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<https://doi.org/10.1057/s41599-023-01616-y>

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From one Darwin to another: Charles Darwin's annotations to Erasmus Darwin's 'The Temple of Nature'

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In the history of evolutionary thought, it has often been said that ideas on the transformation of species found in the work of Erasmus Darwin, principally as set forth in his *The Temple of Nature* (1803), inspired his grandson's theory of evolution. However, little historical evidence has been produced to back up this claim. Based on a physical examination of Charles Darwin's own copy of *The Temple of Nature*, this paper presents the 25 markings Darwin made in the book as evidence of his interest in and familiarity with Erasmus Darwin's ideas on the change over time across species. This finding contradicts previous statements reporting only two annotations, which suggested he had little to no interest in the book. This paper purposes that Charles Darwin's annotations indicate his and his grandfather's shared interest in the competition for reproduction (sexual selection) and point to a more remarkable resemblance between Erasmus Darwin's *The Temple of Nature* and Charles Darwin's *The Descent of Man* (1871) rather than to Charles Darwin's theory of evolution by means of natural selection (*The Origin of Species*), to which Erasmus's ideas are more often compared.

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Introduction

Erasmus Darwin (1731–1802) is recognized as one of eighteenth-century England's leading intellectuals and naturalists. Not only was he an outstanding physician whose services were requested by King George III, but he also stood out as a botanist, inventor, philosopher, and scientific poet. He is famous for founding four (perhaps six) scientific societies throughout his life (McNeil, 1987) and successfully covering more academic fields than any subsequent scientist.¹ One of the most exciting aspects of Darwin's work—from the perspective of modern science—is how he presented his revolutionary theories since most of them are embedded in long poems with philosophical notes. Therefore, it is unsurprising that many recognized him as the leading English poet after publishing *The Botanic Garden* in 1791 (King-Hele, 1986; Priestman, 2016; Ryan, 2012). In the same decade, he was regarded as the best physician and author of specialized medical texts in England after the publication of *Zoonomia, or the laws of organic life* (1794–1796) (Dunn, 2003; King-Hele, 1985), which was promptly translated into French, German, Italian and Portuguese, and maintained its reputation as the leading medical education textbook well into the nineteenth century.

Regarding the history of evolutionary thought, Section XXXIX, 'Of Generation', of Erasmus Darwin's *Zoonomia*, is worth noting as it describes a process by which a species can give rise to another by natural means. For the author, the main forces driving the change are hunger, security, and lust. By lust, he refers to the competition for reproduction among males of the same species. The outcome of this struggle is what Charles Darwin would refer to a century later as 'sexual selection', which is none other than natural selection itself applied to the case of reproduction.² The transformist ideas of E. Darwin are further developed in his last poem, *The Temple of Nature*, published posthumously in 1803. The similarity of the topics mentioned by Erasmus Darwin to those expressed by Charles Darwin in *On the Origin of Species by Means of Natural Selection* (1859), coupled with family kinship, has led those who study the history of evolutionary biology to consider Erasmus Darwin as having a fundamental influence on Charles Darwin's ideas on the change over time across species. For example, in *The Meaning of Evolution*, Robert J. Richards states, 'Not only did the elder Darwin's blood pulse in the veins of his grandson, but his suggestions, ideas, and poetical fancies warmly surged through the mind of Charles. The younger Darwin's mechanism of heritable modifications from habit probably derived at least partly from ruminations on his grandfather's work' (Richards, 1992, p. 94). Other authors, such as Michael Antolini (2011), extend credit for the idea to the other doctors in the family. Particularly to Charles Darwin's father, Robert Waring Darwin (1766–1848), and several other members of his extended family who either had attended medical school or were naturalists with liberal religious views and a deep love of science, natural history and active outdoor living. Antolini claims that, from an early age, their influence on the upbringing of Charles Darwin instilled in him the idea that 'the diversity of life has changed over eons of time under the force of natural laws' (Antolini, 2011). However, although the similarities between Erasmus and Charles Darwin's have been pointed out,³ we still lack historical evidence of the grandfather's influence on the grandson.

Many books and articles dealing with Erasmus Darwin allude to his writings' artistic, literary and philosophical analysis. Examples of this are Donald Hassler's 1971 work on the relationship between the thought of David Hume and that of Erasmus Darwin (Hassler, 1971); the literary studies of Erasmus's poetry by Maureen McNeil (1987) and Martin Priestman (2004, 2016), and the review of the engravings by Henry Fuseli that accompany the text of *The Temple of Nature*, carried out by

Samuel Kessler (2013). Studies of his scientific work include discussions of his botanical and taxonomic works by Clive Bush (1974), Janet Browne (1989), Donna Coffey (2002), Catherine Packham (2004), Dahlia Porter (2007), Alan Bewell (2009), and Patricia Fara (2012); the work of Edward Reed (1997) and Ben S. Bradley (2010) on the implications of Erasmus's work for psychology; and six papers that analyse the link between Erasmus Darwin and evolutionary theory, particularly in comparison to Charles Darwin's *The Origin of Species*, in chronological order, by Samuel Butler (1882), Irwin Primer (1964), James Harrison (1971), Desmond King-Hele (1998), Paul Elliott (2003), and Michael Page (2012). However, the only work to date that seeks to support the idea that Erasmus influenced Charles Darwin is a 1976 article by Michael T. Ghiselin. On Charles Darwin's copy of *The Temple of Nature*, Ghiselin merely notes that it contains two annotations without specifying where they appear in the text.

Based on our physical examination of Charles Darwin's copy of *The Temple of Nature*, our study presents 23 previously unreported annotations found throughout the book, both in the poem and in the additional notes, bringing the total to 25 and attesting to Charles Darwin's interest in and familiarity with Erasmus Darwin's ideas on the change over time across species. This finding not only disproves previous reports made by Ghiselin (1976), which might imply minimal interest in the poem, but the nature and positioning of some of the markings, coupled with a more careful reading of Canto III, also highlights the importance of looking, not to *The Origin of Species* for echoes of his grandfather's ideas (as done in the past), but rather to *The Descent of Man* (1871), whose resemblance to Erasmus Darwin's *The Temple of Nature* merits closer consideration.

