

Middlemarch
AND
THE UNCERTAINTY OF SCIENCE

A STUDY OF
KNOWLEDGE AND IMAGINATION
IN THE NINETEENTH CENTURY

An Essay by
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Like the narrator of *Middlemarch* we tend to look back on past times as the “dark ages” of knowledge and at the same time as a lost “golden age”. The Victorian Period, so we assume, was the golden age of certainty in science. People saw that what science presented to them was something that was there in an “objective” way and this certainty about the objectivity of science forced them to give up old superstitions and religious faith. According to this picture, the period was the golden age of certainty about the objectivity of observation combined with the view that observation was all that science was about. Science was nothing but common sense and common sense was there for everybody to see who was willing to look. George Levine points out that Darwin uses this attitude as a strategy of argumentation in the first sentences of *The Origin of Species*. In this passage Darwin moves from the look on “individuals of the same variety or subvariety” to “the first point which strikes us” about them, from there to “reflection” and finally to a conclusion that “we are driven” to make.¹ This implies, as Levine remarks, “that simple observation overwhelms us so that there is no escape from the coming conclusions.”² The process of reflection is dominated by “striking facts” for which the observer is only the receiver. From our twentieth-century point of view this attitude belongs to the innocent dark ages of science before Heisenberg’s uncertainty relation which proved that the experimentator is always influencing the experiment. Observation in our understanding is not a passive, merely receptive state but an active and creative process to construct a picture and we generally assume that the Victorian Period was not aware of this.

Middlemarch, however, can be read as a systematic deconstruction of any naive attitude towards observation. Interpretation is shown to penetrate every aspect of life, the limitations of point of view are demonstrated and the common sense picture of the world is depicted as inadequate instead of self-evidently true.

¹Charles Darwin, *The Origin of Species by Means of Natural Selection or The Preservation of Favoured Races in the Struggle for Life*, ed. J.W. Burrow, (Penguin Classics: London, 1985), p. 71

²George Levine, *Darwin and the Novelists: Patterns of Science in Victorian Fiction*, (Harvard University Press: Cambridge, MA, and London, 1988), p. 214

The novel is placed in a time in which, as the narrator remarks, a common worldview has been lost. There is “no coherent social faith and order”³ and the only person who seems to have experienced such coherence, the old Mrs Farebrother, recalls her golden age in which “there never was any question about right and wrong . . . Every respectable Churchperson had the same opinion.” (M 176) Now the common worldview has become fragmented and indeed the characters in the novel have quite different opinions and beliefs. Mrs Cadwallader, for example, believes “unquestioningly” in “birth and no-birth” (M 58) , Mr Bulstrode believes in Providence, people believe in old medicine or new medicine, Caleb Garth believes in work, Ladislav in a receptive state of being, and so on. Most of the characters, however, do not think of their beliefs and principles as possibilities or points of view but as self-evident truth and common sense and wonder why other people do not share them. Sir James, for example, “did not usually find it easy to give his reasons: it seemed to him strange that people should not know them without being told, since he only felt what was reasonable.” (M 67) and his contempt for Casaubon is nothing but “the sound feeling of an English layman” (M 69). When Mrs Dollop suspects that Lydgate wants to let people die in order to be able to “cut them up” because “it was a known ‘fac’ that he had wanted to cut up Mrs. Goby” she likewise feels convinced that “if that was not reason, Mrs. Dollop wished to know what it was.” (M 476) The similarity of this kind of arguing with the one used by Darwin in the above quoted passage is obvious. Characters feel overwhelmed to draw certain conclusions by what they believe to be some kind of evidence. In doing so they behave like Mr Vincy who thinks that “I take the world as I find it, in trade and everything else” (M 133), while instead they act as Mrs Dollop whose misuse of the word fact indicates that she lacks any concept of it.

