swedenborg. These were printed in pamphlets for the price of sixpence; reviews reproduced on the back of which proudly proclaimed that the *Weekly Christian News* expostulated to have ‘read some strange things in our day – the ravings of fanaticism, the dreams of insanity, and the blasphemies of infidelity, but this ‘Oration’ in some respects outdoes them all.’

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I want you to familiarise your mind with Swedenborg, until you catch the light which radiates from his eye, and see the creation as he saw it, full of God. With him as our guide we not only pick up the pebble of science on the shores of the great ocean of truth, but look out upon the main, even to the horizon of eternity, and see wave after wave of God's love rolling on in everlasting succession, sparkling with heavenly light, and awakening music in every atom of this vast universe...  

Mill recalled the quotation attributed to Newton, as well as Mantell's emphasis on how picking up pebbles could open up vistas of time and laws of nature, as I discussed in chapter one. The first song in Fossil Spirit was entitled 'The Pebble-Stone', and gave details of this 'wondrous traveller' 'of yore', as just one example of the geological 'music' that had been 'awakened'.  

This passage was part of Mill's conclusion to his third lecture in the series, which was given on February 8th, and addressed 'The Philosophy of Death'. Geology was his chosen theme, and he claimed that in the succession of creatures in 'the crust of the earth', and as found in a microscopical examination of limestone, reveal 'the transmutations through which matter is destined to pass'. After a recapitulation of Ansted's division of geological time – very similar to the technical content of Fossil Spirit – Mill determined that this history would provide 'the text book from which to expound the laws affecting [man's] natural death'. The rocky evidence, a genre of educational publications, and the laws underpinning a Swedenborgian book of nature were all tied together. The idea of a sustained spirit inhabiting different material forms that was so central to the success of Fossil Spirit was also raised:

288 Ibid., 31-32.
290 Mill, Swedenborg, 6.
291 Ibid. 7.
All things are altered, but nothing perishes; for as the softened wax receives a new impression every time the seal is applied to it, so death effaces one image whose place is shortly supplied by another, the forms disappear, the names are changed, but the substance remains the same. 292

The spirit — for Mill, the ‘substance’ — would be conserved, whilst its incarnation in matter — its ‘forms’ — would disappear, preserved only as a series of fossils. In *Fossil Spirit*, this idea that ‘nothing perishes’ and that man would go on to a higher, spiritual plane of existence, was encapsulated in many of the songs that end the book’s chapters; for example, ‘The Song of Death’, though it began with an emphasis on the relentless extinction of the natural world, closed with a reminder that there was a ‘brighter day’ to come:

They are dead, dead, dead,
I have slain them all,
In the grave are laid
The great and small.
... all that was
Is crushed and broke
And I reign supreme o’er every breath,
The Lord of all, and my name is DEATH.
...
Behind the cloud it is bright and fair,
But they see not the sun that is shining there.
I am the cloud, fruitful and kind,
And a brighter day is still behind. 293

Mill followed Swedenborg’s philosophy of ‘resuscitation’, namely ‘the withdrawing of
the spirit from the body, and its introduction into the spiritual world’, that would
form this ‘brighter day’. Indeed, Swedenborg’s account of his journeys to the spirit
realm had supposedly demonstrated this process ‘by actual experience’; much like the
Fakir’s story of his actual transmigrations as embodied, first-person accounts. In
these ways, spiritualistic convictions underpinned Mill’s writings, in contrast with a
materialism that, as he declared, ‘finds man ignorant and leaves him helpless’.

These spiritualistic convictions help explain the role of spirits within *Fossil
Spirit*, including how they fulfil the promise of its title in combining with fossils. The
spiritual form of the Fakir is present but he also converses with the ‘spirit of nature’.
These spirits, encountered on *Fossil Spirit’s* journey through geological time, are
characters who can introduce new geological concepts or opposing opinions and help
retain a child’s interest in the text. Spirits and revivified fossils could therefore play
different roles in a more nuanced presentation of science; for example, when Mill
speaks through the character of the ‘spirit of nature’ the replacement of ‘you’ when
indicating the second person with ‘thou’ demonstrated the change in voice: this is
perhaps intended to denote that the spirits come from another age, or that they have
a personal relationship with the Fakir, and hence the reader.

Through differentiating such personae, Mill could also present ideas that were
counter to his surface narrative of a seemingly unstoppable progress up to Victorian
Britain. For example, from the perspective of the spirit of nature, the steam engine
becomes a monstrous and noisy antediluvian beast, not unlike the bodies of those
creatures inhabited by the fakir’s spirit:

“Dost thou see that huge monster, hissing, groaning, bellowing, with lips
of iron and nostrils of steel; dost thou not hear him grunt like a huge

elephant, vomiting forth fire and smoke as it drags along the inhabitants of a town, annihilating time and space in its tremendous rush? – that steam engine is the child of the COAL.'”

Through its onomatopoeic language, this quotation explicitly evoked the ‘soundscape’ of the text. Like the fossils, the steam engine was given animal characteristics, in this case a blend of the most terrifying and powerful that exist or have existed: a ‘hissing, groaning’, ‘grunting’, ‘vomiting’ ‘monster’. Its characterisation as an elephant linked to the location of the story in India, ‘by the sacred rivers of Hindoostan’, and also to the elephantine mammoths of Britain’s previous ages.

_Fossil Spirit_ played on these ideas of distinct and layered voices with an additional complicating level: the Fakir’s fictional tale was recounted by an old man to an audience of boys as they sat on stones containing fossils along the banks of the river Ganges. This recreated the educational experience of many of Mill’s audience themselves, as at this time it was often through the reading aloud and discussion of texts in the family circle that children came to learn in a domestic setting: teaching and learning could be spoken activities that themselves required training. For example, this can be seen in the illustration to Margaret Gatty’s ‘Training and Restraining’ in her 1855 _Parables from Nature_, which depicted a child and an adult reading together, rather than portraying the events of the story. Much recent scholarship has illuminated how complex ideas of ‘implied’ readers in children’s literature are: a reader can fulfil many roles, as adult or child, mute or dramatist, bringing their own interpretation to the text – particularly with this emphasis on reading texts aloud. First-person narratives such as the dramatic monologues of _Fossil Spirit_ have been seen as a particularly important genre as they ‘repeat and enact

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298 Ibid., 139.
this production of locution'. As Alan Rauch notes in his discussion of Gatty, 'the reader; when reading aloud, may, in a child's eyes, become the author'. It was as though voices were conjured directly from deep time.

In the introduction to her compilation of extracts designed to teach 'young ladies' 'the art of reading aloud', Sarah Ellis, well-known author of the series of conduct books Daughters, Wives, and Mothers of England, believed that this communal, conversational way of learning was superior to the solitary skimming of texts: whereas the latter often resulted in 'extremely erroneous' and 'vague' 'notions', 'social reading' resulted in the 'right apprehension'. More than this, such conversations between family members and texts served to affect the thoughts and conduct of children: 'Reading aloud, and reading well, ought not to be considered as mere amusement. It deserves a much higher place as a moral agent in the discipline of human life.'

Therefore it was not just, as Garrett Stewart has written, that reading mentally 'evocalised' the voice from the words on the page: through this common practice of reading texts aloud, contemporaries expected that children's actual ways of speaking would be affected, particularly by such first-person tales. This can be seen in a review of Frances Freeling Broderip's Tales of the Toys, told by Themselves, which emphasised that when writing children's works, attention must be paid to the slightest alterations in the type of speech represented. By misspelling magenta as 'magenter', the author had imitated 'uneducated modes of speech and pronunciation'; such a representation was 'not advisable' since '[c]hildren have a strange faculty for picking up wrong modes of speech.' Moreover, this was 'more objectionable in a book than

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299 Roberts, 'Browning', 124.
300 Rauch, 'Parables and Parodies', 139.
301 Sarah Stickney Ellis (1845) The Young Ladies' Reader: or, Extracts from Modern Authors. (London: Grant and Griffith, successors to John Harris), 14.
302 Ibid., 9.
in real life.\textsuperscript{304} When reading tales about talking things, it was expected that readers’ actual ways of speaking would be affected; indeed, such vicarious experience could even be more potent that direct conversation.

The education of the implicit and explicit voices contained within the text can be traced through a subtle but definite change in the Fakir’s voice, and in the increasing replacement of illustrated explanations with purely verbal expositions. The character himself called attention to this fact around a third of the way through the book: “Hitherto,” said the Fakir, “I have told the story of my life in brief and simple sentences”.\textsuperscript{305} For example, compare the complexity of the following passage to Mill’s description, earlier in the book, of the plesiosaurus:

There are two substances which are formed from combinations of the principal earths, which, if our time permitted, it would be well to speak of. These are Hornblende and Mica; the former a prevalent ingredient in the trap rocks, and the latter of a soft lemellar texture, easily split into flexible transparent slates.\textsuperscript{306}

By pages 204 to 205 the Fakir was confident enough to revisit his previous reincarnations from a more sophisticated perspective, presenting the information in a more technical and synthesising way, and as conceived of by geologists, starting with the Azoic period.

Drawing attention to the vocal act of reading at the time, by using varied voices Mill’s text also stressed the oral nature of geological practice. For example, for Victorian writers about geology the Biblical story of the prophet Ezekiel provided

\textsuperscript{304} [G.E. Jewsbury], (1868) ‘Review – Tales of the Toys, Told by Themselves’, Athenaeum, 2145 (Dec. 5), 753.
\textsuperscript{305} Mill, Fossil Spirit, 90.
\textsuperscript{306} Ibid. 140.
one way of thinking about the power of the voice in relation to their discipline. In this story, Ezekiel is led by God into ‘the valley of dry bones’ and instructed to ‘say unto them, O ye dry bones, hear the word of the Lord.’ As he speaks, ‘there was a noise, and behold a shaking, and the bones came together, bone to his bone. And when I beheld, lo, the sinews and the flesh came up upon them, and the skin covered them above: but there was no breath in them...So I prophesied as he commanded me, and the breath came unto them, and they lived, and stood up upon their feet, an exceeding great army.’

Echoes of this tale abound in *Fossil Spirit*, for example Mill’s prefatory hope that he has ‘succeeded in clothing the dry bones of the earth with flesh, and animating them with spirit’. In the appendix, Mill directly quoted this biblical passage, investing Georges Cuvier, the Parisian ‘father’ of comparative anatomy, with the prophetic role of Ezekiel: ‘Well prepared by previous study, this distinguished anatomist went among them with the inquiry, “Can these bones live?” The spirit of scientific prophecy was upon him, and, as he uttered his inspirations, “there was a noise, and behold...”’

The work therefore argued that if prepared by suitable study (such as reading Mill’s book), readers could themselves become Cuvier by the power of speaking; they too could summon up extinct creatures.

Many different conversations about geology were occurring throughout Victorian Britain, from fashionable dinner-party gossip and introductory lectures to the spoken presentation and discussion of papers at the Geological Society. Indeed, it was said that the Society had been founded as ‘a little talking geological dinner club’ in November 1807. Though there were some concerns that if internal debate were reported the public might become confused at the lack of a coherent body of geological knowledge, and fears that being too free with arguments could lead into unrestrained and ungentlemanly conduct, discussions were formalised as part of the

307 Book of Ezekiel 37:7-8,10.
Society's meetings in 1827. In William Fitton's Presidential Address for that year he commended the:

self-command that renders both agreeable and instructive the conversations, (I will not call them discussions – much less debates) with which it is now our practice to follow up the reading of memoirs at our table; and which have given to our evening meetings a character more like that of social intercourse in a private circle, than of the formal proceeding of a public body.311

How close the activities of the Society were to Mill's project in *Fossil Spirit* can be seen in a punning letter written by Charles Lyell to his father in June, 1823:

We had a very full meeting of the Geological last night; many foreigners at our club dinner, who were very entertaining. Professor Oersted, of Copenhagen, pronounced the following eulogium of our scientific dinners of which, as it was spoken in English, you may imagine the ludicrous effect. 'Your public dinners, gentlemen, I do love, they are a sort of sacrament, in which you do beautifully blend the spiritual and the corporeal!!'312

The emphasis on discussion at the Geological lingered into the 1850s, when Mill was writing *Fossil Spirit*. Andrew Ramsay recorded in his diary the experience of a visit in January 1855:

After lecture dined at the Geological Club. Sat next Lyell who bored me with heavy metamorphic talk. Evan Hopkins read an insane paper on the

311 Ibid.
crystalline rocks. We all talked. Smyth pitched in heavily, & Hopkins
thick skinnedly bore it all; nothing affects his self conceit.\footnote{313}

What was ‘metamorphic talk’? The conversation of the eminent Lyell was itself rock-like – dull, heavy, and seemingly from another age, we can surmise. Most importantly was the aside, ‘we all talked’. As the preface to \textit{Fossil Spirit} stressed, the gaining of geological knowledge was considered by many to be ‘an essential part of a polite education’, at the Geological Society and beyond.\footnote{314} Part of conforming to the norms of polite society was knowing the appropriate ways in which to speak: of what, and to whom. For Mill, that meant being conversant on (and indeed, with) fossils.

More than this, the identity of geological practitioners was tied into these kinds of organisations, and kind of talk. The clubbable culture of the time in geology provided an important sense of brotherly camaraderie, and perhaps help explain why Mill’s book was subtitled \textit{A Boy’s Dream of Geology}.\footnote{315} One of the most famous of these groups was the metropolitan Red Lion Club; Thomas Hirst’s journal for January 1854 demonstrated both the fraternalising atmosphere of these clubs but also the continued interest in resurrecting and almost becoming the objects they studied in their daily work:

‘Among the Red Lions are to be found some of the more able scientific men, who meet once per month and “roar” in a strange manner. At the head of the table sits the President [Forbes] in a chair characteristic of the Society’s name. The skin of a veritable lion forms the back and canopy of the chair; his hind legs serve as arms for resting the elbows, and they are so arranged that the chairman can use the lion’s paw to beat the table and

\footnote{313} Andrew Ramsay’s diary entry, 17 January 1855. Quoted in \textit{Ibid.}, 192.
\footnote{314} Mill, \textit{Fossil Spirit}, x.

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command attention, or applaud at will. ... When the chairman laughs the
lion paws and nods to the company sympathetically. His tail, too, can be
conveniently reached, and occasionally very appropriately introduced.
After a very plain supper with stout and pale ale instead of wine, glasses of
stronger stimulants were ordered, and toasts and songs and speeches at
once began. [After one toast to] “our noble selves” ... every member
seized his coat tail, wagged it over the table, and roared like a veritable
lion. ... Forbes furnished most amusement ... he does not sing but is in
the habit of making communications, as he calls them. These consist of
scraps of original verse ... He proposed Tyndall’s health and welcome as a
Red Lion in a very humorous speech ... the lions roared vociferously.”

Mock-epic, mock-educational, or simply mocking songs were part of this
brotherly culture of sociable scientific dining. For example, the following was
chorused by dinner guests inside the mould of the Iguanodon model for the Crystal
Palace’s monstrous display, which heralded in 1854 itself. Appropriately enough, its
lyrics were fitted to the hymn ‘O God Our Help in Ages Past’:

A thousand ages underground,
His skeleton had lain,
But now his body’s big and round
And there’s life in him again!

His bones like Adam’s wrapped in clay
His ribs of iron stout,
Where is the brute alive today
That dares to turn him out.

316 Quoted in Ibid., 432-433.
Beneath his hide he's got inside
The souls of living men,
Who dare our Saurian now deride
With life in him again?

_Choir:
_The jolly old beast
_Is not deceased
_There's life in him again! (roar)_

This song once again portrayed the creation of the monsters as an act of resurrection: the booming tenors and basses of men including Richard Owen affirmed the presence of life, with even an attempt at recapturing the voice of the Iguanodon itself: like the activities of the Red Lions the singing ended with a communal 'roar'.