The paper is organized as follows: the first section introduces *The Temple of Nature*, while the second half presents the annotations made by Charles Darwin to his copy of *The Temple of Nature*. Notes on the competition for reproduction and the origin of cognition are analysed regarding Charles Darwin's ideas on the matter. We conclude that while Charles Darwin denied having a profound knowledge of Erasmus Darwin's ideas or of having been influenced by them in his own work on evolution, evidence in the form of annotations made in his copy of Erasmus's posthumous poem, *The Temple of Nature*, indicates that he was fully acquainted with his grandfather's work and that it may have inspired his ideas on sexual selection and the natural origin of human cognition, as presented in *The Descent of Man*.

A brief introduction to *The Temple of Nature*; or, the Origin of Society

Published in 1803, *The Temple of Nature; or, The Origin of Society* is situated in the transition from the eighteenth to the nineteenth century. The poem aimed to describe 'the progress of society', as indicated by the tentative title of the work in the notes of Erasmus Darwin (King-Hele, 1999, p. 359), in which it is divided into five songs that represent the stages of hunting, grazing, agriculture, commerce, and philosophy.⁴

In the first published version, the publisher added 'The Temple of Nature' to the title after the death of Erasmus Darwin. As Martin Priestman (2016, p. 8) has pointed out, it consists of a total of 1928 lines organized into four Cantos, in which the author narrates the history of human society from the phases of production of life, the reproduction of life, the progress of the mind, and the existence of good and evil.

Canto I, 'Production of life', describes the creation of the universe and the emergence of life on earth. It states that the universe was formed through explosion and separation, resulting in the creation of the sun and planets. Verse 227 implies that this

process occurred at the very beginning of time. These verses deal with the processes of matter coming together to form life. The poem refers to the earth being covered in water at the time of its creation, and it was there that life arose from several physical phenomena and chemical reactions, including heat, repulsion, attraction, and contraction. The author portrays these forces working together to cause matter to dissolve, explode, and combine, eventually forming living beings. It also states that this process happens spontaneously, without any external cause or parent. Once generated, life, in its simplest forms, transforms, over time, into different kinds of animated beings. Here, for the first time in his poem, we see the gradual and directional transformation of living forms, from the simplest to the most complex, beginning with microscopic forms that, generations later, give rise to plants and animals. When he describes the origin of plants and animals, he includes humanity in this category, making it explicit that although language, reason, and reflection distinguish humankind from all other animals, our origin is no different from that of all other living creatures. For Erasmus Darwin, humankind was the result of natural processes. This idea was common in the philosophical thought of the time, especially in Germany, and was still widely debated in scientific circles (Lansley, 2018).

Canto II, 'Reproduction of life', addresses the production of one living being from another and raises the question of the difference between parents and children. The verses of this section present an abbreviated account of both sexual and asexual reproduction. Moreover, the author highlights the importance of the production of variation through sexual reproduction to improve the line. For Erasmus, passion and desire are crucial elements of life and the main drivers of the competition among members of the same species, which will be further addressed regarding Charles Darwin's annotations in section three below.

In Canto III, 'Progress of the Mind', Erasmus Darwin wonders how humans become aware of themselves and their surroundings, giving rise eventually to the ability to reason. First, the author discusses the process of perception, which involves the physical response of the senses to stimuli from the environment and the interpretation of these sensations by the mind. He notes that perceptions can be positive or negative and can be stored in the mind as memories that can be retrieved through recollection. Next, he examines imagination, the ability to create new mental images, and reason, the ability to think and make judgments. These mental processes are influenced by emotions and can be triggered by pleasure or pain. The author also considers the concept of association, the tendency of the mind to link or connect different ideas or experiences. Throughout his argumentation, Erasmus suggests that while some animals may have superior senses in certain areas, humans have a highly developed sense of touch, particularly in their hands, which gives them a greater capacity for understanding and perception. In addition, he debates the psychological states of surprise, novelty, and curiosity that can be experienced in response to new or unexpected stimuli and the role of imitation in language acquisition. For Erasmus, human beings are distinguished by their ability to use language, allowing them to communicate their desires and needs, and volition, leading to the conscious decision to work towards a better future for humankind. These topics and their relation to Charles Darwin's *The Descent of Man* will be further discussed in section "Annotations on the development of human cognition, speech and morality" of this paper.

Canto IV, 'Of Good and Evil', reflects on right and wrong, concluding that man must always be a friend of man and show tenderness towards the sister forms, all living beings. The work ends by reaffirming that everything alive on earth has been created by nature, which is, in turn, the daughter of God. Like many scientists in eighteenth-century England, Erasmus Darwin is

considered to have been a deist, that is, he believed in the existence of a God who created the world and was the driving force behind everything, but thought that his work could be deciphered through the study of empirical reality since the world operates according to natural laws (the laws of God) (Martin, 2012).

Empirical evidence and rationality played a crucial role in the belief system of many deists in eighteenth-century England, including Erasmus Darwin. While they acknowledged the existence of a creator God who was responsible for the universe's creation and function, they believed that this reality could be understood through empirical observations and rational enquiry (Clark and Haakonsen, 1998; Force, 1990). Deists like Darwin were convinced that the natural world operated according to a set of universal laws established by God and that these laws could be observed and analysed through scientific study. They viewed reason and evidence as essential tools for understanding the divine plan and unlocking the secrets of the universe. Therefore, in deism, empirical evidence and rationality were not only significant but also inseparable from the belief system. They were the means to decipher and comprehend the workings of the world created by God.

Erasmus Darwin's belief in the importance of empirical evidence and rationality is directly linked to the five significant processes he mentions in *The Temple of Nature*: the creation of nature, the origin of life, the history of life on earth (what today we call Evolution), the origin of humans and the development of cognitive abilities that make life in society possible. Erasmus Darwin believed that these processes could be observed and understood through scientific enquiry and that they were guided by natural laws established by God.

