Technē as a Science for Aristotle

Simona Aimar & Carlotta Pavese

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Abstract. Aristotle claims that *technē* is productive knowledge (*poiētikē epistēmē*). It is tempting to think that here '*epistēmē*' is used loosely, and thus productive knowledge is far away from any form of scientific knowledge. We argue that in fact for Aristotle productive bodies of knowledge are bodies of knowledge that can be modelled in terms of *demonstrations*. The relevant notion of demonstration is the same one Aristotle uses to account for the science of nature (*physikē epistēmē*), namely that of demonstrations with premises that are true either of necessity or for the most part. In this sense, for Aristotle *technē* is as scientific as the natural sciences are. We consider how Aristotle conceived of the relation between *technai* and other sciences and how he can tell technical and natural sciences apart. Our interpretation, we claim, also explains the sense in which technical knowledge is productive. Technical demonstrations effectively break down a task into a set of sub-steps. For example, the demonstrations that constitute the art of house-building show you what steps you need to follow in order to build a house. So technical knowledge is productive because its demonstrations are *production-guiding*. Along the way, we consider how technical sciences relate to the sciences of nature and how their being productive by itself does not disqualify them as sciences.

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§1. Introduction

Technai for Aristotle are things like the art of medicine and the art of building. When it comes to characterizing what *technē* is, he is *prima facie* inconsistent. Sometimes he states that *technē* is a productive form of knowledge[1] (*poiētikē epistēmē*; see esp. *Met*. Θ.2 1046b3). Yet in the *Nicomachean Ethics* he famously states that *technē* is of what can be otherwise (*EN* VI.4, 1040a1ff), whereas knowledge (*epistēmē*) is only of what is necessarily the case (*EN* VI.3 1139b19ff and VI.6 1140b31ff). So here *technē* is *not* knowledge. One is left wondering: In what sense, if any, does *technē* qualify as knowledge?[2] This is the question we ask in the present essay.

Given how flexible the extension of the term '*epistēmē*' seems to be throughout the corpus, one way to avoid inconsistency is to conclude that the passages that deny that *technē* is *epistēmē* employ a narrow notion of *epistēmē*. Here '*epistēmē'* may stand for scientific knowledge—the type of knowledge that can be modeled in terms of scientific demonstrations (*apodeixeis*; cf. *Post. An*. I.2 71b9-70b19, *EN* VI.3 1139b30ff). By contrast, when Aristotle says that *technē* is *epistēmē*, he employs a notion of knowledge which is weaker than scientific knowledge—a type of knowledge that *cannot* be modelled in terms of scientific demonstrations. If so, Aristotle is consistent after all.[3]

Yet although the weak-knowledge interpretation of *technē* does settle the problem of consistency, it does not fit well with the passages in which *technē* is treated on a par with

[1] For the most part, we translate *epistēmē* as 'knowledge', but sometimes translate it as 'science' (see Fine: 2010 and Bolton & Code: 2012 for support for the knowledge-translation; see the next fn for initial motivation for the occasional science-translation). Burnyeat's (1981, 2011) seminal pieces make an important case for translating '*epistēmē*' with 'understanding' whenever it is used in its strictest sense. Yet his translation may not help one to bring out connections among Aristotle's different notions of *epistēmē*. As we shall see, some of these connections are crucial for present purposes.

[2] Just like the term 'knowledge' in English, '*epistēmē*' can be used either to refer to a cognitive state of having knowledge or to content which can be known. The latter in some cases can be a body of knowledge that satisfies the requirements for being a science; if these cases, one can translate '*epistēmē*' as 'science'. Aristotle assumes that the status-sense and the content-sense of '*epistēmē*' correlate, and switches back and forth between them. Similarly, sometimes he uses '*technē*' to refer to the state of having a given type of content in the soul (cf. *EN* VI.4 1140a6-10). Some other times he treats *technai* as bodies of knowledge, and thus refers to the content of cognitive states that qualify as *technai* (cf. *Post. An*. I.13 78b13-17). So one can also state the view that *technê* is a science by saying that the content of cognitive states that are *technai* qualifies as a scientific body of knowledge.

[3] This view is often implicitly assumed in the literature. The view is widespread, we believe, partly because of a general tendency to understand *technê* by merely relying on *EN* VI. For authors who make this assumption the most explicit see Lorenz & Morison (forth); see also Moss(2014b). See Bronstein (2016: 60) for a recent example of an author who implicitly assumes a contrast between *technē* and a scientific (i.e. demonstrative) body of knowledge. Coope (forth) allows for the claim that *technē* is a science, but denies that it is a demonstrative body of knowledge. Angier (2010: ch.2) has a similar position in this respect.

disciplines that seem to qualify as sciences. In the *Prior Analytics*, for instance, Aristotle states that disciplines like geometry, astronomy and *technai* involve scientific demonstrations (*Pr. An.* I.30 46a18-27; see also *Post. An*. I.14 79a21-23 and *Post. An*. II.12 96a8-19). In several other passages he also treats *technai* on a par with further sciences.[4] Overall, this suggests that technical knowledge does in some sense qualify as scientific.

This essay argues that for Aristotle *technai* are demonstrative bodies of knowledge and in this sense they qualify as sciences. The claim that *technai* are demonstrative bodies of knowledge might seem to clash with the very beginning of the *Posterior Analytics*, where demonstrations are exclusively associated with claims that are true of necessity (cf. *Post. An.* I.4 73 a21-24, I.6 5-12, I.33 88b30-33; cf. also *EN* VI.6 1140b31ff). Call *strict sciences* the bodies of knowledge that can be modelled in terms of these demonstrations only include claims that are true of necessity. Admittedly, *technai* do *not* qualify as strict sciences. For they concern not only what is the case of necessity but also what is the case for the most part (*hōs epi to polu*) (cf. *Met*. E.2 1027a20-25). But over the course of the *Posterior Analytics* Aristotle broadens up his notions of demonstration and demonstrative knowledge (*apodeiktikē epistēmē*) up to the extent of telling us that a demonstrations contain claims that are true *either* of necessity *or* for the most part (*Post. An.* I.30 87b19-27; cf. *Post. An.* I.14 79a21-24, *Post. An.* II.12 96a8-19). Thus the bodies of knowledge that can be modelled in terms of these demonstrations include claims that are true for the most part. Call these bodies of knowledge *non-strict* sciences. Our claim is that *technai* are non-strict sciences. Unlike the connection between natural sciences and the category of non-strict sciences, the connection between the category of non-strict sciences and *technai* has remained largely unexplored. On the assumption that natural sciences involve demonstrations that include claims that are true for the most part, the argument we develop in this essay implies that natural and technical sciences are structurally alike.[5]

[4] For example: *Top*. Z.6 145a15-18, *Met.* E.1 1025b7ff*, Met*. E.2 1026b3ff, *EN* VI.10 1142b34-1143a4, *Met.* K.7 1063b36ff, *Met*. K.8 1064b17ff, *Post. An*. I.13 78b13-17*, Met.* Λ.9 1074b38a2, *De Cael.* III.7 306a16, *EE* I.5 1216b6ff (esp. 1216b17-18).

[5] A number of scholars has explored whether and to which extent natural sciences fall under the category of non-strict demonstrative sciences. For instance: Cooper (2004: 137-147); Detel (1999: 55-59), Ferejohn (1991: 117-23, 2013: 82-84 & 165-167); Gotthelf (1987: esp. 197-198, 2011), Kullmann (1997), Leunissen (2010a: 35), Lennox (2001a: 128, 2001b: 25-33), Reeve (1992:1-5 & 13-22). These scholars are sympathetic towards a yes-answer. Not so Barnes (1969: 134): "The natural sciences, being non-rigorous and "for the most part" are not demonstrative sciences". For milder skepticism, see also Lloyd (1996a: 32-37). Here we will largely presuppose a sympathetic picture when it comes to natural sciences being non-strict sciences, but also offer some arguments in its support (§5-6).

The barebones of our argument are as follows. We first consider Aristotle's claim that *technē* is productive knowledge (*Met.* Θ.2 1046b3). As we shall see, Aristotle expands on this claim by telling us that *technē* is *logos*. We argue that here a *logos* is an account of what the product of the *technē* is. For instance, the art of house-building is an account of what a house is (cf. *Met.* Z.7 1032a32-b6, *Met*. Z.9 1034a30-1034b1, *Met*. Λ.4 1070b33, *PA* I.1 641b13). Such an account does not refer to particulars, and spells out causal paths that lead to the production of houses (§3). We then look at whether technical accounts are robust enough to qualify as demonstrative bodies of knowledge (§4-5). We argue that the reason why Aristotle often seems to take *technai* to be analogous to other sciences—especially the natural sciences—is that, just like other sciences, *technai* can be systematized as sets of demonstrations. The *Posterior Analytics* sketches examples of demonstrations which plausibly include premises that are true not of necessity, but for the most part. We reconstruct some of these demonstrations and consider how some of them belong to the science of nature (*physikē epistēmē*), and some of them belong to *technai* (§6). We conclude from here that *technai* are demonstrative bodies of knowledge, and that in this respect they are structurally analogous to the natural sciences.

One may worry that on our account *technai* are in fact *too similar* to the sciences of nature. For instance, since both medicine and biology study health, if they are both demonstrative bodies of knowledge, it is unclear how Aristotle can avoid considering medicine as a branch of biology. In §7, we clarify how *technai* differ from and relate to other sciences. We argue that medicine and biology differ because the demonstrations that belong to medicine involve reference to artificial causes of health and these causes are *not* spelled out by the biological demonstrations of health. Yet this is not to say that there is no sense in which medicine and biology are closely related. For Aristotle, as we shall see, the science of medicine is subordinate to biology in the sense that medicine inherits first principles from biology (*De Resp.* 480b22-30, *De Sensu* I.1 436a17-b1). More generally, *technai* often relate to other sciences so as to presuppose some of the theorems of these sciences.

We close by pointing out three implications of our picture. First, the difference between technical sciences and other sciences allows Aristotle to state that the content of technical knowledge is distinctively productive (§8). This is because technical demonstrations effectively break down a task into a set of sub-steps to be performed, at least

in part, by the artisan. The content of this knowledge is productive in the sense that it is production-guiding. Our picture also explains why, although *technai* are not contemplative sciences (*theōrētikai epistēmai*), one can nonetheless consider them to be scientific bodies of knowledge (§9). Finally, on our interpretation one can both preserve a sense in which *technai* are sciences and understand Aristotle's claims about *technai* throughout the *corpus* as consistent. Our reading is compatible with the statements we read in the ethical writings because, when Aristotle denies there that *technē* is *epistēmē*, he uses '*epistēmē*' in a narrow sense that only applies to *strict* sciences (§10). We conclude that Aristotle has a consistent conception of *technē* throughout the *corpus.* On this conception, *technai* are non-strict sciences.

§2. *Technai* as productive forms of knowledge

Metaphysics Θ.2 takes *technai* to be productive forms of knowledge (*poiētikai epistēmai*):[6]

> (**T1**) Since some principles (*archai*) of this sort are present in the things that lack a soul, and others in things that have a soul, and in a soul and in the part of the soul that has reason (*logon*), clearly some powers will be non-rational and some will involve reason (*meta logou*). Hence all *technai*, i.e. all productive forms of knowledge (*kai hai poiētikai epistēmai*),[7] are powers; for they are principles of change in another thing or [in the thing itself] *qua* other.
>
> Ἐπεὶ δ᾽αἱ μὲν ἐν τοῖς ἀψύχοις ἐνυπάρχουσιν ἀρχαὶ τοιαῦται, αἱ δ᾽ἐν τοῖς ἐμψύχοις καὶ ἐν ψυχῇ καὶ τῆς ψυχῆς ἐν τῷ λόγον ἔχοντι, δῆλον ὅτι καὶ τῶν δυνάμεων αἱ μὲν ἔσονται ἄλογοι αἱ δὲ μετὰ λόγου. διὸ πᾶσαι αἱ τέχναι καὶ αἱ ποιητικαὶ ἐπιστῆμαι δυνάμεις εἰσίν· ἀρχαὶ γὰρ μεταβλητικαί εἰσιν ἐν ἄλλῳ ἢ ᾗ ἄλλο. (*Met.* Θ.2, 1046a36-b4)

The passage introduces a distinction between rational powers (*meta logou dunameis*) and non-rational powers (*alogoi dunameis*). The former, but not the latter, belong to the rational part of the soul. We shall focus on the claim that they are productive forms of knowledge.

