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Erfahrung und Beweis

Experience and Demonstration

WISSENSKULTUR UND GESELLSCHAFTLICHER WANDEL

Herausgegeben vom Forschungskolleg 435
der Deutschen Forschungsgemeinschaft
»Wissenskultur und gesellschaftlicher Wandel«

Band 14

Erfahrung und Beweis

Die Wissenschaften von der Natur
im 13. und 14. Jahrhundert

Experience and Demonstration

The Sciences of Nature
in the 13th and 14th Centuries

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und Peter Hoffmann

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Vorwort

Die hier versammelten Beiträge sind aus einer Konferenz hervorgegangen, die unter dem Titel „Erfahrung und Beweis: Die Wissenschaften von der Natur im 13. und 14. Jahrhundert" im Dezember 2005 an der Johann Wolfgang Goethe-Universität in Frankfurt am Main stattgefunden hat.

Veranstalter der Konferenz war das von uns geleitete Teilprojekt „Spekulatives, naturkundliches und politisches Wissen: Die Differenzierung der Wissenschaften und intellektuellen Lebensformen im 13. und 14. Jahrhundert", das mit weiteren Teilprojekten zum DFG-Forschungskolleg „Wissenskultur und gesellschaftlicher Wandel" an der Johann Wolfgang Goethe-Universität Frankfurt am Main gehört.

Seit seiner Einrichtung im Jahr 1999 befasst sich unser Teilprojekt mit der Erforschung der epistemologischen Voraussetzungen der Wissensrevolution an den Schulen und Universitäten der Wissenskultur des Mittelalters und ihrem Beitrag zur philosophischen Diskussion der Frage nach den Grundlagen des menschlichen Erkennens und der Wissenschaften. Von herausragender Bedeutung für diese sogenannte „intellektuelle Revolution" ist zweifelsohne die im 12. Jahrhundert einsetzende und im 13. und 14. Jahrhundert zu ihrem Höhepunkt gelangende Rezeption der aristotelischen Erkenntnis- und Wissenschaftstheorie, die den epistemologischen Diskussionen des Mittelalters wesentliche Impulse und Einsichten gab, durch deren systematische Aufnahme, Auslegung und Fortentwicklung der konzeptionelle und organisatorische Rahmen für den Prozess der „okzidentalen Rationalisierung" geschaffen wurde, in deren Tradition nicht nur die gegenwärtigen Fragen und Probleme der Epistemologie stehen, sondern darüber hinaus auch die Entstehung der modernen Gesellschaften und ihrer Wissenskultur in der Neuzeit.

In einer ersten Phase unserer Forschung standen die Wissensumbrüche im 12. Jahrhundert im Mittelpunkt, insbesondere die wissens- und wissenschaftstheoretischen Diskussionen und Entwicklungen, die im Anschluss an Boethius in der Francia zu beobachten sind, sowie die Anfänge der über die arabische *falsafa* vermittelten Aristotelesrezeption auf der Iberischen Halbinsel, v.a. in Toledo. Die Ergebnisse dieser ersten Forschungsphase sind nicht nur in zahlreichen Monographien, sondern auch in zwei Sammelbänden erschienen, die auf Konferenzen zurückgehen, welche vom Teilprojekt in den letzten Jahren organisiert wurden: der Band *‚Scientia' und ‚Disciplina'. Wissenstheorie und Wissenschaftspraxis im 12. und 13. Jahrhundert* (Berlin 2002), herausgegeben von Rainer Berndt und Matthias Lutz-Bachmann, befasst sich mit der allgemeinen epistemologischen Grundlegung der Wissenschaften im 12. Jahrhundert; die Veröffentlichung *Metaphysics in the 12th Century – On the Relationship among Philosophy, Science and Theology* (Turnhout 2004), herausgegeben von Matthias Lutz-Bachmann, Alexander Fidora und Andreas Niederberger, fokussiert unter diesem epistemologischen Gesichtspunkt den Status der Metaphysik im 12. Jahrhundert. In einer zweiten Phase beschäftigt sich das Teilprojekt mit der Eigenlogik und Ausdifferenzierung der Wissenschaften im 13. und 14. Jahrhundert. Auch hier liegen erste Ergebnisse nicht nur in Einzelstudien, sondern ebenfalls in einem Sammelband vor, der grundsätzliche Fragen der Epistemologie dieser Zeit zum Thema hat: *Erkenntnis und Wissenschaft – Probleme*

der Epistemologie in der Philosophie des Mittelalters (Berlin 2004), herausgegeben von Matthias Lutz-Bachmann, Alexander Fidora und Pia Antolic. Der hier vorgelegte Band schließt an diese Untersuchungen an, v.a. an die zuletzt genannte Publikation. Er fokussiert im Hinblick auf das 13. und 14. Jahrhundert die epistemologische Begründung des naturkundlichen Wissens, genauerhin das Wissenschaftskonzept eines neuen Erfahrungswissens von der Natur, wie es in der Wissenschaft der Physik und den naturkundlichen Disziplinen der Astronomie, der Meteorologie und Optik, der Geologie und der Biologie im 13. und 14. Jahrhundert begegnet.

Im Zentrum der in diesem Band versammelten Beiträge steht die Frage, wie die mittelalterlichen Autoren im Anschluss an die Aristotelesrezeption und angesichts des Aufkommens der neuen naturkundlichen Disziplinen das Verhältnis von Erfahrung und Beobachtung einerseits und den strengen Ansprüchen von apriorischem Beweiswissen andererseits bestimmen. Die hier veröffentlichten Untersuchungen bieten damit einen umfassenden und bisher in der Forschung nicht geleisteten Überblick über die Bedeutung und Reichweite der epistemologischen Debatten im Hinblick auf die Wissenschaften von der Natur im 13. und 14. Jahrhundert. Zugleich eröffnen sie systematische Perspektiven zu Fragen der Epistemologie der Gegenwart, etwa zum Problem der Induktion, der Subordination und der Anwendung der Wissenschaften.

Die Herausgeber danken der Deutschen Forschungsgemeinschaft für die Gewährung eines großzügigen Druckkostenzuschusses. Ferner gilt unser Dank Tatjana Ruge und Dorothée Werner für ihre Unterstützung bei der Vorbereitung des Bandes für den Druck.

Frankfurt am Main, Oktober 2006   Alexander Fidora und Matthias Lutz-Bachmann

Antike Voraussetzungen

Wolfgang Detel

Logic and Experience in Aristotle

In this paper, I want to discuss not the relation between experience and scientific demonstration but the relation between formal syllogistic and experience in Aristotle. The question I shall try to answer is: Does Aristotle feel that syllogistic has an empirical foundation, and if so, in which way? In particular, does he think that claims about the validity and invalidity of syllogisms are in some sense claims about the external empirically accessible world? There is, as far as I can see, not much textual evidence in Aristotle's works that we can rely on to approach this problem. It seems clear, though, that the way he proves the *invalidity* of certain syllogisms throughout the first chapters of the Prior Analytics, by way of relying on empirical examples, must be our starting point.