Throughout the text, the author uses Greek and Roman myths to illustrate scientific phenomena and provides detailed descriptions that guide the reader to conclusions that are close to Charles Darwin's idea of the change over time across species by means of natural selection. His intention is clearer if we remember that it was the author's conviction that the poems should show rather than say. In other words, to paint a visual image of the related facts: 'our ideas derived from visible objects are clearer than those that arise from the other senses, the words that build ideas for vision are the central part of poetic language. That is to say that the poet writes mainly for the eye; the prose writer uses abstract terms.' (E. Darwin, 1791, p. 48)

In *The Temple of Nature*, Erasmus Darwin evokes allegories to lead to the fact, not through reason but by painting the landscape of what, from his perspective, has been the natural development of world history. Above all, *The Temple of Nature* is a didactic poem (Priestman, 2016, p. 26), so it is likely to have been read aloud in a group. To date, we do not have a source that indicates the sale price of *The Temple of Nature*. However, if we consider that: (1) according to J. E. Elliott (2010, p. 362), *The Seasons* (1730) by James Thomson (1700–1748) sold for as much as 6 shillings in 1746; (2) that according to Macleod and Daunton (1996), the average salary of a working family in 1795 was 6 shillings a week, and (3) that around 1810 a loaf of bread cost more than a shilling, we can conclude that the readers of Erasmus Darwin were very probably to be found in an economically well-off segment of the population, even taking into account the fact that a domestic worker's salary could reach up to 15 pounds per year (300 shillings).

As for the narrative of the poem, as Irwin Primer points out, it is inspired by the Eleusinian mysteries (Primer, 1964), religious rites through which the hierophants, priests, and priestesses inducted initiates into the cult of Demeter and Persephone, and which Erasmus Darwin interpreted as a teaching form of the works of Nature including the origin and progress of society—to the initiated through allegory (E. Darwin, 1803, p. i). The Greek

myths are accompanied in the poem by Christian theology, which provides a cosmological structure for his narrative on the progressive development of life forms.

Charles Darwin's annotations to *The Temple of Nature*

Although Ghiselin's work does not mention the date the poem was read, it is known that Darwin began recording his readings in 1838 in notebook C. In 1839, these lists were copied and continued in different notebooks. The first of these (DAR 119) begins with some notes transcribed from notebook C and goes back to 1851. In this notebook, Darwin dates his reading of *The Temple of Nature* to February 20, 1842.⁵

Our physical exploration of Charles Darwin's copy of the poem revealed that it contains 25 markings on 14 pages. Figure 1 represents the whole book by sections, highlighting the pages containing Charles Darwin's annotations. A detailed list of his markings is given in Appendix. Although not all annotations are relevant to this paper's conclusions, we believe they are worth noting as they reflect on the care and attention Charles Darwin paid while reading the poem.

Some of the annotations made by Charles Darwin indicate poetical introductions and allegories setting the tone for later descriptions of the origin of organic forms from inorganic matter

(TN01, TN02), while others show an interest in Erasmus's dissertation on the spontaneous vitality of microscopic animals (TN03, TN04). The words underlined in TN05 in Canto II mark the note to a stanza of no particular importance for Charles Darwin's theory on the change over time across species or for sexual reproduction. There are two notes on the stanzas dealing with hereditary diseases (TN09, TN10), while several other markings refer to the topic of the chemical theory of electricity and magnetism (TN11–TN15, TN21, TN22), and one more contains a puzzling declaration unrelated to the topic at hand (TN23). Of particular interest are notes TN06 on the competition for reproduction, TN07 and TN08 on the competition for resources and differential survival, and TN16–TN20 on the analysis of articulate sounds.

Among the markings made by Charles Darwin to the book, those that have received the most attention from previous scholars are undoubtedly those where he brackets text in TN07 and TN08, lines 63–66:

— —Air, earth, and ocean, to astonish'd day
 One scene of blood, one mighty tomb display!
 From Hunger's arm the shafts of death are hurl'd,



Fig. 1 Charles Darwin's annotations to *The Temple of Nature*. Each grey rectangle represents a page in the book. Pages containing annotations made by Charles Darwin are indicated in black. The annotations are numbered TN01, TN02, etc. in the order found in the book (see Appendix).

And one great Slaughter-house the warring world! (E. Darwin, 1803, v. IV: 63–66)

Ghiselin's (1976) proposal was that they could be taken as an antecedent to the idea of the 'struggle for existence', a notion we fully agree with.⁶ However, he considers that the idea that one organism eats another is relatively commonplace and that the notion of 'limitation of resources', a fundamental aspect of competition, is not found in the Erasmus document. We differ with Ghiselin on this point since the competition for resources is indeed found in the poem, as lines 41–46 of the same Canto show, where Erasmus describes the interspecific competition of plants for air, light, water, and soil.

TN07 and TN08 have also been interpreted by authors such as Patricia Fara (2020) as 'Malthusian lines'. We disagree with this interpretation because Malthus was referring to intraspecific competition for resources, while the lines marked by TN07 and TN08 convey interspecific competition. Biologically speaking, this distinction is fundamental: intraspecific competition is a key driver for evolution and the principle of population has often been cited as a radical inspiration to Darwin (Bowler, 1976; Herbert, 1971; Vorzimmer, 1969). That is not to say the principle is absent in Erasmus's account, only that it is not present in the cited lines. It can be found much later (unmarked by Charles Darwin), in lines 369–374 of the same Canto:

'So human progenies, if unrestrain'd,
By climate friended, and by food sustain'd,
O'er seas and soils, prolific hordes! would spread
Erelong, and deluge their terraqueous bed;
But war, and pestilence, disease, and dearth,
Sweep the superfluous myriads from the earth. (E. Darwin, 1803, v. IV: 369–374)

According to Ghiselin, however, perhaps the most direct evidence we have of Erasmus's possible influence on his grandson's ideas is to be found on page 503 of *Zoonomia*, where Charles Darwin underlined the following passage: 'The final cause of this contest amongst the males seems to be, that the strongest and most active animal should propagate the species, which should thence become improved' (E. Darwin, 1794, p. 503). Various authors have interpreted this quotation (Darlington, 1960; Eiseley et al., 1960; Irvine, 1955) as evidence that Charles Darwin took the idea of sexual selection from his grandfather. Ghiselin, however, believes that this merely indicates that reading Erasmus could have been the stimulus for the development of a different hypothesis. Annotation TN06 found in this study provides further evidence of Charles Darwin's attention to his grandfather's ideas on what he would later call sexual selection.