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[6] This is not the only place where Aristotle assumes that *technai* are productive forms of knowledge, although it does seem to be the most explicit. See also *Met.* E.1 1025b7ff, where Aristotle takes there to be difference sciences (*epistēmai*), including productive disciplines (*poiētikai*, 1025b21, 25) and seems to have in mind *technai* with the latter category. Similarly, *Met*. E.2 tells us that sciences are practical, productive and contemplative (1026b4-5); *ditto Top*. Z.6 145a15-18; see also *Met.* K.7 1063b36ff—esp. 1064a10-11 and 16-17—and *Met*. K.8 1064b17ff, although their authenticity remains in dispute. Aristotle also uses '*epistēmē*' in such a way that it includes *technai* at: *Met.* Λ.9 1074b38a2; *De Cael.* III.7, 306a16**;** *EE* I.5 1216b6ff (there is an explicit reference to "productive sciences" at 1216b17 and medicine is given as an example at b18); *Top*. Z.6 145a15-18; *Post. An*. I.13 78b13-17 (we return to this passage in §7), *Post. An.* I.12 77a40-41; *Post. An.* I.32 88b10-13; *EN* I.2 1094a25ff (Rowe translates it with 'expertise' here, but this might not be the best choice).

[7] The translations of this essay are curated by Simona Aimar.

This claim is made in passing, by means of an epexegetic *kai* (1046b3),[8] so as to provide support for the view that *technai* are rational powers. But what exactly does it mean to say that *technai* are productive forms of knowledge?

Aristotle does not quite raise this question. But he does identify technical knowledge with an account (*logos*)[9] some lines later:

> (**T2**) And for each of the ones in accordance with *logos*, the same [powers] are of their contraries (*enantiôn*), but for the non-rational ones, one [power is] of one [outcome] – say the hot only of heating, but medicine both of illness and health. The reason is that knowledge is *logos*, and the same *logos* reveals both a thing and its lack.
>
> Καὶ αἱ μὲν μετὰ λόγου πᾶσαι τῶν ἐναντίων αἱ αὐταί, αἱ δὲ ἄλογοι μία ἑνός, οἷον τὸ θερμὸν τοῦ θερμαίνειν μόνον ἡ δὲ ἰατρικὴ νόσου καὶ ὑγιείας. αἴτιον δὲ ὅτι λόγος ἐστὶν ἡ ἐπιστήμη, ὁ δὲ λόγος ὁ αὐτὸς δηλοῖ τὸ πρᾶγμα καὶ τὴν στέρησιν. (*Met.* Θ.2, 1046b4-7)

Here 'knowledge' refers to the knowledge that *technē* consists of. So (T2) tells us that technical knowledge is an account (*logos*) (1046b7-8). This claim is meant to support the

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[8] Here treating 'καὶ' as epexegetic seems preferable. Burnyeat (unpublished notes), (Ross (1924, *ad. loc*.), Tricot (1953, *ad. loc*.), Coope (forth), and possibly Pseudo-Alexander (see below) agree with this reading. Note that the assumption that the καὶ is epexegetic is needed to make sense of Aristotle's present argument for the claim that *technai* are rational powers, and also to make sense of the subsequent argument for the claim that *technai* are for contraries (10464ff). As Coope (forth) points out, Aristotle defends the latter claim on the ground that productive knowledge is for contraries.

Ross' apparatus (1924, *ad. loc*.) states that Pseudo-Alexander (presumably, Michael of Ephesus—cf. Goulet: 1989, *ad loc*.) cites line 1046b3 by inserting 'καὶ αἱ' after 'ποιητικαὶ'. Pseudo-Alexander says: "Διὸ πᾶσαι αἱ τέχναι αἵ τε ποιητικαί, ἥ τε οἰκοδομικὴ καὶ ἡ ναυπηγική, καὶ αἱ ἐπιστῆμαι (κοινότερον δὲ τέχνας εἶπε τὰς ἐπιστήμας) δυνάμεις εἰσίν" (*In Met. Commm.* 569.3-6). This translates: "Because of that, all *technai* are powers: both the productive ones, like the art of house-building and the art of ship-making, and the sciences (he has called the sciences '*technai*' in a broader sense)." It seems at least possible that Pseudo-Alexander might (over)interpret, rather than cite, Aristotle, and it may well be that he reads 1046b3 as containing only one 'καὶ'. Similarly, Aquinas in his commentary (*ad loc*.) glosses line 1046b3 by saying that for Aristotle there are two kinds of *technai*, those that make one produce an external product, the productive ones, and those that don't make one produce a further product. Yet the Latin translation Aquinas plausibly worked with—Moerbeke's—does not contain an additional *et*. So his gloss also seems to be the result of an (over)interpretative choice. Further, since the sub-archetype in which the mistake has occurred (Harlfinger's ν) may be rather old—even if not as old as the above-mentioned manuscripts—it may be that Pseudo-Alexander actually read that text.

Note that all the *recentiores* have 'καὶ αἱ' after 'ποιητικαὶ' (*pace* Ross' apparatus, which misreports them as only containing an additional 'καὶ'). On this version of the text, Aristotle would say that all the productive disciplines and all the sciences (*epistêmai*) are powers. But (a) the addition of 'καὶ αἱ' is not attested by all the ancient manuscripts of Harlfinger's stemma (E, J, and A^b), nor by any of the available Latin translations, and (b) it makes the sentence syntactically problematic. So the insertion is probably either the result of copyists' mistakes (easy ones to make) or an interpolation related to a reluctance to think of *technai* as *epistēmai* (a reluctance that this paper hopes to weaken).

[9] In the chapter, *logos* might initially be used to refer to the faculty of reason (1046b1-5). From 1046b7 onwards, Aristotle clearly uses *logos* to refer to an account. The implicit connection between these two senses is that *logoi* are rational accounts, namely accounts of things that one possesses in virtue of having the faculty of reason. See Moss (2014a: 182, and 2014b) for a helpful account of these senses of *logos* in Aristotle.

view that rational powers differ from rational ones because they are for contrary outcomes. For instance, medicine enables a doctor to bring about both health and sickness.[10] Aristotle claims that the reason medicine can do both is that it is in some sense an account of both health and its privation, namely sickness.

We find again the claim that *technē* is a *logos* in *Metaphysics* Z.7:

> (**T3**) [I]n the case of *technē* what comes to be are the things of which the form (*eidos*) is in the soul (by 'form' I mean the what-it-is of each thing, namely its primary being). For in fact contraries have in a sense the same form; for the being of a privation is the opposite,[11] like health of disease; thus disease is the absence of that; and health is the account (*logos*) in the soul, namely the knowledge (*epistēmē*) [of health].
>
> [Ἀ]πὸ τέχνης δὲ γίγνεται ὅσων τὸ εἶδος ἐν τῇ ψυχῇ (εἶδος δὲ λέγω τὸ τί ἦν εἶναι ἑκάστου καὶ τὴν πρώτην οὐσίαν), καὶ γὰρ τῶν ἐναντίων τρόπον τινὰ τὸ αὐτὸ εἶδος: τῆς γὰρ στερήσεως οὐσία ἡ ἀντικειμένη, οἷον ὑγίεια νόσου; ἐκείνης γὰρ ἀπουσία ἡ νόσος, ἡ δὲ ὑγίεια ὁ ἐν τῇ ψυχῇ λόγος καὶ ἡ ἐπιστήμη. (*Met.* Z.7, 1032a32-b6)

Like (T2), (T3) assumes that a *technē* is productive of contrary outcomes. But here Aristotle gives us more information about the notion of *logos*. A *logos* is an account of what something is (1032b1-2; cf. *Phys*. II.1 193a30-31).[12] For instance, the *logos* of medicine is an account of health, namely an account that states what health is. Similarly, the art of building consists in an account of a house, namely an account stating what a house is. That is to say, a technical account states the essence of the product of the given *technē*. In this sense, it defines the product. So *technai* are definitional accounts that state what their products are.

According to (T2), having an account of X is also in a way having an account of its contrary. Aristotle concludes from this that *technai* are productive of contraries. Note that here Aristotle does not aim at establishing that *technai* are productive. He presupposes as

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[10] Aristotle shares the assumption that rational powers are for contraries with Plato (cf. *Phaedo* 97d1-5, *Charmides* 166e7-8, *Republic* I 333e-334a). He refers to this claim while describing Academic views at *Met.* M.5 1078b26-7. We agree with Menn (ms: §IIIa2) that although here Aristotle leaves open that some rational powers may not be *technai* (*pace* Beere: 2009, 79ff), *technai* are a paradigm case. So it is important for Aristotle to show that his picture delivers a commonly accepted and distinctive feature of *technai*: their being for contraries. For a comprehensive picture of the use of '*technē*' in Plato, see Balansard (2001).

[11] We read 'τῆς γὰρ στερήσεως οὐσία ἡ ἀντικειμένη', following E. Primavesi's edition currently reads 'τῆς γὰρ στερήσεως οὐσία ἡ τῆι οὐσίαι ἀντικειμένη'.

[12] (T3) contains both the claim that to have a *technē* is to have a *logos* and the claim that to have a *technê* is to have the form of X in one's soul. But this is just because the passage does not carefully distinguish between a *logos* and what the *logos* refers to. Strictly speaking, to have the form of X is in the soul is to possess an account of X, namely an account that states what X is. Aristotle identifies *technē* with a form in the soul in several other passages, including *PA* I.1 641b13, *GA* II.1 735a2-4, *Met*. Z.9 1034a30-1034b1 (where he says that whoever has the *technē* has the form potentially), and *Met*. Λ.4 1070b33 (where he states that the art of building is the form of the house, and the art of medicine is the form of health).

much. Rather, (T3) provides us with an argument for the claim that the productivity of *technai* is for contraries. It goes like this. Since *technē* is productive knowledge, and this knowledge is an account of X, *technē* is productive of X. An account of X is also, derivatively, an account of not-X. But then, the given *technē* is productive of not-X too. For instance, if one knows what health is, and one knows that sickness is the lack of health in a body, then one knows what kind of thing the bodies of sick people lack, and so what sickness is. But then, to the extent that knowing what health is puts one in a position to produce health, it also puts one in a position to produce sickness. So, given that technical knowledge is productive of what it is knowledge of, it is productive of contraries.[13]

Here the fact that one can deny an account of X so to obtain an account of not-X suggests that the account is somehow propositional.[14] Moreover, given that this account is meant to make an artisan produce the outcome(s) in a variety of circumstances, it is plausibly at some level of generality. But that is all one can gather from these passages, and this is a pity. To be sure, much more needs to be said for Aristotle's picture of *technē* to work. Among other things, we still do not know *why* Aristotle feels entitled to assume that an account of a product qualifies as productive. We also do not know exactly *what* information about the product this type of account provides us with. This is important because, on some ways of understanding the notion of a definitional account of the product, Aristotle's view of *technai* becomes implausible. Sometimes he defines health as uniformity in the body (cf. *Met*. Z.7 1032b20-1032b21). This account states what health is. But it cannot be the sort of account that makes someone a doctor. If Aristotle is to avoid the conclusion than most of us are doctors, the notion of an account in play in *Metaphysics* Θ.2 and *Metaphysics* Z.7 has to be

[13] Beere (2009: 88-89) argues, correctly in our view, that the argument for the two-directionality of *technē* goes through only if *technē* consists entirely of the *logos*. For any further component might stand in the way of the two-directional productivity of the power: "One can now see how important it is for Aristotle that rational powers do not merely involve rational comprehension (along with other things) but simply consist in it. The rational comprehension is itself the guide for motion, and thus it is a guide that can be reversed, because it consists in an account and accounts can be denied. The reversibility of the arts depends, in the end, on the deniability of statements. But if something other than rational comprehension were also involved—e.g., certain habituated movements—then Aristotle could not argue that the power to produce F + is also the power to produce F −." For an alternative view, according to which *technai* encompass the *logos* and a further component, corresponding to *empeiria*, see Johansen (2017: 113-114, and forth). Cambiano (2012: 22) also talks of the *logos* of *technê* as one of the components of *technê*. By contrast, this essay assumes that Aristotle's *technai* consist entirely of *logos*/knowledge. Yet this assumption is not indispensable for our arguments to succeed. The reader who prefers to think that a *technē* only partly consists of knowledge can take our arguments to provide an account of that part of a *technē*.