[FIGURE THIRTY SIX: Dining inside the Iguanodon]

318 Adam Roberts has read Robert Browning's dramatic monologues as a similar vocal 'resuscitation of the dead': 'aesthetic attempts to call forth particular dead individuals and hear what they have to say to us'. The narrator of Browning’s _The Ring and the Book_ (1887), himself identified as a mystical 'Mage', gives voice to the ten deceased speakers who tell of the murder in seventeenth-century Rome, and declares that the 'life in me abolished the death of things'.
In *Fossil Spirit*, songs suitable for the subject of the chapter ended each evening’s narration of part of the Fakir’s tale as simple recapitulations of one of its key subjects, with titles such as ‘Song of the Sea’, or ‘Song of the Pterodactyl’. An extract from one of these odes appeared in Robert Hunt’s *Athenaeum* review:

There the turtles dwell, in their stony shell, 
And they dine on the best of cheer; 
With their house on their backs, they dread no tax, 
And they need no wine nor beer.319

Like the Iguanodon song, a simple rhyme scheme and lilting cadence were employed, to which presumably could be added a cheery melody. More than this, however, in Mill’s educational vision, “rhymes will greatly aid a child in remembering the number, order, and functions of the animal kingdom, and its various organisms.”320 These songs were rhythmic and memorable didactic devices that summarised the message of the chapter’s contents: thus, the often scathing, usually satirical odes of the metropolitan clubs were cleverly reworked as geological lullabies, the last thing heard on each particular ‘evening’.

Mill’s text had opened with a boy asking ‘with the utmost simplicity’ ‘what is’ geology? It closed with a glossary of technical geological definitions. The shifting registers of the text had chronicled the reader’s and the Fakir’s educational progress, and had facilitated the acquisition of a geological voice and vocabulary. The final words of the book urged the ‘juvenile reader’ to ‘commit the whole of the above definitions to memory, as they will be of the utmost importance to him in all his future efforts, whether in theory or practice.’321 *Fossil Spirit* therefore furnished the reader with verbal skills both for those who wished to have a polite conversation

320 John Mill (1871) *Primary, Industrial and Technical Education: What to Teach and How to Teach It*, 90.
about geology, but also those who desired to pursue a practical investigation. Mill’s voices inspired fossils with life and personality; but also, he hoped, could inspire in boys an enthusiasm for the science. They could even call them to a vocation for geology.322

By the time it reached its fourth edition, *Fossil Spirit: A Boy’s Dream of Geology* had gained a new title: the enticing original replaced by the rather more prosaic *Introductory Reader in Geology*, a self-aware beginning for a more detailed future career (figure thirty seven). Retaining the same text, this shift in emphasis from an imaginative dreaming narrative to an overtly didactic tract demonstrates how very different attitudes could be taken to the same book, and utilitarian as well as spiritual education solicited from the same material. In 1871 Mill would write on *Primary, Industrial, and Technical Education*, in which he advocated ‘Lessons on Objects’ as most suitable for elementary education. Indeed, the impetus behind the framing narrative of *Fossil Spirit*—that of the old man’s tale of the Fakir—was a child picking up a rock, and asking what it was, the clichéd opening to any number of object lesson texts.

322 Ibid., x.
FIGURE THIRTY SEVEN: Title-Page and frontispiece to later edition of *Fossil Spirit*, renamed *Introductory Reader in Geology*, and paired with a Biblical quotation. The same ‘scene from deep time’ was retained as a frontispiece.

Picked-up objects formed the title-page to *Fossil Spirit*, which was designed with letters constructed from fossils (see figure thirty eight) as a direct reference to Friedrich Froebel’s method of teaching children letters by forming them out of objects such as sticks or pieces of cardboard. Mill shared Froebel’s Pestalozzian educational vision, and the technique first introduced on the title page was extended and enhanced in the body of the text, forming the first letter of each chapter. At this time this type of educational philosophy was being promoted in Britain: in 1851 Johann and Bertha Ronge had established a kindergarten in London, and in 1854 the Baroness von Marenholtz-Bülow visited England on a ‘propaganda tour’ to promote Froebel’s teaching, a promotion which included sending an exhibit of Froebel’s ‘gifts and occupations’ to the Society of Arts’ Educational Exhibition, held in July of the year.323 With articles about the kindergarten appearing in the *Times* and *Athenaeum*, amongst other periodicals, these references may well have been picked up by contemporary readers.324 Perhaps most interestingly for this specific topic, reports of object lessons were themselves presented as voiced dramas, in which a teacher asked and answered questions about a particular common object.

323 E. Lawrence, *Froebel and English Education*, 36-38.
324 Ibid., 37.
The next section will move away from religious terrain to consider these issues of the voice and of autobiographical objects in relation to conversational education in Annie Carey's *Autobiographies of a Lump of Coal* (1873), rather than the dramatic monologues that have been the focus in the preceding pages. I shall explore how object lesson teaching was itself a process of combining the study of things with the conversational didactic dialogues that characterised (indeed, caricatured) elementary instruction in this period. Through an emphasis on conversation, the practice of object lesson teaching, and via transcribed discussions with actual children, the distinctions between written and enacted experience, vicarious and direct knowledge, can be, and were, blurred. Didactic dialogues were spoken as well as intellectual exercises, and were designed to train children's speech.

**A grain of salt, or object lesson as conversation**

The practice of object lesson teaching was founded on conversations, as pupils and teacher talked to each other about a chosen artefact. Annie Carey's
Antobiographies of coal, water, iron, flint, and, especially, a grain of salt, in which the object of the lesson itself participated in the conversation in the role of the teacher, provides a novel perspective on this practice, and will be the focus of this section. My analytical focus reflects recent work highlighting the importance of conversation to the nineteenth-century sciences. More importantly, it permits a rethinking of the ubiquitous didactic dialogue of nineteenth-century instructional children’s literature as not only a written form; but rather fundamentally an educational practice in which the aims of Mill’s Fossil Spirit to affect the speech of learning children could be achieved.

The object lesson tradition itself was enacted through conversational learning, a dialogue between teacher and pupils. The first example included in Charles and Elizabeth Mayo’s Lessons on Objects, on a piece of glass, made this explicit by writing-out the lesson in full as a voiced drama:

TEACHER. What is that which I hold in my hand?
CHILDREN. A piece of glass.
TEACHER. Can you spell the word ‘glass’? … You have all examined this glass; what do you observe? What can you say that it is?
CHILDREN. It is bright.

The reference indicated (after the children had been asked ‘What can you say that it is?’) elaborated on the very precise choice of spoken language given to the figure of the teacher by the Mayos:

327 Mayo, Lessons on Objects, 22.
†This question is put instead of asking “What are its qualities?” because the children would not yet, in all probability, understand the meaning of the term, but by its frequent application to the answers of this question, they will shortly become familiarized with it.

As we have seen throughout this dissertation, object lesson teaching was a spoken practice of lectures, conversations, or as books that directly addressed and involved the reader through first person narrations. The Edgeworths’ Practical Education was often a point of reference for these nineteenth-century works dealing with active instruction: as an appendix, actual recorded conversations with various ages of children had been reproduced, some of which reveal a sensory educational process of object lesson teaching:

(Dec. 1st, 1795.) After dinner to-day, S- was looking at a little black toothpick-case of his father’s; his father asked him if he knew what it was made of.

The children guessed different things; wood, horn, bone, paper, pasteboard, glue.

Mr. - . “Instead of examining the toothpick-case, S-, you hold it in your hand, and turn your eyes away from it, that you may think the better. Now, when I want to find out any thing about a particular object, I keep my eye fixed upon it. Observe the texture of that toothpick-case, if you want to know the materials of which it is made; look at the edges, feel it.”

S - . “May I smell it?”

Mr. - . “Oh yes. You may use all your senses.”

S- . (feeling the toothpick-case, smelling it, and looking closely at it.) “It is black, and smooth, and strong, and light. What is, let me see, both strong and light, and it will bend – parchment.”
Mr. -... "That is a good guess; but you are not quite right yet. What is parchment? I think by your look that you don't know. ... But S-, don't keep the toothpick-case in your hand, push it round the table to your neighbours, that everybody may look again before they guess. I think, for certain reasons of my own, that H- will guess right."

H- "Oh, I know what it is now!"

As the commentary stated, 'we hope, that from these trifling but genuine conversations of children and parents, the reader will distinctly perceive the difference between practical and theoretical education.' Readers could move between conversations as written out in these works and how, in practice, they could be the basis of leading educational conversations. Authors often remarked in their prefaces that they had based their writings on actual discussions, affirming the effectiveness of their method of instruction and their suitability as educators for others. For instance, Mill had opened *Fossil Spirit* by claiming that it was a casual conversation with a boy on a train that had convinced him of the need to write a treatment of geology suitable for interesting modern youth in the subject, as it was not being taught at the traditional schools; Caroline A. Halsted, in *The Little Botanist*, also proclaimed that: 'the conversations of which [the book] consists ... are not imaginary; but such as, with little variation, occurred between the writer and a most intelligent little girl of about nine years old', presumably Miss Louisa Atherley, to whom the book was dedicated.

In 1870 the children's author Annie Carey published a series of 'Autobiographies' of common objects, namely a lump of coal, a grain of salt, a drop of water, a bit of old iron, and a piece of flint. Emphasising the singular, and

328 Ibid.
329 Maria Edgeworth (1835) *Practical Education* (New York: Harper and Brothers), 525.
seemingly unimportant, nature of such objects (‘a bit of old iron’), she demonstrated
that through hearing each particular story, the contribution of such commodities to
creating the Victorian domestic sphere in which she situated her work, and the
amount of scientific knowledge obtained from their analysis, could be elucidated.
Each object was introduced through its discovery by one of four main characters (see
figure forty), and proceeded to tell its ‘history’, responding to questions posed by the
children along the way. The text rewrote earlier conversations in didactic dialogues on
topics such as chemistry or geology to include the animated object itself: children
could discuss scientific topics with natural objects directly.

Carey’s work opened with her group of ‘children, sitting round the fire one
cold winter’s afternoon’. One child, Arthur, asked for a fairy-tale; another for her .
elder sister to “‘break up that ugly, dark lump of Coal on the top of the fire.”” “‘Make
it blaze””, she requested: “‘I like to see the flames jumping about; they always seem to
be alive.”331 As if responding to her desire for animation, the lump of coal
interrupted, and said that he would tell his ‘own history’: a story ‘as wonderful as any
fairy tale can be’.332 Though Carey’s preface seemingly split the entertaining purpose
of the text (as ‘semi-amusing stories’) from its educative role (to ‘increase the sum of
actual information’), these were conflated in an advertisement for the book in the
Times: the Autobiographies were ‘a series of fairy tales, in an entertaining form, to teach
the child simple, scientific knowledge, that will be useful both now and in after life.’333
The Athenæum termed ‘Miss Carey’s autobiographies’ ‘delightful’, praising both the
correctness of the facts she imparts, and the ‘graceful lightness and vivacity’ with
which they were told, ‘which makes them as entertaining as fairy tales.’ More
importantly, the facts of the sciences themselves were deemed so powerful – and so
correctly presented – as to override any misgivings the reviewer might have about the
choice of fictional presentation: ‘We do not, as a general rule, approve of the plan of

331 Carey, Autobiography, 9.
332 Ibid., 10.
333 The Times, Wed. Dec. 7th, 1870, 8.
turning the acquisition of useful knowledge into a mere amusement; but the elementary facts of natural science are so fascinating and so wonderful, that when put before either children or grown persons with any sort of skill and power of narration, they cannot help being attractive; and Miss Annie Carey has the gift of being able to do justice to her subjects.334

FIGURE THIRTY NINE: The four children converse with the grain of salt.

Carey’s ‘autobiographical’ text taught about a range of topics connected to the common object and linked by the thread of the conversation. Indeed, she also published *Threads of Knowledge* (which was reprinted with the *Autobiographies* as *The Wonders of Common Things*), which, as its introduction claimed, argued that ‘there are no subjects so simple, no objects so commonplace, as not to possess some one or more “Threads,” connecting them with others that are at once intricate and wonderful.’335

335 Carey, *Threads of Knowledge*, iii.
Mrs Norton, the mother character in the book who gave the lessons, taught her children how to make the most of these threads, telling them that they had to contribute to the educational process, too:

Parents and teachers can only give their pupils the ends of threads, so to speak; threads, that if you are patient and inquiring, will unwind and unwind themselves from the endless web of knowledge.336

Carey’s ‘Autobiography of a Grain of Salt’ connected its readers to ‘the endless web of knowledge’, as it managed to cover the increase in the duty on salt during the Napoleonic wars, the mines of Poland, what is meant by a solution, details about the salinity of the oceans, Scandinavian poems, elementary chemical theory, Herodotus, Homer and the New Testament, as well as the properties of crystallisation. The children each had different characters, with appropriate levels of knowledge; and occasionally the voice of a scientific expert is invoked, such as a quotation from Charles Lyell on the definition of a ‘brine spring’. However, the most prominent voice in the text was – rather than that of Mrs Norton – that of the grain of salt as an informative and, because of its direct access to phenomena, authoritative lecturer. As it said:

when two things are chemically combined, the new substance formed may be as different as possible from either of the two things of which it is composed. Take me for example. You all see that I am white and pleasant to the eye and taste; you know also that I am useful and edible, that is fit to be eaten; that I help to make food agreeable and suitable, and that I tend to preserve food from decaying. Such are my personal qualities. Now what will you say, when I tell you that my two elements are each of them separately most destructive to life. If you breathed much of my gas Chlorine,

336 Ibid., vi-vii.
you would certainly be suffocated ... If you throw a piece of [sodium] upon water, it will cause effervescence ... You must ask your uncle to show you these things, next time you are in his laboratory.337

By taking on the persona of the object Carey was able to provide a lively account of chemical phenomena, and to urge the students to pursue further enquiries into the sciences. The quotation articulated and recapitulated her process of education: it first stated the central concept the grain of salt wished to impart (properties of elements); it then drew attention to itself as an example of this concept; it then went through common knowledge of common salt – first what the children could see, then what they already knew – its ‘personal qualities’; then subverted these expectations with an unfamiliar fact – the different properties of salt’s constituent elements; there was a demonstration of this fact with experiments the children could conceivably do; and finished with a gesture towards going to visit their uncle in his laboratory and the actual experience of scientific investigation. Thus from the object lesson notions of reasoning and also practice were imparted – as well as how such phenomena should be talked about.

Conclusion

This chapter has echoed with the voices of nature, with speech given to natural and chemical objects in the second half of the nineteenth century. From the mouths of oak-trees, a grain of salt, and a series of fossils, we have heard tales of vegetable structure, chemical composition, and rocky strata; learned what life was like in Silurian seas, the dangerous sides of separated sodium and chlorine, and how water travels from root to leaf. However, and as I have implicitly argued in the preceding pages, the idea of an uninterpreted, unmediated voice from nature speaking through these objects and through these pages is an illusion. Rather, the choice of explicitly

337 Carey, Autobiography, 39.
Talkative artefacts demonstrated most clearly that things never speak for themselves: they are always enmeshed in networks of books, illustrations, authors, lecturing practices, religious convictions, shops, conversations, letters, dining clubs and advertisements – amongst others – without which they are mute. By investigating the contextual fabric of these ‘subject lessons’ – who was speaking for and through the object, what the object was saying, the genre and oeuvre of works in which the object was embedded – we can complicate the notion of ‘talking for themselves’, and tease out specific stories.

