transversal
International Journal for the Historiography of Science

Transversal: International Journal for the Historiography of Science 2018 (5): 157-170
ISSN 2526-2270
www.historiographyofscience.org
Belo Horizonte – MG / Brazil

Article

Newtonian Optics and the Historiography of Light in the 18th Century: A critical Analysis of Joseph Priestley's *The History of Optics*

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Abstract:

In 1772, Joseph Priestley published *The History and Present State of Discoveries Relating to Vision, Light and Colours*, also known as *The History of Optics.* The book intended to present all the achievements in the matter of light and colors, from the Ancient times to the 18th century. This paper presents a study of the content of *The History of Optics*, in order to analyze how it sold Newtonian optics in the historiography of light. It will comprise discussions on Priestley's views on History, his involvement with optical studies, his perceptions on Newtonian optics and the Biographical Chart included in the book. This analysis can add new elements for the current Historiography on Priestley, clarifying other aspects that demonstrate his commitment to a Newtonian view of the History of Optics, as well as an example of the prestige that Newton's Natural Philosophy had throughout the 18th century.

Keywords:

Joseph Priestley; Isaac Newton; Historiography of Science; Newtonian Optics; Light

Received: 31 July 2018. Reviewed 3 September 2018. Accepted: 19 October 2018.
DOI: http://dx.doi.org/10.24117/2526-2270.2018.i5.12

Introduction

Joseph Priestley (1733-1804) was a recognized educator, writer and natural philosopher, widely renowned for his writings and ideas on many subjects, from Religion to Natural Philosophy. In his biography of Priestley for the *Dictionary of Scientific Biography*, Schofield (2008, 147) asserted that "books and articles about Priestley are almost as profuse as those by Priestley". Therefore, it is not difficult to find scholarly work on his life, ideas, methods

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A preliminary draft of this paper was presented at the 13th Biennial Conference of the International History, Philosophy and Science Teaching Group (IHPST), held in Rio de Janeiro, Brazil, in 2015.

and achievements (Schofield 1967; Garret 1973; Griffith 1983; Rivers and Wykes 2008, to cite few examples).

Priestley wrote more than two hundred books and papers on many subjects. Although most of them have been subject to careful studies, his *The History and Present State of Discoveries Relating to Vision, Light and Colours* (hereafter, *The History of Optics*) still occupies a secondary position.[2] Published in 1772, the book intended to be the first volume of a history of all branches of Natural Philosophy, an extensive project Priestley aimed to undertake, in order to give a complete account of the History of Natural Philosophy from the Ancient times to his own. The book was a continuation of a prior successful enterprise, *The History and Present State of Electricity, with Original Experiments* (hereafter *The History of Electricity*), published in 1767.

Priestley wrote the book when optics in Britain was largely dominated by the corpuscular tradition and Isaac Newton (1642-1727) was considerably popular. Since the publication of Newton's *Opticks* in 1704, a "Newtonian optics" emerged, founded on the principles of the materiality of light and its interaction with other bodies by forces. The 18th century saw the popularization and transformation of Newtonian Natural Philosophy. Newton's name was frequently associated with absolute and true knowledge, which could not be questioned or refuted. Many "Newtonianisms" flourished as models of authority (Dobbs and Jacob 1995). To be Newtonian was a synonym of being always correct.

My aim in this paper is to show that *The History of Optics* is a relevant example of how Newtonian optics played an important role in the historiography of light written by Priestley, establishing parameters of what could be classified as Newtonian – and, therefore, relevant to the History of Optics – and what could not. First, I will discuss the process of writing and publishing the book, emphasizing his views on History. Then, I will proceed a critical analysis of two core parts of *The History of Optics*: the Period V – where Priestley discussed Newton's conceptions – and the Biographical Chart included at the beginning of the book. With this study, I intend to contribute to a wider understanding of Priestley's writings on Natural Philosophy and History and of the influence of Newtonian optics on the studies on light throughout the 18th century.

Joseph Priestley, A Historian of Optics

The history of *The History of Optics* began with Priestley's other book on Natural Philosophy, published in 1767: *The History of Electricity*. In 1765, he had spent some months in London, where he was introduced to eminent researchers on electricity, such as Benjamin Franklin (1706-1790), John Canton (1718-1772), William Watson (1715-1787) and Richard Price (1723-1791). In his memoirs, Priestley claimed to have mentioned to Franklin "an idea [...] of writing the discoveries in Electricity" (Priestley and Priestley Jr. 1806, 50). With their help, Priestley was able to trace the main events to the development of electricity until his days, also describing original experiments (Schofield 1997, 142). The reception of *The History of Electricity* was better than Priestley could have imagined. It sold very well and had four editions published years after – with revisions, corrections and additions made by the author – and translated versions to French and German.

