ISSA Proceedings 2006 – Utilising Pragma-Dialectics For The Study Of Scientific Controversies: The Published Part Of The Newton-Lucas Correspondence, A Case Study From The 1670s.

Abstract

I**[i]**use the pragma-dialectical model to study the published part of the Newton-Lucas correspondence from the 1670s. Through analysing Lucas's letter I highlight the fruitfulness of the model: the dynamic nature, the ability to evaluate earlier historical work, and the fine-grained analysis. Via the analysis of Newton's response I point to two difficulties that need to be overcome if the model is to become truly useful for the historian of scientific controversies: the unsatisfactory way rhetorical insights are incorporated into the analysis, and the positioning of meta-level, methodological arguments.

1. *Incorporating argument-analysis into the study of scientific debates*

History of science has significantly departed from the view that it should serve as a handmaiden for philosophy of science or be relegated as a discipline collecting facts and anecdotes about the past. And the study of scientific controversies has become one of the most important areas of post-Kuhnian history of science. The reasons are manifold, but one is doubtless the failure of "logic-centred" philosophy of science as a true and useful guide to assist historians. The disenchantment with logic coincided with the failure to entrench a meaningful internalist-externalist dichotomy, i.e. what factors influence science from the "outside" and what from the "inside", and thus resulted in the decline of internalist approaches. But if not "logic" drives science forward then what? The *practical turn* in history of science introduced novel ways of investigating what actually scientists do, and how knowledge is produced and transmitted from the workbench through the scientific community to the wider public. Science became

practice, and culture (Pickering, 1992), but when attention was given to a major focal point of knowledge production, the practice and culture of debating, that is the „argumentative" sphere of science (Caplan & Engelhardt, 1987; Pera, Machamer, & Baltas, 2000), historians have paid relatively little attention to what methods of analysis and reconstruction they use.

In the following I will investigate only a small part of an important scientific controversy, the debate that followed Isaac Newton's first publication in 1672 (Newton, 1671-72), outlining his new theory of light and colours. I hope to show some symptomatic features characteristic of controversy-studies in general by concentrating on this single example. And while I feel the need to provide some background, I hope to keep this to a minimum (section 2), to be able to spend more time discussing the moves of the actors – and of analysts.

2. *Background to the Newton-Lucas correspondence*

Newton's first publication connected two areas that up to the 17th century have generally been considered as separate: the study of light and the system of colours. It also employed the notion of the crucial experiment to prove Newton's proposition that "Light consists of Rays differently refrangible" (Newton, 1671-72, p. 3079). Accepting that refrangibility determines colour entailed the rejection of the modificationist accounts of colour production dominant at the time, and the way Newton "proved" his theory also questioned a number of accepted methodological norms. Not surprisingly, a controversy ensued. This was one of the first major debates in a scientific periodical. The controversy was only settled – more or less – after the publication of Newton's Opticks in 1704, and the public reproduction of the experiments in 1714 and 1715. My main interest is in the debates that followed Newton's first publication in the *Philosophical Transactions* (Newton, 1671-72). The exchange of letters included well known figures, like Robert Hooke, Christiaan Huygens, and courteous correspondents like Ignace Gaston Pardies. But among the correspondents Jesuits from the college of Liège also appeared, among them Anthony Lucas. The controversy ended with Newton's termination of the correspondence.

As the letters from Lucas are closely connected to those of his colleagues, a short recapitulation is in order before the analysis. In October 1674 the seventy-nine year old Francis Hall (Line or Linus, 1595-1675) suggested that the clouds near the sun could have disturbed Newton's experiment (they do). The letter from an "old fool" (Westfall, 1966, p. 303), Newton's "bitterest and least intelligent critic"

(Kuhn, 1958, p. 34) was followed by a second one in February 1675. Their import and that of Line's visit to London and to the Royal Society was that Newton decided to write a long letter to the Royal Society in the autumn. After the death of Linus, John Gascoigne continued his professor's fight and raised objections to the crucial experiment. He was 'wanting convenience' to carry out experiments, and handed the case over to Anthony Lucas (1633-93). Originally from Durham, Lucas succeeded Line as Professor of Theology in 1672 in Liège, and became Rector of the English College at Rome after 1687. In 1693, shortly before his death, he was appointed Provincial of the order (Gjertsen, 1986). Lucas embarked on correspondence with Newton on 17 May 1676; (Turnbull, 1960, p. 8f), who was by this time probably eager to terminate the debate that was sparked by his "New Theory" of light and colours and consumed much of his time for over four years. In the following only the published part of the Newton-Lucas correspondence will be investigated.