As part of an emphasis on practice and the senses, many different disciplines claim a renewed awareness of all things noisy.338 Much recent scholarship has suggested that the second half of the nineteenth century can be characterised as a culture interested in aural phenomena and technologies, which was echoed in contemporary literature.339 For Stephen Connor, this involved a reconceptualisation of the natural world as itself alive, capable of communicating secrets and understanding to those who possessed the correct meld of mental and physical skills, what he termed the ‘curious revival of a very ancient conception of the expressiveness of the material world, a sense that the world could speak’.340 However, this sense of direct communion with nature had by no means disappeared in the intervening centuries; for example, poets and philosophers had used the Aeolian harp as an actual and metaphorical instrument for capturing the sounds, moods, and thoughts of nature.341 By the end of the nineteenth century, the persona of the

338 Some of these texts include: Tess Cosslett, Talking Animals in Children’s Fiction, Picker, Victorian Soundscapes, Stewart, Reading Voices.
339 See, for example, Gillan Beer, ‘Authentic Tidings of Invisible Things’, 85; Picker, Victorian Soundscapes, 85: this was ‘an age defined by new emphases on and understandings of the capacity for listening, in which Victorian science at first gave substance and form to sounds that had once seemed indefinite and immaterial, and Victorian technology then fundamentally destabilized aural communication’.
scientist similarly became conceived of as a conduit, a direct and unmediated conveyor of natural knowledge, particularly with what has been termed the appeal to considerations of ‘objectivity’ in this period. Many writers in the second half of the nineteenth century emphasised their role as conveyer or interpreter of the ‘voice of nature’: just as the visual impressions of the natural world could overwhelm the neophyte, so too could he be deafened by the ‘cacophony’ of voices emanating from the natural world, what George Eliot termed ‘that roar which lies on the other side of silence’. For experienced naturalists such as Charles Kingsley, nature “was a companion speaking with a thousand voices”: he might have been able to comprehend such speech, but new audiences required help. Popular texts would make sense of these experiences. Many of these works were explicitly intended as introductions to the sciences: their use of a singular object and presentation as dramatic monologues helped to filter and decipher the confusing messages potentially heard by those seeking enhanced sensory perceptions.

Imbuing objects with spirit, personalities, and voices made manifest these senses of direct, aural, and oral communication with nature. If things were going to talk to Victorian audiences, considerations of how they would talk became of paramount interest. It has been said that the Victorian ‘fascination’ with conversing and conversation “represented an area of private life open to the dictates of self-improvement which was also an area of public life where progress could be tested against contemporaries” … for speech to be useful in itself, there had to be a forever elusive “right” way to talk. Speech was a physical mode of communication as words were enunciated, both virtually in the text, but also through processes of reading, reading aloud, and talking about what one had read. The ‘soundscapes’ of

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these texts, their sonic environments, were formed, and reformed, through these acts of reading.346

Recent historical, anthropological, literary, and sociological studies have emphasised how material objects can ‘speak’ to us: that seemingly trivial objects are eloquent of their place in wider systems of thought, practice, and natural law.347 By considering the presentation of explicitly talking things, this chapter has argued that what objects can say to historians can be made especially clear when their actual way of speaking is taken into account; when, rather than an object, they became a subject lesson. The self-conscious use of literary techniques of personification and anthropomorphism gave different kinds of voices to objects: voices that readers were supposed to emulate.

The texts that I have studied in this chapter provided a series of voices for objects from the natural and manufactured worlds. Some writers lectured on behalf of the object in question, ‘telling their stories’, as Crookes memorably put it. Others, drawing on early nineteenth-century models of the conversational genre, presented a fictionalised representation of the correct forum for discussing natural knowledge, teaching, when, where, how and to whom was it appropriate to talk about the sciences. These authors sought, quite literally, to bring the sciences to life for their readers as a series of animated object lessons. Thinking about these soundscapes of introductory texts therefore helps us to elucidate and emphasise the oral cultures of reading and education in this period. These voices of geology also draw attention to the fact that for many Victorians the discipline could be conceived of in vocal terms, or as a voiced activity: fossil and rock sequences formed a hieroglyphic language; comparative anatomy aped the resurrectional voice of Ezekiel; memorable geological education, convivial post-prandial entertainment and even painfully punning satire

347 For example, Daston, Things That Talk.
could be produced by singing. If we are to analyse and historicize the sciences as a group of practices involving many different types of sensory interactions, it makes sense to think about how these senses were made by educational processes. Through hearing the voices of nature and conversing on commodities, children could learn to speak about technical subjects using novel vocabularies in an authoritative tone.
5. **PLAYING AMONG THE STARS**

‘This is the place for those who attend to the motions of billiard balls, more than to the motions of the planets.’

*Science in Sport* rule-book

On 17<sup>th</sup> December 1804, *Science in Sport, or the Pleasures of Astronomy* appeared on sale at John Wallis’s warehouse, 16 Ludgate Street, London. This ‘New Game’ could be found on the proprietor’s shelves housed inside a teal slipcase, which advertised its contents with a decorated paper label (see figure forty). It was accompanied by a printed, twelve-page rule book, outlining further details of how to play. Opening up the illustrated game surface, an engraved sheet, cut and mounted on linen, an array of astronomical objects met the buyer’s eyes (see figure forty one). Squares around its edge depicted planets, instruments, and constellations. Lines of prose detailed playing instructions. And, flanked by portraits of Ptolemy, Tycho Brahe, Nicholas Copernicus and Isaac Newton, in the centre stood Flamsteed House, home of the Royal Observatory, Greenwich.

Anke te Heesen’s *The World in a Box* has demonstrated that physical objects designed for educational and ludic purposes can prove particularly fruitful sites of academic analysis. This chapter uses these twin themes of hands-on learning and playful activity to investigate several artefacts: the *Science in Sport* game, a pocket globe, a miniature library — *The Book-Case of Knowledge*, and two texts, William Graeme

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349 ‘Flamstead’ rather than ‘Flamsteed’ House is the spelling used on the game board.
Rhind's 1842 *The Creation*, and John Ayrton Paris's 1827 *Philosophy in Sport Made Science in Earnest*. Through these focused case-studies, I shall explore the dextrous practices of recreative astronomy in the first half of the century, and analyse how gaining scientific knowledge could be affected and achieved through the framework of games and amusements. Some of the objects employed in these lessons were the usual trappings of the nursery, from fruit to balls to bows and arrows; others, including board games, cards, lantern slides, and spheres, were familiar to their audiences, but had been specialised, rendered scientific by their conversion into containers of astronomical facts. As Ludmilla Jordanova has indicated in relation to productions like *Science in Sport*, such surviving objects 'do not themselves indicate who bought them, why they did so, how the games were used, whether children enjoyed them, or what impact they had on those that used them'. This chapter argues that when brought together with contemporary publications, images, educators, and, not least, rule-books, they can, however, paint an evocative picture of nineteenth-century children, playing among the stars.

*FIGURE FORTY: Slipcase for 'Science in Sport' game: rays of light illuminated a boy making an astronomical measurement and the signs of the zodiac.*


FIGURE FORTY ONE: The opened-out playing surface of the 'Science in Sport' game. Players started in the bottom right corner of the board and then moved clockwise and then to the central illustrations, culminating at the Royal Observatory.

The Pleasures of Astronomy, or object lesson as game

Science in Sport was one of many educational games published in the decades from the end of the eighteenth to the mid-nineteenth century, covering topics from didactic tours of Europe and The History of England from the Conquest to the Accession of George the Third, to subjects more suited for an adult audience, including the New Game of Elopement, or a Trip to Gretna Green, which promised to 'enliven the winter evenings
The sciences were well represented, and not just with the original, geographically-formatted games: topics covered included 'botanical conversation', 'The Naturalist', mathematics – both addition and multiplication – and 'Jumbo the children’s friend', which depicted a day out at the Zoological Gardens. A few key firms were responsible for this boom in production, including that of John Wallis, and later his son, Edward, who were leading game publishers for sixty years. Wallis and his competitors produced a range of complementary instructive recreations including card sets, miniature libraries, fairy-tale puzzles, paper dolls, alphabets, and dissected maps that provided various tactile means of instruction for their young audiences. Collected in an 1813 catalogue under the title ‘amusing productions for the improvement of youth’, Wallis’s range of 346 games, books, illustrated stationery, maps and atlases included Science in Sport, or The Pleasures of Natural Philosophy. This followed an identical format to its astronomical sibling, with a central depiction of that spectacular demonstration of gravity, “the Falls of NIAGARA”, surrounded by the figures of Boyle, Descartes, Franklin, and Bacon.

Throughout the eighteenth century, children and the family had been identified as a new audience and market for educational commodities: Wallis’s ‘amusing productions’ addressed the middle- and upper-classes, who could afford their prices of, for example, from one and sixpence to a guinea for a more elaborate...


354 See Whitehouse, Table Games, 87-93; for 'Jumbo the Children's Friend' see Oxford Digital Library online collection.

355 For further details of the Wallis family, see Hannas, English Jigsaw Puzzle, 30-35.


357 Whitehouse, Table Games, 76, 78. ‘The pleasures of natural philosophy' was also advertised at the bottom of the ‘astronomy' board (see figure forty-one).

358 Whitehouse, Table Games, 35-6.
dissected puzzle. At seven shillings sixpence in 1813, *Science in Sport* was a mid-priced object, and would have been bought by similar homes. At this time, parents and children were brought together and identified themselves as a family, and sought such communal entertainments. For example, educational books, novels and plays were all read aloud in the family circle of parents, children, and even servants. Of course, these games were produced to promote the idea of family recreations, too, as they suggested appropriate group activities.

The game answered an existing demand for specifically astronomical productions for children, a demand which had been expanding over the past fifty years as learning about astronomy, geography, and 'the use of the globes' became a standard subject of educational syllabi. Connected to natural theology, wonder, and mental discipline, astronomy and natural philosophy were identified as subjects suitable for the young, with many books written on the sciences, including Tom Telescope's *Newtonian System of Philosophy*, and dialogues for young ladies and gentlemen by itinerant instrument-makers and lecturers Benjamin Martin and James Ferguson. These were often literary representations of children's conversations on astronomy, and presented scientific education as spoken and collaborative, and as an everyday entertainment, often employing objects. Joseph Wright of Derby's depiction of the lecture on the Orrery (1776) is perhaps the most famous example of children in a group learning about astronomy from this time: the focus of the painting is a boy

360 Fyfe, 'Young Readers and the Sciences', 286.
361 For more on the history of the family in this period, and its centrality to religious, political, commercial and educational activities, see: Leonore Davidoff and Catherine Hall (1987) *Family Fortunes: Men and Women of the English Middle Class, 1780-1850*, (London: Hutchinson).
and girl gazing into the mechanisms of the solar system, whose central 'sun' casts light onto their faces.

Unlike the pedagogical processes of the lecture, conversation, or story, all of which have been discussed earlier in this dissertation, *Science in Sport* linked gaining celestial knowledge to an exciting and actual race around a board, as players of the game encountered a range of heavenly phenomena and astronomical instruments, as well as appropriate penalties and rewards, on their way to the Royal Observatory. Nevertheless, the game built on these linguistic genres by beginning with instructional speech: before play began, one participant was directed to read aloud the astronomical information printed on the illustrated surface, which gave details and definitions of novel words, such as meridian or ecliptic, and objects, including the telescope and celestial globe. In her periodical *The Guardian of Education*, evangelical educationalist Mrs Sarah Trimmer claimed this way of learning was 'often beneficial to children, to accustom them to the use of such words, as they will hear and speak while engaged in this amusing play.'

In a further preliminary to competition getting underway, the 'laws of the game' had themselves to be read and understood. As with the laws of nature *Science in Sport* sought to introduce, these were universal directives for rule-bound motion. Indeed, the game was played according to a format established by the traditional rules of 'Goose', which provided the model for most Georgian instructional games. They were rendered thus by *Science in Sport*, and placed next to the 'introductory observations':

6. The number turned up at each spinning is to be added to that on which the players [sic] pyramid stands: thus, if a player whose pyramid

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stands on N.3, spins & the te-totum turns up 4, he must place his pyramid at N.7 & so on till some one arrives at 35, who wins the game.
7. If the last spin does not exactly make up 35, but goes beyond it, the player is to go back as many as he exceeds that number, & try his fortune again till some one arrives at the lucky N.
8. When a player is to stop one or more turns, he must place as many counters as he is to stop turns upon the No. he arrives at, & when his turn of spinning comes he is to take up a counter instead of spinning, & so on, until they are all redeemed, when he may proceed.364

Because there was an established standard format for these entertainments, players potentially already knew these rules, so could concentrate on the novel aspects of astronomy written out on the other half of the game surface rather than paying attention to the ‘laws’ of play. Indeed, in his History of Board Games David Parlett claims that the rules of Goose ‘were so well known that many boards bear just the pictures without any associated verbal instruction.’365 The assumption that the te-totum (a spinning top with flat sides, which generated random numbers) and counters required for play would have been owned by the purchasers also implies that Science in Sport was just one of many similarly-formatted games to be enjoyed in the family circle. Both ‘The Game of Goose’ and ‘Tetotum’ were included on a list of approved games appended to the Society for the Diffusion of Useful Knowledge’s 1835 Exercises for the Improvement of the Senses.366

Central to these rules, and to the idea of a race game, was movement: the pursuit of astronomical knowledge became a physical journey on the board, through the solar system, and from ignorance to expertise. Many of the first juvenile table

364 As written on the surface of Science in Sport. Further instructions for the action to be taken on each square were included in the accompanying booklet.
366 Anon., Exercises for the Improvement of the Senses, 122, 123.
games, including Wallis's own, had an overtly geographical format, and often ended up in London, partly because they were based on game boards superimposed on the travellers' maps published by the same printing houses (see figure forty two)\textsuperscript{367} The tactile and spatial senses were engaged with by grasping counters and moving them around the board, whilst reading from the accompanying booklet, and in competition with the movement of other players.

\textbf{FIGURE FORTY TWO: Wallis's \textit{Tour Through England and Wales: A New Geographical Pastime} was basically a map of the country.}

However, the pleasure of the game was perceived to be enhanced as the entertainment was not purely sensory: it provided an appropriate balance between the rational mind and active body, as stressed by many in the nineteenth-century sciences, particularly in educational contexts.\textsuperscript{368} \textit{Science in Sport} tied these pleasures together, with one's progress in the game dependent on learning the information attached to the particular object depicted, which was detailed in the game's accompanying booklet. This described both the picture under consideration and the appropriate

\textsuperscript{367} Shefrin, 'Pleasure', 259.

penalties or rewards imposed. A range of actions was required of the players: for example, landing on some numbers resulted in having to read a passage of information, such as the opening square which imparted knowledge about the sun, ‘an immense globe of fire, ... nearly a million times as large as the earth’. Others were designed to interact with the observations read out at the commencement of play, with the player in question acting as a teacher for others in the group: ‘Explain the use of the terrestrial globe as described in the introduction, or stay two turns.’ (4) For squares further along the track the player was expected to have sufficient explanatory knowledge of their own: no. 14, ‘A TELESCOPE: Explain the use of this instrument, or stay two turns.’ (6) These objects might have been close to hand and could have been demonstrated, rather than explained. Occasionally the player was instructed to pause in their progress to continue an individual education: ‘No. 9, THE ARMILLARY SPHERE, Is a machine invented to represent the axis, poles, and circles, which are described in the introductory observations. Stay here a turn, and read the introductory observations to yourself.’ (5)

The scientific accuracy of this knowledge to be learnt through the game was affirmed: underneath its title, *Science in Spor* declared that it had been ‘revised and approved by Mrs Bryan of Blackheath’, combating any claims that a firm with such a diffuse range of productions might lack intellectual rigour in particulars. An astronomical author and educator, Margaret Bryan had published introductory works based on the lectures she gave to her female pupils at her boarding school Bryan House in Blackheath, just across the park from the Royal Observatory. It is possible that she had connections to the current Astronomer Royal and his family:

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369 [Anon.], [1804] *Science in Sport, or the Pleasures of Astronomy* (London: John Wallis), 3. Henceforth, references to this booklet are included in parentheses in the body of the chapter. Though anonymous, we can speculate that this was composed by John Wallis in collaboration with Margaret Bryan.

370 It is possible that Bryan ‘revised and approved’ Wallis’s *Pleasures of Natural Philosophy* game, too: it is catalogued ‘on the same approved Plan’. Whitehouse, *Table Games*, 76.