Prompted by the success of his book on electricity, Priestley envisioned writing a history of all branches of Natural Philosophy. In the preface of *The History of Electricity* he claimed that this would be "an immense work; perhaps more than one man ought to undertake", but he hoped to see "persons who have leisure, and sufficient abilities" to proceed part of the project (Priestley 1767, vii). He soon decided to embrace the task himself.

[2] The best analysis so far was presented in Schofield's biography on Priestley (Schofield 1997, 240-249). Brock (2008, 55-57) also discusses some aspects of the book.

According to Schofield, Priestley planned to collect as many materials as he could from all fields and then analyze them separately. His idea was writing about magnetism first. He changed his mind by November 1770, since he had acquired more books on Optics than on other fields (Schofield 1997, 242).

However, unlike the assistance Priestley had to write *The History of Electricity*, he did not have many supporters for *The History of Optics*. He only acknowledged the aid of the reverend John Michell (1724-1793), who probably consolidated on him the influence of Newtonian optics (McCormmach 2012, 190). I will return to this topic later. Soon after the publication, it had a favorable review, written by William Bewley (1726-1783). Bewley was particularly interested to see the continuation of Priestley's series of books on the history of Natural Philosophy and mentioned the necessity of financial and human support.

> To this piece of intelligence, however, we must not omit to add that, on account of the very considerable expences [*sic*] attending the execution of his general plan, and for other considerations, the continuation of this philosophical history will intirely [*sic*] depend on the favourable reception of the present work. On this head we can only express our wishes that the public patronage may animate and enable the Author to prosecute and complete his useful undertaking. (Bewley 1772, 319)

The sales of *The History of Optics* were "not such as to encourage me to proceed with a work of so much labour and expence", said Priestley in his *Memoirs* (Priestley and Priestley Jr 1806, 64). Soon he abandoned the project of writing about all the branches of Natural Philosophy. In the revision of Priestley's works included in other editions of his *Memoirs*, Thomas Cooper (1759-1839) suggested that the great popularity of electricity and chemistry had eclipsed the book. According to him, the subject of Optics did not attract much attention from the "Sciolists and Amateurs" and Priestley neglected many important theories, such as Huygens' and Euler's (Priestley and Priestley Jr 1806, 285).[3]

Schofield (1997, 248) and Brock (2008, 56) add other factors to the unsuccessful fate of *The History of Optics*. The book was significantly different from *The History of Electricity* and did not have many parts that were eulogized, like the description of original experiments. The style of writing was tedious since Priestley had to recollect a great amount of ideas, concepts, theories and experiments from other natural philosophers, describe and analyze them. Furthermore, it seems he had completed the work only two months after he decided to begin it. The errata included at the end of the book indicates he had a lot of work not done when it was published. It had just one edition in English and only one German translation appeared, two years later.

Despite of all difficulties Priestley faced with the writing and publication of *The History of Optics*, the book remains a fine piece of 18th century Natural Philosophy, a portrait of what Optics was and how Newtonians like him saw the previous developments in the field. The book has two volumes, comprising 812 pages, along with others that included the dedication, preface and plates. There are 24 plates, with 173 pictures, most of them borrowed from the works of other authors. For example, the reader will see many pictures from Newton's *Opticks* from plates 11 to 15.

Priestley divided *The History of Optics* into six periods. Period I, with no more than thirty pages, covers the developments of more than a millennium and a half in Optics, from Ancient Greece to the beginning of the 17th century. Periods II and III describe the achievements in

[3] It is worth to mention that Cooper's view on Priestley's *The History of Optics* may have been influenced by the status of Optics at the beginning of the 19th century, when the corpuscular theory of light did not hold the same prestige as before. It seems natural that he would mention vibration theories, such as Huygens' and Euler's, but they were not widely accepted in Britain when Priestley wrote *The History of Optics*. See Cantor (1983).

the 17th century, especially the ones of René Descartes (1596-1650) and Johannes Kepler (1571-1630). Period IV includes the discoveries until Newton, whose theories are analyzed in detail in Period V. Period VI covers the 18th century Optics. In the end, Priestley included a list of technical terms he used, an index and a catalogue of books. He claimed to possess 265 books in different formats, 35 in folio, 95 in quarto, 73 in octavo and 62 in twelves (duodecimo), numbers that are greater if different volumes from the same book are taken into account. That list indicates Priestley's effort in bringing together the history of a well-stablished discipline.

From a distant perspective, we can see both *The History of Electricity* and *The History of Optics* as historiographical works, possibly the first on both fields. However, these books had a clear purpose for Priestley. They were connected with his current ideas on Education and History of the secular world, as well with the 18th century conceptions of History.[4] This "Baconian" history (Schofield 2008, 141) was a portrayal of progress, a way to see how the achievements of the past could lead society to a better and brighter future (Gay 1969). Priestley, immersed in these ideas, believed that History could foster in future generations a concise, objective and clear knowledge about the natural world. For him, History "was a means to discovery [...] and a means of conveying information and persuasion" (Schofield 1997, 139). According to Kragh, "Priestley was one of the many who regarded the historical development as a natural part of their science, a stocktaking of what had been achieved and of the problems that were still unsolved" (Kragh 1987, 3).