Annotations on the competition for reproduction. Annotation TN06 discusses how various animals have developed physical characteristics, such as the horns and spurs used in fights with members of their own species over the possession of females. The passage explicitly mentions boars, stags, and birds such as cocks and quails as examples of animals that have these types of weapons. The note points out that these weapons are not used for defending their owners from other species but are rather for fighting members of their own species for the exclusive possession of females. It also compares the behaviour of female animals to the way that ladies in the time of chivalry would attend the victor.

There are a few possible parallelisms between Charles Darwin's *The Descent of Man* and the text he underlined in TN05. Both mention the concept of sexual selection, which is the process by which certain traits or characteristics are either selected for or against, based on their attractiveness to members of the opposite sex. In the underlined paragraph, this is seen in the example of male animals having weapons (e.g., horns, spurs, thick skin) that they use to compete for access to females. Erasmus and Charles discuss the idea that certain physical traits or behaviours explicitly evolved to attract mates and ensure reproductive success. For example, in the note to the poem, the horns of a stag and the spurs of a cock are described as being used to attract females and win mating opportunities.

Charles Darwin used several examples of sexual selection in his book *The Descent of Man* to illustrate how natural selection has led to the development of physical characteristics—most frequently in male animals—that are advantageous for attracting mates and reproducing. Some of the examples he used include (1) the bright colours and elaborate displays of male birds, such as peacocks, which are used to attract females; (2) the large antlers of male deer, which are used to fight with other males for access to females; (3) the long, elaborate tail feathers of male birds of paradise, which are used to attract females; (4) the large, brightly coloured mandibles of male stag beetles, which are used in fights with other males for access to females; (5) the bright colours and elaborate courtship displays of male hummingbirds, which are used to attract females.

Although the specific details and examples provided in TN06 do not entirely coincide with those presented in *The Descent of Man*, the famous example of antlers in stags is integral to both accounts, and the argument is similar, though far more highly developed in the grandson's discussion. Charles Darwin argued that these physical characteristics, which are often costly to maintain and do not contribute directly to survival, evolve because females prefer mates with these characteristics and are more likely to mate with them. As a result, males with these characteristics are more successful at reproducing and their genes are passed on to the next generation. Over time, this can lead to the evolution of these physical characteristics in a population. In section XXXIX 4.8. of *Zoonomia*,⁷ referred to in TN06, Erasmus Darwin argued that various animals have developed physical characteristics that are used in fights with other members of their species over the possession of females. He suggests that these physical characteristics have emerged due to hunger, lust, and the desire for security in animals. The desire for security is mentioned as the reason for developing the thick, shield-like skin on the shoulders of boars, which is used as a defence against other boars. The desire for hunger is not explicitly mentioned, but lust or the desire for reproduction is given as the reason for the development of horns and spurs in animals such as stags, birds, and quails. Section XXXIX 4.8 says that these weapons are used in fights with members of their species over the exclusive possession of females and that the final result of this contest is the improvement of the species through the reproduction of the strongest and most active animals.

As previously stated, in *The Descent of Man*, Charles Darwin explores the idea that certain physical traits or behaviours have explicitly evolved to attract mates and secure reproductive success. Another parallelism can be found in his mention of hermaphroditism, the possession of both male and female reproductive organs in the same individual. Although hermaphroditism is not mentioned explicitly in *The Descent of Man*, Charles Darwin does discuss the concept of sexual dimorphism, the existence of physical differences between males and females of a species. In Chapter II, 'On the Development of the Intellectual and Moral Faculties,' Darwin discusses the fact that specific

physical characteristics, such as beards, are present in males and absent in females due to sexual selection. He also mentions that some animals, such as the seahorse, may have evolved from a hermaphroditic state. However, he does not go into this topic in great detail. In his note to line 122, Canto II, of *The Temple of Nature* (close to the position where TN06 is located), the idea of humans being hermaphrodites is mentioned as a theory proposed by some philosophers.⁸

Finally, both Erasmus and Charles Darwin discuss the idea of progress or evolution toward greater perfection. In *The Descent of Man*, Darwin explores the idea that all living things are constantly evolving and progressing towards greater complexity and perfection, while in the passage commented on here, this idea is mentioned in the suggestion that ‘perhaps all the productions of nature are in their progress to greater perfection.’

Annotations on the development of human cognition, speech and morality. In addition to sexual selection, another central theme in *The Descent of Man* is ethics (the biological origin of moral capacities). In the third chapter of *The Descent of Man*, Charles Darwin explains his theory on the origin of ethics in detail, offering ideas from his position as a naturalist that contrasts with traditional ethical postulates that were based on utilitarianism and Kantian ethics (Sloan, 2019). Both of these focus on the constant opposition between good and evil resulting from each individual’s actions, while Charles Darwin’s central problem is how the ability to make value judgments arises in the evolutionary history of the species.

In agreement with the sentiment of the time, Erasmus Darwin recognized that the moral capacity of the human being was qualitatively different from and superior to altruism⁹ and empathy observed in other animals, such as dogs and apes. This is something that Charles Darwin knew very well, which is why, when formulating his theory of the evolution of species, he kept his distance from such discussions and retained his most profound reflections on the origin of human beings and their moral capacities for *The Descent of Man*. In this book, he not only presents ‘evidence that man descends from an inferior form’ in the first section but also explores the emergence of the mental capacities of the human being through natural processes, particularly morality, avoiding all religious or supernatural explanations related to the emergence of the human ability to distinguish between good and evil.

Interestingly, while Charles Darwin made no markings to his copy here, Canto III (Progress of the Mind) of Erasmus Darwin’s *The Temple of Nature* sets out the question of what distinguishes men from other animals and how humankind came to be. Moreover, Erasmus offers a natural explanation of how reason, language, and even the moral capacities of humans came into existence, describing them as progressing from phenomena observed in other animals. At the beginning of Canto, the author describes the process of perception, or how we sense and interpret the world around us. He suggests that when subjects are exposed to stimuli from the environment, such as light or sound, their senses are ‘excited’ and respond to them, creating perceptions of external things, and also explicitly mentions the sense of sight, saying that when light shines on objects, the eye receives these rays of light and creates an image of the objects on the retina. This process is called ‘irritation,’ as the impact of the light on the eye creates a physical response or change in the eye. According to Erasmus, perception also involves attention to and interpretation of these sensory experiences. The author distinguishes between ‘perception,’ which includes both the physical response of the sense organ and our attention to it, and ‘irritative ideas,’ which are simply the physical response of the sense organ to stimuli without our conscious attention.