'Reverend Dr. Maskelyne' was a listed subscriber to her *Lectures on Natural Philosophy* (1806). Moreover, in *A Comprehensive Astronomical and Geographical Class Book* (1815) she claimed: 'I can with integrity affirm that many very learned men of both Universities, and the first Mathematicians and Astronomers in this country, have afforded me the honourable distinction of their avowed approbation of my scientific researches, and mode of communicating the same'. Through books like these Bryan was known in the London circles who would purchase the game, and to whom her approbation would be a guarantee of its quality. Bryan’s involvement also served to tie the game to the familial, domestic way of learning about astronomy that was stressed in her works: she claimed to think of her pupils as of her own children, with whom she was depicted in a frontispiece to her *Compendious System of Astronomy* (first published 1797), alongside astronomical instruments including a telescope and armillary sphere (see figure forty three). She dedicated *A Compendious System* to her pupils, connecting language of scientific status and of enjoyment:

ASTRONOMY [is] the most important science I have had the pleasure of introducing to your acquaintance…

In Thomas Smith’s own *Compendious System of Astronomy*, published by Wallis and John Harris as part of their small-format *Scientific Library* in 1806, the prestige of astronomy was similarly emphasised:

The advantages resulting from the study of astronomy are equally numerous and important – calculated to expand and dignify the mind, to

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372 See the list of subscribers reproduced in: Margaret Bryan (1806) *Lectures on Natural Philosophy…*, London. Nine unmarried female subscribers are listed as resident at Bryan House, and are probably the current pupils at the Blackheath school.


374 Benjamin, ‘Elbow room’, 41-42.

correct and improve our ideas, and to raise our contemplations from earth to heaven; and from the creatures to the infinitely wise and adorable Creator. 376

![Image](image_url)

**FIGURE FORTY THREE:** Margaret Bryan, holding a writerly quill, her young daughters, and assorted astronomical instruments.

Bryan’s *Compendious System* distinguished four ‘operations of the mind’ that contributed to the process of scientific education:

The first is perception, from which result our ideas.

The second judgement, which is assembling ideas together, and comparing them.

The third is reasoning, which is exercising our minds to produce proofs in order to establish facts.

The fourth, is called method; this is the last operation of the mind, as we must perceive, judge, and reason, before we can methodize.\textsuperscript{377}

Elements of this process can be seen in \textit{Science in Sport}; for example, before play began initial ideas of what constituted astronomy were imparted through perceiving the illustrations on the game board. Moreover, the rulebook sometimes drew attention to particular elements of the game surface; in picture no. 16 (the stars), after identifying the objects as bodies like the sun – ordered by magnitude according to their brightness, and divided into constellations – the player was then enjoined to ‘Observe likewise in this plate, that faint streak of light in the heavens, called the milky way, which Dr. Herschel has found to be an assemblage of stars, he having discovered in it many thousands.’ (7). Similarly, the player was instructed to look more closely at image no. 24, the air, or atmosphere, to ‘observe the figure of the earth, called an \textit{oblate spheroidal} – that is, not exactly round, but broader about the Equator, and rather flatted [sic] at the poles’ (10). Intriguingly, Muir’s catalogue seems to imply that \textit{The Pleasures of Natural Philosophy} was available as a dissected map, ‘a jigsaw puzzle that forms a board game when completed’: in this case, the different images could quite literally be assembled, as in phase two of Bryan’s educational system.\textsuperscript{378}

The comparative forms of reasoning entrained through \textit{Science in Sport} can also be exemplified, particularly through competing explanations for the ‘phases of the moon’. These are first met with on square 13, where they are explained, along with an appropriate image, similar to those found in an introductory textbook (see figure 2):

Like the planets, the moon does not chine by any light of her own, but reflects that of the sun. It is this that causes the different phases, or changes of the moon; as in her revolution that part only which is enlightened by him can be visible to us. Thus, when the earth is so situated

\textsuperscript{377} Bryan, \textit{Compendious System}, 4-5.
\textsuperscript{378} Muir, \textit{Children’s Books}, 51.
between the sun and moon that we see all her enlightened parts, it is full moon. When the moon is so situated between the sun and us, that we do not see her, it is new moon; and when her situation is such that she is only partly concealed from us, we see a half moon or horned moon. (6)

Two squares later, a player would encounter the ‘man in the moon’, in a rather more artistic or emblematic image, along with the following text:

It is the ridiculous idea of some ignorant people, that there is a man in the moon, with a dog and a bundle of wood, who causes the different appearances of it by eating it away, while they say it grows again every month. That you may know better, go back to No. 13, and read to yourself the description you will find there. (6)

The folkloric, narrative explanation for a lunar phenomenon is explicitly labelled ‘ignorant’ and ‘ridiculous’; with their new knowledge players could thus distance themselves from such stories, having learnt the correct scientific language from square 13. This direction back to knowledge taught on another square also demonstrates an attempt to control the randomising element that had been introduced into the educational process by its framing as a game: all players might miss some squares, or attend only to those on which they landed. To obtain a comprehensive astronomical education, Bryan, Wallis and the players must have relied upon the repeated playing of the game, indicated in the final instructions of the book (12), perhaps along the lines that the game might be treated somewhat like a book, which does not have to be read in order, nor in its totality, but can aspire to such treatment.

Another way of learning illustrated by the explicatory rule book was the use of everyday analogies, often employed in introductory works on Newtonian mechanics.
at this time, as we shall see later in this chapter: thus, ‘the motion of the planets’,
diurnal and annual, was ‘compared to the motion of one billiard ball rolling round
another, while its own body rolls round a line within itself at the same time’ (5). However, the possible range of associations of this analogy was curtailed: the very
next square distanced the game from other types of sport by depicting ‘The County
Gaol’:

This is the place for those who attend to the motions of billiard balls,
more than to the motions of the planets.

However hard you think your case,
Stay here till some one takes your place. (5)

Connected to a punishment of the disruption and potential termination of the game,
should no players remain to replace the inhabitant of the ‘Gaol’, this square
advocated the ‘correct’ types of pleasure and gaming with an appropriate and witty
comment on contemporary amusements. Other aspects of the game reinforced
appropriate forms of recreation: the te-totum was used to generate random numbers
as it did not have connotations of the morally-suspect practice of gambling with
dice. Wallis’s firm in particular argued against the use of dice in family games: in
1790 Wallis and Elizabeth Newbery had noted in ‘The Utility and Moral Tendency of
the Game’, which accompanied their New Game of Human Life, that use of the te-
totum was advised ‘to avoid introducing a dice box into private families’. Not all
games of chance were to be encouraged.

379 The third section of this chapter will discuss the use of the playful everyday analogies in
introductory texts.
380 Parlett, History of Board Games, 30.
381 Quoted in Shefrin, ‘Pleasure’, 255. Shefrin notes, however, that ‘[t]his rejection of the forms of
gambling was far from universal.’
Indeed, *Science in Sport* overtly promoted a moral education. Mrs Trimmer applauded a contemporary publication, Harris’s 1805 *The New Game of Emulation for the Instruction and Amusement of Youth*, on these very grounds:

> this may perhaps appear to some of our readers too trifling an article for critical regard; but as even things of this kind are made engines of corruption in some degree, whoever endeavours to make them instrumental to the culture of good morals, performs a service to the rising generation, which should not be passed over without its share of praise, and we are ready to give our sanction to this innocent toy...\(^\text{382}\)

Some games presented themselves explicitly as a moral journey, along the lines of *The Pilgrim's Progress*, including a dissected puzzle entitled *The Hill of Science — An Allegory*, published by John Wallis Snr and John Wallis Jnr in 1807. Once assembled, in this engraving children ascended from ‘The Barren Land of Ignorance’ through the ‘Gate of Languages’ up the ‘Path of Virtue’ to the ‘Temple of Truth’. They learned to avoid the ‘Cells of Ignorance’, the ‘Precipice of Pride’, and the ‘Mansion of Passion’.\(^\text{383}\)

Echoes of these types of teaching can be found in *Science in Sport*, and not just in its hilltop culmination: for example, the rules punished the ‘negligent boy’ by sending him back twenty squares, a considerable distance:

> You’re idle and uncleanly too, Therefore return to Number two. (9)

Other squares taught the proper way in which to learn, contrasting the ‘studious boy’, whose spin is doubled, and the ‘blockhead’, who ‘loses his chance of the game’ (6).

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\(^\text{382}\) [Trimmer], *New Game of Emulation*, 77.

Smith’s volume in the *Scientific Library* had argued for the moral and spiritual benefits of studying astronomy (as well as its practical, navigational uses) since it was ‘the acknowledged handmaid of true religion’.\(^{384}\) Despite no mention of religion, save the use of Christ’s birth to date Ptolemy’s life (12), the game did draw on the iconography of natural theology, particularly in the landscape scenes that formed the corners of the game board (see figure 5.2). The writings of Margaret Bryan have been read as espousing a ‘conservative natural theology’; and at the beginning of Bryan’s *Compendious System* she advocated the edifying character of natural science: \(^{385}\)

NATURAL objects, when properly contemplated, continually admonish us in the important science of Divine Wisdom, leading us to consider our situation in this sublunary state, our connections and dependencies; from which we learn the duties required of us, and the exertions we are capable of making.\(^{386}\)

Perhaps most importantly, therefore, the moral quality of the game lay in its call for players to take control of their destinies: *Science in Sport* hinted at possible outcomes and uses of learning astronomical knowledge, the ‘exertions’ children who had played the game would be ‘capable of making’. These included taking measurements with a quadrant, as depicted on the slipcase advertisement (see figure 1), or observing the stars through a telescope. The wartime ‘volunteer’ (11) and the ‘mariner’s compass’ (10–11) served to connect the game and astronomy to wider culture, and to real-world situations and professions where astronomical knowledge was used and useful, perhaps in a way analogous to that in which games that took players around the sites of Europe ‘[prepared] the way for the pleasures of the Grand Tour’.\(^{387}\) Another possible outcome of playing the game would be to participate in

\(^{386}\) Bryan, *Compendious System*, 1.  
the wider astronomical enterprise oneself: the copy of *Science in Sport* held at the Greenwich collections was originally owned by the father of Richard A. Proctor, who in the second half of the nineteenth century introduced wide audiences to astronomy through his many books, articles and lectures.388 Playing with the game in his father’s library as a boy may have served to whet Proctor’s appetite for the science, confirmed when, after returning home from Cambridge, he ‘picked up [two books] at a book stall in Glasgow … Nichol’s “Architecture of the Heavens,” and Mitchell’s “Popular Astronomy”’.389

*Science in Sport* concluded when a player reached the game’s goal: ‘the grand Observatory and residence of the King’s Astronomer’, Flamstead House. The first to scale the heights of the ‘lofty eminence in Greenwich Park’ would ‘take the title of Astronomer Royal’ (12). The game’s joint purposes had been achieved: the competition had been won, and beginners had been converted into knowledgeable astronomers. On their journey around the board and heavens, players had travelled from the family group at home to the furthest reaches of the Milky Way, from the County Gaol to the planet Jupiter, from a rainbow to Flamsteed House. They had learnt to speak a novel vocabulary of oblate spheroids, ecliptics, and meridians; to memorise details of the solar system; to emulate the studious boy, not the blockhead; to teach others about the use of the telescope and globe; to refute credulous beliefs about the man in the moon; and to stay away from billiards, or risk the County Gaol. By couching this educational experience as a game, the object conflated entertainment and pedagogy in an instructional pastime. *Science in Sport* situated astronomy as an appealingly competitive communal endeavour; an engagement of body and mind; and an instructive and moral pastime. Perhaps few could aspire to become a Newton, a Maskelyne, or a Herschel, but they could participate in a wider...

388 The set belonged to Proctor’s father: descendants donated it to the Royal Observatory and National Maritime Museum. See museum accession record for further details.
culture interested in exploring the heavens as a recreational activity, and in the pleasures of learning astronomy.

An orange, or object lesson as world in miniature

Object lesson enthusiast John Mill could put the world in the palm of his young pupils’ hands, as his thinly-veiled authorial persona ‘Arthur’ commented in *Primary Industrial and Technical Education: What to Teach and How to Teach It* (1871):

I have often found it a very convenient way, in giving a child his first lessons in geography, to take an orange and, having marked on it with a pen-knife the form of the continents, and first explained that the globe and the orange are the same shape, remove those portions of the skin which correspond with the oceans; the land will then be represented by the remaining portions of the outer skin.⁹⁹⁰

The not-quite-spherical shape of the earth was introduced by being equated with an analogous common thing: the oblate spheroid of the orange. After being put in the hand, the fruit was manipulated: carved by a pen-knife into a diminutive replica of the terrestrial globe. This section considers how children’s hands were used in teaching the spherical shape of the earth: how the strategies employed by educators including Mill fitted the subjects and objects of geography and astronomy to the scale of children’s bodies.

Mill was not the only educator to teach using a miniature model of the world: from the eighteenth century onwards, small, so-called ‘pocket’, versions of the terrestrial and celestial globes used to teach the standard subjects of geography and astronomy had been sold by instrument-makers across Europe (see figure forty four).

A cheaper counterpart to the often extravagant table and floor globes – before mass
production in the mid-nineteenth century made the terrestrial globe, in particular,
much more affordable – small pairs of pocket globes were marketed as gentlemen’s
toys and as especially appropriate for children. 391 In 1832, William Newton advertised
his firm’s ‘improved pocket globes’ in his Familiar Introduction to Astronomy, explaining
the financial advantages of the smaller models:

IMPROVED POCKET GLOBES

FOR the purpose of affording the means of pursuing the delightful study
of Astronomy to those persons who have not access to globes of a large
size, or convenience for using them, the author has constructed improved
pocket globes, with all the appendages necessary for solving problems. It
cannot be expected that these little globes should give the results of
problems with equal accuracy to large ones; but in all instances, such
astronomical questions as appertain to the globes, may be answered
sufficiently near the truth, to satisfy the pupil, and explain the principles of
the science. 392

For Newton’s commercial purposes, pocket globes were small because they were
cheap: they were accurate enough for introductory purposes, but did not compare
with their larger counterparts when making more complex calculations. The smallness
of the globes had an additional significance for children, though: it brought them
onto the scale of their world as miniature artefacts that could be grasped, sensed, and
manipulated.

Museum Publications) 3, 24.
392 William Newton (1832) A Familiar Introduction to the Science of Astronomy, and the Use of the Globes,
illustrated by numerous diagrams; to which is added, a description of the orrery and armillary sphere. (London:
Sherwood, Gilbert, and Piper, Paternoster Row, and Newton, Son and Berry, Chancery Lane), 135.
The kind of sensory teaching I have analysed in this dissertation relied on making things child-sized; 'fitting' subjects for the hand, as we have seen with the conversion of geological time into a smoothed, palm-sized pebble, or the rudiments of chemical knowledge into a cup of tea, held by the pupil. In her discussion of small
things, Susan Stewart claims the hand as ‘the measure of the miniature’. As the naming and adventures of Tom Thumb, already a staple character in children’s literature by the early nineteenth century, made explicit, the connections between size, scale and the hand, digits and measuring, were profound. ‘Scale’, Stewart writes, is established by means of a set of correspondences to the familiar, as is remembered in the terminology of parts of the body to indicate values such as feet and inches. Thomas Smith elaborated on the analogy between an orange and a model globe in the astronomical volume of Wallis and Harris’s \textit{Scientific Library}, using Stewart’s ‘set of correspondences’ to compare mountains in relation to the world to dust on globes and bumps on the surface of an orange:

The figure of the earth is an oblate spheroid, or in the shape of an orange, the diameter from pole to pole being about 37 miles shorter than that at the equator, and with this small difference it resembles the artificial globe; for the mountains, valleys, &c. which might be considered material objections to its rotundity, are, in reality, scarcely equivalent (in proportion to the bulk of the earth) to the smallest protuberance on the surface of an orange, or to a grain of dust on an artificial globe twelve inches in diameter.