History was a powerful tool for teaching once it could present a wide view of all the advancements in Natural Philosophy. Histories showed "how scientific progress needed the participation of many investigators, meaning that science was accessible to everyone" (Brock 2008, 53). This is manifest in the Preface of *The History of Optics*, where Priestley mentioned his historical methods, claiming the importance of two things in the process of advancement of "useful science":

> The first is an [*sic*] historical account of their rise, progress, and present state; and the second, an easy channel of communication for all new discoveries.[5] [...] such histories as these are, in a manner, absolutely necessary. (Priestley 1772a, i)

As a "historical account of their rise, progress, and present state" (Kragh 1987, 4), Priestley's historiographies enabled a quick access to available knowledge. History was not a critical study of past events, but a collection of facts and episodes designed to facilitate the understanding of the progress of societies. Therefore, Priestley was interested in describing the different ideas on Optics in the easiest and most objective way possible.

> At present philosophical knowledge is so dispersed in various books and languages, that the very reading of what is absolutely necessary, in order to be properly acquainted with any one branch of it, would take up more time and attention than any person, though ever so much devoted to philosophical pursuits, would ever think of bestowing upon it; unless he should make it his business to digest the materials into a history, or system, for the use of *others* as well as of *himself* [...]. (Priestley 1772a, ii)

Priestley claimed to have adopted a "historical method", in order "to communicate knowledge with the greatest ease, certainty, and pleasure." He mentioned his "systematical" approach, which would be particularly useful to "young students", so they

[4] In his theological writings, Priestley showed a different form of historical thinking, being much more provocative and controversial in his aim to prove Unitarian beliefs through History. On the secular and the theological perspectives in Priestley's historiography, see Kennedy (2008, 181-201).
[5] This is a reference for scientific journals, such as the *Philosophical Transactions* of the Royal Society.

could access any information they wanted very quickly. He also emphasized the intelligibility of the book for those "who have little or no knowledge of Mathematics" (Priestley 1772a, vii-viii). These passages evidence that Priestley's purpose was to offer an easy, intelligible and comprehensive image of the development of Optics until his own days. As we will see, this image was dominated by the selling of the Newtonian optics.

The History of Optics, Period V: The Selling of Newtonian Optics

When *The History of Optics* appeared in 1772, Newtonian conceptions were well established among British natural philosophers, with a growing insertion in continental Europe. The publication of the *Opticks* in 1704 and its subsequent editions and translations aroused a corpuscular tradition for Optics as well as the popularization of the inductive method, influencing a whole generation of natural philosophers. The focus was mainly on Book I, where Newton exposed a series of experiments with prisms and drew conclusions from them, and on the *Queries* of Book III, where he speculated on the nature of light and its interactions with other bodies through short-range forces. The modern historiography on this subject is abundant and suggests a remarkable institutionalization of the Newtonian optics throughout the 18th century (Cohen 1956, Schofield 1970, Steffens 1977, Cantor 1983, Hakfoort 1995, among many other books and papers).

Priestley immersed in Newtonian views early in life. When he studied at Daventry Academy, a dissenting school, from 1752 to 1755, he soon became familiar with the works of Newton and other corpuscularians, like Wilhelm Jacob's Gravesande (1688-1742) and John Rowning (1701-1771). The latter seemed to be very influential in Priestley's reading of optical knowledge, since Rowning presented a detailed Natural Philosophy in a corpuscular bias. Priestley might have seen in Rowning's book a compilation of what Newton's followers had been doing with the content of the *Opticks* and the *Principia* in their attempts to merge the concepts and explanations of both optical and mechanical phenomena (Schofield 1997, 53). After a brief stay in Needham Market and Nantwich, Priestley moved to Warrington, where he worked more often with Natural Philosophy.

As mentioned above, the writing of *The History of Optics* had the assistance of Michell, more known today for his contributions to Astronomy and Geology. Michell moved to Thornhill in 1767, a village near Leeds, where Priestley had just arrived. They became close and exchanged ideas on Natural Philosophy (McCormmach 2012, 179). Once Michell defended the materiality of light and praised Newton's *Opticks*, his interactions with Priestley played an important role in the selling of the Newtonian theory of light in *The History of Optics*. He also helped Priestley in several other subjects of Optics, such as telescopes, colors and in the mathematics involved in optical phenomena (McCormmach 2012, 187-196).