Prima facie Aristotle seems to ground the validity of the perfect syllogisms firmly on the *meaning* of the syllogistic relations. Thus, one is inclined to think that at the end of the first chapter of the Prior Analytics he introduces the *semantics* of the crucial logical constants of his syllogistic, namely of the expressions "predicated of every" and "predicated of none" (the syllogistic a- and e-relation, in the usual notation) by saying:

> We say (*legomen*) "predicated of every" when none of the subject can be taken of which the other term cannot be said, and we say "predicated of none" likewise".[1]

In his excellent new translation (with a helpful commentary) Robin Smith translates *legomen* by "we use the expression" to indicate the *semantic* force of *legein* in this context. In the following chapters Aristotle seems to rely on this logical semantics to justify the validity of the perfect syllogisms. For instance, introducing Barbara he remarks:

> For if A is predicated of every B and B of every C, it is necessary for A to be predicated of every C. For it was stated earlier in which way we say the of every (Smith: what we mean by "of every").[2]

It seems justified, then, to celebrate Aristotle as the first thinker to have in fact founded formal logic on the meanings of the logical constants, although he certainly did not have a clear notion of meaning (as distinct from reference) in the modern Fregean sense. However, after having introduced the Barbara syllogism, Aristotle goes on to remark:

> (*) However, if the first extreme follows all the middle and the middle belongs to none of the last, there will not be a deduction of the extremes, for nothing necessary results in virtue of these things being so. For it is possible for the first extreme to belong to all as well as to none of the last. Consequently, neither a particular nor a universal conclusion becomes necessary; and, since nothing is necessary because of these, there will not be a de-

1 Aristotle, *An.Pr.* I 1, 24b28-30.
2 *Ibid.*, I 4, 25b37-40, cf. also, e.g., *ibid.* 26a23, 27-28.

duction. Terms for belonging to every are animal, man, horse; for belonging to none, animal, man, stone.[3]

This is the first, and actually the most comprehensive, case of Aristotle's famous counter-model technique of showing that certain syllogisms are *not* valid. He does not always use exactly the same form of argument, but this passage certainly represents the standard form. Given the limited space for this paper, I will focus primarily on this passage not only because it is of the standard form, but also because it is the only passage that is preceded with a short explanation and will suffice as a basis for making my most important points.

Clearly in this passage Aristotle is talking about the two syllogistic premises AaB and BeC, and he is claiming that no syllogistic conclusion containing the extreme terms, viz. A and C, follows syllogistically from these two premises. In particular he points out, correctly of course, that since the truth of AaC as well as of AeC is compatible with the conjunction of the premises, this goes also for the truth of AiC and AoC. In the final sentence of the passage he introduces empirical predicates as examples of his argument:

> (a) Animal (=A) is predicated of every man (=B); man is predicated of no horse (=C); but at the same time, animal (=A) is predicated of every horse (=C);

> (b) Animal (=A) is predicated of every man (=B); man is predicated of no stone (=C); but at the same time, animal (=A) is predicated of no stone (=C).

Of course it follows that also the true sentences "animal is predicated of some horses" and "animal is not predicated of some stones" are compatible with the truth of both premises.

Often Aristotle uses a short form of this argument by just indicating an example of a triple of empirical terms that is supposed to show the invalidity of some syllogism. Thus, the very passage we are looking at continues as follows:

> (**) Nor when neither the first belongs to any of the middle nor the middle to any of the last, there will not be a deduction in this way either. Terms for belonging are science, line, medicine; for not belonging, science, line unit.[4]

Here Aristotle is obviously talking about the premises AeB and BeC, and again the claim is that both AaC and AeC (and therefore also AiC and AoC) are compatible with the conjunction of the two premises:

> (c) Science (=A) is predicated of no line (=B); line is predicated of no medicine (=C); but at the same time, science (=A) is predicated of every medicine (=C);

> (d) Science (=A) is predicated of no line (=B); line is predicated of no unit (=C); and at the same time, science (=A) is predicated of no unit (=C).

The frequent use of the short argumentation form (**) (compare, for instance, the number of examples in the first part of *APr.* I 5, 26b34-27b10) instead of the longer form (*) has supported the impression that the quote of a triple of universal empirical terms is the core of Aristotle's way of refuting the validity of certain syllogisms. Therefore the debate about Aristotle's countermodel technique has concentrated on the validity of this technique. Some modern commentators and logicians think that the technique is just fine and became even

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3 *Ibid.*, 26a2-9.
4 *Ibid.*, 26a10-13.

usual later. Thus, in his commentary on this passage Robin Smith says that "there is nothing logically flawed in Aristotle's procedure: in fact, countermodels are the paradigmatic means of proving invalidity for modern logicians".[5] Ancient commentators like Alexander of Aphrodisias or Philoponus, or older modern scholars like Waitz, Maier or Rolfes think that Aristotle wants to show by means of empirical examples that two syllogistic premises do not imply syllogistically any syllogistic conclusion exactly if two empirical conclusions can be deduced from these premises that contradict each other.[6] This interpretation is, of course, logically flawed because the conclusions Aristotle is quoting and discussing in most cases do *not* logically follow from the premises (and Aristotle does not say so either); indeed, contradictions can be deduced correctly at most from contradictions (in his syllogistic Aristotle never discusses contradicting *premises* simply because this does not make sense, since, as he remarks in *Metapysics* IV, everything follows logically from contradictions).

Commentators who are better trained in logic, like Ross and Lukasiewicz, complain that Aristotle's use of counterexamples relies on concrete terms and thus on extra-logical knowledge which they think is not appropriate in formal logic.[7] Obviously, here the worry is that Aristotle brings together what does not seem to belong together, namely logical language and knowledge on the one hand, and empirical language and knowledge on the other hand. Finally, in his seminal study on Aristotle's syllogistic Patzig presents an interpretation that looks elegant and avoids criticism of the confusion between the realm of logic and the realm of empirical knowledge.[8] Put as briefly as possible, his reading is as follows. We should start by looking at Aristotle's criteria for validity. Aristotle thinks:

(e) A *pair P of syllogistic premises* containing the universal terms A, B and C is *valid*, in the sense that there are valid syllogistic deductions containing these premises, just in case that for all A, B and C, P implies AaC, or for all A, B and C, P implies AeC, or for all A, B and C, P implies AiC, or for all A, B and C, P implies AoC.

By using (e) we can determine what an invalid pair P* of syllogistic premises is:

(f) A *pair P* of syllogistic premises* containing the universal terms A, B and C is *invalid* if P* is not valid (in the sense of (e)), that is just in case that there are terms A, B, C such that P* and AaC is true, and that there are terms A, B, C such that P* and AeC is true, and that there are terms A, B, C such that P* and AiC is true, and that there are terms A, B, C such that P* and AoC is true.

As Patzig emphasizes, (f) is simply the logical negation if (e). And that (f) is satisfied can indeed be proved by providing one single empirical example simply because (f) is a conjunction of existential quantifications. According to Patzig, this is exactly what Aristotle's counterexample technique is doing. On this reading Aristotle's procedure does not seem in any way problematic or flawed.

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5 Cf. Aristotle, *Prior Analytics*, transl., with introd., notes, and comm. Robin Smith, Indianapolis 1989, p. 114.

6 Compare, for instance, Alexander von Aphrodisias in *An.Pr.* 55, 21-26; Philoponus in *APr.* 74, 30-75; Heinrich Maier, *Die Syllogistik des Aristoteles*, Tübingen 1896-1900, II 1, p. 75 f.