The \textit{Scientific Library} was just one set of miniature books for children published by figures such as Wallis and Harris; these diminutive objects were smaller versions of the standard introductory texts available at the time. \textit{Science in Sport} publisher Wallis’s \textit{Book-Case of Knowledge} (1801) included ten tiny titles that covered a range of disciplines: botany, biography, scriptural and natural history, mythology, arithmetic, moral tales, grammar, and, most relevant for the concerns of this chapter, \textit{Geography}.

\begin{itemize}
\item \textit{Science in Sport} publisher
\item Wallis’s \textit{Book-Case of Knowledge} (1801) included ten tiny titles that covered a range of disciplines: botany, biography, scriptural and natural history, mythology, arithmetic, moral tales, grammar, and, most relevant for the concerns of this chapter, \textit{Geography}.
\end{itemize}
and Astronomy Familiarized: for Youth of Both Sexes. The Book-Case comprised a wooden box; fashioned, quite literally, to resemble a glass-fronted bookcase, with an carved top: the titles of the works it contained could be glimpsed on the multicoloured trompe l’œil engraving that was pasted on to the front, and gave the illusion that one could see through to the pastel-coloured spines of the books that nestled within. Underneath the box’s sliding lid were revealed compartments where the volumes were stowed, above a small drawer (see figure forty five).

FIGURE FORTY FIVE: An early nineteenth-century miniature library: the decorated wooden box was almost identical to that of the Book-Case of Knowledge and Infant’s Library, including the ornate lid.

Picking up one of the books, it was clear that aside from its petite appearance, once its pages were opened Geography and Astronomy much resembled a standard introductory treatise on these twin subjects, the kind of work such as Newton’s

398 Apparently the drawer contained letters of the alphabet carved from ivory, though the example I looked at had lost these contents. See Cambridge University Library catalogue entry.
Familiar Introduction that would have accompanied a pair of celestial and terrestrial globes: definitional, standardised, uncontroversial. Geography was the first subject tackled by the miniature book, defined as ‘the description of the globe of the earth as made up of land and water’; the second set of 32 pages dealt with astronomy in a similar manner. Neither the geographical nor the astronomical segments made any concession to the physically small size of the pages on which their doctrines were to be displayed, besides, perhaps, an exaggerated brevity of sentence-structure. This was unlike The Natural History of Birds and Beasts and Scriptural History, both of which exploited the diminutive format of the book to more clearly convey information – in the case of Natural History with a creature given a page of writing, and the illustrations bound at the back of the book depicting two animals to the page; in Scriptural History with each Book of the Bible condensed to a page each (leading to some amusingly laconic summaries, particularly that of Genesis in a swift 77 words). Marshall’s Infant’s Library, produced in a virtually identical box, but containing sixteen smaller books and no drawer, had, however, made the most of the physical size of the format – in its first volume the reader had to turn the recto page to reveal the verso objects named by particular letters of the alphabet; in later volumes illustrations of flowers, animals, and birds, as well as familiar objects and traditional pastimes faced their verbal descriptions.

The volumes in these miniature libraries thus urged an active engagement with the books as objects themselves, as well as with other objects as part of the educational process: A Compendium of Simple Arithmetic, from A Book-Case of Knowledge, depicted two children working with mathematical instruments including an abacus on its frontispiece, underneath the spreading branches of tree, and the critical, gesturing gaze of their teacher. A Familiar Introduction to Botany – which aside from its

400 ‘Scriptural History’, in Anon., Book-Case of Knowledge, 3.
coloured plates had been a fairly dry exposition of competing classificatory systems – closed with an enjoiner to the young readers to augment their book-learning with studying real examples: ‘Confirm your knowledge by practice, and do not suffer a day to pass without amusing yourself in dissecting some flower or other.’403 Once the basic precepts were understood, botany then became an everyday entertainment, a suitable afternoon employment for boys and girls. Geography and Astronomy Familiarized also concluded by turning to activities, with an experiment employing the familiar objects of a bent wire, a candle, and an ivory ball. The didactic voice reassured the reader that with the knowledge they had gained after ‘this little’ (possibly a pun on the size of the book) ‘illustration the following experiment will be found easy’.

Bend a piece of wire into a circle, and let some person hold it even with a candle placed on a table, so that the candle may be exactly in the centre, then sling an ivory ball (which may be had at any turner’s shop) with a piece of thread, and twist it towards the left hand, so that when it untwists, it may go to the eastward or to the right hand, at the same time moving the ball round the wire slowly; when the first motion will shew the days and nights, and the other the annual motion of the earth...

The miniaturized instruction of the shrunken bookcase was thus a preparation for creating a miniature model of astronomical bodies. Hands were crucial in this process: with one person required to hold the wire orbit, and other to wind and move the planetary ball; handedness was equally vital to ensure that the ball would rotate ‘to the eastward’, mimicking the earth’s actual movement. The ease of obtaining the objects required to construct the model was emphasised – ‘any turner’s shop’ could provide an ivory ball – just as the introduction had stressed the ease of the illustrative

405 Ibid., 62-63.
demonstration itself. There was a problem with this simple model, however, as the
text went on to detail:

but in this case, the days and nights would be equal, and the seasons
alike, which is not the case, as the Earth's orbit, represented by the wire,
should be inclined to the equator, a circle supposed to be drawn round
the globe in an angle of twenty-three degrees and a half…406

The final series of instructions therefore proposed amendments to the model so that
it more closely resembled the astronomical phenomenon in question, and rendered
unequal the days and nights of countries furthest from the equator:

therefore, let the person who holds the wire raise it up at one side, and
depress it on the other, so that the candle may still be exactly in the
middle, then let the ball down to the lower part of the wire, and the
candle which represents the Sun will shine on the tropic of Cancer, and
on all the countries from the equator to the North pole, which will have
longer days and shorter nights, and those countries towards the South
pole exactly the converse. In those countries situated on the equator, the
days and nights are equal.407

Familiarity of objects and ease of assembly were important, but accuracy in
representing the astronomical relationships was crucial.

For all its playful trappings, toy-like size, and witty cover images, then, the
Book-Case of Knowledge was a pedagogic object: the prose contained in A Familiar
Introduction to Botany, A Natural History of Birds and Beasts, and Geography and Astronomy
Familiarized was intended to impart rigorous and accurate information. The toy

406 Ibid., 63
407 Ibid., 63-64

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bookcase did not house toy books. Whilst the order in which the titles were dipped into could be determined by the student, the volume on moral tales was entitled *Rewards for Attentive Studies; or Stories Moral and Entertaining*. An announcement at the end of the book made it clear that ‘the Studies alluded to in the Title-page are the preceding Volumes of this Collection’.\(^{408}\) After learning the facts of geography and botany, pupils could turn to the more narrative presentation of these moral tales, to derive wider ethical and personal lessons from the works. Both rote-learning – for example of the multiplication table in *Arithmetic* – and fabular stories were hence combined in the same object, as the *Book-Case* shelved fact and fiction side by side, complementary aspects of rational entertainment and amusing education.

As well as its playful connotations, one of the meanings of the verb ‘to toy’ is ‘to manipulate’: the two practices of fanciful experimentation and manual dexterity are closely allied.\(^{409}\) A lesson on the different movements of the hand opened the SDUK’s *Exercises for the Improvement of the Senses*:

**Hands.**

OPEN your hands – shut them – touch something – hold something – lift something – clap your hands – close your hands together.\(^{410}\)

Beginning with the hand, children could then move to exploit the smallness of these objects, which encouraged finer manipulation and the employment of the fingers. As kindergarten teacher Jane Mill, daughter of John, explained, this was one of the aims of hands-on activities advocated by the Froebelian system, such as cutting and folding paper, and forming shapes with sticks and peas:

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\(^{409}\) Stewart, *On Lanquing*, 56.

\(^{410}\) Anon., *Exercises for the Improvement of the Senses*, 1.
One very important point is always gained by these lessons, namely, that the children are *taught to use their fingers*. The constant handling of large objects has a tendency to render the hands clumsy and incapable of manipulating smaller and finer implements. [This] 

... gives sensibility and power to the hand.\(^{411}\)

Manipulation by the hands and use of the fingers was encouraged in another kindergarten activity, which involved moulding objects from clay. One of which was a model globe:

In the early lessons where Fröbel’s Kinder-Garten system is used the children make their own globe out of a ball of clay. They are not expected, in this case, to make any form of the sea or land, since that would be too difficult for them. They can, however, mark the zones, and learn that there are two that are cold, the north and south; two that are temperate, and that between these two there is one that is hot, and called the torrid zone. It is not desirable to attempt too much upon one ball, and will be better, therefore, to encourage them to make another, and upon this second, teach them to mark lines which indicate the latitude and longitude of our sphere. They will, in this way, have learnt a great deal concerning the earth, and will be able to follow the teacher when he uses the map or globe. ...\(^{412}\)

Moulding the shape of the earth from clay (another form of earth itself) was a tangible experience for the learning children, as they had to make and mark the objects from which they were to learn themselves, and were not simply presented with the globe as an already existing object. In a departure from some of the other


\(^{412}\) Mill, *Primary, Industrial, and Technical Education*, 78.
kinds of object lesson teaching, in this case the pupils had to create the objects from which they were to learn themselves.

Marking lines on the globe was one way of extending astronomical and geographical lessons to more complex topics, after pupils had initially learnt the shape of the earth. Oranges were again used in the 1812 edition of Tom Telescope's *Newtonian Philosophy*, to demonstrate gravitational force acting towards the centre of the earth, in different directions in opposite hemispheres (see figure forty six):

![Figure Forty Six: Illustration from the 1812 edition of Tom Telescope’s *Newtonian Philosophy*, demonstrating the action of gravity towards the centre of the earth by two boys dropping oranges at Antipodean positions. Note that the globe appears to be upside down from how it is usually represented, with the southern hemisphere on top.]

‘To illustrate and explain what I have said, let us suppose the following figure to be the earth and seas: let Tom Wilson stand at this point of the globe or earth where we are, and Harry Thomson at the opposite part of the earth, with his feet (as they must be) towards us: if Tom drop an orange out of his hand, it will fall down towards Harry: and if Harry drop
an orange, it will fall seemingly upwards (if I may so express myself) towards Tom: and if these oranges had weight and power enough to displace the other particles of matter, of which the earth is composed, so as to make way to the centre, they would there unite together, and remain fixed: and they would then lost their power of gravitation, as being at the centre of gravity and unable to fall, and only retain in themselves the power of attraction.

This occasioned a general laugh...\textsuperscript{413}

This demonstration of positional relationships was quite literally a scientific amusement, as the narrator recorded the audience’s risible response to the rational reasoning of the lecturer.

In the Society for the Diffusion of Useful Knowledge’s \textit{Exercises for the Improvement of the Senses}, a book – indeed, the book itself – and the learning child’s body were used to teach very elementary relationships between objects:

\textit{Position.}

1. Take this book (or any small object): hold it near you.
2. Hold it far from you.
3. Hold it behind you.
4. Hold it before you.
5. Hold it above you.
6. Hold it low down.
7. Hold it high up.
8. Hold it to the left of you.
9. Hold it to the right.\textsuperscript{414}

\textsuperscript{413} Tom Telescope (1812), \textit{The Newtonian System of Philosophy, Explained by Familiar Objects, in an Entertaining Manner} (London: Printed for J. Walker et al. New edn.), 7-8.
\textsuperscript{414} [Anon.], \textit{Exercises for the Improvement of the Senses}, 9.
In a different way, William Graeme Rhind’s *The Creation* (1842) also used itself as an object to teach positional relationships. It appealed to the dexterity of its readers by including a manipulable volvelle inside its front cover (see figure forty seven), with which reading children could dial up a series of times across the ‘Habitable Globe’. As Rhind explained:

> The arrangement of the names, on the inner circle, is to meet the desire of these who have friends going abroad, or already settled there. How often is the question asked, in every family where those dear to them are far away, “I wonder what our brother, or sister, or friends are doing now?” One glance at the Dial, will, at least, in part, answer the question.

Rhind picked out particular locations that ‘traced’ the ‘line of the steam voyage to Bombay, Calcutta, China’ via the Red Sea as well as the Cape of Good Hope; to Australia and North America, as well as Nice and Dublin, which, though it was relatively close-by, had ‘a sensible variation of time’ from Britain. Children reading the book — formatted as a series of letters from a father to his offspring, mimicking the theological connotations of God as Father to man — were encouraged to explore their personal relationships with figures standing in various positions around the world. Though it utilised only two dimensions, the title given to the frontispiece declared that this representation was self-consciously a ‘globe’, flattening but simultaneously mimicking the planet’s real shape. Throughout the book, a series of steel engravings had depicted the earth as a whole, mapping its appearance on the successive days of creation, with the sun and moon, land, plants and animals, and finally man, accumulating on the plates according to the order laid out in Genesis. The concept of connecting individual pieces of information to the planet as a whole

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415 Rhind, (1842) *Creation.*
416 Ibid., appendix [i]
417 Ibid.
was foregrounded, as through analysing and experimenting with the spatial relations between themselves and their actual relatives elsewhere in the Empire, children were taught to abstract these lessons to more general precepts in positional astronomy.

**THE HABITABLE GLOBE.**

*Though I take the Wings of the Morning and dwell in the uttermost part of the Sea even there shall thy hand find me and thy right hand shall hold me.*

![Diagram](image)

**FIGURE FORTY SEVEN:** Volvelle from Rhind's *Creation*. The Instructions read:  
**DIRECTIONS** Place the hour of your time opposite the Country you are in, & the Dial will mark the relative time at the other parts of the Globe.  
**EXAMPLE** When it is Noon at London, it is Midnight at the Friendly Islands, Morning at New Orleans and Evening at Calcutta.
EXAMPLE When it is Noon at London, it is Midnight at the Friendly Islands, Morning at New Orleans and Evening at Calcutta.

Above the ‘Habitable Globe’ volvelle was written a quotation from the psalms that epitomised the purpose of the book in drawing together scriptural writings with the surrounding natural world, and the hands-on activity of the child: ‘Though I take the wings of the Morning and dwell in the uttermost part of the Sea’, it read, ‘even there shall thy hand lead me and thy right hand shall hold me’ (see figure forty seven). Knowledge came to the child through the divinely-ordered natural world: as the first letter had set out, the purpose of the book was to enlighten its audience to the ‘manner in which the things around us are continually used in the blessed Word of God to set forth divine truths’, that the reading children might ‘get instruction from every object around’. Both time (‘the Morning’) and space (‘the uttermost part of the Sea’) could be reached with and could reveal the presence of God, if handled appropriately. Most significantly for our purposes, the quotation asserted that the child was ‘led’ down the path to that knowledge by the hand: the right-handed child would hold the book, and spin the volvelle, which apparently spoke to the child in the first person, referring to the child’s hand as ‘thy hand’, and itself as ‘me’.

The left hand came to life and petitioned ‘those who have the superintendence of education’ to give her the same training as her right ‘twin’, in Benjamin Franklin’s letter on the subject, cited in Charles Bell’s Bridgewater Treatise on The Hand: Its Mechanism and Endowments, as Evincing Design. Mill opened his work on What to Teach and How to Teach It with a similar extended discussion comparing the differences between the hands. What could one do with the right hand, Arthur had asked his sister, Kate? And how about the left? Why was this so? Through a carefully-directed

418 Ibid, quotation reproduced above frontispiece. My emphasis.
419 Ibid, 1, 2.
series of questions and answers, Arthur led the reader, and his sister, to the following conclusion:

“Then you see, Kate, we have arrived at this, that your right hand is powerful and useful because it has been educated; that the great difference between that and your left is, that the latter is uneducated or uncultivated – in one word, neglected. Now we come to the point I have been trying to bring you to – the grand difference between the educated and the uneducated. The one is strong, powerful, useful, because it has been trained; the other weak, inefficient, helpless, because it has been neglected.”

“Of course I know that,” retorted Kate, “and so does everybody; and that is what is intended by the new acts of the Legislature, which are designed to make educations universal, or, if you like similes better, take care of the left hands.”

In Mill’s extended analogy, the synecdochic right hand became the body of the schoolchild, that – like Rhind’s reader – held knowledge, in contrast to those who were ignorant, and uneducated. This polemical, political use of the hand as synecdoche was at its most resonant in debates over labourers, or ‘hands’, resonances on which Kate punned in her retort to her brother.