The novel shows, however, that nobody takes anything as he or she finds it, because there is no such thing as a self-evident world. One demonstration of this is, of course, the accumulation of different view-points which often contradict each other and cannot possibly all reflect the circumstances as they are. Again and again the narrator draws our attention to perspective and point of view. People look from different directions and therefore see different things. Already in the ‘Prelude’ the narrator alerts her readers to the fact that there are different ways of seeing when she says that “to common eyes their [the later-born Theresas’] struggles seemed mere inconsistency and formlessness”, thereby implying that other eyes might be able to find patterns in them. Communication between people is impossible or disturbed because they “each lived in a world of which the other knew nothing.” (M 172) These different worlds come into existence because each person throws a different light on the world, thereby creating a different pattern that others might not be able to share. The parable of the

³George Eliot, *Middlemarch: A Study of Provincial Life*, (Everyman’s Library, Alfred Knopf: New York and Toronto, 1991), ‘Prelude’. In the following the novel will be cited as M with pagenumbers in parenthesis.

pier-glass illustrates this point. When it is rubbed it

will be minutely and multitudinously scratched in all directions; but place now against it a lighted candle as a centre of illumination, and lo! the scratches will seem to arrange themselves in a fine series of concentric circles round that little sun. It is demonstrable that the scratches are going everywhere impartially, and it is only your candle which produces the flattering illusion of concentric arrangement, its light falling with an exclusive optical selection. (M 277)

Patterns like this are created by Bulstrode whose Providence arranges the events of the world around his personal needs, by Rosamond who perceives “other people’s state of mind . . . as a material cut into shape by her own wishes” (M 826) or by Fred Vincy who feels certain that money will come to him according to his needs. The lights that create these patterns are self-interest and strong feeling. Dorothea for example sees Casaubon in the way she does because her “faith supplied all that Mr. Casaubon’s words seemed to leave unsaid” (M 47) and the narrator comments: “what believer sees a disturbing omission or infelicity? The text, whether of a prophet or a poet, expands for whatever we can put into it”, thereby again stressing the creative activity of the observer as interpreter. The light that is thrown on the world by the observer is also a subject in the relationship between Dorothea and Celia. Celia, adopting the position of the existence of a self-evident, commonsense world, repeatedly complains that her sister “always see[s] what nobody else sees . . . you never see what is quite plain.” (M 32-33) Much later in the novel she describes her own light on the world as “daylight” , while that of Dorothea consists of “strange coloured lamps”, again implying that in contrast to her sister she sees through a clear medium which does not influence her view. The narrative as a whole, however, argues that this, i.e. viewing the world through a clear, non-interacting medium, is almost impossible and that there are only people who are not aware of their acts of interpretation. It introduces another scientific image which emphasises that what we see depends on the medium through which we see when the narrator tries to examine Mrs Cadwallader’s motives for match-making. The narrator asks whether there was “any hide-and-seek course of action which might be detected by a careful telescopic watch?” and concludes that such an instrument would be unsuitable since it would not give us any useful information because “you can know little of women by following them about.” (M 57) A microscope can be more useful, but the information we get depends on its lens. A weak lens shows “a creature exhibiting an active voracity into which other smaller creatures actively play” while a stronger lens “reveals to you certain tiniest hairlets which make vortices for these victims while the swallower waits passively at his receipt of custom.” (M 57) These different kinds of information influence our conclusion so that it is only the strong lens which will “show a play of minute causes producing what may be called thought and speech vortices to bring her the sort of food she needed.”

(M57) Other phenomena might not need a microscope but, like the electric battery, “a change of place” and an examination from “some distance” (M 421) to watch their effects adequately.

All this implies that the position of the observer is an extremely difficult and uncertain one. He or she does not only to a certain extent create what is observed but also has to make use of different ways of seeing, in order to achieve adequate information about his or her object. But who can decide what the adequate way of seeing is in relation to what object when all our conclusions are incomplete interpretations that do not represent the world as it is? Interpretation, instead of uncomplicated, unconceptualised observation, penetrates all walks and all situations of life in *Middlemarch*. Dorothea reads the signs of Sir James whom she believes to be in love with Celia and the signs of Casaubon whom she believes to be a man of universal genius and is wrong in both cases. Lydgate and Rosamond interpret each other and come to wrong conclusions. The will of Featherstone is interpreted in advance and its definitive version disappoints almost everybody. Fred Vincy interprets Mary Garth and Farebrother, Ladislaw interprets Dorothea who in turn interprets him and the supposedly twentieth-century idea that everything is a text is stressed by the fact that Fred has to learn to write in a legible way to make interpretation possible.