3. *Earlier discussions of the controversy and choice of method*

How can an individual persuade his cohorts that his (novel) point of view is worth adopting by others as well – even by sacrificing some of their own views? As the question is to find the appropriate means of persuasion – given a certain topic and a given audience –, the appropriate means of study seems to be rhetoric. This might appear the most fruitful approach and is also the most common, as contemporary argumentation-studies is dominated by rhetorical approaches (Schiappa, 2002). The legitimacy of this view is strengthened by the general attitude of the historians of science. Concerning the controversies after Newton's first publication, Richard Westfall in his still authoritative biography held that the impact of the correspondence on Newton's views was negligible: "The continuing correspondence provoked by the initial paper … involved only one addition to his optics, his introduction to diffraction and brief investigation of it" (Westfall, 1980, p. 238). An explicitly rhetorical account is given by Charles Bazerman, who writes:

"Newton, perceiving journal publication as a platform, created a forceful statement, but the bitter experience of controversy taught him that journal publication meant entry into an agonistic form. To address this newly perceived situation, he developed new rhetorical resources to answer criticisms in the following issues of the *Transactions*." (Bazerman, 1986, p. 82).

According to this view the history of the controversy is a history of how Newton –

already having developed a revolutionary theory – acquired successful means of persuasion. In Bazerman's account "The basic claims that Newton presents in these various forms were set by the first university lectures, even though later controversy and developments of the argument would cause some drawing back, some further elaboration, and further precision" (Bazerman, 1986, p. 84). Once a theory is discovered, the task of the scientist is to find the most persuasive forms of presentation of his standpoint, given a specific audience.

While very fruitful for the study of self-fashioning and the creation of credibility, this approach is unidirectional, and breaks up an interaction into separate attempts at persuasion. The whole credit of developing a theory is attributed to the individual. This view raises a number of issues. A major problem is that the dynamics (and the proper role of the other participants) cannot be captured. Why and exactly where would Newton draw back, elaborate?

To be able to account for this dynamic nature of argumentation, a model is required where the actors' moves can be analysed in detailed, and where causal connections can be assigned to certain functional elements of the discourse which can account for respective moves or changes in argumentation in the opponent's arguments. This will necessitate the use of pragmatics or some sort of speech-act theory, but this is exactly what most rhetorical approaches are lacking (Dascal & Gross, 1999).

Also, while in a social setting, a rhetorical analysis portrays an individual in his repeated attempts to convert the cohorts. These are separate, individual actions, and it is not unproblematic to relate these to one another. To overcome this difficulty, one possibility is to connect individual attempts at persuasion and incorporate them into the analysis of the debate. But this is more in line with a 'dialectical' approach. In contrast to the comparison of successive isolated attempts at the persuasion of a (mostly passive) group of listeners, as in a rhetorical analysis, traditionally designed for speeches, dialectics studies conversations, which might contain speeches. In the following I therefore treat the correspondence as small speeches that together constitute a dialogue and use a dialectical model that can assign functional role to elements of the utterances.

Such a starting point has numerous benefits. It is able to track subtle changes in standpoints and can account for some of these in the argumentative moves of the opponents. As functional roles can be assigned to elements in the exchange, it becomes possible to relate the different "speeches" to one another. Thus an evaluative dialectical account can point to the active participation of antagonists

in the production of knowledge.**[ii]** This has obvious relevance for any constructivist view of the development of science. While constructivist works argued for the importance of social and institutional norms in the production of scientific knowledge, the question of attributing credit did not arise with respect to *antagonists* to a certain view. A normative dialectical model can thus give a "truly" constructivist account of scientific controversies (Kutrovátz, 2006 further explores the connection of social constructivism and dialectical models of argumentation). Furthermore, the use of pragmatic insights can contextualise philosophical or methodological notions as functional elements in a debate, which would otherwise be treated in an abstract space of ideas (like "the Newtonian methodology"). But to demonstrate all these benefits is far beyond the possible scope of this paper. Radically reducing the aspirations of the study I will only show some of the promises of such an approach while analysing Lucas's letter, and some possible problems reconstructing Newton's reply.