Michell would have also "introduced (or rather reintroduced) Priestley to the concept of matter as particles surrounded by concentric spheres of attractive and repulsive forces" (Schofield 1997, 247). This idea was considerably popular at that time, especially due to the Jesuit priest Roger Boscovich (1711-1787) and his *Theoria Philosophiae Naturalis*, published in 1763.[6] Boscovich claimed that the ultimate particles of matter were impenetrable and could be considered point-atoms that interacted with each other through an alternate scheme of attractive and repulsive forces. Other authors studied by Priestley during his first studies had similar ideas, such as Rowning, but he focused on Michell and Boscovich in *The History of Optics*.

The background on Newtonian optics and the corpuscular nature of light contributed to the construction of a solid defense of these subjects in *The History of Optics.* The first

[6] On the works and reception of Boscovich in Britain, see Whyte (1958), Olson (1969) and Schofield (1970).

evidence of this defense can be observed in the manner Priestley divided the periods of the book. Newton was the only author to have an exclusive Period, which suggests that Priestley considered the History of Optics as *before* – Periods I to IV – and *after* Newton, Period VI.[7] He declared that, before Newton, "we find no hypothesis concerning colours of the least consequence, or indeed, that was held in any degree of esteem among philosophers" (Priestley 1772a, 240). He emphasized that Newton proved by a "series of experiments" his theories and that he "attempted, and succeeded" in his purpose to unveil the properties of light and colors. Newtonian optics was "justly considered as the best model for all future inquiries into the powers of nature" (Priestley 1772a, 267, 270). For him, the objectors did not advance other ideas and they were not worthy to mention.

Newton's occasional mistakes in his theory of light and colors were ignored or minimized. For instance, in the period VI, Priestley discussed the experiments with achromatic lenses developed by John Dollond (1706-1761). In 1758, James Short (1710-1768) received a letter from Dollond, in which he contradicted Newton's ideas on the dispersion of light. Dollond showed that the dispersion of light depended on the refracting substance and observed that refracted light which was not deviated could also produce colors. Even in cases in which the refraction of light was supposedly corrected, white light could not be produced. For instance, rays of light coming out parallel after a refraction, in relation to its incidence, could still show themselves colored, depending on the refracting substance (Steffens 1977, 56-9; Pav 1975, 3102-3018). Priestley recognized Dollond's contribution, asserting that he made "the greatest improvement in optical instruments within this period, by means of original principles" (Priestley 1772b, 729). He concluded that Newton failed, but tried to justify his mistake:

> The fact probably was, that Sir Isaac deceived himself in this case, by attending to what he imagined to be the clear consequence of his other experiments; and though the light he saw was certainly tinged with colours, and he must have seen it be so, yet he might imagine that this circumstance arose from some imperfection in his prisms, or in the disposition of them, which he did not think it worth his while to examine. (Priestley 1772b, 475)

Priestley was aware that not every Newtonian concept was widely accepted in the 18th century. The theory of fits, exposed in Book II of the *Opticks*, is an example. Historians have pointed out the conceptual problems of this theory and its rejection throughout the century, mainly due to its incompatibility with mechanical models for Optics (Silva and Moura 2012, Shapiro 1993). Priestley insinuates this sentiment in *The History of Optics*, explicitly denying the validity of the fits.

> In these thin plates, and also all other cases of the reflexion or transmission of light, Sir Isaac Newton advances an [*sic*] hypothesis; but, like a wise man and a cautious philosopher, he professes not to lay much stress upon it, though he seems not to entertain any suspicion of its truth. (Priestley 1772a, 305)

Newton did not classify the fits as a hypothetical concept, in a Newtonian sense. He believed they were original properties of light, like colors, and discussed them at the end of Part III and the entire Part IV of Book II. Priestley, on the other hand, worked actively to discredit the fits, claiming that there were "no optical experiments with which Sir Isaac Newton seems to have taken more pains than those relating to the *rings of colours* which

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[7] This structure is very similar to that presented in *The History of Electricity*, where Priestley put Franklin in the forefront (Schofield 1997, 146).

appears in *thin plates*" (Priestley 1772b, 498). He often used terms such as "conjectures", "supposes", "improbable supposition" to discuss Newton's arguments on this conception (Priestley 1772a, 306, 308). At the end of *The History of Optics*, Priestley reinforced that much was done on that topic, "but a complete illustration of this difficult subject seems to be still wanting" (Priestley 1772b, 779).

The selling of Newtonian optics involved the defense of the corpuscular conception of light. Probably inspired by the ideas of Michell and Boscovich, he gave considerable attention to the "*powers of repulsion and attraction*" in order to account for optical phenomena.[8] By the time *The History of Optics* was published, there was a renascence of discussions about the attractive and repulsive powers of nature. Priestley was among those authors who attempted to resurrect the influence of mechanism into Natural Philosophy, building an alternative path to materialistic views based on concepts of ether that had emerged decades before (Schofield 1970, 235). For instance, after rejecting the theory of fits, Priestley affirmed: "all the mystery of these coloured plates depends upon the attractions and repulsions of the particles of the bodies that compose them" (Priestley 1772a, 310-311). In addition, in commenting Newton's studies on inflection, Priestley copied the first four queries of Book III of *Opticks*, which argued on the role of short-range actions in the phenomena, "observing that the preceding observations [on inflection] seem to authorize us to answer them all in affirmative" (Priestley 1772a, 329).