In these aspects the novel reflects the contemporary situation of science as well as contemporary theories of science and knowledge. The act of seeing the world, the act of capturing the world in science had become uncertain with the insight that interpretation and imagination play an important role in all scientific activity. Sally Shuttleworth remarks that like *Middlemarch* “Victorian Science was not . . . a unified body of knowledge, but rather a diffuse collection of disciplines divided internally by competing theories and intellectual schisms”⁴ which might have helped to bring this insight about. Shuttleworth points out that there was a “decline of belief in the self-evident order of the world”⁵ while at the same time the role of the scientist was no longer “simply to record and observe, but actively to construct experiments” and their “potential results”⁶. Accordingly, George Lewes stressed in his writings on science that interpretation and observation are inseparable.⁷ With his imagination the scientist has to transform the “raw registration of reality” into a pattern which then produces an idea that forms a working hypothesis of the nature of reality.⁸ Such a concept-building is essential to scientific activity⁹ since the “raw registration of reality” is in itself not

⁴Sally Shuttleworth, *George Eliot and Nineteenth-Century Science: The Make-Believe of a Beginning*, (Cambridge University Press: Cambridge and London, 1984), p. x

⁵Shuttleworth, 1984, p. 6

⁶Shuttleworth, 1984, p. 22

⁷Michael Mason, ‘*Middlemarch* and Science: Problems of Life and Mind’, *Review of English Studies*, Vol. 22 (1971), 151-169, (p. 165)

⁸George Levine, ‘George Eliot’s Hypothesis of Reality’, *Nineteenth-Century Fiction*, Vol. 35 (1980), 1-28, (p. 10)

⁹Mason, 1971, p. 163

meaningful. For Lewes, therefore, science is necessarily an ideal construction.¹⁰ There is no science or knowledge or meaning without construction. Without preconception we do not see anything. As Lydgate in *Middlemarch* says: “People talk about evidence as if it could really be weighed in scales by a blind Justice. No man can judge what is good evidence on any particular subject, unless he knows the subject well” (M 162), i.e. is in possession of its concepts and ways of construction. These concepts are supplied by the imagination which Lewes even compared to the imaginative activity of the poet. Lydgate’s concept of scientific work corresponds generally to the one proposed by Lewes. Bichat, the French scientist he wants to follow in his work, is called “a great seer” (M 153), which implies the combination of observation and imagination that is so important for Lewes. It is the imagination that can reveal what is still “obscure” (M 170), that creates connections and patterns that have not been discovered so far, that penetrates regions that are invisible to the eye, “inaccessible by any sort of lens” (M 170) because it can illuminate them with “inward light”, “bathing even the ethereal atoms in its ideally illuminated space.” (M 170) The imagination can see atoms while the eye cannot and it has to create the experiments that can make them indirectly visible. In these phrases, Lydgate is essentially expressing the same thing as Lewes when he writes “from known facts the philosopher infers the facts that are unapparent. He does so by an effort of imagination . . . he makes a mental picture of the unapparent fact.”¹¹ And it is precisely this work of the imagination that is Lydgate’s passion, his “delightful labour” (M 170), just as much as it might be the passion of George Eliot as an author.

The questions which arise by introducing the concept of a constructing activity of the imagination to the method of science are actually the same questions that George Eliot’s novel poses to the reader and to her characters in the narrative: How can we arrive at certain knowledge when we are all using our imagination as interpreters and constructors? When “signs are small measurable things, but interpretations are illimitable”? (M 20) How can we prevent feeling like Raffles who loses all his ground? George Lewes insists on the possibility of truth and so do Lydgate and Dorothea in *Middlemarch*. Both work out certain criterions that might help to bind imagination to reality in order to limit uncertainty.

Lydgate’s quest for the primitive tissue is definitely intended to produce certain knowledge. It is his aim “to contribute towards enlarging the scientific, rational basis of his profession” (M 152) and he longs to “help to define men’s thought more accurately after the true order” (M 153), not only concerning “special questions of disease” but also, and mainly, concerning “fundamental knowledge of structure.” (M 152) In the work on this fundamental questions Lydgate wants to follow Bichat who had proposed an organic view of the body which suggests that it is not only the sum of its parts but an organic whole “consist-