One could opt for a number of different methods of analysis, but in this case I use the pragma-dialectical model for reconstructing and evaluating the debate. The model needs little introduction. It investigates to what extent the argumentative discourse contributes to the resolution of debates (Eemeren & Grootendorst, 2004). It is normative, investigates argumentation using a pragmatic framework, and arguments are treated as series of speech acts (Eemeren & Grootendorst, 1984). Specific criteria are introduced that guide the reconstruction and analysis of the arguments in a way as to optimally support the evaluation. The model incorporates traditional fallacy-typologies into a unified procedural model (Eemeren & Grootendorst, 1992), and recent attempts have been made to incorporate rhetorical insights as well (Eemeren & Houtlosser, 2002a).

4. *The reconstruction of Lucas' first letter: the issues*

In his first letter addressed to Oldenburg on 17 May, 1676, Lucas took up Line's argument, earlier crusaded by Gascoigne (Turnbull 1959, p. 393), but also supplied new challenges. These have been shortly alluded to in the introduction to the debate, but will not be discussed in detail here. Lucas had to comply with the "party-lines" and further maintain Line's earlier criticism about the possible disturbance of the image by clouds, which, as it seems, he did not value too highly. At the same time he attempted to introduce his own experiments and objections. This required manoeuvring, and an attempt to shift the focus of the debate without admitting Line's defeat. So while the letter seems to combat Newton on numerous points, one of the criticisms does not *create* a difference of

opinion, but rather aims to *resolve* it (issues will be referred to by the bracketed numbers):
(1) "I constantly found the length of the coloured image … considerably greater than its breadth, … on a clear day: but if a bright cloud were near the sunn, I found it sometimes exactly as Mr. Line wrot you, namely broader than long…" (Turnbull, 1960, p. 8)
Apart from this face-saving move, the letter challenges one of Newton's factual statements, and Lucas raises a new issue:
(2) According to Newton "the length of the coloured image was 5 times the diameter of it's breadth; but "I never have found the excesse above thrice the diameter, or at most 3 1/2, while the refractions on both sides of the prism were equall. Soe much as to the matter of fact." (ibid.8-9)**[iii]**
The rest of his letter is arranged around the third issue, a challenge to Newton's general theory:
(3) "Since severall experiments of refraction remaine still untouch'd by him I conceived, a further search into them would be very proper in order to a further discovery of the truth of his assertion" (ibid., p. 9). Following this Lucas lists a number of cases, where in his view Newton's theory should hold, but his experiments show different results.

5. *Analysing Lucas's arguments*
The fine grained analysis allows for a detailed mapping of the debate. Controversies are often seen as involving dichotomies, but on a closer look, this view can hardly ever be maintained. In Lucas's letter many standpoints are at issue and the difference of opinion is *multiple.*

As to (1), Lucas writes: "And indeed the observations of thes two learned persons, as to this particular, are easily reconcileable to each other, and both to truth, Mr. Newton (as appears by his letter of Nov. last, wherein more fully he delivers his minde) contending onely for the length of the image (transverse to the axis of the prisme) in a very cleare day; whereas Mr Line only maintaining the excesse of breadth, parallel to the same axis, while the sun is in a bright cloud" (Turnbull, 1960: 8). Here Lucas *establishes the result* with an *assertive*, which – in case it is accepted – *concludes* the debate over this issue. Newton's original view was contested by Line, Newton *modified* his view in a letter in November, and this modified view does not contradict the Jesuit's experimental findings.