On the material nature of light, the most decisive evidence for Priestley was a series of experiments performed by Michell and described exclusively in *The History of Optics*. According to him, Michell had developed a method to measure the momentum of light more accurately than others had done before.[9] Michell's original descriptions were never published elsewhere. The experiment consisted of a copper plate, "which was fastened to one end of a slender harpsicord [*sic*] wire, about ten inches long" (Priestley 1772a, 387). The plate was placed inside a box, with the lid and the back made of glass. After focusing sunlight reflected by a concave mirror, he detected a slight movement of the plate. "[The copper plate] began to move with a flow motion, and struck against the back of the box as before, and this was repeated once or twice with the same success" (Priestley 1772a, 389).

Priestley seemed to believe in the veracity of the experiment: "There is no doubt, however, but that the motion above mentioned is to be ascribed to the impulse of the rays of light" (Priestley 1772a, 389). Notwithstanding, he indicated some flaws that compromised the results, like the melting of the plates after some time of exposure to sunlight. He also mentioned that Michell did not have a mirror in his house to continue the experiments. Priestley did not go further on these issues, suggesting that, despite the problems, they showed consistent evidence of the materiality of light. Shortly after the publication of *The History of Optics*, Michell's experiments were considered by corpuscularians an experimental proof that light had a momentum (Cantor 1983, 57).

The corpuscular theory of light also played an important role at the end of *The History of Optics*. In the "SUMMARY", Priestley advocated in favor of the theory, asserting that the 18th century optical studies had confirmed its validity:

> The observations that were made in the first part of the last period of this history will authorize us to take it for granted, that light consists of very minute particles of matter, emitted from luminous bodies. Some of these particles, falling upon other bodies, are reflected from them, in an angle equal to that of their incidence, while other particles

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[8] In the 18th century, there were different meanings of "power" and, on many occasions, they differed from Newton's ideas – which were already diverse. A good literature on this subject can be found in McGuire (1967), Schofield (1970), Thackray (1970) and Heinmann and Mcguire (1971).

[9] In the 18th century, many natural philosophers attempted to measure the momentum of light. See Worrall (1982) and Cantor (1983, 52-59).

> enter the bodies; being either bent *towards* or *from* a perpendicular to the surface of the new medium, if the incidence be oblique to it. In general, rays of light, falling obliquely on any medium, are bent as if they were attracted by it, when it has a greater degree of density, or contains more of the inflammable principle, than the medium through which it was transmitted to it. More of the rays are reflected when they fall upon a body with a small degree of obliquity to its surface, and more of them are transmitted, or enter the body, when their incidence is nearer to the perpendicular. (Priestley 1772b, 769)

The defense of Newtonian optics and the corpuscular nature of light also implied the depreciation or omission of rival theories. As expected for a Newtonian in a context where Newton's ideas were esteemed, he criticized most philosophers before Newton – including the Greeks and obviously Descartes –, mentioned briefly the theories of Hooke and ignored Huygens.[10] Euler, who had written a massive number of works on Optics and other subjects, had his theories mentioned in no more than three and a half pages. Priestley affirmed that he did not want to "trouble" his reader "with mere hypothesis", claiming that Euler's ideas were "inconsistent" with Newton's doctrine or "contrary to experience" (Priestley 1772a, 358-359).

Franklin's objection to the corpuscular theory is particularly interesting. Although Priestley followed Franklinian ideas on electricity, he deliberately omitted his comments on light. From the catalogue of books read by Priestley and displayed at the end of *The History of Optics*, we can see he possessed the 1769 edition of Franklin's *Experiments and Observations on Electricity*, which contains a letter written in 1752 wherein Franklin explicitly claimed that he "was not satisfied with the doctrine that supposes particles of matter called light" and proposed a vibration interpretation for optical phenomena (Franklin 1769, 264). In *The History of Optics*, Priestley did not mention the content of this letter but described an experiment made by Franklin that analyzed the intensity of light and heat produced by two candles. Priestley wrote:

> Dr. Franklin shewed me that the flames of two candles joined give a much stronger light than both of them separate; as is made very evident by a person holding the two candles near his face, first separate, and then joined in one. For immediately upon the junction, his face will be observed to be much more illuminated than it was before. It is conjectured that the union of the two flames produces a greater degree of *heat*, and that this cause a father attenuation of the vapour, and a more copious emission of the particles of which light consists. (Priestley 1772b, 807)

It is possible that Franklin demonstrated the experiment or discussed it with Priestley in the time of *The History of Electricity*, but it is unlikely that Franklin would have agreed with the explanation based on the emission of particles of light (Cohen 1956, 323, n. §). As an admirer of Franklin, Priestley might have interpreted his experiment in his own ways as another proof of the materiality of light.