¹⁰Levine, 1980, p. 9

¹¹As quoted in David Carroll, *George Eliot and the Conflict of Interpretations: A Reading of the Novels*, (Cambridge University Press: Cambridge, 1992) p. 25

ing of certain primary webs or tissues, out of which the various organs . . . are compacted.” (M 152) With his conception as a working hypothesis Lydgate sets out to discover “What was the primitive tissue.” (M 153) It does not so much matter that his question is not put “quite in the way required by the awaiting answer” (M 153) just as it does not so much matter that Casaubon pursues an outdated theory, since “a vigorous error vigorously pursued has kept the embryos of truth a-breathing: the quest for gold being at the same time a questioning of substances, the body of chemistry is prepared for its soul, and Lavoisier is born.” (M 507) Even a quest as ridiculous as alchemy has brought an advance in knowledge. The same argument is used by the narrator when she comments on Dorothea’s interpretation of Casaubon: “Wrong reasoning sometimes lands poor mortals in right conclusions: starting a long way off the true point, and proceeding by loops and zigzags, we now and then arrive just where we ought to be.” (M 21) All quotations stress that there is a true point to be reached, an answer waiting, a correct advance in knowledge to be made which can be distinguished from wrong ones. This distinction can be made because imagination has to follow a strict procedure which will prevent it from moving into the regions of mere fantasy. It is not intended to be

mere arbitrariness, but the exercise of disciplined power – combining and constructing with the clearest eye for probabilities and the fullest obedience to knowledge; and then, in yet more energetic alliance with impartial Nature, standing aloof to invent tests by which to try its own work. (M 170)

Imagination, that is, has to work according to the facts that have been derived from nature so far and has to test its conceptions on nature. Since nature is impartial, the test results guarantee a certain amount of objectivity and certainty. The hypothetical concept then has to be adapted to the external facts. This adaptation to facts is a tendency which can be discovered as an organising principle for almost every character’s story. Dorothea has to adapt to her factual husband and learn that he is not identical with the one she has imagined. Fred Vincy’s money spending habits have to adapt to “external facts” and he has to give up unconfirmed confidence in the “wisdom of providence or the folly of our friends, the mysteries of luck or the still greater mysteries of our high individual value in the universe.” (M 239-240) The Lydgats’ spending habits must be rearranged “in accordance with that fact” (M 688) and Bulstrode has to adapt to his former misdeeds and reinterpret the role of Providence in his life accordingly. Casaubon’s theory, by contrast,

was not likely to bruise itself unawares against discoveries: it floated among flexible conjectures . . . it was a method which was not tested by the necessity of forming anything which had sharper collisions . . . it was as free from interruption as a plan for threading the stars together. (M 507)

It was, therefore, in danger of being a mere fantasy without ever finding it out, “questionable riddleguessing” (M 507) instead of an advancement of knowledge.

An even worse failure to adapt preconceptions to upcoming or missing external facts can be found among the “common sense” inhabitants of Middlemarch after Raffles death. They convict both Bulstrode and Lydgate of murder although they

could see nothing in these particulars which could be transformed into a positive ground for suspicion. But the moral ground for suspicion remained . . . this vague conviction of indeterminable guilt . . . had for the general mind all the superior power of mystery over fact. Everybody liked better to conjecture how the thing was, than simply to know it; for conjecture soon became more confident than knowledge, and had more liberal allowance for the incompatible. (M 766)

This description of their procedure is directly opposed to the method given in connection with Lydgate. These people are not interested in testing their theory against factual evidence and, what is even worse, they are not willing to accept that they cannot make a judgement until they have done so. For the proposed scientific method also involves open-mindedness. It is a process of “*provisionally* framing its object and *correcting* it to more and more exactness of relation” (M171, emphasis mine) and Lydgate acts according to it when he “construct[s] the probabilities of the [Bulstrode] case” (M 784) but refrains from final judgement because “What we call the just possible is sometimes true and the thing we find it easier to believe is grossly false . . . Bulstrode may have kept his hands pure, in spite of my suspicion.” (M 784) As Lydgate explains to Farebrother, open-mindedness also involves the readiness to change perspectives: “a man’s mind must be continually expanding and shrinking between the whole human horizon and the horizon of an object glass.” (M 678)