[14] Moss (2014b) also supports this claim on the basis of further passages.

much more informative than that of a minimal definition of the product. But then, so far, Aristotle has hardly told us enough about what kind of knowledge *technē* is.

In the face of this difficulty, it is tempting to think that Aristotle's claim that *technē* is knowledge of the product might just be fast and loose. After all, he does not seem to even bother arguing for it. Yet it seems to us that this conclusion should nonetheless be resisted. This is because, if we are correct, Aristotle *does* have a view of what technical accounts look like. It is a view according to which technical knowledge is rich enough to qualify as a science. But it is also a view for which Aristotle does not argue all at once. Accordingly, our argument for the claim that technical knowledge is scientific requires a number of steps. We aim at making them in the rest of this paper.

§3. *Technai* as causal accounts at the level of universals

The first step of our argument for the view that technical knowledge is scientific knowledge consists of establishing that technical knowledge (i) is merely at the level of universals and (ii) involves a grasp of explanations of the product.[15]

i) Technical accounts are at the level of universals

Let us say that a definitional account of X is at the level of universals when 'X' denotes a universal, and its account includes no reference to particulars. Aristotle states that *technê* concerns universals in several places. Here is *Metaphysics* A.1:

> (**T4**) To have a judgement that when Callias was suffering from this disease this benefited him, and similarly with Socrates and many other individuals, is a matter of experience (*empeirias*). But to judge that it benefits *everyone* of a certain sort, marked off in accordance with a single form (*kat'eidos hen*), who suffers from this or that disease (e.g., the phlegmatic or bilious ones when burning with fever) is a matter of *technê*.
>
> Τὸ μὲν γὰρ ἔχειν ὑπόληψιν ὅτι Καλλίᾳ κάμνοντι τηνδὶ τὴν νόσον τοδὶ συνήνεγκε καὶ Σωκράτει καὶ καθ'ἕκαστον οὕτω πολλοῖς, ἐμπειρίας ἐστίν· τὸ δ'ὅτι πᾶσι τοῖς τοιοῖσδε κατ'εἶδος ἓν

[15] Here Aristotle shares with Plato the view that knowledge is merely at the level of universals and involves a grasp of the causes of X. In the *Meno*, for example, Plato says: "True beliefs (*doxai*)…[when] one ties them down with reasoning about the cause (*aitias logismos*)…become *epistēmai*" (98a)—cf. also *Gorg.* 465a and *Gorg.* 501a. See Moss (2014a) for a discussion of Plato's conception of *logos* and Moss (2014b) for a discussion of Plato's conception of *epistēmē.*

> ἀφορισθεῖσι, κάμνουσι τηνδὶ τὴν νόσον, συνήνεγκεν, οἷον τοῖς φλεγματώδεσιν ἢ χολώδεσι πυρέττουσι καύσῳ, τέχνης. (*Met*. A.1, 981a7-12)[16]

We find here a contrast between *technê* and experience (*empeiria*). If one has experience of healing, one can judge whether a particular individual suffers from a given disease. So experience concerns the level of judgement about particulars. But someone who has the *technē* of medicine possesses knowledge at the level of universals. She can judge what benefits whoever has a certain sort of disease. This is because her knowledge is at the level of universals: it concerns what makes a given class of people healthy. So, for example, medical knowledge includes claims of the form: 'a given kind of medicine makes a person in a given kind of state become healthy'.

(T4) does not rule out that *technē also* involves a grasp of particulars, and several scholars have assumed that it does.[17] Yet in the *Rethoric* Aristotle rules out that a grasp of particulars is part of *technē* :

> (**T5**) [N]o *technē* looks at the particular. For instance, medicine does not look to what is healthy for Socrates or for Callias, but rather what is healthy for someone of a given sort, or the ones of a given sort: for this is a matter of *technē* (*entechnon*), whereas the particular is indefinite and not knowable.
>
> [O]ὐδεμία δὲ τέχνη σκοπεῖ τὸ καθ'ἕκαστον, οἷον ἡ ἰατρικὴ τί Σωκράτει τὸ ὑγιεινόν ἐστιν ἢ Καλλίᾳ, ἀλλὰ τί τῷ τοιῷδε ἢ τοῖς τοιοῖσδε (τοῦτο γὰρ ἔντεχνον, τὸ δὲ καθ'ἕκαστον ἄπειρον καὶ οὐκ ἐπιστητόν). (*Rhet.* I.2, 1356b30-33)

Technical knowledge does not look at particulars. For particulars are not objects of knowledge (1356b33).[18] For example, medicine is not knowledge of what it healthy for

[16] We follow Primavesi's edition of the text (Primavesi & Steel: 2012, 465ff), and preserve 'τοῖς φλεγματώδεσιν ἢ χολώδεσι πυρέττουσι καύσῳ' (bracketed in the OCT) but omit 'ἢ' before 'πυρέττουσι' (as originally suggested by Jackson).

[17] For some recent examples of scholars making this assumption, see Johansen (2017 and forth) and Moss (2014b). Note that Aristotle only explicitly states that in order to bring things about one needs to be acquainted with particulars. This falls short of stating that knowledge of particulars is part of the content of *technê*. Johansen (2017: 103-105, and forth) suggests that *technē* includes knowledge of particulars. He argues on the basis of an analogy with *phronēsis*, and thus relies on the fact that at *EN* VI.7 1141b15-23 Aristotle says that *phronēsis* includes knowledge not just of universals but also of particulars. We think that Aristotle's point about *phronēsis* does not extend to *technē*. We postpone arguments for this last claim to a future occasion.

[18] (T5) adds that the kind of knowledge that a *technē* consists of cannot be of particulars because the latter are in some sense indefinite, and therefore cannot be an object of knowledge (1356b32-33). Elsewhere he says that one cannot define nor demonstrate particulars (cf. *Met*. Z.15 1039b27-29, where the point is however only made in connection with individual substances). If this claim applies to particulars in general, perhaps the thought is that since the account which is *technē* is a definition of a product, it is cannot be of particulars (cf. *Post. An.* II.13 97b26-28, where Aristotle states that a doctor does not define what a specific eye is, but what kind of thing an eye is). Devereux (1986: 497) acknowledges that for Aristotle *technê* is merely at the level of universals when it

Socrates, nor for Callias. Instead, medicine is knowledge of what brings about health in a given type of patient—say, someone who has fever. Presumably, the same point applies to the things that are healthy: a doctor knows what kind of things restore or preserve health. But then, technical accounts make no reference to particulars at all. They consist of generalizations that exclusively belong to the level of universals.

This is not to say that medicine has no bearing at the level of particulars. Rather, for Aristotle medicine *does* study the health-states of particular people, but only *insofar as* these states instantiate the universal of being healthy. Thus, Aristotle tells us, "doctors do not determine what is healthy for some particular eye, but rather for every eye, or for some kind of eye"[19] (*Post. An*. II.13 97b26-28). In this sense, *technai* just study universals.

(ii). Technical accounts are explanatory

Metaphysics A.1 also tells us that technical knowledge is in some sense explanatory:

> (**T6**) [W]e still think that knowledge (*eidenai*) and comprehension belong to *technê* rather than to experience (*empeirias*), and we take artisans to be wiser than experienced people (which implies that in all cases wisdom depends rather on knowledge [than on experience]). And this is so because the former [i.e. artisans] know the cause, but the latter [i.e. experienced people] do not. For experienced people know *that* the thing is so, but do not know *why*, while the others grasp (*gnōrizousin*) both the why (*to dioti*) *and* the cause. Hence, we think that the masters (*tous architektonas*) of each [*technē*] are more honourable and know in a truer sense than the manual workers (*tōn cheirotechnōn*), and are wiser, because they know the causes of the things that they produce (*tōn poioumenōn*), so that artisans are wiser not in virtue of being able to act, but in virtue of having the account (*logos*) for themselves and grasping the causes.
>
> [T]ό γε εἰδέναι καὶ τὸ ἐπαΐειν τῇ τέχνῃ τῆς ἐμπειρίας ὑπάρχειν οἰόμεθα μᾶλλον, καὶ σοφωτέρους τοὺς τεχνίτας τῶν ἐμπείρων ὑπολαμβάνομεν, ὡς κατὰ τὸ εἰδέναι μᾶλλον ἀκολουθοῦσαν τὴν σοφίαν πᾶσι· τοῦτο δ'ὅτι οἱ μὲν τὴν αἰτίαν ἴσασιν οἱ δ'οὔ. οἱ μὲν γὰρ ἔμπειροι τὸ ὅτι μὲν ἴσασι, διότι δ'οὐκ ἴσασιν· οἱ δὲ τὸ διότι καὶ τὴν αἰτίαν γνωρίζουσιν. διὸ καὶ τοὺς ἀρχιτέκτονας περὶ ἕκαστον τιμιωτέρους καὶ μᾶλλον εἰδέναι νομίζομεν τῶν χειροτεχνῶν καὶ σοφωτέρους, ὅτι τὰς αἰτίας τῶν ποιουμένων ἴσασιν, ὡς οὐ κατὰ τὸ πρακτικοὺς εἶναι σοφωτέρους ὄντας, ἀλλὰ κατὰ τὸ λόγον ἔχειν αὐτοὺς καὶ τὰς αἰτίας γνωρίζειν. (*Met*. A.1, 981a24-b6)[20]

comes to *technai* like medicine and rethoric. We have not found conclusive evidence for the claim that this picture only applies to disciplines that qualify as *technai* in the proper sense of the term. Coope (forth) takes (T5) to imply that *all* the explanations that belong to the body of knowledge that constitutes a *technē* are at the level of universals, like we do in the main text.

[19] "Οὐ γάρ τινι ὀφθαλμῷ λέγει τὸ ὑγιεινὸν ὁ ἰατρός, ἀλλ' ἢ παντὶ ἢ εἴδει ἀφορίσας."

[20] Like Primavesi (Primavesi & Steel: 2012, *ad loc*.) and the OCT, we take 'τοὺς δ'ὥσπερ καὶ τῶν ἀψύχων ἔνια ποιεῖ μέν, οὐκ εἰδότα δὲ ποιεῖ ἃ ποιεῖ, οἷον καίει τὸ πῦρ—τὰ μὲν οὖν ἄψυχα φύσει τινὶ ποιεῖν τούτων ἕκαστον τοὺς δὲ χειροτέχνας δι'ἔθος' (b2-5) to be an interpolation. So we do not include it in (T6).