This identification between the working classes and their hands is used by Barnes and Shapin in severing the intellectual, complex and active (or ‘gnostic’) process of education from the sensual, simple and passive (or ‘banausic’), which they argue formed the two ‘mentalities’ ‘constructed’ in this period. This was a useful rhetorical separation for those advocating the higher status and mental pleasures of

421 Mill, Primary, Industrial and Technical Education, 6-7.
science, but obscures how these categories were, in practice, brought together: complex thoughts and active practices were communicated through sensual processes, and by beginning with simple objects and concepts. Even Henry Brougham’s argument for learning the sciences being a process of transcending the body and training the mind was itself couched in a sensory language of ‘tastes’. Rather than being dangerously ‘base’, then, sensory impressions could in fact be upheld as the rational – and natural – way to train the mind. Moreover, playful activities exploited actions already known to the hand, and could be the way to understanding rational processes.

This section has explored how children’s hands, and, by extension, children themselves, were taught about the shape of the earth in the nineteenth century. From an elaborately-carved orange to a lump of clay, children were taught to handle astronomy and geography through a range of different types of tactile activities engaged in with a variety of paper, card, and paste, two- and three-dimensional objects. Often manufactured and sold by the same enterprises that created games such as Science in Sport, specialist card-sets, slides, puzzles, and globes provided hands-on explanatory aids to the introductory teacher. Problems including demonstrating the spherical shape of the earth, and one’s place on it, were also solved by practical examples using more everyday items such as fruit, magnets, balls, and wheels. Books were themselves revealed as sites of hands-on learning, in the volvelle with which Rhind’s readers manually dialled up the time across the globe, or on the pages of miniature libraries that presented child-sized knowledge. Above all, therefore, by placing artefacts in the hand of the child these object lessons on the spherical earth brought the immense subjects of astronomy and geography onto a human – indeed,

423 See Henry Brougham (1827) A Discourse of the Objects, Advantages, and Pleasures of Science (London: Baldwin, Cradock, and Joy, 2nd edn.). For example, he declares that ‘the appeal is made to reason, without help from the senses’, but also that ‘you will, as it were, taste a little to try whether or not you relish it’, and that ‘the pleasure derived from this study is unceasing, and so various, that it never tires the appetite’ (6, 7).

424 See, for example, George Wilson (1856) The Five Gateways of Knowledge (Cambridge: Macmillan and Co.).
an infant – scale. Shrinking the subject of the lesson to the size of the child’s world was more than a rhetorical flourish: object teaching proceeded and succeeded through sensory training. The hands and body could be trained to relate to abstracted phenomena, and relationships between objects extended to encompass the whole of creation.

A see-saw, or object lesson as plaything

Object lessons, as I have demonstrated throughout this dissertation, were firmly situated in the child’s surrounding physical environment, and exploited the artefacts at hand and activities known to the learning child. The kitchen, local countryside, garden, parlour, and nursery were converted into sites of scientific instruction. So far, the objects recruited as the foci of these lessons have been commonplace household commodities and natural historical specimens. But it was the commonplace playthings of childhood, from marbles and kites to hoops and peashooters, that populated the pages of John Ayrton Paris’s Philosophy of Sport Made Science in Earnest, which first appeared in three volumes with illustrations by George Cruikshank in 1827 (see figure forty nine). As its subtitle declared, this book was ‘an attempt to illustrate the first principles of natural philosophy by the aid of the popular toys and sports of youth’: rather than creating new ways of playing, older pastimes were recast as educative, scientific, activities. Indeed, not only the toys and sports of youth, but the tools of discipline associated with the sterner sort of classical education found a place in the book’s system of instruction: ‘Imagine not’, Paris’s preface averred, ‘that I shall recommend the dismissal of the cane, or whip; on the contrary, I shall insist on them as necessary and indispensable instruments for the accomplishment of my design; but the method of applying them shall be changed’.425

The last section of this chapter analyses how Paris achieved this aim of changing how objects were applied – and how children applied themselves – in games. It argues that

'sport' became 'philosophy' in two ways: through games and humorous language science was converted into a pastime itself, and through physical activities scientific theories were adapted to fit the child’s body and mind.

FIGURE FORTY EIGHT: One of George Cruikshank’s illustrations for *Philosophy in Sport*, here depicting some of the childhood playthings used as examples in the book: a kite, cricket bat, shuttlecock, bow and arrows, and balls. The original illustrations were retained throughout the subsequent new editions.

The tension inherent in Paris’s oxymoronic title – *Philosophy in Sport* – played on the perceived contrast between education and entertainment, a contrast reified in the contemporaneous publication of the SDUK’s *Libraries of Useful and Entertaining Knowledge*. The book began by explaining that it ‘proposed’ a ‘series of amusements’ for the ‘instruction’ of Tom ‘during the holidays’; a creed immediately criticised, to pre-empt concerns that could be raised by the reader of the book:
"Amusement and instruction," replied the vicar, are not synonymous in my vocabulary..."426

If not precisely synonymous, 'amusement' and 'instruction' could be complementary, and books and lessons reconciled their different demands in a variety of ways, as we have begun to see in the discussion of miniature books above. For Paris, they would primarily be brought together by taking already existing amusements, and revealing their instructional value. He also, however, navigated the waters by playing off different genres of writing, including the didactic dialogue (Ciceronian, not Platonic, he was at pains to stress), farces, and even claimed to have 'ventured so far to deviate from the beaten track as to skirmish upon the frontiers of the Novelist, and to bring off captive some of the artillery of Romance..."427 The genre of the caricature was also encroached on by the book, with 'amusing' illustrations by George Cruikshank a counterpoint to what could appear at first sight as 'instructional' prose.

In these ways, the playfulness of Philosophy in Sport was not restricted to the activities it depicted: linguistic gymnastics and, especially, plays on words were central to its narrative and didactic success. A spectrum of puns provided everything from knowing references to the educated reader, to simple light relief for their younger counterparts, and were identified in the text in italic font, as they were in contemporary publications such as The Comic Offering (see figures sixteen and twenty four in chapter two). For example, the use of puns played a key role in one of the first conversations between the educational voice of natural philosophy, Mr. Seymour (the family name itself a pun on their enlightened perspective: 'See-More'), and Reverend Twaddleton, a Virgil-quoting antiquarian vicar (and supposedly allergic to puns, which at the beginning of the book provoked in him a visceral reaction, likened by the narrator to 'the quivering back of a horse, when goaded by the sting of a gad-

426 Ibid, 25.
427 Ibid. xiii.

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fly’). A vogue for natural science was, the Reverend reported to his dismay, sweeping the village, after Tom Plank — the carpenter, naturally — had visited a Mechanics’ Institute in London, and returned with ambitions to set up a local philosophical society. Lamponing the rhetoric of critics of contemporary movements such as the SDUK, the Reverend remonstrated that ‘unless this “march of intellect,” ... is speedily checked, Overton, in less than twelve months, will become a deserted village; for there is scarcely a tradesman who is not already distracted by some visionary scheme of scientific improvement’. This ‘distraction’ from appropriate activities greatly resembled Thomas Love Peacock’s satirical depiction of the calamitous — indeed, conflagratory — results of the working classes learning philosophy, in *Crotchet Castle* (1831). As one of his characters lamented: ‘I am out of all patience with this march of mind. Here has my house been nearly burned down, by my cook taking it into her head to study Hydrostatics, in a sixpenny tract, published by the Steam Intellect Society’; the cook had read this ‘rubbish’ in bed, promptly fallen asleep and overturned her candle, setting fire to her curtains.

Back in Overton, Roger Naylor, the blacksmith, had even abandoned the forge to found an elementary school, news of which provided the basis for an evermore elaborate series of puns: from how ‘writing and forging’ could be the same business — if one wished to risk conviction in the courts — to Mr Seymour’s riff on ‘elementary education’. Initially, none of the other characters understood this joke — Tom, the learning schoolboy with whom the reader identified, ‘was quite unable to comprehend what elements had to do with the shoeing of a horse; the vicar was equally at a loss to discover the speaker’s meaning; for, as he said, he could not possibly imagine what affinity existed between the heels of a quadruped, and the head of a child.’ Mrs Seymour offered the observation ‘that, in both cases, it is the business of the artist to hammer something soundly into them,’ which her husband confirmed.

428 Ibid. 29.
429 Ibid.
was ‘a happy hit’ of hers; but none guessed that he was connecting the elemental materials with which the blacksmith worked to introductory instruction, and the elements of knowledge. As Mr Seymour implored his audience, ‘Are not fire, water, earth, and air, the elements? and has not the air animated his bellows, the fire heated his iron, the water tempered his work, and the earth afforded him moulds for his castings?’431 Audiences both in and reading the book could now appreciate the patriarch’s wordplay, and enjoy an ‘enigma’ on the topic relayed by Mrs Seymour:

A shoemaker once made shoes without leather,
With all the four elements joined together;
There were Fire and Water, and Earth too, and Air,
And most of his customers wanted two pair.432

Arguably, it was parents, tutors, and governesses, rather than children, who would have appreciated chapters such as this on the very business of education and the spread of philosophical knowledge – reflected in the fact that in this section it was primarily the speech of the adult characters in the book that was relayed, unlike in other passages, where the various Seymour children contributed more to the discussions. Allusions, such as the reference to the ‘march of intellect’, and the ‘liberal’ politics of Mr Seymour, made the book’s awareness of contemporary political debates clear to a newspaper-reading adult. Paris was well aware that by playing around with different ways and levels of writing and explanation, portions of his book could be criticised for failing to appeal to its avowedly childish audience, to whom he apologised in the preface for ignoring for a few pages ‘that I may address a few words to your parents and preceptors’.433 There was also an apology for the parents themselves:

431 This discussion takes place on Ibid., 40-42.
432 Ibid., 42.
433 Ibid., viii.
If it be argued that several of my comic representations are calculated, like seasoning, to stimulate the palate of the novel reader, rather than to nourish the minds of the younger class, for whom the work was written, I may, upon such a charge, at least, plead common usage; for does not the director of a juvenile fête courteously introduce a few piquant dishes, for the entertainment of those elder personages who may attend in the character of a chaperone?  

In his role as 'chaperone' to the sciences, Paris justified his aim of providing conversational 'sport' for the adult as well as nursery games for the child reader, both nourishing in their way.

Thus, the playful verbal patchwork of novelistic passages, Latin quotations from the *Aeneid*, witticisms and knowing references formed part of the same enterprise as Paris's actual use of play and activity in the book, just as contemporary titles such as *Exercises for the Improvement of the Senses* punned on the word's dual meaning of both a mental and physical work-out. Andrew Warwick has analysed how mathematics students at Cambridge University used exercises to train both their bodies and minds with competitive examinations in the first half of the nineteenth century; it appears that precisely this undergraduate experience underpinned Reverend Twaddleton's bitter antipathy towards the sciences in *Philosophy in Sport*, as the book's narrator explained:

> He entertained a singular aversion to the mathematics, a prejudice which we are inclined to refer to his disappointment in the senate-house; for,
although he was what is termed at Cambridge a "reading man," after all his exertions he only succeeded in obtaining the "wooden spoon," an honour which devolves upon the last of the "junior optimes."

Exercises for the Improvement of the Senses had drawn together actual artefacts and verbal artifice, describing language as 'the most important' 'instrument' 'for the acquisition of knowledge and virtue', advising that children 'should understand it well, and use it with accuracy, dexterity, and ease'. Language itself was cast as an object capable of manipulation, and in need of careful handling.

Playing on or with actual objects was an equally important part of Philosophy in Sport (see figure fifty), discussion of which operated in tandem with these linguistic puns. The conversion of playing into learning was perceived as an effective means of instruction since, Paris pointed out, playing was deemed a natural activity of childhood: 'Youth is naturally addicted to amusement', he declared; indeed, so addicted that 'his expenditure too often exceeds his allotted income'. On this excess expenditure, Paris proposed to 'draw a draft'; or, as his epigrammatic quotation from Cowper declared, to levy 'a tax of profit from his very play'. The educational practices of Froebel relied on many playful activities, incorporating games with objects as well as songs as ways of learning particularly suited to developing children's minds. In Primary, Secondary, and Technical Education Mill remarked on this identification:

437 Paris, Philosophy of Sport, Vol I, 13. See Warwick, Masters of Theory, 208-11 for discussion of the 'wooden spoon', given to the student who came bottom of the list. From 1804, conceivably around the time that the Reverend graduated, an actual wooden spoon was constructed and presented at the Senate House.
438 Anon., Exercises for the Improvement of the Senses, xvi-xvii.
It was well said by Frobel, ‘Play is the labour of the child,’ and in play we must find the sources of our physical culture, especially for children under ten years of age. A series of games have been organized in what is called the ‘Kinder-Garten system,’ which are designed, taken as a whole, to exercise the whole bodily faculties of the child. You will see from the samples which I submit to you that they are derived principally from games which have existed among children from time immemorial, and are only systematized and reduced to order for the special requirements of industrial children.441

As in Philosophy in Sport, it was traditional games ‘from time immemorial’ that formed the basis of these activities, and rendered scientific; Paris also, however, dealt with the science of new optical amusements, such as the thaumatrope.442 Discussing the stereoscope, one such new amusement, a contributor to Household Words writing on ‘Playthings’ criticised the conversion of playing into learning:

In the use of these philosophical toys I utterly object to all attempt to turn them into lessons, or to say one word about the science that is in them, more than can be made pleasantly intelligible. ... It is not at all necessary that a child should do more than wonder at a plaything of this kind...443

Such an opinion echoes with Dickens’ frustration with the fictional Mr Barlow’s propensity to ‘didactically improve’ almost any occasion – indeed, Sandford and Merton

441 Mill, Primary, Technical, and Industrial Education, 49-50.
was an important model for *Philosophy in Sport*.\textsuperscript{444} *Punch* would satirise the taking of science to the nursery in an 1848 article on ‘Old and New Toys’, which argued that new and scientific objects needed to be created for the rising generation. Toys, it proclaimed, should ‘advance with the age’, since children ‘are too clever now to be amused with’ traditional toys such as kites or dolls; rather, they should be instructed and amused with balloons, gasometers, and velocipedes, or even a Megatherium rocking-horse. Reminiscent of Paris’s manifesto, it concluded that in this way a ‘lesson will be contained in every toy’, and ‘the most abstruse sciences be made easy to the smallest understanding by the aid of a plaything’ (see figure fifty)\textsuperscript{445}

\textsuperscript{444} See chapter two, section one.

\textsuperscript{445} Anon. (1848) ‘Old and New Toys’, *Punch* 14, 76
FIGURE FORTY NINE A, B AND C: Some of the childish games and activities used to impart scientific knowledge in *Philosophy in Sport*: trundling hoops, flying kites, and blowing bubbles.
FIGURE FIFTY: *Punch* proposes modifications of several traditional toys, using 'Science' to 'unmesmerise them' and fit them for the 'expanded' mind of 'advanced' nineteenth-century youth.

The Seymour boys' new hobby of playing upon a see-saw provided one opportunity to demonstrate a scientific 'principle' through a familiar activity, and is typical of how *Philosophy in Sport* attempted to combine instructional didacticism from Mr Seymour with depictions of playful activities and the input of learning children. After walking 'to the grove, in which a plank had been placed across a wooden post', Tom and his younger brother John:

again mounted their new hobby; and, after amusing themselves for some minutes, Mr. Seymour desired them to stop, in order that Tom might explain the principle upon which the see-saw acted. Tom replied, that he was not aware of any principle which could apply to riding on a plank.

"Have I not often told you, my dear boy, that the principles of Natural Philosophy may be brought to bear on the most trivial acts of life? Listen, therefore, and you shall find that your present amusement teems with instruction. You are already well acquainted with the nature and operations of the centre of gravity; tell me, therefore, whereabouts it lies in the plank upon which you are riding."