While (2) seems to be a singe objection, the rejection of Newton's statement (-

/pN1) it is in fact also the assertion of Lucas' own view (+/pL1).
pN1 : The ratio of the spectrum is at least 1 : 5
pL1 : The ratio of the spectrum is at most 1 : 3 ½

On this point, the discussion is *mixed,* and there are two standpoints. Lucas wants arguments from Newton in favour of his standpoint, or wants him to retract his standpoint. At the same time, by committing himself to another position with respect to the shape of the prismatic image, he also can be challenged to defend his position.

As for (3), Lucas appears to ask for further support for his theory from Newton (?(+/pN2)).
pN2: Newton's theory, not clearly specified by Lucas, but referring to (Newton, 1671-72).

As a support for his challenge he lists eight experiments. To discuss these would require a time- and space-consuming technical introduction to seventeenth century optics and modificationist colour-theory. It is enough to show that this list of experiments is evaluated radically differently by different historians. As Westfall, writer of the still authoritative biography of Newton notes: "Lucas's letters betrayed no particular acumen; the experiments he presented were not well designed" (Westfall, 1980, p. 275). A "close scrutiny of Lucas' letters simply cannot sustain a high regard for his scientific ability", and "his letters manifest a failure to comprehend the very nature of experimental investigation" as "Lucas espoused the grab-bag method of experimentation" (Westfall, 1966, p. 306-7). Other historians, however, consider Lucas as one of the ablest but little recognised of Newton's opponents. Gruner labelled the dispute "very promising", and claims that the interesting points were never effectively answered by Newton (Gruner, 1973. p, 328). Laymon calls Lucas's arguments "ingenious and bold" (Laymon, 1978b). More recently Sepper called Lucas's critique "sustained and well-planned" (Sepper, 1988, p. 159), and in Guerlac's narrative Lucas is "the ablest of Newton's continental critics" (Guerlac, 1981). On the one hand we have the degrading comments on the "grab-bag" method of experimentation, on the other an ingenious and bold critique.

6. *Evaluating evaluations of historians*
The wide range of opinions shows that historians have their different criteria for evaluating scientific controversies. If it is any use to evaluate the views of earlier

historians, one must find criteria according to which this evaluation can be carried out. An obvious possibility is to trace or uncover the agenda that they subscribed to – and label these outdated, *passé*, or simply wrong. What I attempt to do, however, is to evaluate via analysis. Through the contestable and detailed analysis, the historians' view can be evaluated *without* recourse to sweeping generalizations about historiographical trends.

Already at the crucial starting point historians differ, as the *actual position* of Lucas is reconstructed differently. The weaker the conclusions attributed to Lucas, the stronger his arguments for that conclusion are. If the analyst, like Westfall, expects to find a coherent alternative model (+pL2), Lucas's position is definitely weak. Historians who have negative opinion about Lucas usually follow this path. Such a strong reading, however, is pragmatically unsupported, as he nowhere gives a rival theory. On the other end of the spectrum, the evaluation is very favourable if Lucas' work is reconstructed as only questioning some of the truth claims (?/+pN2), but this is equally problematic, as a large part of the letter describes Lucas's experiments, where at times he clearly denies the truth of Newton's assertions.

Therefore the reconstruction of an intermediate position is justified, where Lucas is taken to deny the Newtonian theory (-pN2), not only requesting further arguments (?/+pN2), and obviously not providing an alternative view (+pL2). This reconstruction is supported by the fact that later in his letter Lucas *challenges* Newton's position, claiming that further experiments can both 'much strengthen' or 'wholly overthrow' the theory (Turnbull, 1960, p. 9). On a methodological note Lucas seems to be committed to the view that renewed experiences are needed to make Newton's results evident**[iv].**

Specifying Lucas's position partly explains why historians differ in their evaluations. But they also disagree as to how good Lucas's experiments are, and this requires further examination. Without going into the nitty-gritty details I will offer only a few general observations. First of all, historians seem to *pick* elements from Lucas's letters, that further support their evaluation. Writers sympathising with Lucas can draw attention to the fact that the data Lucas gives in (2) should have made Newton seriously consider the problem of achromaticity, as it coincides with Newton's own earlier measurements, and already surfaced in the debate with Hooke (Bechler, 1975; Whiteside, 1966), but Newton disregarded this. One can also pick the experiments that are reasonable and cannot be explained easily by the Newtonian theory, challenging specific propositions of