7 See Jan Lukasiewicz, *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic*, Oxford 1951, p. 72.

8 Günther Patzig, *Die aristotelische Syllogistik*, Göttingen 1963, pp. 180-196.

It seems to me that Patzig is right – but only from a purely logical point of view. For he must presuppose that we understand correctly what Aristotle means by syllogistic validity and whether, and if so how, syllogistic validity is related to the empirical world. Put in another way, Patzig's reading does not answer the question why Aristotle's procedure is just fine. How can it be that empirical counterexamples can decide correctly about logical invalidity and so indirectly also about logical validity? Moreover, the longer passage (*) seems to indicate that the abstract reasoning preceding the empirical counterexample suffices to complete the proof and that the introduction of empirical terms is only an illustration that has not much autonomous argumentative force. There are a few more passages of this extended form.[9] What is more, there are also cases in which, as Aristotle emphasizes correctly, it is not possible for logical reasons to give concrete empirical counterexamples. In these cases the proof of invalidity can *only* be given in an abstract way, "from the indeterminate", as Aristotle says.

A case in question is this (see *APr.* I 5, 27b10-23): In the second syllogistic mood, the claim is that the premises BeA and BoC are invalid because AaB as well as AeB are possible, i.e. are consistent with the premises. For the subcase AeB concrete examples can be given: black (=B), snow (=A), animal (=C). That is to say, black e snow, black o animal, snow e animal are all true. But for the subcase AaB no empirical example can be given, since if AaB were true, then according to Celarent it would follow, by relying on one of the presupposed premises, viz. BeA, that BeC is true, which is, however, inconsistent with the second premise, viz. BoC. Therefore, the proof of invalidity by emprical counterexamples cannot be completed. Instead, a proof from the indeterminate must be constructed. This is, in short, the following reasoning: We know already that the premises BeA and BeC are invalid; now BeC is stronger than the original second premiss BoC; and we can invoke the principle that if a pair of premises is invalid, then a pair of weaker premises is also invalid. What is indeterminate here is simply that the proof does not really distinguish between the premises BeC and BoC.

It seems important, then, to ask how abstract logical reasoning and the quote of empirical concrete counterexamples are theoretically related to each other in Aristotle's proofs of invalidity. An answer to this question can, I think, also be helpful for approaching deeper philosophical problems concerning the relation between syllogistic and empirical knowledge.

A first move is to realize that logical relations between syllogistic premises and conclusions – whether valid or invalid – are relations between set-relations, to use some modern vocabulary. Obviously, every syllogistic sentence represents a relation between two sets, like set-inclusion in the case of AaB or set-intersection in the case of AiB. As is well-known, modern logicians use the Venn diagram technique to illustrate these syllogistic relations by using a circle for each set. The crucial idea is to say:

AaB means: No B is not-A, that is: the intersection of B and not-A is empty;

AeB means: No B is A, that is: the intersection of A and B is empty;

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9 E.g. Aristotle, *An.Pr.* I 4, 26a39.

AiB means: Some B is A, that is: the intersection of A and B is not empty;

AoB means: Some B is not A, that is: the intersection of B and not-A is not empty.

So two intersecting circles can be used to illustrate these set-relations by shading out the empty sets and marking not-empty sets by an x. The important point for our purposes is that Venn diagrams can be used for testing the validity *and* the invalidity of syllogisms. To do this, we must draw three intersecting circles representing the three terms. In fact, this comes down to putting the diagrams of the two premises together and then inspect the result concerning the diagram of the conclusion that simply emerges from our picture.

The main reason for pointing to the Venn diagram technique is that it supports the theoretical insight that in Aristotle's syllogistic all proofs of validity *and* invalidity can be given on an *abstract* level and in the very same manner – after all, the circles in the diagrams represent *variables* of syllogistic terms that can be *instantiated* and *illustrated* by empirical predicates; but the proofs are not really dependent on this instantiation or illustration.

We have to concede, though, that by using Venn diagrams we can only check whether certain *given* syllogisms are valid or invalid. It is less obvious how we could check whether a given pair of premises cannot yield *any* correct syllogistic conclusion whatsoever or is consistent with *any* syllogistic sentence containing the extreme terms, as Aristotle is showing again and again in the *Prior Analytics*. But if we illustrate syllogistic terms in the well known more traditional way (given the sets we are talking about are not empty), then it becomes more obvious what Aristotle is up to. In the traditional way, we represent syllogistic sentences without shading them out or marking them with an x. We can then diagram the two syllogistic premises concerning the AB-relation and the BC-relation seperately and take them as conditions or constraints for diagramming the AC-relation by trying to put them together. Thus, for Barbara we see immediately that the two premises constrain the AC-relation to AaC. But in case we have invalid syllogisms we can see that there is in fact no such constraint since we can diagram the AC-relation in all four possibilities, that is as AaC, AeC, AiC or AoC. Here are three examples:

BaA, BaC invalid (see above);

AaB, BeC invalid (Aristotle´s very first example (see above) in 26a2-9);

BeA, BoC invalid, reducible to BeA, BeC invalid (the complicated example in 27b10-23 discussed above).

These examples and figures indicate that we can get insight, not only into the validity but also into the invalidity of syllogisms on an abstract level, i.e. taking A, B and C as variables and not having to invoke concrete empirical term examples. More precisely, it seems that we can get insight into the invalidity of syllogisms *in the same manner as we can get insight into the validity of the perfect syllogisms* (since the validity of the imperfect syllogisms can be proved). The question is, though, *what is this manner?* Interestingly, in the case of invalidity it does not seem to be related to the meaning of the syllogistic constants.

To approach this problem, we have to look briefly at Aristotelian induction which for Aristotle is one way of establishing universal facts. He claims that "we learn either by induction or by demonstration and that it is impossible to consider universals except through induction" (*APo*. I 18, 81a39-b2). Aristotle even says that, in a sense, we become familiar

with the immediate premises of science by induction (*APo*. II 19, 100b3-4). Scholars disagree about how Aristotle conceived of induction. Is it a form of *argument* leading from a finite set of singular premises to a universal conclusion, pretty much in the modern sense, as for instance Ross argues? A minority of scholars, like Solmsen and Engbert-Pedersen, denies this and claims that an Aristotelian induction is simply a list of singular facts sharing a structure and is, therefore, not an argument at all. According to this view, universal assumptions cannot be inferred from singular propositions, but must rather be already presupposed for classifying singular facts and establishing an induction.[10] Indeed, there is not a single passage in which Aristotle unambiguously calls the *transition* from singular to universal propositions an induction. We must be careful not to read formulas like *this is evident by induction* or *secured by induction* (*Phys*. I 2, 185a14, *Top*. I V 2, 122a19) as pointing to a procedure of deducing or concluding; rather, these formulas are fully consistent with the claim that by looking at certain singular facts or propositions as *heuristic devices* it is that we can make a good *guess* about a universal. Looking at some things *and* classifying them under *presupposed* universals as "swan" and "white" (the finite list of these things *thus described* forming the induction) we may *guess*, not conclude, that all swans are white. This guess holds good as long as we do not encounter a swan that is not white.[11] In short, Aristotelian induction consists basically in pointing to empirical examples and classifying them by a fallible pattern recognition, i.e. a recognition of structures ("forms") that are metaphysically realized by the examples.

Remarkably, though, Aristotle himself uses the term *induction* almost exclusively, not in relation to empirical generalizations like AaB, but mainly in respect to very general philosophical claims. In the ten books of the *Historia Animalium* that present a great number of empirical generalizations the term *induction* is completely absent. But Aristotle says, for instance, that the claim that non-accidental change occurs only in contraries or contradictories can be shown by induction (*Phys*. V 1, 224b27-30). More interestingly for our purposes, the fact that what is contrary to a good thing is necessarily bad is clear by induction (*Cat.* 11, 13b37f.); likewise, the fact that the contrary of the species must be of necessity in the contrary of its genus, if there is any contrary to the genus, is made plane by induction (*Top.* I V 3, 123b6-8). Obviously, then, for Aristotle even necessary relations of structures can be revealed by induction. So why should this not go for logical relations? Indeed, he says that the logical rule "if AaB, then not-B a not-A" (that is, if every B is A, then every not-A is not-B) can be grasped by induction (*Top.* II, 113b15-21). Here we have an explicit remark about a sort of relation between logic and experience.