Here again we have a contrast between *technē* and experience. This time the contrast is not drawn in terms of grasping universals versus grasping particulars, but in terms of knowing the cause of some fact versus knowing that the fact is the case. In the passage, to know 'the why' means knowing a correct answer to a why-question about X, which in turn picks up the cause of X.[21] So if one knows why-X one possesses explanation(s) in relation to X. Moreover, here the term 'master' (*architektōn,* 981a30) refers to whoever has the relevant *technē*. The expression 'manual-worker' (*cheirotechnēs*, 981a31-32) seems to either refer to (a) whoever can perform the actions prescribed by a *technē* but lacks the *technē* itself or (b) to someone who has a subordinate (*hupēretikē*) *technē.* If the former, she merely has experience. If the latter, her *technē* is subordinate to the *architektonikē technē*, and she uses her *technē* to do what the *architektōn* tells her to do (e.g. build a door of these dimensions here), without knowing the higher *technē*'s reasons for why it is appropriate for him to use his subordinate art in this way.[22]

(T6) associates again *technē* with having an account of the product (981b6) and gives us more information about this sort of account. Aristotle states that artisans know 'the causes of the things that are produced' (981b1). This line is compatible both with the claim that each artisan knows a single cause of the product, and the claim that an artisan grasps a causal chain that leads to the product. Since the context contrasts artisans with people who can nonetheless bring about the product, Aristotle seems to implicitly assume that somehow the artisan relies on this causal account to bring about the product. This suggests that a technical account has to be rich enough to allow a doctor to judge what steps are needed to bring about the product in a given sort of situation. So plausibly the artisan knows why a given product comes about in the sense of grasping causal chains that lead to the product. For example, in order to be able to establish what kind of cure a given disease requires, a doctor has to know different set of causes of the product, and in fact grasp a number of causal chains that lead to health.[23]

A comparison with natural sciences can be helpful here. Biologists grasp the essence of living things. Here too grasping the essence is not just a matter of grasping a minimal definition of living things. At some level of explanation, one might grasp certain definitions of living things without being a biologist. For instance, our knowing the mere definition of

[21] Cf. *Phys*. II.3 194b18-20.
[22] Cf. *Pol.* VII.3 1325b22-23.
[23] We shall see how this reading is further supported by other passages in subsequent sections (see esp. §8).

human being does not quite suffice to make us scientists of human biology. Rather, what characterizes biological knowledge is that this sort of knowledge can be systematized in a rigorous fashion and that her full system can provide explanations for why living things have the characteristics that they do. By analogy, technical accounts have to be robust to contain systematic sets of explanations about a given sort of product.

§4. Analogies between *technai* and other sciences

So far, we have seen that technical knowledge involves knowing causal paths to a product, and that they are at the level of universals. For Aristotle, both of these features are requirements for scientific knowledge. In fact, sometimes Aristotle *does* go as far as to treat *technai* on a par with other sciences:

> (**T7**) Quick-wittedness (*synesis*), and also good quick-wittedness, in virtue of which we say that some are witty or have good wit, are neither entirely the same as opinion nor knowledge (for otherwise all [of us] would be witty), nor are they one of the particular sciences (*tōn kata meros epistēmōn*), such as medicine, which is concerned with what conduces to health, or geometry, which is concerned with magnitudes.
>
> Ἔστι δὲ καὶ ἡ σύνεσις καὶ ἡ εὐσυνεσία, καθ' ἃς λέγομεν συνετοὺς καὶ εὐσυνέτους, οὔθ' ὅλως τὸ αὐτὸ ἐπιστήμῃ ἢ δόξῃ (πάντες γὰρ ἂν ἦσαν συνετοί) οὔτε τις μία τῶν κατὰ μέρος ἐπιστημῶν, οἷον ἡ ἰατρικὴ περὶ ὑγιεινῶν, ἡ γεωμετρία περὶ μεγέθη. (*EN* VI.10, 1142b34-1143a4)

Geometry is concerned with magnitudes and medicine with health. Both disciplines fall under the scope of *kata meros epistēmai* (1143a1-2). This expression seems to refer to a systematic body of knowledge about a particular aspect of reality.[24] Accordingly, (T7) suggests that medicine and geometry are both disciplines that in some way systematically investigate a particular aspect of reality.

Now what makes these bodies of knowledge systematic? In the *Prior Analytics*, Aristotle states that philosophy, *technai*, and all other kinds of study (*mathēma*)[25] involve the same method (46a3). Shortly afterwards, he adds:

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[24] For the claim that geometry studies magnitudes see also *Rhet*. I.2, 1355b29-30; cf. also *Phys.* II.2 193b23–25 and *Met.* M.3 1078a21–22, where Aristotle talks about mathematics in general. For the claim that most sciences mark off a certain aspect of reality and focus on it, see *Met*. E.1 1025b7-9.

[25] There is a question of whether 'μάθημα' at 46a4 refers to (i) applied mathematical sciences, like optics, that are thus dependent on experience; or (ii) all mathematical sciences; or (iii) any discipline more generally. Striker (2009: *ad loc*.) prefers (ii), following Bonitz's suggestion that the term in the plural always denotes mathematical sciences. We are inclined to follow Philoponus and other ancient commentators in favoring (iii)—so does Smith (1989: *ad loc*.).

> (**T8**) [I]t is the business of experience to provide the principles (*tas archas*) of each [discipline]. I mean for example that astronomical experience [provides the principles] of the astronomical science (*tēs astrologikēs epistēmēs*) (for once the phenomena had been adequately apprehended, the astrological demonstrations were therefore discovered). Similarly with any other sort of *technē* or science (*kai peri allēn hopoioanoun technēn te kai epistēmēn*). So that, if the things belonging to each are grasped, we will then be prepared to readily bring the demonstrations (*tas apodeixeis*) to light. For if nothing that truly belongs to the things has been omitted in the survey, we will be in a position to find and show the demonstration of every thing of which there is a demonstration, and to make clear of which things there is no natural demonstration.[26]
>
> [Τ]ὰς μὲν ἀρχὰς τὰς περὶ ἕκαστον ἐμπειρίας ἐστὶ παραδοῦναι, λέγω δ'οἷον τὴν ἀστρολογικὴν μὲν ἐμπειρίαν τῆς ἀστρολογικῆς ἐπιστήμης (ληφθέντων γὰρ ἱκανῶς τῶν φαινομένων οὕτως εὑρέθησαν αἱ ἀστρολογικαὶ ἀποδείξεις), ὁμοίως δὲ καὶ περὶ ἄλλην ὁποιανοῦν ἔχει τέχνην τε καὶ ἐπιστήμην· ὥστ'ἐὰν ληφθῇ τὰ ὑπάρχοντα περὶ ἕκαστον, ἡμέτερον ἤδη τὰς ἀποδείξεις ἑτοίμως ἐμφανίζειν. εἰ γὰρ μηδὲν κατὰ τὴν ἱστορίαν παραλειφθείη τῶν ἀληθῶς ὑπαρχόντων τοῖς πράγμασιν, ἔξομεν περὶ ἅπαντος οὗ μὲν ἔστιν ἀπόδειξις, ταύτην εὑρεῖν καὶ ἀποδεικνύναι, οὗ δὲ μὴ πέφυκεν ἀπόδειξις, τοῦτο ποιεῖν φανερόν. (*Pr. An.* I.30, 46a17-27)

The passage draws an important analogy between *technai* and other bodies of knowledge. In a discipline like astronomy, one spells out demonstrations on the basis of principles that are ultimately derived from experience (*empeiria*) (46a19-21).[27] We shall not focus on the reference to experience here. What interests us is how Aristotle generalizes his overall point. Just like in astronomy, he says, "in any sort of *technē* and science" (46a22) we must start from principles and from these infer demonstrations (*apodeixeis*). That is to say, in this passage he commits to the claim that both *technai* and other bodies of knowledge consist of *demonstrations*.[28]

Let us look into what 'demonstration' may mean here. In (T8), 'demonstration' is either used in (i) the proper sense of scientific demonstration, or it denotes (ii) a syllogism, or it is used in (iii) a somewhat weaker sense.[29] A syllogism is Aristotle's notion of a deductive inference (*Pr. An.* I.1 24b18-20). A demonstration is a syllogism *via* which, when we possess

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[26] The claim that a discipline proves things can either mean that a discipline demonstrates facts, or it can be interpreted as the more precise point that a discipline demonstrates which attributes belong to a given subject. We aimed at offering a non-committal translation, to the extent that this was possible. If one prefers the former option, 46a24-25 might best translate as: 'For if none of the truths that pertain to facts has been omitted…'.

[27] For other contexts in which science and *technai* are both said to derive in some sense from experience, see *Met*. A.1 981a1ff., and *Post. An*. II.19 100a4ff.

[28] See also *PA* I.1 639a12-32 and *EE* II.11 1227b28-32, taken together, for further methodological analogies between *technai* and the sciences of nature; the latter passage in particular appear to compare the principles grasped by geometricians to the ones grasped by doctors.

[29] For general remarks directed to support the view that elsewhere Aristotle uses 'demonstration' in a somewhat even looser sense, see Lloyd (1996b: 31ff).

it, we have knowledge of the conclusion (*Post. An.* I.2 71b18-19). Among other things, its premises must be true, prior to, and explanatory of the conclusion (*Post. An.* I.2 71b19-33; *Post. An*. I.6 74b27-28).

Aristotle seems to have in mind scientific practice when he refers to 'principles from which things get demonstrated' in (T8) (46a17-18). For in his view sciences are bodies of knowledge where all the claims are demonstrated from a set of indemonstrable principles (*Post. An*. I.2 71b26-27, 72a14-15, 72a19-20).[30] If so, (T8) presupposes the theory of science of the *Posterior Analytics*. This speaks for option (i).[31] On this option, here Aristotle plausibly claims that sciences and *technai* consist of demonstrations in order to establish the weaker claim that they are both structured in terms of deductive inferences. But then, all *technai* and sciences are systematized in terms of demonstrations derived from first principles.

If one were to adopt the weaker assumption that here 'demonstration' merely denotes syllogisms—option (ii)—(T8) would suggest that *technai* and other sciences can be modelled in terms of deductive inferences. In fact it would claim that both *technai* and other sciences are *deductive* bodies of knowledge, where the relevant deductions proceed from indeducible principles.

Thirdly, Aristotle might here be using 'demonstration' even more loosely, in the sense of somehow establishing something without this being necessarily accomplished through inferences, let along demonstrations.[32] Although we take the fact that the language of this passage is highly reminiscent of the *Posterior Analytics* not to speak in favor of this third option, it seems to us that we cannot fully rule it out on the basis of (T8) alone. What we will assume for now is that Aristotle takes it that there is something about the method of all *technai* and sciences that makes them all alike. For further progress, we need to turn to the *Posterior Analytics*.

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[30] See also the reference to natural demonstrations at 46a27—cf. *Post. An.* I.26 87a17-20, accounted for by Malink (ms: §3-5)—this is the paper Malink will present at the *Princeton Classical Philosophy Conference* this December.

[31] Alexander (*In Pr. Anal.* 330.31ff) commits to the claim that in the chapter Aristotle has in mind scientific demonstrations. Bronstein (2016: 125-127) also assumes that in (T8) Aristotle has in mind scientific demonstrations. Like Alexander, he does not consider how to square this with the fact that *technai* are into the picture.

[32] Coope (forth) does not directly consider (T8), but endorses a view of this sort about *technai*. She suggests that "the conclusion of a demonstration, unlike the conclusion of a productive explanation, is entailed by its premises"; she adds that "Aristotle never suggests that the steps in a productive explanation are logically entailed by the first principles of the craft, as the steps in a chain of demonstrations are entailed by the first principles of the relevant theoretical science". Since the point of (T8) extends to *technai*, this last remark by Coope implies that she commits to a (iii)-reading of (T8).