Newton's theory. Those, however, who did not think highly of Lucas, would pick the elements that fit their views. After the last of the listed experiments, where ivory discs are placed in the way of sunrays and a change of colour from yellow to red is observed, Lucas concludes that "whence it seems to follow that yellownesse of light, is not a primary color, but a compound of red &c." (Turnbull, 1960, p. 11) This cannot be grounded on the experiment without very contrived and most likely forced reconstruction – so the standpoint Lucas puts forth is not well-supported, even though the *experiment* in not trivially explainable using the Newtonian theory. Or the experiments can be selected that are rather naïve, and where Newton's theory has the potential to accommodate Lucas's findings.

Without discussing in detail the numerous accounts of the debate from the early nineteenth century onwards, a major and rather trivial, but often disregarded point of the article becomes apparent. The different evaluations are closely connected to varying norms employed in the reconstruction of the letters, as well as the method and detail of the reconstruction. As the "grain size" of the analysis decreases, and the details are discussed, a more nuanced and less clear-cut picture of Lucas emerges. As the reconstruction shows, it seems far-fetched to call this critique 'well-planned', but the more positive accounts often skip over the problematic aspects of Lucas' views. It is also unsupported to believe that there are no gems in the 'grab-bag'. Lucas's attack is thus a respectable but flawed attempt to challenge Newton's position. The pragma-dialectical model's detailed methods of analysis provide an ideal tool for the evaluation of evaluations of scientific controversies.

7. *Newton's first answer*

Newton's first answer on 18 August 1676 to Lucas was the last letter of the correspondence that was published in the *Philosophical Transactions.* The letters following this were highly significant as they highlighted numerous differences between the mostly neo-Aristotelian Lucas and the more mathematically oriented Newton and shed light on Newton's views on demonstrative knowledge, the changing role assigned to the crucial experiment, etc. But the publication of these letters was hindered by Newton. As they remained unpublished, and also as the a result of the rather severe limitations on the size of the contributions in this proceeding, only a few elements of Newton's published reply will be investigated in detail, to draw attention to a few problematic features of the use of the pragma-dialectical model in scientific controversies. The first of these is connected to the indispensability of rhetorical insights for a meaningful study of scientific

controversies, the other a small but not negligible problem of the stages that the pragma-dialectical school posits.

8. *Rhetoric in a dialectical model?*

In the first paragraph of his letter Newton directly replied to Lucas's establishment of the result concerning (1): "The things opposed by Mr. Line being upon tryalls found true & granted me: I begin wth ye new question about ye proportion of ye length of ye Image to it's breadth." (Turnbull, 1960, p. 76). This also *concludes* the discussion of issue (1), but by establishing a different result: Newton was right all the way and the challenge was retracted and there is no mention of any modification of his standpoint.

But the lion's share of the letter deals with point (2). Newton claims that his position (+/pN1) and that of Lucas' (+/pL1) can both be reconciled with his theory. So, while maintaining the correctness of his theory, he accepts the observations by Lucas. In a later letter Lucas's trustworthiness will be questioned concerning these same measurements, but here Newton takes pains to account for both positions, just as Lucas did for (1) in his letter. Newton measures the length and breadth of several spectra. He meticulously tests several angles of two prisms, noting: "You may perceive that the length of ye images in respect of ye angles that made them, are somewhat greater in the 2d Prism then in ye first: but that was because ye glass of wch ye second Prism was made, had ye greater refractive power." (Turnbull, 1960, p. 77).