Two other aspects which can help to achieve objectivity are knowledge and a reduction of self-interest. Lydgate assumes that the inhabitants of Middlemarch are not able to judge his work properly because they are ignorant and have no appropriate grounds for making judgements. Their praise is “ignorant” and therefore “misses every valid quality” (M 476) and their criticism is equally ill informed. Dorothea shares this optimistic view of knowledge. She believes that she is often unable to decide “from ignorance. The right conclusion is there all the same, though I am unable to see it.” (M 27) Knowledge for her is the ultimate provider of certainty. She hopes that “a wise man could help me to see which opinions had the best foundation, and would help me to act according to them.” (M 37) This man “could illuminate principle with the widest knowledge” and therefore his “learning almost amounted to a proof of whatever he believed.” (M 18) For Dorothea knowledge is the “lamp” that should direct her life. It is, however, not certain whether these optimistic enlightenment attitudes towards knowledge are shared by the narrator. She warns “the wise . . . against too great readiness at explanation: it multiplies the source of mistake lengthening the sum

for reckoners sure to go wrong.” (M 469) In this view information and new knowledge only leads to further confusion. For Dorothea also knowledge does not fulfill her hopes and she has to learn that the supposedly wise man she married was not able to direct her in the objective way she wished. Instead he seems to have been more able to prove whatever he believed without any reference to the objectivity Dorothea longs for. This is because Casaubon lacks the quality which both the narrator and Dorothea value highly, a reduction of self-interest. Like so many characters in the novel he organises the world around his personal needs and therefore feels pleased that “Providence . . . had supplied him with the wife he needed” whereas the question “Whether Providence had taken equal care of Miss Brooke in presenting her to Mr. Casaubon was an idea which could hardly occur to him.” (M 293) This makes Casaubon a bad judge even about his scientific theories and the narrator comments that “It was not wonderful that, in spite of her small instruction, her [Dorothea’s] judgement in this matter was truer than his: for she looked with unbiased comparison and healthy sense at probabilities on which he had risked all his egoism.” (M 506) Here impartiality even overrides a deficit in knowledge and on the whole the “current” in Dorothea “into which all thought and feeling were apt sooner or later to flow – the reaching forward of the whole consciousness towards the fullest truth, the least partial good” (M 213) seems to be much more important. Lydgate values his impartial judgement equally highly and after Raffles’ death he is annoyed that his “scientific conscience had got into the debasing company of money obligation and selfish respects.” (M 786) It is important to note that this restriction of self-interest is not directed at a restriction of feeling. Feelings play an important role in the process of interpretation, construction and science, and a good example for this is Celia who seems to lack any kind of strong feeling and has difficulties making sense of the world. When people “talked with energy and emphasis” she merely sees “their faces and features” (M 28), when people quarrel with her she observes with wonder that they “look like turkey-cocks” (M 43) and when her baby is born she watches it but needs the constant interpretation of its behaviour by the nurse because she cannot see or construct any meaning into it. (M 516) Merely watching does not help. People need preconceptions and feelings in order to fill their observation with meaning. When Celia asks Dorothea whether she can tell her why she decided to marry Ladislaw her sister answers: “No dear, you would have to feel with me, else you would never know.” (M 873) The feelings, however, should not be directed primarily at the self but in form of compassion and sympathy at others.

In *Adam Bede* the narrator told the reader

I aspire to give no more than a faithful account of men and things as they have mirrored themselves in my mind. The mirror is doubtless defective . . . but I feel as much bound to tell you, as precisely as I can, what that reflection is, as if I were in the witness-box narrating

my experience on oath.¹²

This account of the method of narration ultimately implies the concept of the passive observer in whose mind the world is mirrored. The mirror image might be distorted, but this still leaves the observer passive. While George Eliot adopts this passive point of view in her earlier work, she moves on and remarks at the beginning of *Daniel Deronda*:

Men do nothing without the make-belief of a beginning. Even Science, the strict measurer, is obliged to start with a make-belief unit, and must fix on a point in the stars' unceasing journey when his sidereal clock shall pretend that time is at Nought.¹³

Here, Eliot stresses the imaginative act which is implied in the construction of all human experience and thus also in science – both contain an element of make-belief in the formation of their concepts.¹⁴ *Middlemarch*, I hope to have shown, might be viewed as the work where the passive observer is deconstructed and the interpreter is established. This implies that the distinction between illusion and subjectivity becomes increasingly difficult to draw. Just as it is hard to imagine a single observer who would not see a pattern in the impartially distributed scratches on the pier-glass, so it is hard to imagine a single observer who would perceive without mixing “the raw material of reality” with any preconceptions. On the other hand, the narrator of *Middlemarch* insists that it is “demonstrable that the scratches are going everywhere impartially” and that the light of the candle is only producing an “illusion”.