Perceptions can trigger ‘sensation’ (pleasure or pain), and they become stored in the mind as memories. These memories can then be recalled through ‘volition’ or recollection which involves recovering and organizing stored memories. The argument goes from recollection to ‘imagination,’ which is the ability to create new ideas or mental images and to ‘reason,’ the ability to think and make judgments. The explanation also dwells on the capacity to create new ideas or mental images and ‘suggestion,’ which is the capability to bring previously stored memories or ideas to mind in response to a current stimulus or thought. Erasmus says that these mental processes are influenced by emotions and can be triggered by pleasure or pain. He also mentions ‘association,’ which is the tendency of the mind to link or connect different ideas or experiences.

According to Erasmus Darwin, the capacities derived from irritation, sensation, and volition, up to association, are not exclusive to humans. Other animals such as hawks, vultures, foxes, and even insects employ them to navigate and interact with their surroundings, to hunt and compete with one another. However, recollection, imagination, and reasoning appear to be exclusively human traits.¹⁰ He thought that an important distinction between humans and other animals was in their hands. Drawing on previous work by Georges-Louis Leclerc, Comte de Buffon (1707–1788), he mentioned that while some animals, such as cats, squirrels, monkeys, and elephants, have a more developed sense of touch due to the structure of their limbs or appendages, and some insects, such as spiders, bees, and wasps, have a highly developed sense of touch due to their finely-tuned sense organs, it is the highly developed sense of touch in humans’ hands that gives them a greater capacity for understanding and perception.

The assimilation of the surrounding world through the senses of touch and sight opens the door to surprise for human beings. From here on, the poem describes a sequence of psychological states that a subject might experience in response to a new or unexpected stimulus. It suggests that when the subject encounters something unexpected, they initially experience a sense of shock or surprise. As this shock decreases, it is replaced by the pleasant feeling of novelty, the excitement of experiencing something new. This can lead to curiosity, which is the desire to learn more about the stimulus or to experience it again.

Erasmus suggests that accurately perceiving and understanding objects through the sense of touch plays a role in the human ability to imitate others, which he considers to be a strong tendency in humans, particularly in comparison to other animals. He sustains that this propensity to imitate is partly due to the heightened sensitivity and accuracy of the human sense of touch, which allows humans to learn and understand objects’ shapes and contours. This, in turn, permits humans to imitate others more effectively through the sense of sight. To support this claim, he cites Aristotle as having observed this phenomenon, referring to humans as ‘the imitative animal’.

Although Erasmus dwells in great detail on imitation regarding humankind and its importance as the basis for the development of the human mind, he also asserts that there are other animals capable of imitating each other. From imitation, he says, the acquisition of language follows. This process involves the transmission of emotions and thoughts through visual communication. This occurs when a subject experiences strong emotion, causing physical changes in their appearance. The observer may then mimic these changes through the association process, leading to the communication of emotions and thoughts. As an example, the author mentions the sizing of opposing village-cocks, serpents, hyenas, and even ‘savage men’, contending for the favour of females.

Erasmus’s explanation of the origin of speech begins with body language. He says that the ability to speak is developed by

imitating others and associating particular sounds with specific ideas and that the larynx mechanically produces the volume or pitch of the voice, and the tongue and lips shape these sounds into distinct sounds through articulation. This process is explained in more detail in Note XV, where Charles Darwin added several annotations to his copy (TN17–TN20). For Erasmus Darwin, language grants human beings the capacity to articulate what they want and need as well as the means to procure it. The mindful decision to carry out an act displays volition, which he grants as the proper distinction of humankind. Volition allows the conscious and proactive procurement of security and other commodities that benefit the future of humanity. Thus, says the author, labour is favoured over rest. The human capacity to distinguish right and wrong, the moral sense as such, derives from the power of reflection, which gives man a conscience (E. Darwin, 1803, v. III: 457–458).

Regarding Charles Darwin's impressions of his grandfather's ideas on the natural origin of human cognition, we believe annotations TN16 through TN20 on Note XV, 'Analysis of Articulate Sounds', provide further evidence that he took an interest in Erasmus's speculations since they refer to the evolution of language. In TN17 and TN18 he underlines and used inverted commas to mark the paragraph where Erasmus describes his attempt to design a machine capable of producing the sounds of human speech. TN19 correctly identifies this section as a 'speaking machine' in Charles Darwin's writings (he would speak of this discovery later in his *Life of Erasmus Darwin*, if only in passing). The device, reportedly built at Clifton in 1799 (King-Hele, 1977, pp. 88–89), consisted of a wooden mouth with soft leather lips and a valve for the nostrils that could be opened or closed. The device used a thin silk ribbon stretched between two smooth wooden pieces that were slightly hollowed out to produce a vocal sound. When a gentle stream of air was blown onto the edge of the ribbon, it vibrated between the wooden pieces in a way that resembled a human voice. According to Erasmus, this device was able to accurately produce the sounds 'p', 'b', 'm', and the vowel 'a', and it even fooled people who heard it pronounce the words 'mama', 'papa', 'map', and 'pam' without seeing it. The device also had a mournful tone when the lips were gradually closed. Although he did not pursue the invention further, he believed that it could potentially be developed to produce a variety of musical notes and be connected to the keys of a harpsichord or piano to play the melody and accompaniment of a song. Alternatively, if built on a larger scale, it could hypothetically speak loudly enough to give orders to an army or address a large group of people.¹¹

TN20 highlights one of the most radical conclusions of Erasmus Darwin's reflections on language: the notion that once the war had ended,¹² people would return to focusing on areas of study and research to improve human life and there would be efforts to reform and modernize the alphabet. He also thought that as science progressed and became more widely available, modern languages would become more precise and distinct than ancient ones and that metaphors would only be used for artistic purposes in poetry rather than being necessary for everyday conversation. It is a curious and interesting fact that his grandson was the creator of one of the most important scientific metaphors ever devised.