His exact description of his different prisms, image-lengths in different atmospheric conditions has been much praised since (Rosenfeld, 1927). For some historians his superior precision was a sign of superior method (Westfall, 1966, p. 306). Surely this part of the letter is highly significant *scientifically*, as it gives the most detailed data about spectra up to this time. But the text is explicitly aimed at a wider readership – "that no body a mind to try ye experiment exactly might be troubled to procure a Prism" (Turnbull, 1960, p. 77). As a result, these pages – replying to the four lines written by Lucas – are seen as strengthening the *ethos* of the meticulous observer Newton, and little direct role can be assigned to them in resolving the difference of opinion. In fact as I understand the pragma-dialectical theory they do not even appear in the reconstruction. They are, however, instrumental for the resolution of the difference if we take the general state of the discipline and the lack of standardisation into account (Schaffer, 1989). But how to translate this to the speech-act level?

Especially that these measurements are acquired through a process where some data have clearly been used by Newton simply to "look smart". Even though the rhetorical uses of precise data have often been discussed in detail, it is worth looking at some of them to show how precision is used to support both Newton's status as an experimenter and his theory.

First, commenting on the clearness of the sky he measures the difference of the length of the spectra between two reasonably clear days "to be about ¼ of an inch", but here he gives the *smallest* value of his measurements as an approximation to make Line's main objection less significant (the actual values are ¼, 1/3, 3/8). He measures the distance of the prism and the wall as "18 feet & 4 inches". And later remarking on his prism states that "the convexity being about as that of a double convex glass of a sixteen or eighteen foot Telescope". This imprecision disappears when he suggests specific prisms for the Jesuits to try the experiments with: "If a Prism may be had wth sides exactly plain, it may do well to try ye experiment wth that: but it's better if ye sides be about so much convex as those of mine are … For this convexity of ye sides does ye same effect as if you should use a Prism wth sides exactly plain, & between it & ye hole in ye window shut, place an object glass of an *18 foot* Telescope" (Turnbull, 1960, p. 78. Lucas in a later letter stresses that his prisms are slightly concave.)

Lucas only gave the refracting angle of his prism a round 60° value (Turnbull, 1960, p. 8), while Newton gave as many as twelve values with accuracy to the minute (e.g. 63°48', see Turnbull 1960, p. 77). Not taking into account that Newton's prisms were admittedly convex, and he did not specify how he measured the angles, one minute difference accounts to 1/150 of an inch difference in the length of the spectrum, 10' account for 1/15 inch, and even a whole degree difference results in a length error of 2/5 of an inch (Laymon, 1978a; Zemplén, 2005) – not easy to perceive with the relatively fast movement of the spectrum in the Newtonian setting (about 3 cm/min), and even less significant, if the difference on two relatively clear days can be up to 3/8 of an inch according to Newton (Turnbull 1960, p. 77). It is thus unnecessary and meaningless to provide more exact measurements than Lucas did. By not conforming to Newton's standards of accuracy he simply wasn't following an – in this case – pointless practice.

Such rhetorical techniques in early modernism have recently been analysed, and many insightful studies have resulted. However, as already argued for, a dialectical approach is more suited to study the dynamic developments of

controversies. As it presently stands, however, the pragma-dialectical approach chosen for this study is still far from incorporating all or most rhetorical insights. Early steps have been made with the concept of "strategic manoeuvring" (Eemeren & Houtlosser, 2002a), but in the recent synthesis (Eemeren & Grootendorst, 2004) this still only plays a minor role. Even when investigated, the rhetorical aspects only find their way in the reconstruction as subordinated to the resolution-oriented dialectical goals. In this above case it means that only the elements that have a functional role in the resolution of the difference of opinion will become visible in the reconstruction – and only in these cases can we account for the use of rhetoric. Therefore the primarily audience- and persuasion-oriented elements still do not surface in the reconstruction. So many elements that are of primary importance for the historian studying the scientific controversies, like the scientifically important measurements that Newton made or the changing norms of "literary technology" and rhetorical moves are overlooked. For these either a traditional rhetorical analysis is needed or a much more thorough integration of dialectic and rhetoric, a synthesis much wished for by the experts, but not yet achieved (Eemeren & Houtlosser, 2002b).