This coexistence of an almost relativistic epistemology with an insistence on the possibility of a clear distinction between truth and illusion is not uncommon in the nineteenth century. It is this ambivalence which makes it necessary to search for ways to limit the implied uncertainty. Therefore, Lydgate as well as the narrator propose the use of certain criteria and methods in order to bind imagination to reality, such as the constant comparison of hypothetical concepts and experience, the use of established knowledge, and the reduction of self-interest. Do, then, the efforts to arrive at certain knowledge really create the certainty that has been lost by the insight in the active and imaginative role of the observer? Ultimately, I would argue, uncertainty prevails and the only certainty that is attainable is, paradoxically, the deconstructed illusion of a common-sense that is unaware of the loss of self-evidence, the problems of point of view, the dangers of interpretation and takes feeling for reason. For the person who is aware of the factors that create his or her common world-view they create uncertainty

¹²George Eliot, *Adam Bede*, edited by Valentine Cunningham, (Oxford University Press: Oxford, 1996), p. 175

¹³George Eliot, *Daniel Deronda*, edited by Terence Cave, (Penguin Classics: London, 1995), p. 7

¹⁴This argument can be found in Shuttleworth, 1984, p. 1

by demonstrating that any one person's knowledge of the world is subjective, incomplete and preliminary and this position can never be overcome. The proposed method to bind imagination to reality can only correct but never transcend interpretation and preconception, and ultimately the corrections themselves are always in the danger of being preliminary until different instruments and different experiments reveal new aspects and new facts. George Lewes stresses that objectivity can only be hypothetical and David Carroll observes that this position allows "no resting place in any orthodoxy."¹⁵ Accordingly Dorothea interprets from the first to the almost last chapter, seeing people in love with each other who are not, and although she reimagines the scene between Rosamond and Ladislaw over and over again it never occurs to her that she is simply wrong in her basic assumption, until she is once again corrected by external facts. No distancing from her own situation, no compassion for Rosamond leads to this insight before this moment. Interpretation and its danger, misinterpretation, seems to be the human condition. Ideally, in many areas of life judgement would have to be suspended indefinitely because the only thing that is certain is that we do not really know. But then the process of judgement also seems to be necessary to drive the process of scientific inquiry on and this is one of the problems of the proposed process of knowledge: Everything that hinders knowledge at one stage, leads to it at another. Conditions and obstacles are in a way the same thing. Uncertainty is therefore always part of a system we cannot escape, every gain of certainty is replaced by new uncertainties and even the omniscient narrator cannot convince us of security, since she demonstrates to us that her position can never be attained by "ordinary mortals".

¹⁵Carroll, 1992, p. 22

BIBLIOGRAPHY

- Brody, Selma B. 'Physics in *Middlemarch*: Gas Molecules and Etheral Atoms', *Modern Philology* 85 (1987) 43-53.
- Carroll, David. *George Eliot and the Conflict of Interpretations: A Reading of the Novels*. Cambridge University Press. Cambridge, 1992.
- Darwin, Charles. *The Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life*, edited by J.W. Burrow. Penguin Classics. London, 1985.
- Eliot, George. *Middlemarch: A Study of a Provincial Life*. Everyman's Library, Alfred A. Knopf. New York and Toronto, 1991.
- . *Adam Bede*, edited by Valentine Cunningham. Oxford University Press. Oxford, 1996.
- . *Daniel Deronda*, edited by Terence Cave. Penguin Classics. London, 1995.
- Greenberg, Robert A. 'Plexus and Ganglia: Scientific Allusion in *Middlemarch*', *Nineteenth-Century Fiction* 30 (1976) 33-52
- Levine, George. 'George Eliot's Hypothesis of Reality', *Nineteenth-Century Fiction* 35 (1980) 1-28.
- . *Darwin and the Novelists: Patterns of Science in Victorian Fiction*. Harvard University Press. Cambridge, MA, and London, 1988.
- Mason, Michael York. '*Middlemarch* and Science: Problems of Life and Mind', *Review of English Studies* 22 (1971) 151-169.
- Neal, Catherine. 'Torpedoes, Tapirs and Tortoises: Scientific Discourse in *Middlemarch*', *Critical Survey* 2 (1990) 57-62.
- Shuttleworth, Sally. *George Eliot and Nineteenth-Century Science: The Make-Believe of a Beginning*. Cambridge University Press. Cambridge and London, 1984.