The best interpretation of this material I can think of is to say that Aristotle conceived of necessary relations between various sorts of structures as parts or aspects of the empirical world, pretty much in the sense of a de re necessity. The *de re* necessities entail also logical (i.e. syllogistic valid) relations. Exploiting the way Frank Jackson has recently expressed this idea[12] we can say:

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10 Cf. for this discussion and the literature on this issue Wolfgang Detel, Aristoteles, *Analytica Posteriora*, 2 vols., übers., eingel. u. komm. von Wolfgang Detel, Berlin 1993,vol. I, pp. 248-262.
11 Aristotle, *Top*. II 3, 110a32-36; VIII 2, 157a34-b33; *APr*. II 26, 69b1-8; *APo*. I 4, 73a32-34, II 7, 92a37-38.
12 See Frank Jackson, *From Metaphysics to Ethics*, Oxford 1998.

> A pattern Q of an entity E is *necessarily related to* patterns Pi of E if (a) every phenomenon in our world that makes it true that E has one of the Pi, also makes it true in our world that E has Q, and if (b) in every possible world that is identical with our world in containing the fact that E has one of the Pi, it is also true that E has Q.

Ontologically speaking here Q is strictly the same in any of the Pi: there is this *identity in difference*. And it is basically this identity that creates the metaphysical *necessity* of the relations between Pi and Q. This notion of a necessary metaphysical relation seems, according to Aristotle, to hold also for the structures expressed by valid syllogisms and by claims about the invalidity of certain syllogisms. This would, if acceptable, help to explain why Aristotle tries to justify his claims about invalid pairs of syllogistic premises in an abstract way and why the induction of concrete empirical examples, while certainly being an important basis for logical pattern recognition, has nevertheless mostly an illustrative force. Metaphysically speaking Aristotle feels that logical relations are not, as many modern semanticists have it, semantic norms binding us in our argumentation, but second order relations of set-relations that have a modal ontological status such that the modality involved in logical relations is de re. If syllogisms are valid, then the logical second order relations are *de re necessary*; if, however, the syllogisms are invalid, then certain logical second order relations are *de re possible*.

On this reading, the countermodel technique can and should be put in modal terms: Aristotle shows in an abstract way that certain empirical states of affairs are *possible*; in some cases, these states are even actual and therefore possible too; and from this it follows indeed that it is not necessary that these states do not hold. It is in this way that logic is, according to Aristotle, firmly founded in nature. We human sophisticated pattern recognizers can become aware of logical relations by looking either at abstract set-relations or at examples of triples of empirical terms that metaphysically realize, or contradict, set-relations.

Miira Tuominen

How Do We Know the Principles?
Late Ancient Perspectives to Aristotle's Theory

In the *Posterior Analytics*, Aristotle argues that knowledge (*epistêmê*) exists. The argument is grounded on the assumption (I 3) that real knowledge is based on demonstration, but that the starting points of demonstrations are known in a non-demonstrated way. Throughout the treatise, he works on the basis of this assumption and returns to it only in the very last chapter (II 19). When the reader, then, arrives at this chapter, her expectations are high: now, perhaps, Aristotle will finally explain how the principles are known. However, the actual discussion Aristotle offers often produces disappointment, even frustration, in the reader.[1]

At the beginning of the chapter, Aristotle makes some preliminary moves to lay out the questions he will discuss in the remaining 40 lines in the Bekker numbering. His first contribution to the discussion is a rather careless refutation of Plato's theory of recollection. Content with it, however, he proceeds to claim that the cognitive disposition that knows the principles, develops in us from perception. His account of how this development takes place (100a1-9) is concise and difficult.

Some things, however, are quite clear in Aristotle's exposition. Firstly, what he offers is an account of how we come to apprehend universal objects. It is the relation between this account and the question of how we come to know the first principles that is problematic. Secondly, on the basis of the examples Aristotle gives, the universals objects he is talking about seem to be very basic general notions such as 'human being' and 'animal'. At the very end of the chapter Aristotle claims that our intellect (*nous*) is always true, and we know the principles by the intellectual disposition. This has led some scholars to assume that Aristotle proposes a specific intellectual intuition that concerns the premises of scientific proofs, sometimes understood as definitions.[2] The question would then be how this rational insight is related to the capacity to form the very basic universal notions such as 'human being' and 'animal'.

The idea that Aristotle would postulate a form of immediate rational intuition of the first principles seems, at first sight, to be at odds, on the one hand, with what could be called his empiricism,[3] and, on the other hand, with the fact that in his own scientific works Aristotle

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1 Burnyeat, e.g., characterises it as "perfunctory in the extreme"; see Myles Burnyeat, "Aristotle on Understanding Knowledge", in: Enrico Berti (ed.), *Aristotle on Science. The Posterior Analytics* (Proceedings of the Eighth Symposium Aristotelicum), Padova 1981, pp. 97-139, here p. 133. For the discussion concerning the chapter, cf. also, e.g. Charles Kahn, "The Role of *Nous* in the Cognition of the First Principles", in: *ibid.*, pp. 385-414.
2 E.g. Kahn, "The Role of Nous", *op. cit.* Cf. also Michael Frede, "Aristotle's Rationalism", in: Michael Frede / Gisela Striker (eds.), *Rationality in Greek Thought*, Oxford 1996, pp. 157-173.
3 This 'empiricism' is exemplified in the II 19 of the *Posterior Analytics*; cf. also Aristotle, *An. Pr*. I 30, 46a18, *empeiria*, 'experience'.

proceeds through dialectical argumentation. From these discrepancies – whether they are real or not – many scholars have concluded that Aristotle does not, in fact, follow his own methodological instructions. I tend to think that the discrepancies in Aristotle's theory have, to some extent, been exaggerated in the scholarly literature. However, I shall not go deeper into this question here.[4]

In this essay, I shall ask how some of the ancient commentators on Aristotle answered the question of how we come to know the principles. I do not claim to explore all possible evidence. Rather, I shall discuss some crucial passages. These passages show that the commentators' explanations of these passages are of utmost importance to us: they provide us with fresh insight into how to understand the question of principles in Aristotle. I shall first discuss commentaries by Alexander of Aphrodisias and then turn to commentaries the authorship of which is to some extent a matter of dispute. One of them is probably by the historical Philoponus, another possibly so, but the latter is preserved only as a medieval Latin translation. The third commentary is probably inauthentic, but it is one on *Posterior Analytics* II and, hence, of importance to the present topic. In the limits of the present essay I shall not deal with Themistius' paraphrase on the *Posterior Analytics*.[5]

1. Alexander of Aphrodisias

Alexander of Aphrodisias (flourished c. 200 AD) was the first major commentator on Aristotle whose work has been rather well preserved. However, his commentary on the *Posterior Analytics* is lost; only fragments have been preserved by other authors.[6] Those fragments are not very fruitful for our present purposes. More interesting are some of Alexander's commentaries on other Aristotelian treatises. In this connection I shall discuss Alexander's commentary on the *Prior Analytics*[7] (on I 27-30) and that on the *Topics*,[8] as well as his *Treatise on the soul*, which, however, is not a commentary.[9]

1.1 Prior Analytics I 27-30
Before going into the question of how Alexander comments on chapters 27-30 of book I of the *Prior Analytics*, it is appropriate to say a few words about the content of those chapters. Aristotle introduces here a scheme which helps us find premises for any given conclusion. Let us call the terms of the intended conclusion A and E. Since the scheme is introduced in

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4 For my argument concerning Aristotle's position, see Miira Tuominen, *Apprehension and Argument: Ancient Theories of Starting Points for Knowledge* (Studies in the History of Philosophy of Mind 3), Dordrecht forthcoming 2006.