9. The opening stage – a precursor to the argumentation stage?

From the point of view of argumentation theory the other notable move by Newton in this letter is his tackling of issue (3), where Lucas challenged Newton's standpoint (-/pN2). Newton refused the challenge to defend his standpoint. Not surprisingly the most argumentative part of the letter is to support this move. As only fragments of it are quoted in appraisals, I give a detailed reconstruction of the argument (Turnbull, 1960, p. 79):

1. I t is not necessary to reply specifically to Lucas' experimental objections
1.1' Lucas focuses on number of experiments and not on their weight
1.1. instead of a multiple of things Lucas should try only the Experimentum Crucis
1.1.1 it is not number of Expts, but weight to be regarded
1.1.1.1 I could have added more
1.1.1.1.1a I had taken much pains in trying experiments
1.1.1.1.1b (I had) written a Tractate on that subject wherein I had set down at large ye principall of ye experiments I had tryed; amongst which there happened to be the principal of those experiments wch Mr Lucas has now sent me.
1.1.1.1.2 ye Experiments set down in my … letter … were only such as I thought convenient to select out of that Tractate
1.1.1.2 Lucas should not have grownded his discourse upon a supposition of my

want of experiments till he had examined those few
1.1.1.2.1 For if any of those be demonstrative, they will need no assistants nor leave room for further disputing about what they demonstrate
1.1.1.2.1.1 main thing he goes about to examin is ye *different refrangibility* of light *different refrangibility* is demonstrated by ye *Experimentum Crucis*
1.1.1.2.1.1a if this demonstration be good, there needs no further examination of ye thing;
1.1.1.2.1.1b if not good the fault of it is to be shewn,
1.1.1.2.1.1.1 ye only way to examin a demonstrated proposition is to examin ye demonstration.
1.2 Objections arising from an improper method need not be specifically discussed
(1.2') Lucas' objections derive from his improper method
1.2.1 Lucas does not follow the best method and should change the method he uses
1.2.1.1a Lucas's aim is the knowledge of truth
(1.2.1.1a') Whose aim is the knowledge of truth should chose the shortest, clearest (proper) method
1.2.1.1b Lucas should chose the shortest, clearest (proper) method
1.2.1.2 The shortest & clearest (not to say ye only proper way) is not to follow Lucas' method
1.2.1.2.1a If Lucas's method is followed, the discussion is drawn from a demonstrative experiment
1.2.1.2.1b To discuss non-demonstrative experiments might create both parties trouble of a long dispute
1.2.1.2.1c The long dispute (multitude of words) can cloude rather than clear up ye truth
1.2.1.2.1c.1 if we should give our selves up to dispute upon every argument that occurs might create an endless trouble
1.2.1.2.1c.1.1a it has already cost us so much trouble to agree upon a ye matter of fact in ye first and plainest experiments
1.2.1.2.1c.1.1b we are not fully agreed
1.2.1.2.1c.2 in such a tedious dispute truth is in danger
(1.2.1.2.1c') It is not the aim of a debate to cloud truth

This argument is a beautiful example how methodology (like the notion of crucial experiments) acquires specific functions in the course of a controversy. But a

problem arises. In the pragma-dialectical model the preparatory stages of the argumentative exchange are classified to the confrontation stage and the opening stage, and the above reconstructed rather lengthy argument is a part of the opening stage. With his manoeuvring Newton attempts to channel the disagreement. Lucas originally raised experimental counterexamples concerning his theory, but instead accepting the challenge and entering the argumentation stage of the discussion, he remains at the opening stage, arguing for specific procedural norms of the debate (and why the experimental objections need not be discussed). This is not just a prerequisite to resolve the difference of opinion, but a very important question in its own right. We must not forget that this is one of the first major debates in any scientific journal. How should differences of opinion be settled in this newly invented form of scientific communication is a major issue that has already surfaced in earlier parts of the controversy around Newton's paper, but always as an issue linked to a difference of opinion concerning science "proper". These auxiliary issues are of paramount significance for the development of scientific communication and of great interest for the historian. In fact, similar instances can be found in most scientific controversies, and one could argue, that most controversies that are scientifically and philosophically interesting and that in hindsight can be seen as most important for the development of science generally abound in such lengthy arguments. These, and the counterarguments, which take up a significant part of the unpublished part of the Newton-Lucas correspondence as well as most other scientific controversies are in the pragma-dialectical model all crammed into the opening stage. Should the opening stage carry that entire burden? Is this the stage where major scientific and methodological breakthroughs happen? One would naively think that the argumentation stage should play a bigger role. Therefore a different categorisation might be more useful if not indispensable. Newton's argument makes clear methodological commitments, and the refusal to defend a standpoint opens a meta-level debate on the procedural form the debate should take. If we follow Krabbe's suggestion (Krabbe, 2003, 2006) it could be subsumed under the category "metadialogue", and be embedded in the argumentation stage. The opening stage might still contain 'some uncomplicated negotiation', but persuasion dialogues like this, especially as they are extremely important in scientific controversies, could become parts of the argumentation proper.