§5. How *technai* fit into the framework of the *Posterior Analytics*

How far exactly does the analogy between *technai* and sciences like geometry and astronomy go? In the *Posterior Analytics*, Aristotle uses geometry and astronomy as examples of bodies of knowledge that can be systematized as sets of demonstrations—for short, demonstrative bodies of knowledge, or sciences. We find examples of demonstrations from both geometry and astronomy throughout (e.g., for geometry, *Post. An*. I.5 74a13ff; for astronomy, *Post. An.* I.8 75b33-36) and Aristotle often assumes that these disciplines are sciences (*epistēmai*) (cf., for geometry, *Post. An.* I.10 76b39 and I.12 77b1ff; for astronomy, cf. *Post. An.* I.13 78b40). We will assume that in his view a demonstrative body of knowledge respects at least the following features. Each proposition included in a demonstrative body of knowledge is true, and merely about universals. If the proposition within the science is not an indemonstrable claim, one can provide its explanation by deducing it from further premises (*Post. An*. I.2 71b9-23). These premises are either conclusions of further demonstrations, or they are indemonstrable first principles (*archai*) (cf. *Post An*. I.2 72b19-20). Now should *technai* also be understood as demonstrative bodies of knowledge?

From what we have seen so far, there are a number of reasons to think that *technai*, just like geometry and astronomy, are demonstrative. Technical knowledge merely concerns universals and the same goes for demonstrative bodies of knowledge. Having the *technē* of X involves knowing the cause of X, and the premises of demonstrations are explanatory of the conclusions. If so, the prospects for thinking of technical knowledge as demonstrative look quite promising. On top of this, Aristotle refers to *technai* or examples thereof at several points in the *Posterior Analytics*. We find explicit references to medicine (*Post. An.* I.12 77a40-41, *Post. An.* I.13 79a13-16, *Post. An.* I.32 88b10-13; cf. also *Post. An.* II.13 97b26-28), some general references to *technai* (*Post. An.* I.1 77b21, *Post. An.* II.11 95a8, *Post. An.* II.19 100a8-9), and also examples of demonstrations that seem to belong to the art of war (*Post. An.* II.11 94a36-b8), and the art of house-building (*Post. An.* II.12 95b31-37).[33]

[33] We discuss these demonstrations in §6. There is also a demonstration of why walking is good for digestion (*Post. An*. II.11 94b9-26) which plausibly belongs to medicine, but might also be regarded as pertaining to biology; we wonder whether it may even belong to both.

This suggests that for Aristotle *technai* might be bodies of knowledge which are somehow structured like mathematics and astronomy.

Yet evidence in the other direction arises when one considers how Aristotle characterizes the notion of demonstration at the beginning of the *Posterior Analytics*:

> (**T9**) Since that of which there is unqualified knowledge (*epistēmē haplōs*) cannot be otherwise (*adunaton allōs echein*), that which is known in accordance with a demonstrative knowledge (*kata tēn apodeiktikēn epistēmēn*) will be necessary (*anagkaion*). Therefore, the demonstration is a syllogistic inference (*syllogismos*) from necessary premises (*ex anangkaiōn*).
>
> Ἐπεὶ δ'ἀδύνατον ἄλλως ἔχεινοῦ ἔστιν ἐπιστήμη ἁπλῶς, ἀναγκαῖον ἂν εἴη τὸ ἐπιστητὸν τὸ κατὰ τὴν ἀποδεικτικὴν ἐπιστήμην· ἀποδεικτικὴ δ'ἐστὶν ἣν ἔχομεν τῷ ἔχειν ἀπόδειξιν. Ἐξ ἀναγκαίων ἄρα συλλογισμός ἐστιν ἡ ἀπόδειξις. (*Post. An.* I.4*,* 73 a21-24)

On the notion of knowledge (*epistēmē*) at work in (T9), if one knows something, one is in a position to demonstrate it. Crucially, the notion of knowledge associated with demonstrations concerns things that hold of necessity.[34] So the conclusion of a demonstration must be true of necessity. This is guaranteed only if the premises of the syllogism are true of necessity. But then, demonstrations have premises and conclusions that are true of necessity.

(T9) implies that demonstrative bodies of knowledge only include necessary truths. Call these bodies of knowledge *strict sciences*. Disciplines like mathematics and astronomy meet the necessity-requirement without problem: they involve claims like the following:

(1) The sum of the angles of a triangle amounts two two right angles.

That is to say, they are constituted of the sort of claims that are true of necessity (cf. *Post. An.* I.4 73b39-74a4, *Post. An.* I.5 74a25ff, and *Post. An.* I.6 74b5ff, taken together). Yet *technai* cannot be sciences of this sort. After all, *technai* are concerned with things that belong to the realm of contingency, namely products of human agency like houses or states of health (cf. *EN* VI.6 1140b34-1141a1). But then, *technai* seem to deal with non-necessary truths. So perhaps technical knowledge is *not* demonstrative, and *technai* and other mathematical sciences are not much alike after all.

[34] For the claim that *epistēmē* can only be of necessary truths, see also *Post. An.* I.2 71b9-16, *Post. An.* I.6 75a12-14, *EN* VI.3 1139b19-23.

Let us sharpen our reasoning a little bit. Whether or not a body of knowledge can be systematized in terms of demonstrations depends on whether (i) it contains only claims that connect universals and whether (ii) these claims are true of necessity. We have seen that *technai* meet (i). The question, then, is whether they fail to meet (ii). In principle, the fact that products of *technē* are contingent particulars might not entail that the generalizations of a *technê* fail to be true of necessity.[35] Since these generalizations hold at the level of universals, it all depends on whether technical truths include contingent claims about universals. Yet it seems that they do. Aristotle's examples of technical generalizations seem to include the following:

(2) The foundation of a house is made of stones (*Post. An.* II.12 95b35-36).

(3) Honey-water is beneficial to the feverish (*Met*. E.2 1027a23-24).

None of (2)-(3) seem to hold of necessity. So on the face of it technical knowledge cannot be modeled in terms of the scientific demonstrations introduced in (T9). Accordingly, *technai* are not strict sciences.

The fact that *technai* are not explained in terms of the demonstrations that apply to mathematical and astronomical sciences may not fully settle whether these disciplines are demonstrative. For it remains to be explained why Aristotle refers to *technai* at several points in the *Posterior Analytics*. Note that *technai* are not the only bodies of knowledge that include contingent claims to appear in the *Posterior Analytics*. Within the treatise, several of Aristotle's examples belong to the science of nature. They concern things like thunder (cf. *Post. An*. II.8 93b8-14), plants (*Post. An*. II.16 98a37ff), and ice (*Post. An*. II.12 95a16-95a20). Yet Aristotle's science of nature includes claims that are not true of necessity, such as the following:

(4) Light things move upward. (*Phys*. VIII.4 255b10-11)

(5) Human molar teeth are broad. (*Phys*. II.8 198b26)

(6) All crabs have the right claw bigger than stronger than the left. (*HA* IV.3 527b6-7)

(7) Walking is for the sake of evacuation of the bowels. (*Phys*. II.6 197b23-5)

[35] Lorenz & Morison (forth) assume that, in the case of the natural sciences (only), generalizations at the level of universals are true of necessity even though they derivatively concern particulars which exist contingently.

In his view, these claims are not true of necessity. But then the question of why *technai* appear in the *Posterior Analytics* is an instance of a broader question: if demonstrations only have premises and conclusions that are true of necessity, why does Aristotle use examples from bodies of knowledge that involve non-necessary claims?

To answer this question, it is crucial to keep in mind that over the course of the *Posterior Analytics* Aristotle broadens up his notion of knowledge. From *Posterior Analytics* I.14 onwards (79a21-24), we find the claim that scientific bodies of knowledge contain not only claims that are true of necessity but also claims that are true for the most part. Unless they are first principles, these claims are demonstrable:

> (**T10**) There is no knowledge (*epistēmē*) through demonstration of what holds by chance (*apo tuchês*). For what holds by chance is neither necessary nor for the most part, but [it is] what comes to be contrary to these; and demonstration is of one or other of these. For every syllogism is either through necessary or through for the most part (*hōs epi to polu*) premises. And if the premises are necessary, the conclusion is necessary too; and if for the most part, the conclusion is of this sort too. Hence if what happens by chance is neither for the most part nor necessary, there will not be demonstration of it.
>
> Τοῦ δ'ἀπὸ τύχης οὐκ ἔστιν ἐπιστήμη δι'ἀποδείξεως. οὔτε γὰρ ὡς ἀναγκαῖον οὔθ'ὡς ἐπὶ τὸ πολὺ τὸ ἀπὸ τύχης ἐστίν, ἀλλὰ τὸ παρὰ ταῦτα γινόμενον· ἡ δ'ἀπόδειξις θατέρου τούτων. πᾶς γὰρ συλλογισμὸς ἢ δι'ἀναγκαίων ἢ διὰ τῶν ὡς ἐπὶ τὸ πολὺ προτάσεων· καὶ εἰ μὲν αἱ προτάσεις ἀναγκαῖαι, καὶ τὸ συμπέρασμα ἀναγκαῖον, εἰ δ'ὡς ἐπὶ τὸ πολύ, καὶ τὸ συμπέρασμα τοιοῦτον. ὥστ'εἰ τὸ ἀπὸ τύχης μήθ'ὡς ἐπὶ τὸ πολὺ μήτ'ἀναγκαῖον, οὐκ ἂν εἴη αὐτοῦ ἀπόδειξις. (*Post. An.* I.30, 87b19-27; see also *Post. An*. II.12 96a8-19)

The passage clearly weakens the necessity-condition on premises of demonstrations. Here 'syllogism' (*syllogismos*, 87b21) and 'demonstration' (*apodeixis*, 87b19, 21, and 27) both refer to scientific demonstrations. Hence, there seems to be two kinds of demonstrations: those that demonstrate claims that are true of necessity, and those that demonstrate claims that are true for the most part. The former are demonstrations where all the premises are true of necessity. The latter are demonstrations where at least some of the premises are true not of necessity, but merely for the most part—henceforth, *FMP-demonstrations*.

When it comes to FMP-demonstrations, Aristotle keeps it short. Plausibly, like the qualification 'of necessity', the qualification 'for the most part' does not belong to the logical form of premises of demonstrations. It belongs to the meta-level from which Aristotle describes the status of these premises. The contrast with necessity suggests that for the most

part premises have a weaker modal force.[36] The context also seems to presuppose that both FMP-demonstrations and necessity-demonstrations (those with only claims that are true of necessity) are deductive inferences. But there is much more left to clarify.

For instance, it is not clear from (T10) whether one can have demonstrations involving two premises that are true only for the most part, or whether at least one premise has to be true of necessity.[37] The passage also does not tell us what 'for the most part' is supposed to mean. It is not a given that in the *corpus* 'for the most part' is used univocally.[38] We cannot offer here a full account of the formal status of these demonstrations, if indeed any can be provided.[39] But it is at least worth keeping in mind that if both premises can be true merely for the most part, and demonstrations are to be valid syllogisms, then the expression 'for the most part' cannot stand for 'most' or 'in most cases'. This is because, if A belongs to B in most cases, and B belongs to C in most cases, it does not follow that A belongs to C in most cases.[40] So here 'for the most part' must mean something else.

Now let us try to make some progress by taking a closer look. One thing we *can* gather from (T10) is that there is a notion of *epistēmē* in the *Posterior Analytics* whose

[36] Aristotle states that what is for the most part pertains to the realm what is contingent at *Pr. An*. I.3 25b14-15 and I.13 32b4-13. This is of course compatible with the claim that the modal force associated with what happens for the most part is stronger than mere contingency, as long as it is weaker than necessity.