5 For Themistius on *An. Post.* II 19, see further Tuominen, *Apprehension and Argument*, section 1.3.2., *op. cit*.

6 Collected by Paul Moraux, *Le Commentaire d' Alexandre d'Aphrodise aux* 'Secondes Analytiques' *d'Aristote* (Peripatoi 13), Berlin/New York 1979.

7 Alexander of Aphrodisias, *in Aristotelis Analyticorum Priorum librum I commentarium* (Commentaria in Aristotelem Gracea II/1), ed. Maximilian Wallies, Berlin 1883; henceforth *in An. Pr*.

8 Alexander of Aphrodisias, *in Aristotelis Topicorum libros octo commentaria* (Commentaria in Aristotelem Graeca II/2), ed. Maximilian Wallies, Berlin 1891; henceforth *in Top*.

9 Alexander of Aphrodisias, *Praeter commentaria scripta minora: de anima liber cum Mantissa* (Commentaria in Aristotelem Graeca Suppl. II/1-2), ed. Ivo Bruns, Berlin 1887; henceforth *de An*. or *de Anima*. Alexander also wrote a commentary on Aristotle's *de Anima*, but it has been lost.

the framework of the syllogistic analysis, its conclusion is in one of the following four forms: (i) A belongs to all E, (universal affirmative, AaE), (ii) A belongs to some E (particular affirmative, AiE), (iii) A belongs to no E (universal negative, AeE) and (iv) A does not belong to some E (particular negative, AoE).

The instruction, then, is to gather such terms having a universal connection with the terms that appear in the conclusion (A and E). Hence the terms we are looking for are those that either (a) universally belong to the terms A and E (XaA and YaE), (b) the terms A and E belong universally to them (AaX and EaY), and (c) are universally excluded by A or E (XeA and YeE). Aristotle underlines that from a scheme that includes all such predicates we can find premises for any of the conclusions of categorical syllogistic form, provided that the same term is found in the relevant places.

For example, if we need to argue for a universal affirmative conclusion (AaE) – the form which is the most common one in science – we need premises of the form AaX and YaE so that X and Y are identical; in such a case X=Y functions as a middle term (AaX, YaE (Y=X => XaE); AaE). An instance of this kind of a syllogism is a case where we inquire into planets and have discovered that all the planets are non-twinkling (the conclusion of the intended syllogism is AaE, where E stands for 'the planets' and A for 'non-twinkling');[10] we are curious to know how this conclusion can be argued for (cf. *An. Post.* I 13, 78b1-3). To do so, we need to find the same term in two places: among those terms that belong universally to planets (YaE) and the terms that are such that non-twinkling belongs universally to them (AaX).

Suppose now that the following two conditions maintain. Firstly, in our inquiries into astronomy, we have found out that all planets are near (YaE where Y means 'being near'), and, hence, they differ from the fixed stars. Secondly, we have also found out that non-twinkling belongs to all those celestial objects that are near (AaX). We might have some optical scientific results concerning this, or this might just be a generalisation on the basis of experience.[11] Now we would have a universal affirmative syllogism for the conclusion that planets do not twinkle. The relevant middle term (X=Y) would be 'being near'.

All objects that are near are non-twinkling. (AaX)
Planets are near. (YaE, X=Y)
Therefore, planets are non-twinkling. (AaE)

A similar procedure is followed in the case of conclusions of the other syllogistic forms. We can find an argument for the given conclusion if we are able to find the same term from both columns in the right place. The scheme will become clearer when we discuss the evidence from the commentaries.

Having presented the details of the syllogistic scheme, Aristotle comments on its possible applications. I shall quote here the relevant passage:

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10 As is clear from the text of *An. Post.* I 13, Aristotle treats this conclusion as universal and affirmative, not as universal and negative, as one might expect.
11 Such generalisation would be possible in, e.g., the following kind of case. When leaving for the sea in darkness we see lights at the harbour. When we are close to them, they seem to remain stable. However, when we distance ourselves from the harbour, we notice that at some point the lights have started to twinkle. From this we may form the general conception that distant lights seem to twinkle, whereas those that are close, remain stable.

> The procedure described is to be followed in the establishment of all conclusions, whether in philosophy (*peri philosophian*) or in any art or field of study (*peri technên hopoianoun kai mathêma*); we must scrutinize of our two terms what belongs [universally] to them and to what they belong [universally]. One should have an abundance of these and we must proceed by way of three terms establishing conclusions in this way and refuting them in that way. If [we proceed] according to truth, we must [proceed] from predications that are listed as belonging truthfully, if [we aim at] dialectical syllogisms we argue from reputable opinions (*ek tôn kata doxan protaseôn*).[12]

In this noteworthy passage Aristotle indicates that the very same syllogistic scheme may be used to produce arguments both in the dialectical sphere and in cases where truth is required. He does not mention science or knowledge (*epistêmê*) explicitly here, but the term appears a few lines later (46a17). Therefore, it is likely that Aristotle assumes that the same scheme applies in sciences as well.[13]

In his commentary on the *Prior Analytics* I 27-30, Alexander follows Aristotle and claims that organising syllogistic terms according to their universal connections is useful in science – as well as in dialectic and in any situation in which we need premises for a conclusion. When commenting on Aristotle's remark on the uses of the scheme, which we just quoted, Alexander makes clear that the presented method is used in science:

> This is a procedure (*hodos*) and method (*methodos*)[14] in all sciences and arts which prove something appropriate by means of inferences (*en pasais epistêmais kai technais tais dia syllogismôn apodeiknuousais ti tôn oikeiôn*) […] the procedure and method is necessary for a philosopher (*philosophos*), a doctor (*iatros*), an orator (*rhêtôr*), a cultured person (*mousikos*) and everyone alike who is establishing something through inferences (*sullogizomenos*).[15]

Alexander presents a concrete example of how the scheme is applied and he uses the same major and minor terms throughout the presentation. In the example, the intended conclusion involves the terms 'good' and 'pleasure';[16] A stands for 'good' and E for 'pleasure'. Alexander then proceeds to list several such terms that either (i) belong universally to one of the two terms (everything that is good (X) and everything that is pleasant (Y)), (ii) are such that one of the two terms belong universally to them (all X is good, all Y is pleasant), or (iii) are such that they are universally excluded by goodness and pleasure (no X is good, no Y is pleasant).