Let us return to Newton's letter from this theoretical digression for a final note. The above argument by Newton on the procedural form of the debate was not

only uncommon in the Philosophical Transactions, but also seemed to go counter to Newton's own proposal, who was asking for information about the outcome of experimental trials "or if anything seem to be defective, or to thwart this relation I may have an opportunity of giving further direction about it, or of acknowledging my errors, if I have committed any" (Turnbull, 1959, p. 102). And the letter ended with directives that could either be read as suggestions or as normative claims on how to further conduct the debate.

As has been observed by Dascal, Newton rarely took part in controversies (Dascal, 2001). Either he could manoeuvre so as to reduce the stakes and channel the disagreement into a discussion, or else he became relentlessly polemical. In agreement with Dascal, who argues for a special place for scientific controversies, as a middle ground between discussion and dispute (Dascal, 1998, 2000), it is important to note that in case of the Newton-Lucas debate the controversy could not unfold as Newton terminated the correspondence. His final comment on the issue to John Aubrey, secretary of the Royal Society was: "I understand you have a letter from Mr Lucas for me. Pray forbear to send me anything of that nature" (Turnbull, 1960, p. 269). Before the termination of the correspondence, however, Newton and Lucas exchanged some very important letters. Among others Lucas, grudgingly accepting the procedural form suggested by Newton, carried out a detailed investigation of the *experimentum crucis*, described further observations, and challenged Newton's claim to have demonstrated a new property of light. In response Newton gave a detailed explication of his methodology and research strategy. But as Newton forbade the publication of these letters, not until the correspondence of Newton was finally published in the second half of the twentieth century did the public and historians learn about the other letters.

Conclusion

I used the pragma-dialectical model to study the published part of the Newton-Lucas correspondence. Through analysing Lucas's letter I highlighted the fruitfulness of using a dialectical model, while via the analysis of Newton's response I pointed to two of the difficulties that need to be overcome if the dialectical model is to become truly useful for the historian of scientific controversies. Already this preliminary study testifies to the fruitfulness of the model, but there is much work to be done. Issues concerning the normativity of the model, the epistemological grounding, and the metatheoretical commitments (Kutrovátz, 2006) all need detailed analysis before this field-independent

framework becomes a useful and accepted tool in the hands of historians interested in the field-dependent aspects of scientific controversies.

NOTES

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[ii] The problem of authorship and distribution of credit in a scientific community will not be discussed here (Biagioli & Galison, 2003).

[iii] "It is well worth noting here that (in 1668?) Newton measured a spectrum whose length was 3 or 3 ½ times the breadth. But after 1670 he stubbornly insisted that the length must be at least 4 or 5 times the breadth, although the angles of the prisms were all nearly 60 degrees…In 1675 Newton declined to believe in the numbers of his opponent Lucas, although they differed little from his own numbers from 1668." (Lohne, 1968). Even in the Lectiones Opticae there is an observation where the ratio is 1:3 ¼ , see (Newton, 1984, p. 27, fn 3).

[iv] This is also in line the principle of charity, stating that the analysis of argumentation should aim at a maximally argumentative reconstruction, believing that speakers consider their utterances relevant. This should, however, not be overinterpretation. For reasons of politeness or face-keeping it is common to cloak criticism in an expression of doubt (Eemeren & Grootendorst, 1992, p. 21).

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