The Biographical Chart

The History of Optics included an important resource to Priestley's Newtonian approach of Optics: A Biographical Chart. This was not the first time Priestley drew charts. Years before the publication of *The History of Optics*, he published *A Chart of Biography* (1765) and *A New*

[10] The absence of Huygens' theory was not exclusive of Priestley's books. Shortly after his death in 1695, his theories were widely forgotten or rejected in Europe (Hakfoort 1995, 56).

Chart of History (1769). The first one included a list of two thousand people divided into six categories, such as "Mathematicians and Physicians" and "Poets and Artists". *A Description of a Chart of Biography* was published subsequently, bringing a description of the purpose of *Chart* and a list of all the names cited in it. In the *Description*, Priestley summarized his main goal with the charts:

> All my ambition in the BIOGRAPHICAL CHART I now present to the public, is to be an assistant to the great Historians, Chronologers, and Biographers of all ages and nations; in exhibiting an united, a distinct, and a comprehensive view of the succession of great men of every kind, almost from the earliest accounts of things down to the present time [...]. (Priestley 1777, 4-5)

The charts were "one of the mechanical methods of facilitating the study" of history (Priestley 1777, 5). Therefore, it presented an easy visual guide about the most important events or personalities of a certain period. The lines under the names in the *Chart* represented the lifetime. Where the line was full, it meant Priestley was sure about the date of birth and death of the individual. Where there were dots or a broken line, it meant he was uncertain about the dates. The names were of famous people, but, as Schofield points out "not necessarily meritorious; chosen with care, but not with singularity" (Schofield 1997, 129). Priestley himself admitted he chose by "renown and not merit" (Priestley 1777, 16). He complemented by asserting his "impartiality", which, as we shall see, was not entirely true, at least for the chart in *The History of Optics*.

The *New Chart of History* presented a visual scheme of great empires of humanity. Priestley also published some months later an additional material, *A Description of a New Chart of History*, which was dedicated to Franklin. The *New Chart* was supposedly a corrected and more refined version of a French chart that appeared in England around the 1750s (Schofield 1997, 128). Priestley claimed he would "rectify these [the old chart], and improve the whole scheme as much as possible" (Priestley 1786, 5). At the top of the *New Chart*, he expressed his intentions: "This Chart is intended to exhibit a picture of history, or to give a clear view of the rise, progress, extent, and duration of every considerable empire or state" (Priestley 1769, n. p.).

Both charts and their descriptions were extremely successful, going through many editions each one. They were useful not only for Priestley's own lectures but also for those who wished to acquire a wide view of everything and every person considered important. Sheps asserts that Priestley designed the charts "to be hung on the wall for private study to augment and help reinforce what was learned from lectures or reading by using the imagination and by association" (Sheps 1999, 142). Nevertheless, the charts played another important role. They should be considered a true portrait of past events, or, in a literal sense, a portrait of *important facts in accordance with Priestley's historiographical views*. The chart in *The History of Optics* was specially designed to perpetuate how Priestley saw the history of studies on light.

Priestley mentioned 51 natural philosophers in the Biographical Chart presented in *The History of Optics* (figure 1). According to him, those were "who have most distinguished themselves by their Discoveries relating to Vision, Light and Colours" (Priestley 1772a, Frontispiece). While there is no record that allows us to answer why he chose some names and excluded other ones, his list give us some hints of his strategies and purposes with the Biographical Chart. If Priestley aimed to sell Newtonian optics as a crucial element of his history and if the Chart should be used as a quick visual guide of the History of Optics, we must look to the philosophers of the 18th century he listed, in order to verify "who have most distinguished themselves" in this matter after the discoveries of Newton.