In the course of the discussion, Alexander often assumes that X and Y are identical even though literally speaking they are not. For instance, to argue that no pleasure is good, he assimilates unprofitable (*alusiteles*) with effortless (*aponon*) (*in An. Pr.* 304,26) and concludes that since pleasure is effortless, it must also be unprofitable. "No pain, no gain!" seems to be the moral behind this argument. It is remarkable that, throughout the whole

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12 Aristotle, *An. Pr*. I 30, 46a3-10; my translation on the basis of Sir David Ross, *Aristotle's* Prior and Posterior Analytics. *A Revised Text with Introduction and Commentary*, Oxford 1949, p. 396.
13 Cf. also 'philosophy' (*philosophia*) in the quoted passage.
14 Aristotle only speaks of *hodos* in this connection; Alexander also uses the more specific *methodos*.
15 Alexander of Aphrodisias, *in An. Pr.* 330,32-331,1, *op. cit.*; my translation.
16 The example might have been a fairly standard one; it also appears later in Philoponus' commentary on the *Prior Analytics*, see below section 2.

discussion, Alexander does not give any hint whatsoever concerning his assumptions about the truth or the quality of the premises he has thus formed. Similarly, he does not answer the questions of how we are supposed to know the terms in the first place, and, once we have them, that two terms refer to the same thing.[17]

In addition to the passage that has been quoted above (*in An. Pr.* 330,32-331,1), there is further evidence for the claim that Alexander assumes that the syllogistic scheme may be used to form scientific proofs. He refers to the treatises that discuss the applications of the method by saying that dialectical syllogisms are discussed in the *Topics* and apodeictic ones in the *Posterior Analytics* (331,22-24). Therefore, he indicates that apodeictic syllogisms, i.e. scientific proofs, can also be formed from the scheme provided that the premises satisfy some conditions: they are true, appropriate (*oikeia*), and primary (*prôta*).[18]

To sum up, Alexander provides ample evidence for the claim that the syllogistic scheme presented in *Prior Analytics* I 27-30 may be used in science as well as in dialectic. In fact, he indicates that it is applicable in every situation in which an argument is needed.[19] However, the application of the scheme *presupposes* a whole lot of knowledge. We have to know the relevant kind of universal connections between the terms. In addition, if we are to form scientific proofs through the scheme, we must know that the premises are true, appropriate and primary. Neither the scheme nor Alexander's comments on it provides us with means to decide these issues. Do the other commentaries by Alexander, then, offer evidence of how we are supposed to gain such knowledge?

1.2 De anima

As for Alexander of Aphrodisias' works on the soul, he wrote both a commentary on Aristotle's *de Anima* and a treatise of his own (*de Anima*). The commentary is lost, but the treatise has survived. In this section we shall discuss Alexander's treatise on the soul (*de Anima*).

In the last chapter of the *Posterior Analytics*, Aristotle indicates that it is our intellectual capacity or disposition (*hexis*), which is in Greek called *nous*, that comes to know the principles or starting points (*archai*) of the sciences. Do we find the same idea in Alexander?

In his treatment of intellect (*nous*), Alexander of Aphrodisias operates with a distinction between different intellects or different aspects of the intellect. A distinction of this kind is

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17 I have analysed Alexander's reactions to Aristotle's scheme in more detail in Miira Tuominen, "Alexander and Philoponus on *Prior Analytics* I 27-30: Is There Tension between Aristotle's Scientific Theory and Practice?" in: Frans de Haas (ed.), *Interpretations of Aristotle's* Posterior Analytics, (forthcoming).

18 The two last conditions also appear in Aristotle's requirements for the premises of scientific proofs, but otherwise Alexander is somewhat non-standard in this connection. He distinguishes between two main kinds of syllogisms from true premises: (a) apodeictic syllogisms in which the premises, in addition to being true, are also appropriate (*oikeia*) and primary (*prôta*) and (b) true and deictic which proceed from the genus, difference, from a *proprium*, from definition or from reason (*ex aitiou*); see Alexander, *in An. Pr.*, p. 331,17-24, *op. cit.* Normally, the condition of expressing the cause would be counted among the conditions for apodeictic syllogisms, and some conditions of necessity would be added.

19 One possible additional application is construction of poetic plots; cf. *mousikos* in the quotation from Alexander, *in An. Pr.* 330,32-331,1, *op. cit.* This, however, is not necessarily the meaning of *mousikos* in this connection. It might also refer to the idea that learned people have to be able to form arguments for various conclusions.

customary in the ancient commentary tradition. The most important distinction is one be-
tween active or productive (*poiêtikos*) and passive or potential intellect (*nous dunamei*).[20]
Alexander is well-known for identifying the active intellect with God or the unmoved mover
of the universe (*de An*. 89,9-19). The potential intellect is a capacity in human beings which
may develop into a habitual intellect or an intellectual disposition (*nous en hexei*). But how
does the development take place?

One suggestion which is to be found in the literature of late antiquity and the Middle
Ages, and which has also recently been associated with Alexander's *de Anima*,[21] is that the
active or productive intellect makes the principles known to us. I am somewhat dubious
towards the suggestion that such a theory should be attributed to Alexander of Aphrodi-
sias.[22] One of the main reasons why I am not convinced that Alexander would explain our
knowledge of the principles by resorting to a divine intervention is that he offers another
explanation of how our intellectual disposition is activated.

In the course of the discussion concerning human intellect, Alexander makes a distinc-
tion between ordinary concept formation (having *noêmata* or *ennoiai*) and intellectual ap-
prehension in the proper sense (*noêsis*).[23] According to him, some accurate concept forma-
tion takes place in the human soul rather automatically because of the receptive character of
the material intellect. By contrast, intellectual apprehension in the proper sense requires
active cognitive effort. Mastering some basic concepts is not sufficient for that kind of ap-
prehension.[24]

Rather than pointing to a divine intelligence to explain how we attain proper and com-
plex intellectual apprehension, Alexander says that it is acquired through education and
habituation (*didaskalia*, *ethos*).[25] It differs from natural concept formation, and the follow-
ing comparison is used to illustrate the difference. In the *de Anima*, Alexander compares the
process of natural concept formation to how we learn to walk. All human beings, who are
not physically damaged, learn to walk quite naturally, and some basic universal concepts are
supposed to be received in a similar way: naturally and automatically.[26] By contrast, theo-
retical learning, which amounts to proper intellectual apprehension, requires training. Alex-
ander does not mention it explicitly, but if we continue the metaphor of walking, intellectual
apprehension could probably be compared to performing complex physical movements, e.g.,
in gymnastics. In addition, Alexander points out that not all human beings are equally gifted

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20 Alexander also calls this aspect of the intellect 'material', because, he says, it involves the mere capacity
of becoming something: that which becomes something serves as matter (*hulê*) for that something which it
becomes. (Alexander, *de An*., *op. cit.*, p. 81,22-28.) This does not imply that Alexander would assume that
the material intellect is material or physical.

21 For the suggestion, see Richard Sorabji, *The Philosophy of the Commentators, 200-600 AD: A Source-
book vol. 1 Psychology* (with Ethics and Religion), London 2004, p. 104.

22 I have argued against it in Miira Tuominen, "Aristotle and Alexander of Aphrodisias on the Active Intel-
lect", in: Vesa Hirvonen / Toivo J. Holopainen / Miira Tuominen (eds.), *Mind and Modality: Studies in the
History of Philosophy in Honour of S. Knuuttila* (Brill's Studies in Intellectual History 141), Leiden 2006,
pp. 55-70.

23 For the distinction, see Alexander of Aphrodisias, *de An*., p. 85,20-25, *op. cit.*

24 Alexander in fact also uses the term *epistêmê* for such comprehensive theoretical understanding.

25 Alexander of Aphrodisias, *de An*. pp. 81,22-82,15, *op. cit.*

26 *Ibid*., p. 82,5-19.

when it comes to intellectual apprehension. Proper apprehension is possible only for those who are intellectually talented. By contrast, ordinary concept formation happens in all human souls.

Therefore, from a psychological point of view, knowledge that also involves grasping the principles, requires active cognitive effort, namely education and training. Therefore, if we say that, according to Alexander, we have intellectual intuition about, or insight into, scientific premises, we should avoid saying that the premises are self-evident. Rather, understanding premises seems to require understanding them within a theoretical whole, perhaps also understanding their explanatory power.