"I should think," replied Tom, "that in this instance, the centres of gravity and magnitude must coincide, or be very nearly in the same point."446

First, the children's play was interrupted by the patriarch, who asked them 'to stop' their amusement and think about what they were doing. Though Tom did not at first realise this, he was convinced that what he was doing 'teemed' with 'instruction; when

questioned, he could in fact apply his existing knowledge of the actions of gravity to the actions of the see-saw. Mr Seymour then introduced new material, describing how the ‘moments’ on either side of the central fulcrum (the wooden post) needed to be balanced, and how the see-saw in effect acted as a lever, a key mechanical principle:

“... you and John are of unequal weight, so that you perceive the plank must be drawn a little farther over the prop to make the arms unequal; and John, who is the lightest, must be placed at the extremity of the largest arm. Thus arranged, you will exactly balance each other, and as each of you, on your descent, touches the ground with your feet, the reaction afford you a spring, which destroys the equilibrium, and enables you to oscillate in arcs about the centre of motion.” [see figure fifty one]

... said Tom, “I have myself observed, that the lighter person has the better ride, as he moves both farther and quicker, and I now understand the reason of it; it is because being father from the centre of motion he describes a larger arc.”

“... You have here then a striking instance of mechanical advantage gained by opposing motion to matter, or velocity to weight; for I think you will readily admit, that without the aid of the plank, your little brother could never have raised you from the ground.”

“Then the plank thus arranged,” continued his father, “constitutes a mechanical power to which the name of lever has been given...”

Technical terms were in this way introduced to the reader through the father’s didactic prose. However, throughout the passage the playful, enjoyable, nature of the activity in which they were engaged was brought back to the attention of the reader: for instance, Tom recalled that due to these laws of physics, his little brother had a ‘better’ time on the see-saw. The example closed with Mr Seymour telling his

447 Ibid., 274-276.
companion to 'let the children remain at their sports': left alone by the adults, they
returned to the playful activity with which the section had commenced, but with a
newly philosophical understanding of how it worked.\textsuperscript{448}

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{image.png}
\caption{Figure Fifty One:}
\end{figure}

"Do we then describe the arcs of a circle as we ascend and descend?"
"Undoubtedly you must. Look at this diagram," said Mr Seymour,
"and you will see at once that the plank can only move round the
centre of motion".\textsuperscript{449}

In these ways, Paris's Philosophy in Sport Made Science in Earnest epitomised many
of the facets of object lesson teaching that I have explored in this dissertation. In its
presentation of the daily life of an idealised nineteenth-century family, it argued for
the interpenetration of scientific and everyday objects and activities. It both inserted
and revealed the scientific content of almost all components of contemporary culture,

\textsuperscript{448} Ibid., 277.
\textsuperscript{449} Ibid. 274-275.
and claimed that it was subjects such as natural philosophy that should form the foundation of children's education; indeed, it already was the basis of their leisurely pastimes. Moreover, it emphasised learning through demonstration, discussion, and hands-on activities, not through book-reading: sensory education and enlightened conversation were prioritised, as intellectual problems and factual knowledge were couched as interactive games, bodily pursuits, and recreational amusements. In its negotiation between the more 'philosophical' explanations of physical phenomena and 'sporting' pursuits and asides, it drew together instruction and entertainment to exploit playing and amusement as an avowedly natural tendency of children. Humorous passages of prose and numerous caricatures also leavened the dry didacticism. By analysing the way Paris played with language as well with see-saws and pea-shooters, it can be seen that prose and practice, written and actual experience, were different facts of the same enterprise, working together to provide sensory and rational education. Just as oranges and pocket globes matched the vast realms of astronomy and geography to the child's body, then, *Philosophy in Sport* matched Newtonian mechanics to the childish vocabulary and mind.

**Conclusion**

Whether it be a specialist board game, a miniaturised globe, or the more everyday orange or top, children were taught to seize with both hands objects from their surrounding world that contained lessons on astronomy. Through the playful childhood activities of sports and competitions, races and jigsaw puzzles, they could be introduced in an engaging manner to the facts and forces that, it was demonstrated, underpinned every aspect of that world. As the introduction to one familiar treatise put it:

A knowledge of this science is essential to all ranks of society— to all conditions of man, from the prince to the peasant. What must be that
human being who could be satisfied to plod his way upon the earth without knowing something of its form and magnitude? or could cast his eyes up to the sun, the moon, and to the starry heavens, without wishing to understand something of the nature of such magnificent wonders? In fine, the uses to be derived from a knowledge of this science, connect themselves with every part of nature, every branch of art, and every operation of busy and domestic life...\(^{450}\)

This chapter has analysed the playful and tangible ways in which nineteenth-century children learned about the astronomical and geographical sciences as part of 'busy and domestic life'. I have analysed two different facets of familiar object teaching: firstly, how specialist, particular objects were created to teach astronomy, especially, in a hands-on manner, combining sensory and rational instruction (child-sized globes, family-friendly games, interactive books and cards); and secondly, how the playthings of the nursery (balls and marbles, kites and cricket bats) were converted into exemplary demonstrations of physical phenomena – 'sport' made 'science in earnest'.

With titles of *Science in Sport* and *Philosophy in Sport*, and a reliance on playful activities including racing counters around a board, or whipping a top, the arguments and objects analysed in this chapter have shown that an abrupt distinction between instruction and amusement, education and entertainment, does not give an accurate representation of introductory science practice – as well as introductory science writing – in the early nineteenth century. Rather than appearing amusing or anomalous, separate from the main modes of contemporary instruction (for example, the ubiquitous and standard texts on the 'use of the globes'), objects such as an astronomical board game become key sources for understanding elementary science at this time. By analysing how playful learning converted the potentially dry prose of an astronomical textbook into a communal competition, or demonstrating that when

\(^{450}\) Newton, *Familiar Treatise*, ii-iii.
playing at blowing soap bubbles, on a swing, or with a kite, involves and exposes scientific forces at work, this chapter has explored how introductory texts and objects combined didacticism and amusement. The negotiations made in works such as Philosophy in Sport to balance expository, explanatory prose with actual activities, classical allusions, and joking asides, were intended to ease the child’s introduction to the subjects; moreover, they made science a pastime itself.

Physical activity was one way to bring together education and entertainment, with the right kind of play conceived of as a natural and pleasurable way of training the childish mind. Prioritising hands-on learning with child-sized artefacts, children were taught through touch and manipulation: moving game pieces, shuffling cards, turning handles and pages, holding pocket globes. These objects and practices matched the scientific subject to the child’s body, as with contemporary productions such as miniature libraries and, indeed, with the concept of ‘toy’ artefacts in general. This introduction of bodily matching was particularly relevant for the disciplines of astronomy and geography, which – unlike anatomy or botany, say – were not immediately visible on the same scale as the child, but had to be treated in some manner to fit with the philosophy of object teaching. Direct sensory education could only operate on this scale, especially for these potentially remote and untouchable subjects, whose immediate understanding went against usual sense-perception (the earth is flat; the sun moves around the earth; the moon is bigger than the stars). Therefore, children were led to compare these original, common-sense impressions with other, equally powerful, tangible and tactile experiences to overcome their immediate, erroneous, ideas. Learning through space and movement in the infant world was then scaled back up to the cosmos, just as Newton’s apple could stand for the gravitational attraction between celestial bodies, and billiard balls for transcendent laws of motion. By combining rational reasoning with everyday objects and playful activities, children could understand the universe.
Playing family board games in the parlour, swinging from a tree in the garden, making a joke during an afternoon conversation, or peeling an orange at the dinner-table: the activities of childhood were revealed as scientific processes or converted into educational examples by the kinds of object teaching I have analysed in this chapter. The conflation of common life and the scientific world was perhaps the most important argument and consequence of these books and artefacts: it both elevated the status of astronomical understanding and rendered it accessible, placing it not just as one component of the educational syllabus – as the introduction to one Familiar Introduction had it, analogous to learning the notes and staves of music – but as a central part of almost any everyday activity. Life at home, at work and at play, was saturated with the sciences, and it was through common practices and physical objects that their lessons could be revealed.
LESSONS

‘a small beginning has led us to a great ending’
T. H. Huxley, ‘On a Piece of Chalk’

THOMAS HENRY HUXLEY CONCLUDED his 1868 lecture on ‘A Piece of Chalk’ by claiming that a ‘small beginning has led us to a great ending’. He compared the ‘physical metamorphosis’ that would take place if he ‘were to put the bit of chalk with which we started into [a] hot but obscure flame of burning hydrogen’ to what had occurred in the Norwich lecture theatre that night: by ‘subjecting it to a jet of fervent, though nowise brilliant, thought’ it had been made to ‘shine like the sun’, rendered ‘luminous’. The object lesson journey on which Huxley had taken his audience had altered their perceptions; had clarified their views and trained their eyes and thoughts; and had beatified the piece of chalk so that it became an exemplar of the light of science.

In these concluding remarks, I draw together the themes that have run throughout this account of a series of objects and their lessons over the preceding pages. In particular, I discuss the genre of the object lesson as educational practice and literary representation; what the consequences of this work are for the widespread contemporary interest in Victorian things and the material imagination; how these uses of common objects challenge the identification of historical scientific

452 Huxley, ‘Chalk’, 172-173.
artefacts as solely instruments and specialist equipment; and how a focus on education and the label of 'familiar science' can be used to transform our thinking about scientific participation in this period. In these ways, just as object lessons were, despite Huxley's oratorical flourish, not endings – rather, many of the artefacts I have discussed saw themselves self-consciously as introductions to a lifelong pursuit of knowledge through the practice of the sciences – these texts, and toys, and tales can provide beginnings for new ways of analysing the cultural history of mid-nineteenth-century Britain.

Figure Fifty Two: A singular household object – here, a wine jar – in the forefront of a representation of the period, towering over its Victorian audience.
I have defined the object lesson as a genre of both literary representation and educational practice, which can help us in drawing together written and actual experiences, just as educators of the time believed possible. Lessons on objects used and trained children’s senses to develop powers of observation, reasoning, and manipulation; they taught of the scientific forces and substances present and at work in almost every activity of daily life – from morning ablutions to night-time reading by candle-light – and which made possible the contemporary world. An emphasis on the explanatory power of the everyday gave a privileged position to learning through concrete things, and demonstrates that considerations of common objects should be at the forefront of research into this period (see figure fifty three).

One way of abstracting from this emphasis on object lesson teaching to ways of learning and thinking in scientific subjects more generally, can be seen in Barry Barnes’ analysis of training ‘by ostension’.\(^{453}\) Ostension involved the comparison of similar concrete things: Barnes discusses Thomas Kuhn’s example of a small child, Johnny, on a walk with his father ‘in a zoological garden. The child has previously learned to recognize birds and to discriminate robin redbreasts. During the afternoon now at hand, he will learn for the first time to identify swans, geese, and ducks.’\(^{454}\) This post-prandial stroll with a parent reminds us of many of the kinds of elementary lessons on everyday objects and animals dealt with in this dissertation. The ‘primary pedagogaic tool’ for Johnny, Kuhn argues, ‘is ostension’: by a series of ‘correspondence relations’ pointed out between different sets of things the boy is led to draw ‘class boundaries’. In other words, through his father’s corrections when Johnny points to a bird and ducks are mistaken for geese, or geese for swans, the boy learnt how to identify the three different types of waterfowl.\(^{455}\)

\(^{455}\) Ibid., 309-318.
Barnes uses this example to talk about the process of learning in general; its dual requirements of both an authoritative teacher figure, and an inquisitive, sensing child: the ‘child cannot acquire his knowledge of bird kinds without parental assistance; but neither can he acquire it with his eyes shut.’ He argues that ostentive, demonstrative – we might add, sensory – learning must be prioritised over a linguistic, definitive mode of education, just as nineteenth-century educators derided bookish ‘learning’ and emphasised that knowledge of the life sciences must be imparted through ‘irrefragable’ sensory impressions of lobsters; that written chemistry was no use without specimens of reagents and experimental apparatus. However, and as I have demonstrated throughout this dissertation, this is a ‘false contrast’, highlighted by the paradox of claiming in a book that chemistry cannot be learned by reading books: as Barnes declares, the real distinction to be drawn is whether education relied directly or indirectly on the empirical foundations of ‘similarity relations’ that are the basis of conventional knowledge.

Kuhn’s and Barnes’ analysis of these psychological modes of reasoning resonate with the arguments made by theorists such as Froebel and Pestalozzi at the turn of the nineteenth-century for creating ‘natural’ educational methods that matched the development of the childish mind. This is not surprising, given that Kuhn’s core term, ‘paradigm’, is of course taken from educational theory. It is, I suggest, especially pertinent to study this period in the nineteenth century when sensory learning from concrete common objects was especially prevalent and significant; when the sciences and their objects formed an increasingly visible part of everyday life. The lasting legacy of these object-oriented educational philosophies, perhaps, is that they have been taken up by modern scholars as atemporal, as definitive of how we learn and reason.

456 Barnes, Kuhn and Social Science, 25.
457 Ibid., 27.
Reinstituting the object lesson as a central genre of educational practice provides insights into how wide-ranging its implications were for learning one’s place in the world. It was emphatically a moral and spiritual as well as a sensory and technical training: just as there was often a slippage between the use of the word ‘object’ as thing and as ambition, a double meaning was also held in the word ‘feeling’. For example, in the SDUK’s *Exercises for the Improvement of the Senses*, we find the following support for hands-on teaching:

...[the child] must examine and think for himself; for he will do but little if he only learns by heart the words of a book. He cannot know that which he does not understand, by committing to memory any number of words; and little can he know of feelings he has never felt, how much soever he may learn of their names.458

The images depicted on the cover of *The Song of the Five Senses* emphasised how object lessons could teach about ‘feelings’, as physiological specimens in the form of the parts of the body and the senses themselves were converted into objects of analysis (see figure fifty four). The images read: ‘I feel with my hand’ – an umbrella, ‘I feel with my Eye’ – a tree, ‘I feel with my Ear’ – a drum, ‘I feel with my Tongue’ – a piece of fruit, ‘I feel with my Nose’ – a flower. Next to these boxes were more general categories: the ‘outward senses’ of hand and eye experienced ‘all at once’ indicated the concept of ‘SPACE’; the ‘inward senses’ ‘one after another’ led to the idea of ‘TIME’. As a song, the lesson provided was already multi-sensory, as children learnt to speak its lyrics, and hear its (admittedly not terribly tuneful) melody.459

Moreover, the analysis of scientific lessons I have conducted provokes further questions about its use to teach about a range of other subjects: these were interdisciplinary lessons that used the specific level of the particular object to straddle the topics of domestic and political economy, geography and literature, classical allusion, national and scriptural history, and even, as in the previous example, physiology and music. Further study remains to be done on how this type of object-based, sensory learning was used in these other lessons; and, more widely, in the elementary schools founded in the wake of the 1870 Education Act. For example, object lessons were advocated by Government inspectors towards the end of the century, and many manuals for the use of the Board Schools survive. There was also a vogue for object-teaching in America, where even now elementary school 'show-
and-tell’ using objects taken from the home is arguably the descendant of this mode of instruction.460

Looking beyond just object lesson texts narrowly construed, it can be seen that their generic attributes bled out into other publications, as the practice of thing-based, sensory-led thinking could be applied to other texts to achieve something of the same experience. For example, a stress on learning from particular common things helps explain the significance of encyclopaedias in the mid-nineteenth century, a publication format increasingly organised as alphabetical lists of singular topics, rather than by disciplinary systems of subject classification.461 Looking up the discrete entries in an encyclopaedia involved similar practices of isolating a chosen topic, and moving from definitional to abstract knowledge; if the referencing process was required for more information on an actual object placed in front of the reader, then sensory comparisons also formed part of this reading. Indeed, object lessons books could be used as encyclopaedias themselves: their indexes providing alphabetical lists of the things with which they dealt, that pointed readers to the information they desired.

Children learning their letters from alphabet books were also encouraged to use common things, and think in multisensory ways, as an 1870 example entitled Object Lessons, and the Child’s Own Alphabet made clear. The letter ‘B’ was introduced through the following objects (see frontispiece to this dissertation):

461 For debates over the systematic versus alphabetical systems of organising encyclopaedic material, and their consequences in how audiences could read and learn from such works, see Richard Yeo (1991) ‘Reading Encyclopaedias: Science and the Organization of Knowledge in British Dictionaries of Arts and Sciences, 1730-1850’, Isis 82, 24-49.
The **Bi-bie** is the best of all books. You must make haste and learn to spell, that you may be able to read in the Bi-ble.