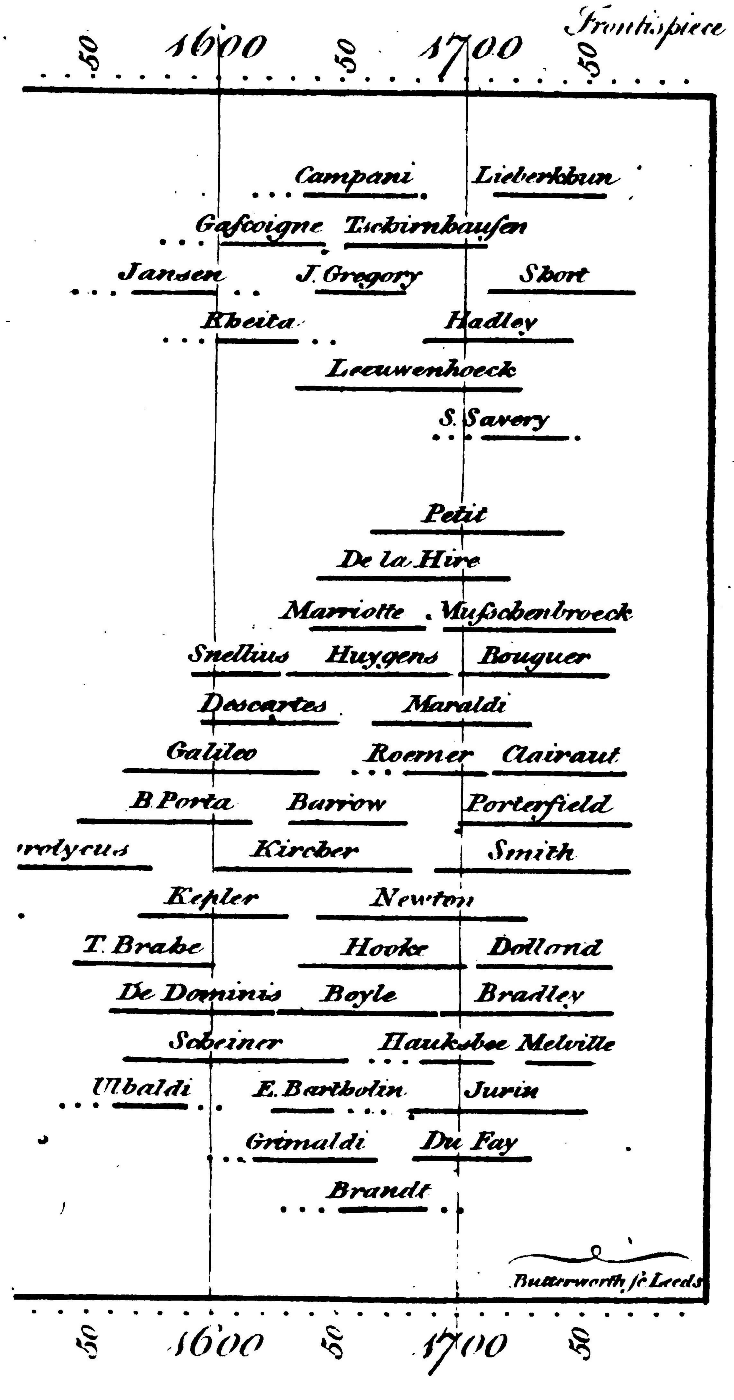

Fig. 1 – Part of the Biographical Chart in *The History of Optics*, as shown in the digitized version of the book. The reader can easily see the 18th century natural philosophers mentioned by Priestley in the Period VI. Source: Priestley (1772a, Frontispiece). The original chart was consulted at the Bancroft Library, University of California (Berkeley).

Among the 51 natural philosophers, 15 were mentioned in Period VI of *The History of Optics*, concerning the discoveries made after the time of Newton:[11] Giacomo Filippo Maraldi (1665-1729), Pierre Bouguer (1698-1758), James Bradley (1693-1762), Alexis Clairaut (1713-1765), Dollond, Charles Du Fay (1698-1739), John Hadley (1682-1744), James Jurin (1684-1750), Johann Lieberkühn (1711-1756), Thomas Melvill (1726-1753), Pieter van Musschenbroek (1692-1761), William Porterfield (1696-1771), Servington Savery (c. 1670-c. 1744), James Short (1710-1768) and Robert Smith (1689-1768).

Among these 15 natural philosophers, at least seven were explicit Newtonians: Bradley, Melvill, Clairaut, Smith, Jurin, Porterfield and Musschenbroek.[12] Newton was still the main reference, but the studies of these authors were probably considered a good continuation of the Newtonian legacy. In many occasions, Priestley claimed that their ideas deserved "to be recited" (Priestley 1772b, 649).

Apparently, other seven authors – Bouguer, Dollond, Du Fay, Hadley, Lieberkühn, Savery and Short – were not explicit Newtonians, but there is no indication that they opposed Newton. For instance, Priestley argued that Bouguer's studies on reflection and absorption of light were "the most valuable materials" that he could present to his reader (Priestley 1772a, 405). Although Bouguer was a supporter of Newtonian mechanics, he was not a full defender of Newton's ideas on Optics and secretly adopted Euler's approach at some point of his life (Darrigol 2012, 112, 163). Priestley was probably not aware of that and quoted Bouguer frequently, even using his studies on reflection and absorption as proofs for the existence of some power between light and bodies (Priestley 1772a, 417).