[37] *Pr. An*. I.27 43b33-35 refers to syllogisms where "all or some" (43b35) premises are true for the most part. *If* FMP-demonstrations are meant to be syllogisms of that sort, this passage provides some support for the claim that both premises of FMP-demonstrations can be true for the most part.

[38] Cf. Irwin (2000b) and Henry (2015). For accounts of the expression 'for the most part' see also Mignucci (1975: *ad loc*.), Mignucci (1981), Judson (1991), Reeve (1992: 13ff and 2000: §2.3-4), Anagnostopoulos (1994: ch.6), Winter (1997), and Velarde Lombrana (1999).

[39] Nor have we found a fully satisfactory account of FMP-demonstrations in the literature (for references to some interesting accounts and some thoughts, however, see fn48). We can envisage pessimistic readers wondering: What is the point of showing that *technai* include FMP-demonstrations, if there is no guarantee that Aristotle has a consistent notion of FMP-demonstration? We sympathize. But we belong to the optimistic camp☺. To the extent that the pessimist can be persuaded, we ask them to consider the argument of this paper—if successful—as motivation for the assumption that Aristotle took himself to have a consistent notion of FMP-demonstration, and thus in turn to provide us scholars with motivation for investigating this notion further.

[40] For further discussion of this point, see Barnes (1994: *ad loc*.), Reeve (1992: 13ff; 2000: 28ff), and Anagnostopoulos (1994: ch.6). In the fact of this difficulty, some scholars opt for keeping the assumption that 'for the most part' means most, and discharging the assumption that FMP-demonstrations are deductively valid inferences, especially when it comes to *technai* (e.g., Di Piazza: 2007, 2011, 2012, 2017). We are cautiously inclined to think that, other things beings equal, this view should be the last resort. Although in the *Rethoric* Aristotle does have a notion of inference that need not be deductively valid (*Rhet.* 1354a14-1355a5), we cannot find sufficient textual evidence that this notion is in play in (T10). Nonetheless, the reader who is inclined to endorse this weak-picture of FMP-demonstration can rest assured that our present arguments—with small amendments—may still apply under under that assumption too. Or at least, this is so as long as one can individuate a notion of validity weaker than classical validity in terms of which demonstrative inferences can be systematized. For a contemporary account of a notion of deduction that is not classically valid, and aims at accommodating inferences involving generic statements, see Veltman (1996).

content concerns both what holds for the most part and what holds of necessity. (T10) contrasts the object of this knowledge with what happens by chance. This is not surprising. In Aristotle's view what happens by chance happens accidentally (*kata sumbebēkos*), and in his view knowledge only concerns what is not accidentally the case—namely, what is the case *per se* (*kath' hauto*).[41] For instance, a triangle has three sides *per se*, or in virtue of what it is to be a triangle. So it is no accident that triangles have three sides. This implies that the claim that a triangle has three sides can be the object of knowledge. By contrast, the fact that people love houses is not true in virtue of what houses are. So this fact is not the case *per se*, but accidentally so. Accordingly, it is not studied by any science.[42]

Aristotle contrasts what is true of necessity or for the most part with what is accidental also in other places in the *corpus*. For instance:

> (**T11**) Since then among entities some are always the way they are and of necessity (not in the sense in which we say that something is forced, but in the sense in which we say that it cannot be otherwise), and some are not of necessity nor always, but for the most part (*hōs epi to polu*), this is the principle and the cause of the accidental being the case. For that which is neither always nor for the most part the case, we call 'accidental'.
>
> Ἐπεὶ οὖν ἐστὶν ἐν τοῖς οὖσι τὰ μὲν ἀεὶ ὡσαύτως ἔχοντα καὶ ἐξ ἀνάγκης, οὐ τῆς κατὰ τὸ βίαιον λεγομένης ἀλλ'ἣν λέγομεν τῷ μὴ ἐνδέχεσθαι ἄλλως, τὰ δ'ἐξ ἀνάγκης μὲν οὐκ ἔστιν οὐδ'ἀεί, ὡς δ'ἐπὶ τὸ πολύ, αὕτη ἀρχὴ καὶ αὕτη αἰτία ἐστὶ τοῦ εἶναι τὸ συμβεβηκός· ὃ γὰρ ἂν ᾖ μήτ'ἀεὶ μήθ'ὡς ἐπὶ τὸ πολύ, τοῦτό φαμεν συμβεβηκὸς εἶναι. (*Met*. E.2, 1026b27-1027a33; cf. *Met*. Δ.30 1025a16-19)

Here again what is not accidental is either the case of necessity (and therefore always) or for the most part. Within the same context, he claims that *epistēmē* is also about what holds for the most part:

> (**T12**) [T]hat there is no knowledge (*epistēmē*) of the accidental is clear; for all knowledge is either of that which is always or of that which is for the most part (*hōs epi to polu*). For how else is one to learn or to teach another? For one must characterize [things] either as holding always or as holding for the most part, e.g. that honey-water is beneficial to a feverish person is true for the most part. But what is contrary to this cannot be stated: when this does not happen, like on the day of new moon; for what holds on the day of new moon also [holds]

[41] Cf. *Met*. E.2 1026b2ff. Now in *Posterior Analytics* I.6 Aristotle tells us that what is accidental does not hold *per se* (*Post. An*. I.6 74b5-12) but also equates what holds *per se* with what holds of necessity (74b5-12; 75a29-30). This is because at that stage in the treatise Aristotle works with a narrower notion of *epistêmê*, associated only with strict sciences. As we have seen, these sciences only look at what holds of necessity. Within these domains what is not accidental is true of necessity. (T10) broadens up the notion of what holds non-accidentally—i.e. *per se*—and can therefore be an object of knowledge up to including not only what is true of necessity but also what is true for the most part.

[42] *Posterior Analytics* I.6 tells us that if something holds *per se*, it is true of necessity (75a29-30).

> either always or for the most part; but the accidental is contrary to this.
>
> [Ὅ]τι δ᾽ἐπιστήμη οὐκ ἔστι τοῦ συμβεβηκότος φανερόν: ἐπιστήμημὲν γὰρ πᾶσα ἢ τοῦ ἀεὶ ἢ τοῦ ὡς ἐπὶ τὸ πολύ. πῶς γὰρ ἢ μαθήσεται ἢ διδάξει ἄλλον; δεῖ γὰρ ὡρίσθαι ἢ τῷ ἀεὶ ἢ τῷ ὡς ἐπὶ τὸ πολύ, οἷονὅτι ὠφέλιμον τὸ μελίκρατον τῷ πυρέττοντι ὡς ἐπὶ τὸ πολύ. τὸ δὲ παρὰ τοῦτο οὐχ ἕξει λέγειν, πότε οὔ, οἷον νουμηνίᾳ: ἢ γὰρ ἀεὶ ἢ ὡς ἐπὶ τὸ πολὺ καὶ τὸ τῇ νουμηνίᾳ: τὸ δὲ συμβεβηκός ἐστι παρὰ ταῦτα. (*Met*. E.2, 1027a19-1027a28; cf. *Met*. K.8 1065a30ff)

Here 'always' (*aei*, 1027a20, 22, 25) seems proxy for necessary.[43] Accordingly, the claim is analogous to what we find in (T11): *epistēmē* concerns what is not accidental, and this is the case either of necessity or for the most part. So the expression 'for the most part' seems to be used in the same way as in (T10). On the broader associated notion of *epistēmē*, demonstrative bodies of knowledge include claims that hold for the most part. We shall call these bodies of knowledge *non-strict sciences*. If we put (T11)-(T12) and (T10) together, then, we get the claim that non-strict sciences are demonstrative.

(T12)'s example also tells us that the following claim is true for the most part (1027a23-24):

(8) Honey-water is beneficial (i.e. restores health) to the feverish person.

Claim (8) plausibly belongs to medicine. So we have a case of *technē* that includes claims that are for the most part. The context of *Metaphysics* E.2 suggests that here Aristotle assumes that not only *technai* but also further sciences concern what holds for the most part. These include the study of nature.[44] Aristotle confirms that the study of nature concerns what is the case for the most part elsewhere (cf. *GA* IV.4 770b9-17, 777a19-21, and 727b29-30;

[43] Aristotle points out in *EN* VI.6, among other places, that in his view what is necessary is the case always and in every case (1140b23-4). On the backdrop of this assumption, he often introduces what is for the most part by contrasting it with what is always the case (cf. *Post. An.* II.12 96a18-22; *Top*. V.1 129a6-16; *Phys*. II.5, 196b10) and with what is the case in every case (*HA* V.14 545a14-18; *PA* III.2 663a28). It is however worth keeping in mind that sometimes within these contrasts Aristotle may be using 'for the most part' in the mere sense of frequency. We can assume that the frequency reading 'for the most part' is not relevant for our purposes, because on that reading what is for the most part can be accidental. For further passages that explicitly contrast the for the most part with what is necessary, see *Pr. An.* I.13 32b5-10 and *Top*. B.6 112b1-9.

[44] In this chapter, Aristotle uses '*epistêmē*' to refer both to contemplative sciences, productive sciences, and practical sciences (cf. 1026b4-5), and takes the study of nature to fall under the first heading. At 1027b34-35 he raises the question of whether the claim that in the dog-days one has storm and cold occurs for the most part. It is also plausible that Aristotle thinks here of practical sciences as concerned with what holds for the most part. For a defence of this last claim, see Anagnostopoulos (1994), Winter (1997), Irwin (2000b), Allen (2015: 62), and Nielsen (2015: 35-44); for concerns, see Henry (2015: 189) and Lorenz & Morison (forth). Although we take the account of this essay to bear relevance for the domain of practical sciences, we bracket them on this occasion.

HA IV.3 527b6-7, *GC* II.10 336b21-2, *PA* 663b28-29, *Phys*. II.7 198b4-9). In *Physics* II.8, he adds:

> (**T13**) When something happens always or for the most part, it is not accidental nor by chance. In the case of things that hold by nature, [they hold] always thus, if nothing prevents.
>
> Ἀλλ'ὅταν τοῦτο αἰεὶ ἢ ὡς ἐπὶ τὸ πολὺ γένηται, οὐ συμβεβηκὸς οὐδ'ἀπὸ τύχης· ἐν δὲ τοῖς φυσικοῖς ἀεὶ οὕτως, ἂν μή τι ἐμποδίσῃ. (*Phys*. II.8, 199b24-26; cf. 199b17-18)

The passage assumes that nature includes reference to what is the case for the most part. For instance, in this context Aristotle takes claims like the following to be true for the most part:

> (6) Human molar teeth are broad. (198b26)

In fact, in his view each of (4)-(7) is true for the most part.[45] He also claims that nature and *technē* works in the same way (cf. *Phys*. II.8 199a9-16, 199a34-b7, and 199b26-33). So the point of (T13) plausibly extends to *technai*. But then, both natural and technical disciplines look at regularities that are true whenever nothing prevents. So in his view each of (3)-(8) states what holds unless something prevents.[46] Thus both *technai* and the sciences of nature are bodies of knowledge that include what holds for the most part. We suggest that the notion of holding for the most part these sciences involve is the notion of holding for the most part that Aristotle connects with *epistēmē* in (T13) above. If so, in his view natural sciences and *technai* are demonstrative bodies of knowledge involving FMP-demonstrations.