Charles Darwin wrote about the origins and evolution of language in *The Descent of Man*. He hypothesized that language evolved from the vocalizations of animals, which were then modified and refined over time through natural selection. He argued that the capacity for language is a characteristic that has been naturally selected for in human evolution because it confers numerous survival and reproductive advantages. According to Darwin, language allows individuals to communicate and share

information, form social bonds, and coordinate group actions, all of which are essential for the survival and success of human societies.

Statements on articulation in Erasmus Darwin's Canto III indicate that language serves an emotional, expressive purpose and that this function may have originated in the expressive cries of babies or early humans. These cries are described as 'quick concussions of elastic air,' indicating the physical nature of sound and the possibility that strong emotions drove them. However, it is only when these expressions are linked to external objects that they become language, as language involves the communication of meaning. The author insists upon the idea that language is based on nouns. By ascribing meaning to sounds and articulating sounds into trains of thought by means of recollection, reason comes into being and distinguishes humankind. Immediately after this assertion, Erasmus describes the industrious ways in which some insects, such as bees, construct their colonies and questions the origin of this behaviour, whether it arises from ideas, imitation, language, or 'tradition taught'. An answer is not given; nevertheless, the idea resonates with Chapter II, 'On the Manner of Development of Man from Lower Animals' in Charles Darwin's *The Descent of Man* and his work on social insects, including bees, ants, and termites, covered in his book *The Formation of Vegetable Mould through the Action of Worms*, published in 1881. In this work, Darwin discusses how these insects work together in large, organized groups and how their complex social behaviours have evolved. He also explores how these insects communicate with one another and the role that their social behaviours play in the overall functioning of their societies. In *The Descent of Man*, Charles Darwin discusses the evolution of human beings and their relationships with other animals. He includes a section on insects, in which he notes that insects have several characteristics similar to those of humans, including the ability to communicate, show empathy and compassion, and display complex social behaviours. He also notes that insects can exhibit advanced cognitive abilities, such as problem-solving and learning, and experience pleasure and pain. Overall, Darwin states that insects have evolved to be highly adaptable and successful animals and that they have much to teach us about the natural world and the processes of evolution.

Charles Darwin thought that the emergence of the mental capacities of the human being was entirely gradual and began in animals. An example is domestic dogs, which, although Charles Darwin thought them to have descended from wolves and jackals, thought they surpassed them in cunning and possessed moral qualities, such as affection, trust, and specific general intelligence lacked by their ancestors. Regarding intelligence, he also maintains that other animals have developed it to a sufficient degree to make some species more cunning than others, conferring on them an advantage for survival. For example, he gives the case of the common rat, which triumphed over several native rat species in North America and New Zealand.

After discussing intelligence, Charles Darwin turned to the use of tools, pointing out that this trait is not only found in humans but also in species such as the chimpanzee, which break the hard shell of an indigenous fruit with a stone and can even if taught, learn to crack a walnut shell.

For Charles Darwin, there was no fundamental difference between the mental capacities of the lower animals and those of human beings. Any animal could achieve a moral sense and conscience if the necessary conditions were met. In Charles Darwin's own words: 'any animal whatever, endowed with well-marked social instincts, would inevitably acquire a moral sense or conscience, as soon as its intellectual powers had become as well developed, or nearly as well developed, as in man' (C. Darwin, 1871, p. 71). What Charles Darwin sustains, in short, is a strict

gradualness in the evolution of the intellect, human and animal, and of morality, equal to that of any other being whose emergence can be explained by natural causes. He maintains that there is a more significant difference between the mental capacities of a fish and an ape than between those of an ape and a human, and that infinite gradations can cover this interval.

As Ruiz Gutiérrez (2019) pointed out in her prologue to the latest Spanish translation of *The Descent of Man*, the human question had been dealt with before *The Descent of Man* was published, not only by Erasmus Darwin, as we mentioned above, but subsequently by Thomas Huxley (1825–1895), in *Evidence as to Man's Place in Nature* (1863); by Charles Lyell (1797–1875), in *Geological Evidences of the Antiquity of Man* (1863); by Alfred Russel Wallace, in *The Origin of Human Races and the Antiquity of Man Deduced from the Theory of 'Natural Selection'* (1864) and in *Contributions to the Theory of Natural Selection: A Series of Essays* (1870); and by Ernst Haeckel (1834–1919), in *The History of Creation* (1868). However, none of the authors who came after Erasmus Darwin had the courage to address the deeper problems of including the human being in the evolutionary process. Lyell, for example, considers that human speech was an insurmountable difference and one that required the participation of God. Only Haeckel elaborated a modest scientific explanation of humanity based on evolutionary theory but did not develop a justification for ethics or social organization. Far less did these authors explore the origins of the human race and the relationship between the mental properties of the human being and those of other animals. The only writer who did this was Erasmus's grandson Charles, starting from his approach to the change over time across species through natural selection and adding new elements, as pointed out by Sloan (2019).

Ever since his voyage on the Beagle, Charles Darwin had had an interest in the human species and was highly progressive in his ideas, just as Erasmus Darwin had been. Given his fixed view of Nature, he had spirited discussions with the ship's captain, Robert FitzRoy (1805–1865), even coming into sharp conflict with him over the latter's defence of slavery. After visiting Tierra del Fuego, he described its inhabitants as bright. It soon became clear to him that the differences between human groups were cultural and not biological. It was then that he understood that all human groups belong to a single species (Ruiz Gutiérrez, 2019). Sandra Herbert (1974) develops a splendid analysis of how Charles Darwin's contact with these groups marked the development of his theory, he was fully cognisant of Lyellian gradualism, leading him to think that cultural differences between human populations prove the gradualness of evolution. He was convinced that evolution in large populations is favoured by many variants, an idea that would later be vindicated through statistical biologist Ronald Fisher's theoretical approach (1890–1962) on the foundation of the genetics of populations.

Charles Darwin's observations of humans, including his friends and family, led him to maintain that there are no substantial differences between humans and other animals, stating 'the differences are only of degree' (C. Darwin, 1871, p. 21). Notebooks 'M' and 'N' from 1838–1840 record many of his central ideas about the evolution of the human species (R.J. Richards, 2003). From his first notes on the transmutation of species, for example, in notebook 'B', he maintained that even the mind and instincts are the result of adaptation to new circumstances (Sloan, 2019).