1.3 Topics

The idea that we need training in order to grasp scientific premises is central in Alexander's introduction to his commentary on the *Topics*. In this context (*in Top.* 27,7-29,16) he discusses the three main applications of dialectic Aristotle suggests in *Topics* I 2, 101a26: training, rhetorical encounters and philosophical sciences. Alexander's main emphasis is on the point that dialectic is good for philosophy because it gives us exercise in examining opposing positions. He explicitly makes the comparison between physical training and its effects on our physical abilities, on the one hand, and exercises and training in argument on the other (*in Top.* 27,27-30).

Alexander never says that dialectic could provide us with conclusive arguments for premises in scientific or philosophical inquiry. This is an important aspect of his discussion. He admits that dialectic can be used to argue for scientific premises in situations where someone contests them in argument, or when someone has not conceived them yet. Later on (*in Top.* 30,26-31,21), he discusses cases of this type, and provides some examples. However, it is assumed throughout the discussion that the one who presents the arguments already knows what the right premises are.

Rather than saying that dialectic could prove the premises of sciences or that it could directly make them known to us, Alexander underlines the training function of dialectical argumentation. He distinguishes two main things dialectic teaches us to do. On the one hand, dialectic familiarizes us with all kinds of convincing positions which, however, are not true. Alexander claims that this teaches us not to be misled by convincing but not true positions when such are presented to us. On the other hand, dialectic trains us to *distinguish* on which side truth lies, in cases where competing positions have been put forward. He says that dialectic teaches us to see (*sunoran*)[27] how to solve problems (*in Top.* 29,15-16); it never proves the solution.

2. Philoponus (?)

In the remaining section of this essay, I shall briefly discuss two commentaries, probably written by Philoponus: one on *Prior Analytics* I[28] and another one on the section on intellect

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27 *Oran* is the Greek present infinitive of the verb that means seeing. Therefore, Alexander indicates that distinguishing truth is a kind of seeing. The metaphor of seeing is, of course, also used in English.
28 Philoponus, *in Aristotelis Analytica Priora commentaria* (Commentaria in Aristotelem Graeca XIII/2), ed. Maximilian Wallies, Berlin 1905.

in *de Anima* III which has been preserved as a medieval Latin translation.[29] Together with these, I shall discuss a commentary on *Posterior Analytics* II[30] published in the CAG XIII/3 together with Philoponus' commentary on book I, but which was probably not written by Philoponus.[31] Before saying anything about these treatises, it must be noted that it is much more difficult to form a picture of how Philoponus assumed that we come to know the principles than it was in Alexander's case, partly because of problems concerning authenticity, partly because of reasons that will become clearer as I proceed.

In the commentary on the first book of the *Prior Analytics*, Philoponus offers a similar syllogistic scheme as Alexander does.[32] When commenting on the possible applications of the scheme, he does not use the term 'knowledge' or 'science' (*epistêmê*) explicitly. Rather, he talks about philosophy (*philosophia*) and claims that logic (*logikê*) is a proper tool for it. Therefore, Philoponus allows that, at least in philosophy, it is useful to organise predicates according to their universal relations with other predicates. In the same context (*in An. Post*. 305,12-21), he also notes that a similar scheme is used in 'vulgar' (*banausos*) fields of study, too. It is not completely clear what he means by 'vulgar' in this context, but he asserts that also in such contexts, people make inferences on the basis of common notions (*koinai ennoiai*), but that they are ignorant of the method (*methodos*).

It is possible that by 'vulgar' studies Philoponus means non-theoretical arts or crafts; he uses 'art' *technê* in the same passage (*ibid*., 305,16-18), and the Greek adjective *banausos* has connotations of working by the aid of fire and, hence, of mechanic arts. In any case, he indicates that in vulgar areas, some kind of inference capacity is required, and it in fact functions similarly to the syllogistic scheme of the *Prior Analytics*. However, many people working in such crafts do not realise that they are using inference schemes in general, or the syllogistic scheme in particular. Therefore, they are, in a sense, ignorant of the method, even though they implicitly use something similar. For example, when a blacksmith uses fire to work on iron, the technique is based on implicit knowledge concerning fire's capacity to melt iron.

Because Philoponus allows that, even in crafts, some similar inference methods are used as one uses in philosophy, it is highly likely that also theoretical sciences use such schemes. Therefore, even though *epistêmê* is not explicitly used in the context, it is likely that a syllogistic background is to be assumed for science as well.

To illustrate the scheme, Philoponus uses the same example as Alexander does; the purpose of the scheme is to find an argument for one of the following four conclusions. Every pleasure is good, some pleasures are good, no pleasure is good, or some pleasure is not good. The predicates he puts forward are very much like the ones Alexander uses, but the lists are not completely identical.

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29 For this commentary, see *Philoponus on Aristotle on the Intellect*, translated into English by William Charlton, Ithaca NY 1991, pp. 1-4.

30 Philoponus, *in Aristotelis Analytica posteriora commentaria cum anonymo in librum II* (Commentaria in Aristotelem Graeca XIII/3), ed. Maximilian Wallies, Berlin 1909.

31 Wallies indicates in the preface to the edition that he thought that the commentary on the second book is not authentic but probably a Byzantine scholium. I am grateful to Sten Ebbesen for a discussion on this point.

32 He puts the terms on a star-shaped map; see Philoponus, *in An. Post*., *op. cit.*, p. 274.

The major difference which is also interesting for our present purposes is that, contrary to Alexander, Philoponus does comment to some extent on the quality of the premises that can be formed from the tables. He complains at one point (276,20-29) that premises used to establish that every pleasure is good are not true, because it is not true that every pleasure would be natural. To show that this is not the case, Philoponus uses the following example: every pleasure is not natural because scratching an itch is not. The idea does not seem to be to point out that we should get some unnatural or perverse pleasure out of scratching our itches. Rather, Philoponus seems to assume that natural pleasures are such that they are desirable as such; we desire them for the sakes of themselves – and nothing else. Scratching an itch, by contrast, is not desirable as such. No one in his or her right mind would want to have an itch just for the pleasure of scratching it. We want to scratch our itches only on the condition that we already have them.

Rather disappointingly, Philoponus does not comment at all on how we know whether some premises are true or not, e.g., how we know that scratching an itch is not desirable as such. Surely, it is not an unquestionable assumption. Socrates, for example, takes great pains in Plato's *Gorgias* to argue against Callicles, who claims that scratching an itch would be sufficient for happiness simply because it is pleasant (see *Gorgias* 494c-d). Philoponus himself does not argue for his claim, however.

Do we, then, find evidence for how the principles are known, in the Latin translation of a commentary on the intellect probably originating from a Greek commentary written by the historical Philoponus? In this treatise the author, whom I will call Latin Philoponus, shows strong opposition to the idea that any intellectual apprehension of universal principles should be acquired from experience. He comments on Aristotle's comparison (*de Anima* III 4, 430a1-2) according to which our potential intellect is, before we come to grasp intelligible objects, like an empty writing tablet on which nothing stands written yet. The Latin Philoponus claims that the analogy is not meant to entail that some forms, which are not in the intellect, could be acquired from outside, i.e., from experience. Rather, he claims that Aristotle is saying that there are hidden objects of knowledge in our soul. We know them similarly to how a sleeping or a delirious person knows things: the knowledge is there but it cannot be used because of the "cataleptic swoon" caused by birth into body.[33]

Philoponus does not explain how the activity of gathering terms according to their universal connections into a syllogistic scheme is related to the kind of recollection that is postulated in the commentary on the *de Anima*. Is it simply that gathering the terms according to their universal relations somehow enables us to get rid of the shock caused by birth? If this is the case, would it not be rather odd, because it seems that such gathering of universally connected terms *requires* that we have understanding of universal objects? If we only have such understanding through recollection, the gathering presupposes rather than promotes recollection.