The next section substantiates our picture further by showing that the *Posterior Analytics* contain examples of demonstrations which pertain to both kinds of disciplines and some of whose premises that hold for the most part. Before looking at examples, let us make one more remark on the notion of for the most part which is in play in (T10)-(T13). We have already mentioned that 'for the most part' is not to be interpreted as meaning 'most'. (T13) helps us to expands on this a little bit. As we have seen, in this passage Aristotle tells us that what happens for the most part is such that it happens *if nothing prevents* (199b26). We take

[45] Cf. *Phys*. VIII.4 255b10ff, *HA* IV.3 527b6-7, *Phys*. II.6 197b23-25; see also *PA* I.1 663b27-28 and *Phys*. II.8 198b34-36, where Aristotle claims: "These and all other natural things either always or for the most part come about in a given way, but not so for what happens by chance or spontaneously." ("Ταῦτα μὲν γὰρ καὶ πάντα τὰ φύσει ἢ αἰεὶ οὕτω γίγνεται ἢ ὡς ἐπὶ τὸ πολύ, τῶν δ'ἀπὸ τύχης καὶ τοῦ αὐτομάτου οὐδέν.") See Ferejohn (2013: 165-167) for further discussion of examples like the one illustrated by claim (6).

[46] We discuss the status of (2) in the next section.

the reference to lack of preventing conditions to provide a gloss on the notion of for the most part.[47]

There are further passages in which Aristotle refers to what holds in the absence of preventing conditions, mostly in connection with *technai* (cf. *Phys*. II.8 199a9-16, *Phys*. VIII.4 255a34-b5 and 255b22-23; *Met*. Θ.5 1048a16-21 and *Met*. Θ.7 1049a5-11) and nature (*Phys*. II.6 197b23-25, *Phys*. VIII.4 255b5-11, *GA* IV.10 778a4-9, *HA* IV.3 527b6-7). This further supports the claim that, when Aristotle thinks of these disciplines as concerned with what holds for the most part, he takes these disciplines to include generalizations about what happens when nothing prevents. We thus suggest that FMP-demonstrations involve a notion of 'for the most part' that correlates with the lack of preventing conditions. Accordingly, these are demonstrations involving premises and conclusions that are true when nothing prevents. Needless to say, much more needs to be said to fully flesh out the formal nature of FMP-demonstrations. But hopefully this point already helps us to see that these demonstrations may not be dismissed from the outset as hopelessly invalid.[48]

§6. Examples of natural and technical demonstrations

The *Posterior Analytics* contain several examples of demonstrations related to both the sciences of nature and *technai*. Often Aristotle states these demonstrations in compact form

[47] For another author who makes a similar suggestion in passing, see Menn (ms: §Ig1).

[48] We are currently inclined to think that Aristotle probably accepts the following: (i) for the most part claims when indefinite can be precisified by means of a quantified copula; (ii) if 'A belongs to all B' is true for the most part, it is true that 'necessarily, if nothing prevents, A belongs to all B'. For authors who defend a view in the ballpark of this thought, see Reeve (1992: 13ff and 2000: 27ff), Anagnostopoulos (1994: ch.6) and Irwin (2000b: 106ff); cf. also Kiefer (2007: 92-93). Striker (1985) contains a helpful discussion of FMP-demonstrations, and is inclined to think that Aristotle hasn't quite made up his mind about the details of FMP-demonstrations. Note that if one thinks that only one premise of FMP-demonstrations is true for the most part, their logical status is easy to settle: one premise is true of necessity and the other has a weaker modal force, and might even just be spelt out in term of possibility. Yet if one wants to allow for both premises to be true for the most part, more work is in order. In principle it seems to us that if 'for the most part' does not belong to the logical form of premises and conclusions of demonstrations, then its gloss in terms of 'if nothing prevents' plausibly does not belong to the logical form of these claims either. The qualification 'if nothing prevents' may (A) directly restrict the modal domain one appeals to when describing the status of claims of a demonstrations, so to state that they are necessary whenever nothing prevents. Or, provided one assumes that premises and conclusions of demonstrations are always implicitly or explicitly quantified, the qualification 'for the most part' may (B) restrict the domain of quantification of a non-modally quantified copula (say, 'belongs to all') so that we only have to consider scenarios in which nothing prevents when assessing the truth-value of the quantified claim. Either way, we end up having either a restricted necessity claim. Perhaps Aristotle has in mind something along these lines when thinking of FMP-demonstrations. The question of whether this picture always guarantees valid inferences, and if so on what basis, requires of course further scrutiny. We shall leave a proper account of FMP-demonstrations to future occasions.

but with some work it is possible to spell them out in full. We shall consider two examples of demonstrations belonging to natural sciences and two examples of demonstrations belonging to *technai*.[49] As we shall see, all of these demonstrations involve premises that are true only for the most part—they are FMP-demonstrations.

1) River Demonstration

In *Posterior Analytics* II.15, Aristotle alludes to a couple of demonstrations concerning rivers:

> (**T14**) Why does the Nile flow more abundantly at the end of the month? Because the end of the month is stormier.
>
> Διὰ τί ὁ Νεῖλος φθίνοντος τοῦ μηνὸς μᾶλλον ῥεῖ; διότι χειμεριώτερος φθίνων ὁ μείς. (*Post. An*. II.15, 98a31-32)

The passage implicitly assumes a point he made earlier on—namely that for each why-question and its answer there is an associated demonstration where the cause is picked up by the middle term and the effect is described by the conclusion (cf. *Post. An*. II.2 90a6-7, II.8 93b9ff, II.11).

To find the conclusion of our demonstration we need to look at the claim contained in the why-question, that the Nile flows more abundantly at the end of a month. It is slightly surprising to find a reference to the Nile here. Strictly speaking, demonstrations contain only universal terms. Aimar (ms) argues that in *Posterior Analytics* I.8 Aristotle claims that one can replace a terms that appears within a demonstration with another term, where the latter term denotes a particular which instantiates the relevant universal the particular term instantiating the universal denoted by that term, so to get a syllogism that, "as it were, accidentally" (ὥσπερ κατὰ συμβεβηκός, 75b25) demonstrates the conclusion. Accordingly, one can extrapolate the relevant universal demonstration from this kind of syllogisms, by replacing the term denoting a particular with the relevant universal it instantiates. We shall assume this picture here.

[49] A healthy number of papers has made the case for the claim that Aristotle applies his scientific method in his discussion of the natural sciences—cf. Leunissen (2010a) for an example, with a direct focus on the *Posterior Analytics.* On the similarities between demonstrations in the natural sciences and geometric demonstrations, see Gotthelf (1987: 197-198, 1997, and 2011) and Lennox (2001b). For methodological similarities between strict sciences and natural sciences, see also Angioni (2002), Balme (1987), Bolton (1987, 1997), Charles (1997, 1999, 2000), Detel (1997, 1999), and Pellegrin (1986).

The proper demonstration to be associated with (T14) is thus presumably about rivers of a certain sort, rather than just about the Nile. The middle term picks up the cause mentioned in the answer to the why-question—namely the fact that it the relevant period is stormier. So, the demonstration Aristotle has in mind goes along the following lines:

A: Such-and-such rivers flowing more abundantly.

B: Stormier periods.

C: The end of the month.

River Demonstration

Such-and-such rivers flowing more abundantly belong to stormier periods.

Stormier periods belong to the end of the month.

So,

Such-and-such rivers flowing more abundantly belong to the end of the month.

This demonstration belongs to the study of nature. The status of the first premise is not obvious. But plausibly the second premise is true for the most part rather than of necessity. This is because presumably it is not necessarily the case that there are more storms at the end of the month than at any other time of the month—this is only the case if nothing prevents the natural course of things. It follows that the conclusion of this demonstration is true only for the most part.

2) Broad-Leaved Trees Demonstration

Here is another example of demonstration from natural sciences:

> (**T15**) [W]hy do trees shed leaves? If it is because of solidification of their moisture, then if a tree sheds its leaves, solidification must be the case, and if solidification is the case—not for everything but for tree—, [the tree] sheds leaves.
>
> [Δ]ιὰ τί τὰ δένδρα φυλλορροεῖ; εἰ δὴ διὰ πῆξιν τοῦ ὑγροῦ, εἴτε φυλλορροεῖ δένδρον, δεῖ ὑπάρχειν πῆξιν, εἴτε πῆξις ὑπάρχει, μὴ ὁτῳοῦν ἀλλὰ δένδρῳ, φυλλορροεῖν. (*Post. An*. II.16, 98b36-38)

Once again, the demonstration is not properly spelt out. But we have enough details to reconstruct it in full. The passage starts off by referring to ‘trees’ in the plural (98b36) and then switches to the singular (98b37-38). We shall pick the first of these two options. The

conclusion of our demonstration is the object of the why-question—that trees shed their leaves. Earlier on in the chapter Aristotle is slightly more precise and clarifies that he has in mind a specific type of tree—broad-leaved trees (cf. 98b3). The cause is the solidification of moisture. So the demonstration seems to go like this:

A: Leaf-shedding.
B: Solidification of moisture.
C: Broad-leaved trees.

Broad-leaved Trees Demonstration
Leaf-shedding belongs to solidification of moisture.
Solidification of moisture belongs to broad-leaved trees.
So,
Leaf-shedding belongs to broad-leaved trees.

The claim that broad-leaved trees solidify their moisture (at a given time of the year) is presumably true not of necessity but only for the most part. If this premise holds for the most part, so does the conclusion.[50] So the demonstration establishes that for the most part broad-leaved trees shed their leaves (at a given time of the year).

3) War Demonstration

Crucially enough, within the *Posterior Analytics* Aristotle also gives us examples of demonstrations that belong to *technai*. Even in this case, the premises of the relevant demonstration only hold for the most part. We offer two such examples.

The first example concerns the art of war:

[50] Cf. Charles (2000: 204-207). Charles adds that Aristotle aims at showing that in all broad-leaved trees leaf-loss (if it belongs to them all in virtue of their being broad-leaved trees) will always and only occur because of moisture solidification. It is unclear whether the second premise qualifies as being true of necessity. But the claim seems to pick up on a relation of efficient causation, and this suggests that it is likely to be a claim that is true for the most part. Nothing in the main text depends on this assumption, however.

(**T16**) Why did the Persian war come upon the Athenians? What is the cause of the Athenians' being warred upon? That they attacked Sardis with the Eretrians—this initiated the change. War A, being first to attack B, Athenians C. B holds of C (being first to attack holds of the Athenians), and A holds of B (men make war on those who have first wronged them). Therefore, A holds of B (being warred upon holds of those who first began), and this — B —of the Athenians (they first began it). Therefore, here too the cause, what initiated a change, is a middle term.

Τὸ δὲ διὰ τί ὁ Μηδικὸς πόλεμος ἐγένετο Ἀθηναίοις; τίς αἰτία τοῦ πολεμεῖσθαι Ἀθηναίους; ὅτι εἰς Σάρδεις μετ' Ἐρετριέων ἐνέβαλον· τοῦτο γὰρ ἐκίνησε πρῶτον. πόλεμος ἐφ'οὗ Α, προτέρους εἰσβαλεῖν Β, Ἀθηναῖοι τὸ Γ. ὑπάρχει δὴ τὸ Β τῷ Γ, (τὸ προτέροις ἐμβαλεῖν τοῖς Ἀθηναίοις), τὸ δὲ Α τῷ Β· (πολεμοῦσι γὰρ τοῖς πρότερον ἀδικήσασιν). ὑπάρχει ἄρα τῷ μὲν Β τὸ Α (τὸ πολεμεῖσθαι τοῖς προτέροις ἄρξασι)· τοῦτο δὲ τὸ Β τοῖς Ἀθηναίοις· (πρότεροι γὰρ ἦρξαν). μέσον ἄρα καὶ ἐνταῦθα τὸ αἴτιον, τὸ πρῶτον κινῆσαν. (*Post. An.* II.11, 94a36-94b8)

The passage comes from a chapter in which Aristotle wants to establish that the middle term of a demonstration may pick up any of the four causes. This is meant to be an example of a demonstration with a middle term that picks up an efficient cause.