Dollond, as mentioned before, was eulogized for having improved optical instruments. Although he demonstrated an important flaw in Newton's theories, he was not considered an adversary.[13] Du Fay, whose ideas Priestley commented on in *The History of Electricity*, also was not an enemy of Newtonian optics, being considered by Voltaire (1694-1778) and Émilie du Châtelet (1706-1749) "an ally against the [Cartesian] vortices" (Heilbron 1979, 251). In *The History of Optics*, Priestley referred to Du Fay's studies on phosphorescence. Hadley was the inventor of an effective reflecting telescope, presented to the Royal Society in 1721 (King 1955, 77). He was a member of the society since 1717 and was possibly affective to Newtonian thoughts. Priestley asserted that his "easy construction of *reflecting telescopes*" was "the most effectual service that was done to astronomy within this period" (Priestley 1772b, 732). Nothing much was said about Short, Lieberkhün and Savery, except in the parts on the improvements of telescopes, microscopes and micrometers. Short was apparently a vibrationist (Cantor 1983, 211), but Priestley did not mention anything that could suggest this.

The remaining author is Maraldi, a French-Italian astronomer, sometimes identified as Maraldi I.[14] In 1723, he wrote a memoir for the *Académie Royale des Sciences* discussing experiments on the inflection of light, which Priestley described in detail in *The History of Optics*. It is not clear whether Maraldi accepted Newtonian Natural Philosophy or not, but it seems he was more inclined to Cartesian views. Priestley recognized that inclination:

[11] It is remarkable that Priestley listed in the Biographical Chart some natural philosophers that published papers or memoirs in the 18th century – such as Philippe de la Hire (1640-1718) and François Pourfour du Petit (1664-1741) –, but did not discuss these works in Period VI of *The History of Optics*. They were described in Period IV, as if they were from before the publication of Newton's *Opticks*.

[12] For their commitment to Newtonian views, see Cantor (1983), Darrigol (2012) and Jorink and Maas (2012).

[13] Years before his discovery, Dollond defended Newton against Euler's suggestion that chromatic aberration could be corrected. See Steffens (1977, 55) and Turner (2008, 148).

[14] Giovani Domenico Maraldi (1709-1788) is usually named Maraldi II. He was Maraldi I's nephew (Taton 1974, 89-91).

> The extraordinary size of the shadows of these small substances M. Maraldi thought to be occasioned by the shadow from the enlightened part of the sky, added to that which was made by the light of the sun, and also to a *vortex*, occasioned by the circulation of the inflected light behind the object; but my reader will probably not think it necessary for me either to produce all his reasons for this hypothesis, or to enter into a refutation of them. (Priestley 1772b, 527)

The reasons that led Priestley to list an apparent Cartesian in the last part of his Chart are undefined. A possible answer relies on the fact that he acknowledged Maraldi as one "we find first upon the list of those who pursued any experiments similar to those of Newton on inflected light" (Priestley 1772b, 521). Perhaps he felt obliged to quote Maraldi, even though he seemed to hold different theoretical backgrounds. On the other hand, these were undervalued, once Priestley alleged that he could contradict them.

Therefore, the reader of *The History of Optics* could learn from the Biographical Chart that the vast majority of 18th natural philosophers that "distinguished themselves" in the matter of light and colors were Newtonians – the first seven – or, in other cases, who have invented new optical instruments, which was the case of almost all other seven natural philosophers. This suggests that Priestley aimed to propagate the idea that proposers of other theories of light have not been successful in their attempts. The only exception could be Maraldi, but the nature of light was not discussed in the work mentioned by Priestley and the brief mention of a vortex was rapidly deconstructed.

Final Remarks

Priestley's *The History of Optics* was a book of its time, an easy and direct source of knowledge for anyone who wanted to understand the historical development of light and colors. There, one could find the "correct" knowledge, represented by Newtonian Natural Philosophy, and not be troubled with obsolete or wrong ideas. Everything that should be learned about Optics was there. The book also shows how Priestley devoted himself to the projects he undertook. As a polymath, he demonstrated his capacity to put together a colossal amount of information, even though displayed in an excessively descriptive style.

The various elements of Priestley's *The History of Optics* show how he managed to promote Newtonianism in the historiography of light. The Biographical Chart indicates how the development of Optics was a consequence of the works of few distinguished people, especially Newton and the Newtonians of the 18th century. There seems to be no rivals to the corpuscular theory of light. In addition, by ignoring opposing views on optical phenomena, Priestley allowed a clear path for the consolidation of the corpuscular theory of light. The result was a fine piece of 18th century historiography, an example of the presence of Newtonianism in historical accounts on Natural Philosophy.

Acknowledgements

The author acknowledges the financial support of the Sao Paulo Research Foundation (FAPESP, grant 2014/04366-2) and of the National Council for Scientific and Technological Development (CNPq, grant 400118/2016-5). He also acknowledges the kind assistance of the librarians of the Bancroft Library, University of California (Berkeley), and the suggestions of the reviewers.

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