In the commentary on the intellect, the Latin Philoponus also refers to the active intellect: the active intellect supposedly sheds light upon the hidden contents in the young person's potential intellect. Further, the author claims that the active intellect belongs to a teacher who perfects the pupil's intellect.[34] Therefore, it is not impossible that Philoponus

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33 *Philoponus on Aristotle on Intellect*, *op. cit.*, p. 58 (38,99-39,7).
34 *Ibid.*, p. 66 (48,32-33).

would claim that using the syllogistic scheme, and arguing for different conclusions under the guidance of a teacher who has already perfected his intellect to a rather great degree, makes it more likely that we start to recollect the hidden knowledge inside our soul. The teacher may perhaps do this by offering arguments for the correct claims and arguing against the false ones. However, this is not explicitly spelled out in the commentary. Therefore, it is somewhat difficult to see how Philoponus would have explained the details of the process of our coming to know the principles.

I shall end this section with a brief discussion of a commentary on *Posterior Analytics* II which, as I already said, was probably not written by the historical Philoponus. In this commentary Aristotle's account of how we come to know the principles in II 19 is left almost as it stands. The author of the commentary claims that our disposition of knowing the premises comes about through perceptual experience.

In the commentary on *Posterior Analytics* II, Aristotle's example has suffered one significant change. Instead of the general notions 'human being' and 'animal' mentioned by Aristotle, the author of the commentary on *Posterior Analytics* II proposes a rather straightforward empirical generalisation on the basis of individual instances: when we have seen that Socrates has used hellebore to purify his bile and we see that in the case of Plato as well, we come to have the idea that hellebore is purifying in general.[35] This generalisation seems, at first sight, to be one that could be used as a premise in a scientific proof – in medicine, perhaps.

However, the case is not as simple as it might seem to be. In fact, a premise like 'all hellebore is purifying' is neither immediate nor explanatory in the sense Aristotle intends in the *Posterior Analytics*. To claim that all hellebore is purifying does not involve the explanation *why* hellebore is purifying. According to Aristotle, the explanatory factor must be contained in the premises of scientific proofs: it typically appears in the middle term which appears in both premises ('AaB' and 'BaC' both have 'B' in them). Therefore, a claim like 'all hellebore is purifying' must appear as a conclusion of a scientific proof. In such a conclusion term A denotes the quality of being purifying, C stands for hellebore. We would still need an explanatory middle term B which would express the factor which is the cause or explanation of hellebore's purifying power.

In spite of the initial difference between the examples given by the commentator or scholiast on *An. Post.* II and Aristotle, they are similar with respect to their role in a scientific proof. Both the claim that all hellebore is purifying and the claim that all human beings are animals should, in an Aristotelian science, appear as *conclusions* of proofs. The latter, namely that all human beings are animals, would involve a major and a minor term indicating a genus and a species respectively: the syllogism should be completed with middle terms expressing the specific differences. The situation would be similar in the case of the example in the commentary: the starting point we come to know through perceptual experience is the conclusion of a real proof. The conclusion states that all hellebore is purifying; in order to have a complete proof, we need to know what the explanatory middle term is.

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35 The example might have been standard. The same example is also found in Themistius' paraphrasis of *Posterior Analytics* II 19; see, Themistius, *Analyticorum posteriorum paraphrasis* (Commentaria in Aristotelem Graeca V/1), ed. Maximilian Wallies, Berlin 1900, p. 63,17-23.

The commentary on *Posterior Analytics* II (in CAG XIII/3) does not contain an explicit discussion about how we come to know the middle terms. We might speculate about the answer, but instead of doing so, I would like to point out that the very same question receives a fairly unclear answer in Aristotle as well.

However, Aristotle seems to assume that both the apprehension of conclusions and the apprehension of explanatory middle terms, and hence also premises, are functions of the intellect (*nous*). However, the two functions differ in the sense that the former, namely coming to know the conclusions, typically happens in us without any very advanced cognitive effort: the conclusions are better known to us and, thus, closer to perception. The premises are not immediately known to us, but we may get to know them through inquiry. However, coming to know the premises involves an intellectual element. We are not forced to understand their truth through argument, but, rather, we come to know the principles through grasping their explanatory (or explicatory in the case of some specific differences) role. This happens when we succeed in finding the correct middle term.[36]

3. Conclusion

We are now in a position to conclude the discussion with a few general remarks. First of all, as I already said, Alexander of Aphrodisias offers us fairly good evidence about how we come to know scientific principles. He follows Aristotle in claiming that the syllogistic scheme that is presented in *Prior Analytics* I functions as a kind of universal tool for producing arguments for any conclusion in any situation, provided that we can find the right kinds of premises. However, Alexander is careful in avoiding terminology which would indicate that the premises are proved. Rather, he indicates that coming to grasp the truth is largely left on an intellectual insight of which Alexander uses a word which refers to a kind of vision. Analysing the strengths and weaknesses of competing positions makes us better able to distinguish where the truth lies.

Even though Alexander does not, in his treatise on the *Topics*, mention experience as a means to attain the principles, there is no need to attribute any strong anti-empiricist tendencies to Alexander. He states quite clearly that an elementary form of generally valid cognition is attained through experience. It is involved in the natural process of concept formation, and the process happens in us as naturally as learning to walk. Therefore, he indicates that repeated observation alone is sufficient to produce some generally valid knowledge. However, Alexander denies that experience should install the principles in us in any very straightforward manner. Rather, in order to know the principles we need to engage in much more systematic research that also involves dialectical analysis of competing theories.

Philoponus' commentaries include much more isolated remarks concerning the question of how we come to know the principles; they do not seem to amount to a worked out theory. From the commentary on *Prior Analytics* I and that on the intellect (preserved only in Latin) we may gather that organising predicates according to their universal relations into a scheme may be used in trying to find the premises of scientific proofs. However, we do not have much evidence about how we are supposed to know, whether the premises we form from the

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36 I have explained my position in more detail in Tuominen, *Apprehension and Argument*, chapter 1.2.2., *op. cit.*

table are true or not, let alone, whether they satisfy other conditions laid out for scientific premises. We may speculate that the reference to the teacher's intellect is intended to play this explanatory role in Philoponus' theory. If this is how his theory should be understood, then it is possible that coming to know the principles presupposes discussions such as the ones Socrates carries out with his interlocutors in Plato's early and middle dialogues (e.g. the discussion with Meno's slave boy). In Philoponus' theory, experience does not play a direct role in the process of our coming to know the principles.

As for the commentary or the scholium on *Posterior Analytics* II we discussed last, there is one important point which can be extracted from it. This is the claim that the universal objects we come to know through the natural cognitive process starting from perception (described by Aristotle in II 19) are the conclusions of scientific proofs. Therefore, the author of the commentary or the scholium seems to follow Aristotle in assuming that starting points for science lie in knowing the conclusions of the proofs. Knowing them comes about in us through a natural cognitive process of forming general concepts as Aristotle indicates, or through fairly straightforward empirical generalisation, as the commentator suggests.

Die Anfänge der Diskussion: Grosseteste und Bacon