Unlike contemporaries who also wrote about human evolution, in *The Descent of Man*, Charles Darwin leaves no doubt about his certainty in the entirely natural origin of our species and all its characteristics just as Erasmus Darwin had thought.

If we compare *The Origin of Species* with *The Descent of Man*, the most significant difference in the theory is that Charles Darwin's second work emphasizes the importance of secondary

processes of sexual selection for the evolution of animals. Broadly speaking, sexual selection is the selection of females by males or vice versa for reproductive purposes. This selection had played a minor role in the original argument of *The Origin of Species*, and its importance was denied by Charles Darwin's contemporaries, most notably by Alfred Russel Wallace. In *The Descent of Man*, Charles Darwin explores the idea of sexual selection in great depth. He considers it a critical factor in evolution that may even work against ordinary natural selection. Both competitions for reproduction and the natural essence of everything human are central to Erasmus Darwin's *The Temple of Nature*: therefore, our proposal is that it makes far more sense to compare the ideas expressed in it with the arguments in *The Descent of Man* and not those in *The Origin of Species* when comparing one Darwin to another.

Conclusions

Given the enormous similarity between the evolutionary thought of Charles Darwin and that of his grandfather, one wonders what evidence there may be that Erasmus Darwin influenced his grandson. In *Darwin's Sacred Cause: How a Hatred of Slavery Shaped Darwin's Views on Human Evolution* (2009), Adrian Desmond and James Moore wonder if Robert Grant, who was a mentor to Charles Darwin and a disciple of Erasmus, may have been the one who introduced Charles to his grandfather's work and the idea of evolution, though they do not present any supporting evidence or documents to support this theory.

Another possibility is that Charles was introduced to Erasmus's work by his father, Robert Darwin—as Ralph Colp speculates—beginning with Charles's visit to Breadsall Priory in his youth (where Erasmus Darwin moved in 1802, only two weeks before his death). During his visit, 'Erasmus's widow showed him [his grandfather's] sofa and chair, still kept in the same place' (Ralph Colp Jr., 1986, p. 2).

In his *Life of Erasmus Darwin*, Charles Darwin himself specifically denied having profound knowledge of his grandfather's ideas, let alone being influenced by him in his ideas on evolution. Regarding *Zoonomia*, he proclaimed, 'I had previously read the *'Zoonomia'* of my grandfather, in which similar views are maintained, but without producing any effect on me. Nevertheless, it is probable that the hearing rather early in life, such views maintained and praised may have favoured my upholding them under a different form in my *'Origin of Species.'* At this time I admired greatly the *'Zoonomia,'* but on reading it a second time after an interval of ten or fifteen years, I was much disappointed; the proportion of speculation being so large to the facts given' (F. Darwin, 1887, p. 38). Whether he intended to distance himself from transformism by denying his grandfather's influence is a matter still under debate. Regardless of the motive for his declarations, it is a fact that he makes no mention of *The Temple of Nature*. Whatever the facts may actually have been, the 25 annotations that we found in his copy of the book, made around 1842, tell a different story.

The annotations Charles Darwin made to his copy of *The Temple of Nature* show that, although he does not quote his grandfather, he did read his works before the publication of *On the Origin of Species*. It would be unfair and inconsistent with the methods of history to affirm with the limited evidence available to date that the simple reading of these works implies the adoption, or even the partial adoption, of some of his grandfather's ideas. However, we believe that the evidence provided by Charles Darwin's annotations in his copy of Erasmus's posthumous poem, as shown in this study, strongly indicates the influence of his grandfather's ideas on the natural origin of human cognition (including the development of articulate language) and morality.

Beyond his reading of his grandfather's work, it is also likely that Erasmus's thought reached Charles Darwin via the Romantics to whom it was so important, specifically in relation to his influence on Alexander von Humboldt, as noted by Dettelbach (2001).

Although it is now clear that Charles Darwin took an interest in his grandfather's work beyond *Zoonomia* prior to the publication of *On the Origin of Species by Means of Natural Selection*, through his reading of *The Temple of Nature*, much work remains to be done regarding the interpretation of his annotations.

Data availability

Data sharing is not applicable to this research as no data were generated or analysed.

Received: 1 June 2022; Accepted: 14 March 2023;