The **Broom** is made of hair, or of split whale-bone. The han-dle is made of wood.

A **Bot-tle**, to hold wine or beer, is made of dark green glass. The cork is cut from the bark of a tree, a sort of oak, in Spain.

The **Ba-sin** holds milk. It is made of clay, dried in an oven.

A Hand **Bell**, if you shake it in your hand, it will ring. Sheep and cows have often a Bell hung round their necks.

Some **Balls** are hard and some soft, a soft one is for use in-doors.\(^{462}\)

In this very elementary work, syllables were separated to aid their use when learning how to read. The sensory impressions of common objects were highlighted, including the ringing of the bell, the dark green colour of the bottle, and the tactile qualities of the ball. The origins (Spanish oak tree), content (hair, whale-bone), production (made of clay, dried in an oven), uses (holding wine, beer, or milk), and different versions (indoor or outdoor, for sheep or cows) of the objects were brought out. And the overarching moral framework within which the lessons were taught was also highlighted in the privileged place of the Bible as first in the list.

An education by these object lessons in the sensory, complex, and fanciful ways of reading everyday things, therefore, gave children specific bodily and mental skills that, I contend, had profound consequences on how they encountered, imagined, and affected the surrounding material world of Victorian Britain. Recent years have seen conferences and special issues of scholarly journals stuffed full of enough things to rival even the most aspirational mantelpiece of the period. Artificial limbs, food and furnishings are taking centre stage in analyses of artefacts, commonly organised – like these lessons – around series of single objects: as museum specimens,\(^{462}\)

\[^{462}\text{Anon.] [1870] Object Lessons, and the Child's Own Alphabet (London: Dean & Son), [3].}\]
parts of collections, or as they recur in novels. My analysis of object lesson teaching brings important insights to bear on much of this contemporary critical work on what has been called ‘the material imagination’ and ‘Victorian thing culture’.

In the ways analysed in this dissertation – through seeing back to the geological past, listening to fairy-tales about the London sewerage system, learning the exotic history of tea, playing with balls and tops – I have shown how the object lesson entrained and demonstrated the transparency of things to many Victorian eyes. They were not opaque marvels, divorced from their origins; rather, in John Ruskin’s words, they teemed with ‘associations and passions’; they were like that emblematic object of the mid-nineteenth century, the Crystal Palace itself, whose surface could be seen through to a wonderful and multi-sensory hive of industry and empire within (see figure fifty five).463 Mary Roberts likened her oak to a prism, with its ‘many sides’ fracturing its meanings into ‘numerous associations’; just as scholars have seen the Crystal Palace as a ‘Victorian Prism’, so too, then, other existing objects were and can be Victorian prisms, multifaceted, refractive, and reflecting points of illumination.464

Audiences who had been trained by object lessons were familiar with these extended, connected, associative ways of thinking and conversing: they knew how a candle had been made, of its chemical constituents, and the process by which it burned; they could discuss where the contents of a cup of tea came from, how best to ensure a tasty brew, and how like the boiling kettle was to the steam-engines that powered trains and ships; they could relate the historic tales of famous trees held in every acorn-cup, or how water travelled through an oak’s trunk, or the religious significances written on its leaves. In these ways, I have shown how audiences could read the multiple meanings of an object; could identify its tangible connections to

463 Ruskin quoted in Bown, *Fairies*, 122.
past, present, and future. Like Annie Carey’s *Threads* of fabrics, grasping the ends of which she hoped would connect her childish readers and their parents to ‘the endless web of knowledge’, they could follow where objects led to the seething and complex network of multiple people and machines, places and interactions that underpinned contemporary culture.465

**FIGURE FIFTY FOUR:** George Cruikshank’s illustration of ‘The Dispersal of the Works of All Nations from the Great Exhibition of 1851’, for Henry Mayhew’s *1851*. Here the Crystal Palace cannot contain the multitude of diverse objects that burst out energetically towards the reader.

This sense of tangibility was crucial: audiences had learned about objects through processes of sensory training, and their knowledge was not restricted to the

verbal or conversational. They could physically manipulate an orange to demonstrate its resemblance to the shape of the earth; they could play with toys from the nursery, exploiting centrifugal and centripetal motion to keep a top stable; they could look through a microscope at pieces of pebbles, twigs taken from the common, or water from the pail, and understand the strange sights and minute animalcules that resolved into view; they could conduct elementary experiments that changed colour, exploded or smelled. The object-centred reality of the lessons made these pedagogic relationships a very different kind of connection from the purely imaginary, or envisioned, that would have been gained from a literary description without a tangible referent. Like the modes of narrative reading Victorians could tap into when looking at a wall of tiles depicting miniatures of various well-known scenes, so too could deeper, complex and, crucially, embodied narratives be read into and evoked by daily encounters with common things.

This, I have argued throughout this dissertation, has consequences for our perceptions of the material world of the Victorian period: it was one composed of objects which held, when held, a wealth of meanings. Recent, and highly influential, books such as Bill Brown’s *A Sense of Things*, or Elaine Freedgood’s *The Ideas in Things* similarly make this point, and find in the background of literary works such connections to far-flung corners of the globe, to defining moments of the day, or stores of knowledge of distant events. This elevation of the seemingly insignificant objects in novels—curtains, tables, tobacco—attempts to recapture the physical worlds in which they were set: not the real social and political problems that have been focussed on with studies of realism, but real things, too. They have put everyday objects firmly in the spotlight of contemporary Victorian Studies. Yet there appears to be a gap between what Freedgood and Brown can read into these objects—their own understanding gleaned from the archives of furniture manufacturers, from trawling newspaper advertisements, and from years of critical work into Victorian literature—and the significance of such objects for nineteenth-century authors and
audiences. It is through the practices of object lesson teaching, I would argue, that contemporary middle-class readers and, indeed, the characters depicted by a Bronte, or a Gaskell, could have themselves acquired such knowledge about their surrounding material environment, and been trained, as I have been detailing, into reading the hidden wonders and interconnected significances of their surrounding material world.

Most of the Victorian objects from this surrounding material world that have appeared in the pages of this dissertation have been commonplace items of the household and garden: water, candles, salt, stones, horses, fruit, and soap. As I have demonstrated, they were simultaneously quotidian and philosophical things, and their dual identity and existence as both avowedly scientific and everyday conflated these domestic and expert, banal and specialist realms. Educators and men of science both revealed the presence of scientific facts and forces in almost every aspect of contemporary life, and advocated that conflation, inserting their own voices and pedagogy as crucial for understanding the everyday world: cookery was chemistry; a water drop a universe teeming with microscopic life. This identification has important consequences for the cultural history of science. Firstly, common things must be considered as potential scientific objects, and even as instruments. Secondly, it is clear that not only things, but also what is done to, with, and around those things should be studied by cultural historians of science: the activities and practices of daily life such as playing, cooking, and conversation, travelling and storytelling, should be set alongside experimenting, lecturing, theorising, or constructing. Indeed, they are often difficult to distinguish.

The identification between scientific and common things was ripe with punning potential, particularly its incarnation in the genre of familiar introductions to specialist subjects. For instance, in 1841 Punch's satirical series providing 'Information for the People' began with what it termed a 'Very Familiar Treatise on Astronomy', in which celestial objects were compared with their banal counterparts to humorous
A sense of familiarity was often evoked through a comic conflation of the humdrum quotidian with the elevated extraordinary: the apparent bathos involved in the mental movement from one to the other delivering (in this case quite literally) a satisfying punch line. That the comparison of scientific and familiar objects, and the notion of the ‘familiar treatise’, was itself familiar enough to be satirised, is a useful starting point when considering ‘familiar science’ as a helpful analytic category for the historian of nineteenth-century science.

As I discussed in the introduction, recent scholarship in the history of nineteenth-century scientific periodicals and poetry, exhibitions and shows, lectures and societies, has argued that ‘popular science’ does not provide a helpful way of lumping together a range of often diverse practices, many of which did not have popularising as their main aim; and separates these activities from their assumed twin, ‘proper science’, which has taken place elsewhere. By foregrounding the practices of education, rather than popularisation, I claimed that some of the assumptions built into this dyad can be exposed and, hopefully, avoided. I now propose that historians add the category of ‘familiar science’ to this emphasis on educational practices.

This analysis of object lessons demonstrates that a popular educational strategy in the mid-nineteenth century was the use of familiar things and analogies to ease the introduction of strange and novel subjects to elementary audiences. By the use of these already-known ideas and already-owned concepts, they hoped to render the potentially abstruse sciences familiar themselves to their audiences. Dickens’ Mudfog satire had relied on the ludicrous conflation of topics such as ‘Jack and Jill’, or the number of legs on chairs, and the erudite setting and serious diction of scientific society; yet, this conflation was ludicrous because it was on precisely these kinds of topics and objects – the mundane activities of daily life, or the stories of childhood – and in these imaginative and entertaining ways that introductory lessons in the

\[\text{Anon.} \text{’Punch’s Information for the People – No. 1. Being a Very Familiar Treatise on Astronomy’} \text{ Punch 1 (1841), 41.}\]
sciences were being given. Thus, when Dickens ended his faux-report with a celebratory feast, he demonstrated that on a serious as well as punning level, household objects and foodstuffs did indeed form an important part of the 'spread of science'. As the satire concluded: 'this is what we meet for; this is what inspires us; this is what keeps us together, and beckons us onward; this is the spread of science, and a glorious spread it is.'

The term 'familiar' appears in numerous titles from the period, as a cursory survey of library catalogues reveals: many were avowedly written 'in a familiar manner'; to provide a 'familiar introduction'; or as 'familiar letters'. It is helpful, I believe, that the phrasing 'familiar science' has fallen from current usage, as it prevents scholars transporting the contemporary connotations of 'popular science' back to the nineteenth century. Indeed, familiar science was not just practiced in a sequestered non-expert realm: specialist research was conducted on or with these common objects. The books and artefacts I have analysed in this dissertation were, as I have demonstrated, more dynamic than diffusive, active claims to domestic territory and expertise. They argued for the inclusion of scientific subjects in elementary, and indeed, in higher, education: they believed a familiarity with scientific knowledge was crucial for existence in the progressive modern world.

Yet familiar science is not an all-encompassing category: it co-existed with other educational and commercial strategies for creating an appetite for scientific knowledge that deliberately invoked the unfamiliar, strange, and sublime, most spectacularly in the wonderful panoramic shows of London. Museums, increasingly open to the upper- and middle-class families that would have purchased the books

467 Dickens, *Mudfog*, 73.
and objects studied in this dissertation, displayed novel and bizarre specimens – which could even include the curators themselves.\textsuperscript{470} Science could also arguably exist outside of the realm of everyday experience.

\begin{center}
\textbf{FIGURE FIFTY FIVE: A family visit the Great Exhibition.}
\end{center}

The deliberate choice of and emphasis on familiar science also highlights the family unit as a focus of analysis (see figure fifty six). Increasingly defined as integral to middle-class society and the moral foundation of the British Empire, the nuclear family was a vital cultural category in the period addressed by this dissertation.\textsuperscript{471} Moreover, it was itself a common object: almost everyone experienced some form of family life, every day, whereas visits to places such as museums or exhibitions, lecture-halls and – unless one lived by the sea – rock-pools were by definition extraordinary. The family was also a well-defined commercial market: publishers collated sets of volumes to be advertised as a ready-made ‘Family Library’, such as

\begin{footnotesize}
\textsuperscript{470} For more on visits to museums and the exhibiting of curators themselves see, for example, Victoria Carroll (2004) ‘The Natural History of Visiting: Responses to Charles Waterton and Walton Hall’ \textit{Studies in History and Philosophy of Science} 35, 31-64.
\end{footnotesize}
John Murray’s series in which David Brewster’s *Letters on Natural Magic* appeared in 1832.472

Reconfiguring the landscape of scientific participation in this way therefore makes sense of such prominent works as Ebenezer Cobham Brewer’s *A Guide to the Scientific Knowledge of Things Familiar* (first published in 1847), one of the best-selling books of the mid-century.473 Introducing this work, Brewer defined the style of writing that typified the familiar introduction, and that included the whole family: he would, he claimed, write ‘in language so simple that a child may understand it, yet not so childish as to offend the scientific’.474 Moreover, the beginning of Brewer’s book defined the subjects with which familiar science dealt, in an evocation of both the sensory knowledge and the questioning, conversational, process through which such knowledge could be augmented:

No science is more generally interesting than that which explains the common phenomena of life. We see that salt and snow are both white, a rose red, leaves green, and the violet a deep purple; but how few persons ever ask the reason why! We know that a flute produces a musical sound, and a cracked bell a discordant one – that fire is hot, ice cold, and a candle luminous – that water boils when subjected to heat, and freezes from cold; but when a child looks up into our face and asks us “why” – how many times is it silenced with a frown, or called “very foolish for asking such silly questions!”475


473 Ebenezer Cobham Brewer, (1847) *A Guide to the Scientific Knowledge of Things Familiar* (New York: James Millar, 1865). See Lightman, *Victorian Popularizers*, 66, for more on the publishing history of Brewer’s book, of which an astounding 195,000 copies had been printed by 1892, and from which he made ‘a small fortune’.


As in the lessons I have described throughout this dissertation, familiar science began with what ‘we see’ — white salt, green leaves — and what ‘we know’ — shining candles, clanging bells — and then went on to detail why these surrounding objects had such effects on our senses, teaching their hidden scientific content. In these ways, thousands of readers of Brewer’s book would go on to rethink the familiar surroundings of their everyday worlds.

A deeper consideration of common things affected not only how many Victorians lived their lives but also how they thought about their pasts and futures, as cosmological narratives traded on ways of writing and thinking derived from object lesson teaching. An extraordinary vision that formed one chapter of Charles Babbage’s autobiographical Passages from the Life of a Philosopher (1864) linked his own bodily experience to that of both a common foodstuff and the beginnings of the universe, which he entitled ‘Parallel Passages in the Creation of the Universe and in the Birth and Education of a Gloucester Cheese’. The several experiential stages of the vision, at first thought to re-enact the early incarnations of the universe, were mapped onto and revealed as what turned out to be the process of manufacturing cheese. Creating everyday comestibles and the entire cosmos were, this comparison demonstrated, analogous processes. The cosmological evolutionary narrative of Vestiges of the Natural History of Creation (1844) also exploited notions of common knowledge and a familiarity with objects: its opening gambit relied on the knowledge entrained through such lessons, that the shape and size of the earth, and its position in the solar system, was ‘familiar knowledge’. Comparisons in the body of the work emphasised the continuities between the small and grand parts of the creation, linked

477 Ibid. 406-417.
by universal laws of force and development; for instance, that ‘the tear that falls from childhood’s cheek is globular, through the efficacy of that same law of mutual attraction of particles which made the sun and planets round.’ Charles Darwin’s *Origin of Species* (1859) also employed as its central conceit a comparison between the everyday processes of artificial selection — seen in any domestic breed of dog or horse — with the larger scale process of shaping species themselves, and the development of life on earth; moreover, it was crammed full of concrete common things as evidence for this process of natural selection, from pages (and pages) of pigeons to its culminating appeal to the familiar experience of contemplating the plants, birds, insects, and worms on that entangled bank.480

This dissertation has demonstrated how scientific knowledge could be revealed in the most mundane of everyday things. The material trappings of the home and garden, its flowers, furnishings, and food, could be co-opted as instructional devices for sensory training, and used as similes to provide explanations of the most profound phenomena. As the first page of Thomas Carlyle’s *Sartor Resartus* declared: ‘to many a Royal Society, the Creation of a World is little more mysterious than the cooking of a Dumpling’.481 Through this two-way educational relationship, common things were turned into marvels of science, but marvels of science could also become common things. The dual vision and sensory skills entrained by these lessons rendered objects at the same time both wonderfully mysterious and utterly familiar.

479 [Chambers], *Vestiges*, 17. Secord argues that ‘the emphasis on “familiar knowledge” continues through the first third of *Vestiges*; and that “familiar images of birth, childhood, the family, and the home … are embedded throughout” (*Victorian Sensation* 100; 101).
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