Published online: 04 April 2023

Notes

- 1 Much A great deal has been written on about the life of Erasmus Darwin. The first biography of Erasmus Darwin was written by Anna Seward in 1804 (Wilson et al., 2010), the second by John Dowson in 1861 (Dowson, 1861), and the third, written by Ernst Krause, was translated from German into English and published in 1879, with a preliminary note by Charles Darwin (C. Darwin, 2002). A further biography was published in 1930 by the actor, writer and theatre director Hesketh Pearson, a descendant of Francis Galton (Pearson, 1930). Nevertheless, the most complete biographical studies of Erasmus Darwin are indisputably those made by Desmond King-Hele in the second half of the 20th century, which are nicely complemented by the additions made by Janet Browne as part of her biographical work on Charles Darwin and Maureen McNeil's study of the historical context of Erasmus Darwin.
- 2 It is worth noting that while Charles Darwin focused on the role of individual choice in intersexual selection, where individuals of one sex choose mates based on certain traits (C. Darwin, 1871, Chapter 2), Alfred Russel Wallace's views on sexual selection were closer to those of Erasmus Darwin. Like Erasmus, Wallace believed that the traits that evolve through sexual selection are often not directly related to survival, but rather to attracting a mate, which he called 'beauty for beauty's sake' (Wallace, 1869). He emphasized the role of competition among individuals of the same sex in intrasexual selection, and believed that these traits were not adaptive but rather evolved through sexual selection through mate choice or competition, as he discussed in 'The Malay Archipelago' (1869) chapter 6.
- 3 As can be seen in the work of Ralph Colp Jr. (1986).
- 4 It might be argued that the ideas, closely linked to cultural evolutionary theories (as developed in the 1960s, not to be confused with the Cultural Evolutionary Framework put forth by Boyd and Richerson (1988) and Cavalli-Sforza and Feldman (1978)), were fundamental for the development of the evolutionary thought of Herbert Spencer and those influenced by him. However, the reasoning behind Erasmus Darwin's first draft of the history of society is far from original and can be found throughout British provincial culture, down to Richard Payne Knight's didactic poem *The Progress of Civil Society* (1796). It is also noteworthy that both *The Temple of Nature* and *The Progress of Civil Society* draw inspiration from book five of *Lucretius De Rerum Natura* (Desmond King-Hele, 1999; Priestman, 2004; Smith and Arnott, 2005). For a detailed account of the relation of Spencer's evolutionary ideas to those of Erasmus Darwin refer to: Elliott, P. (2003). Erasmus Darwin, Herbert Spencer, and the origins of the evolutionary worldview in British provincial scientific culture, 1770–1850. *Isis*, 94(1), 1–29.
- 5 According to the note recorded in DAR 119:12a, Darwin read *The Temple of Nature* in parallel to *The Botanic Garden*. The transcript of Charles Darwin's reading notebooks can be found at: <https://www.darwinproject.ac.uk/what-darwin-read/darwin-s-reading-notebooks>
- 6 Authors such as Janet Browne (1996) and Trevor Pearce (2010) have pointed out the importance of Augustin Pyrame de Candolle. (1778–1841) for the development of Charles Darwin's concept of the struggle for existence. Like de Candolle, Erasmus Darwin also described fierce competition amongst vegetables ('Yes! smiling Flora drives her armed car/ Through the thick ranks of vegetable war;/ Herb, shrub, and tree, with strong emotions rise/ For light and air, and battle in the skies;/ Whose roots diverging with opposing toil/ Contend below for moisture and for soil' (E. Darwin, 1803, v. IV: 41–46). However, it should be noted that both were great admirers of Linnaeus's work and were familiar with his *Politia naturae* (1760).
- 7 'As air and water are supplied to animals in sufficient profusion, the three great objects of desire, which have changed the forms of many animals by their exertions to

gratify them, are those of lust, hunger, and security. A great want of one part of the animal world has consisted in the desire for the exclusive possession of the females; and these have acquired weapons to combat each other for this purpose, as the very thick, shield-like, horny skin on the shoulder of the boar is a defence only against animals of his own species, who strike obliquely upwards, nor are his tusks for other purposes, except to defend himself, as he is not naturally a carnivorous animal. So the horns of the stag are sharp to offend his adversary, but are branched for the purpose of parrying or receiving the thrusts of horns similar to his own, and have therefore been formed for the purpose of combating other stags for the exclusive possession of the females; who are observed, like the ladies in the times of chivalry, to attend the car of the victor." "The birds, which do not carry food to their young, and do not therefore marry, are armed with spurs for the purpose of fighting for the exclusive possession of the females, as cocks and quails. It is certain that these weapons are not provided for their defence against other adversaries, because the females of these species are without this armour. The final cause of this contest amongst the males seems to be, that the strongest and most active animal should propagate the species, which should thence become improved." *Zoonomia*, XXXIX 4. 8.

- 8 "The arguments which have been adduced to show, that mankind and quadrupeds were formerly in a hermaphrodite state, are first deduced from the present existence of breasts and nipples in all the males; which latter swell on titillation like those of the females, and which are said to contain a milky fluid at their birth; and it is affirmed, that some men have given milk to their children in desert countries, where the mother has perished; as the male pigeon is said to give a kind of milk from his stomach along with the regurgitated food, to the young doves, as mentioned in Additional Note IX. on Storge" (E. Darwin, 1803, n. His nymphs and swains, p. 53).
- 9 In the context of human evolution, altruism is thought to have played an important role in the development of cooperation and social cohesion within human societies. One of the main hypotheses for the evolution of altruism in humans is the 'social contract' theory (Seabright et al., 2021), which proposes that those early human groups that were able to cooperate and share resources more effectively would have been more likely to survive and reproduce. As a result, individuals with traits that promoted cooperation, such as altruism, would have been more likely to pass on their genes to future generations. Another theory is the 'cultural group selection' theory (Henrich, 2004), which proposes that altruistic behaviours can spread within a population through cultural transmission, such as through learning or imitation. This can lead to the evolution of altruistic behaviours even if they do not have a direct genetic basis. Altruism is thought to have played an important role in the evolution of human cooperation and social cohesion, as well as in the development of human intelligence and language (von Heiseler, 2022). It may have been a key factor in the success of human societies and the survival of the human species.
- 10 From here onwards, his explanation gets rather convoluted as he moves backward and forwards, distinguishing between man's behaviour, suggesting a continuity of the processes previously characterised as purely human, from the behaviour observed in certain animal species.
- 11 As Jessica Riskin (2003) has pointed out, during the mid- to late 18th century, automata were designed to accurately simulate the textures and substances of life, as well as aspects of physiology, which made them look very different from automata of other periods. Earlier mechanical designs from the 17th and early 18th centuries were artistic representations of animal or human movements but did not attempt to imitate physiological processes. The period from the 1730s to the 1790s was however characterised by efforts to bridge the gap between animate and artificial machinery. One example of this was Erasmus Darwin's speaking machine, which aimed not only to imitate human speech but also to model and improve our understanding of language and communication. In contrast, 19th-century automata, like their 17th-century counterparts, were artistic representations of animal and human activities rather than simulations.
- 12 At the time Erasmus Darwin wrote these lines, the French Revolutionary wars were raging. As is well documented (Deane, 1988; Schroeder, 1994), these military conflicts led to a disruption of trade, significant losses for the British Navy, and the rise of nationalist sentiment in Ireland. Although the Treaty of Amiens brought a temporary respite to the hostilities between Britain and France just over a month before Erasmus Darwin's death, he seems to be thinking of all wars and not exclusively of the conflicts he came to witness during his lifespan.

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Acknowledgements

The authors wish to thank the Darwin Correspondence Project editors for access to the materials leading to this article and the National Council for Science and Technology for the funding provided. They also wish to thank researchers Edgar Antonio Valdés Porras, Susana Esparza Soria, Rodrigo Vega y Ortega Baez, Carlos López-Beltrán, María Antonia González Valerio, Sebastián Lomelí, and proofreader Phil Daniels for their valuable insights.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-023-01616-y>.

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