In (T16), Aristotle slightly rephrases the terms of his demonstration along the way. At first term A is 'war' (*polemos*, 94a39), but then it becomes 'being warred upon' (*to polemeisthai*, 94b5-6). We assume the rephrase is an attempt at being slightly more precise and use 'being warred upon' in the reconstruction below. On the face of it, the demonstration Aristotle has in mind seems to contain at least one term referring to particulars—'the Athenians' (94b2-3). Just like we did in the Nile example above, here we assume that the term denoting particulars goes proxy for an associated term denoting a universal, which is in turn the term that appears in the proper version of the demonstration. Although the passage does not tell us what is the relevant universal feature the Athenians might be instantiating, we can make a guess. We will take this to be the feature of trying to expand one's territory. We get the following demonstration:

A: Being warred upon.

B: First attacking.

C: Trying to expand.

War Demonstration

Being warred upon belongs to attacking first.

Attacking first belongs to trying to expand.

So,

Being warred upon belongs to trying to expand.

This demonstration accounts for the fact that those who try to expand get warred upon—this is because they first attack their enemy. Once again, it seems that it involves claims holding for the most part. After all, a premise like 'being warred upon belongs to attacking first' is plausibly true of necessity, but only for the most part. But then the conclusion is true for the most part.

4) House Demonstration

Posterior Analytics II.12 refers to a demonstration belonging to the art of house-building:

> (**T17**) And it is in this way with regard to tasks (*epi tōn ergōn*): if a house has come to be, it is necessary that stones have been cut and have come to be. Why is this? Because necessarily a foundation has come to be, if also a house has come to be. If a foundation, then necessarily stones have come to be earlier. Again, if there will be a house, in the same way there will have to be stones earlier. And it is shown through the middle term in this way: for there will be a foundation earlier.
>
> Ἔχει δὲ οὕτως ἐπὶ τῶν ἔργων· εἰ γέγονεν οἰκία, ἀνάγκη τετμῆσθαι λίθους καὶ γεγονέναι. τοῦτο διὰ τί; ὅτι ἀνάγκη θεμέλιον γεγονέναι, εἴπερ καὶ οἰκία γέγονεν· εἰ δὲ θεμέλιον, πρότερον λίθους γεγονέναι ἀνάγκη. πάλιν εἰ ἔσται οἰκία, ὡσαύτως πρότερον ἔσονται λίθοι. δείκνυται δὲ διὰ τοῦ μέσου ὁμοίως· ἔσται γὰρ θεμέλιος πρότερον. (*Post. An.* II.12, 95b31-37)

We will abstract for present purposes from the fact that Aristotle here gives us tensed premises, such as the claim that 'there will be a house'. Our assumption is that these premises are derivative on a more canonical demonstration that denotes not events but universals.[51] Such a demonstration seems to go as follows:

A: Stones.

B: Foundation.

C: House.

[51] Leunissen (2010a: 45) states that she takes this example to illustrate "the mode of inference that is appropriate with regard to consecutive causal chains and not necessarily a demonstration itself". Yet at the same time she accepts that the chapter offers a blueprint for applying demonstrations to natural sciences. The blueprint she has in mind (which we would not quite call the blueprint of a scientific demonstration since it has terms denoting particulars) is satisfied by Aristotle's house example. As far as we can tell, Leunissen's hesitation to connect the house example to demonstrations is due to the fact that its subject matter pertains to the art of building.

House Demonstration

Foundation belongs to house.

Stones belong to foundation.

So,

Stones belong to house.

Plausibly at least one of the premises of this demonstration, if not both, is true not of necessity but merely for the most part. For example, it is presumably not necessary that foundations are made of stones. One may build a house out of a less ideal material, such as of wood. Even if that will result in a less durable house, it is plausibly still a house. As long as a given material allows a foundation to fulfill to some extent its role of supporting a house, a house could be made with it.[52]

Thus in the *Posterior Analytics* Aristotle refers to both *technai* and sciences of nature as examples of demonstrative bodies of knowledge and gives us examples of demonstrations from both sets of disciplines. The relevant demonstrations include premises and therefore conclusions that are true for the most part. We conclude that he takes *technai* and natural sciences to be structurally alike: demonstrative bodies of knowledge that include FMP-demonstrations. If two bodies of knowledge that can be systematized as demonstrations qualify as sciences, then the natural sciences and *technai* equally qualify as sciences.

§7. *Technai* and natural sciences: differences and connections

So far, we have seen that both natural sciences and *technai* can be modelled in terms of FMP-demonstrations. To complete the picture, this section discusses how technical sciences differ from natural sciences.

A way of drawing the line between natural sciences and *technai* is that they investigate *different kinds of things*: natural sciences concern natural things, whereas *technai* concern products of *technē*—i.e., artificial things. Aristotle distinguishes between natural things and artificial ones in *Physics* II.1. Natural things have an inner principle of change and

[52] It is unclear whether Aristotle also takes it not to be necessary that a house has foundations, or whether he thinks this has to be necessarily the case. In principle, one may argue, as long as it fulfils its goal of sheltering food and people, a given house may not have foundations. The text does not give us enough details to settle this issue.

stability (*Phys*. II.1 192b13-33; cf. also *Met*. E.1 1025b19-21). More specifically, natural things change in virtue of what they are—their nature. For instance, a tree has an inner principle of change in that its own nature—its being a tree—is responsible for some of its changes, such as growing and shedding leaves. By contrast, artificial things *lack* such an inner principle of change (*Phys*. II.1 192b16-19). A bed is not able to change itself in virtue of being a bed: it always takes an artisan to extend a bed. The distinction between natural things and artificial ones is mutually exclusive. So within the realm of contingency natural sciences look at things that are such as to have an inner principle of change, whereas technical sciences look at things that lack such a principle.[53]

Yet there are cases for which drawing a line between natural and artificial items seems not to be enough to set a technical and a natural science apart. Consider medicine. As we have seen, the object of medicine is health. But health is studied by biology too. After all, one can be naturally healthy.[54] Albeit this result is in itself plausible, it seems to raise a problem for Aristotle. At times he suggests one can individuate sciences in terms of their objects. For instance, in his view biology studies living things and geometry studies magnitudes. On this picture, different sciences study *different* things. The trouble is that both medicine and human biology are set to find out the causes of health. Moreover, as we have seen, medicine and biology are also structurally alike: they both involve FMP-demonstrations. So, medicine and part of biology are both sciences that consist of FMP-demonstrations about health. But then it is not clear how Aristotle can avoid the conclusion that medicine is just part of biology.

To address this issue, let us look more closely at what Aristotle says about artificial things. In the *Physics* he states:

> (**T18**) A bed and a coat and anything else of that sort, *qua* receiving these designations— i.e. in so far as they are products of *technē*—have no innate impulse to change. But in so far as they happen to be composed of stone or of earth or of a mixture of the two, they *do* have such an impulse, and just to that extent—which seems to indicate that nature is a principle or cause

[53] For a helpful account of the notion of nature in Aristotle, see Kelsey (2003).

[54] Aristotle seems to assume that health belongs to natural science in many places. For instance, he makes that assumption when he says: "For in those [i.e. the contemplative sciences] the starting point is what is, in these [i.e. the natural sciences] what is going to be: for since health or man is such and such, it is necessary that this be or come to be" ("Η γὰρ ἀρχὴ τοῖς μὲν τὸ ὅν, τοῖς δὲ τὸ ἐσόμενον· ἐπεὶ γὰρ τοιόνδε ἐστὶν ἡ ὑγίεια ἢ ὁ ἄνθρωπος, ἀνάγκη τόδ'εἶναι ἢ γενέσθαι", *PA* I.1 640a3-5). Setting aside the specific details of the passage, it is clear that here health is one of the things natural sciences can be concerned with.

> of being moved and of being at rest in that to which it belongs primarily, in virtue of itself and not accidentally.
>
> Κλίνη δὲ καὶ ἱμάτιον, καὶ εἴ τι τοιοῦτον ἄλλο γένος ἐστίν, ᾗ μὲν τετύχηκε τῆς κατηγορίας ἑκάστης καὶ καθ'ὅσον ἐστὶν ἀπὸ τέχνης, οὐδεμίαν ὁρμὴν ἔχει μεταβολῆς ἔμφυτον, ᾗ δὲ συμβέβηκεν αὐτοῖς εἶναι λιθίνοις ἢ γηΐνοις ἢ μικτοῖς ἐκ τούτων, ἔχει, καὶ κατὰ τοσοῦτον, ὡς οὔσης τῆς φύσεως ἀρχῆς τινὸς καὶ αἰτίας τοῦ κινεῖσθαι καὶ ἠρεμεῖν ἐν ᾧ ὑπάρχει πρώτως καθ'αὐτὸ καὶ μὴ κατὰ συμβεβηκός. (*Phys.* II.1, 192b16-192b23)

A bed lacks an internal principle of change *insofar as it is due to technē* (196b18). But insofar as a bed is made of stones and earth, it has a nature (196b19-23). In this latter case, a bed is considered *as made of things that have a nature*. Hence, a bed is natural to the extent to which its materials are natural—namely have an internal principle of change. This shows that Aristotle allows one to consider one and the same thing under different aspects.[55] In (T18), for example, he considers artefacts both *qua* having natural components, and *qua* due to *technē*.

Health is more complex than beds. In the case of a bed, only the materials of which it is made can be due to nature. Health, by contrast, can itself be due to nature. After all, an animal is by default naturally healthy, and only lacks health when something prevents it from being healthy. When one is naturally healthy, one has health *qua* due to nature. But when sick, one may get better because of the intervention of a doctor. When one gets healthy because of a doctor, one comes to have health *qua* due to *technē*.[56] This distinction gives us resources to characterize the difference between medicine and the branch of biology that concerns health—biology$_h$, for short. Biology$_h$ studies health insofar as it is due to nature (health-*qua*-due-to-nature). Medicine studies health insofar as it is due to *technê* (health-*qua*-due-to-*technē*). So biology$_h$ and medicine are about different things in the sense that they consider health under different respects. The two respects under which health can be considered correspond to the different kinds of causal paths that can lead to health. One path

[55] For the claim that *qua*-clauses do not pick up altogether different things, see Netz (2006). For the claim that Aristotle only needs sciences to study things under different aspects to be distinct, see also Steinkrüger (2018).

[56] There are of course also the interesting cases of living beings that exist (either at all or in their current form) because of technical knowledge—say, some human-bred animals, such as cows (we thank Christian Pfeiffer for this example). It seems that Aristotle needs to conclude that to the extent that these things exist due to human knowledge, they are artifacts—just like health brought about by doctors is, to this extent, an artifact. It thus seems plausible that for Aristotle having a nature (rather than just being entailed by a given nature) may not imply being fully due to nature. Some contemporary examples are perspicuous in this respect: cloning and further biotechnologies have shown us that substances like Molly the sheep can be due to *technē*, and yet have a nature once created. For a contemporary account of the differences and connections between biology and technology, see Kingma (2018).

consists only of natural causes—namely inner principles of change. The other path includes references to artificial causes—e.g., rubbing (*Met*. Z.7 1032b26) or giving honey-water (*Met*. E.2 1027a23). Since biology$_h$ and medicine spell out different causal paths that lead to health, they are distinct bodies of knowledge.

Now even though medicine and biology are distinct, it is still the case that these disciplines both concern health. In fact they are so closely related that it is unclear how one could be a doctor and *completely* ignorant about biology. After all, if one were, one wouldn't really have a sense of what natural state one is aiming at restoring in a body. But then presumably at least some claims from biology$_h$ need to be, somehow, part of medicine. Can Aristotle accommodate this hunch?

In order to better understand the relation between medicine and biology, it is helpful to look at how Aristotle conceived of different possible relations between sciences. The *Posterior Analytics* give an example of a demonstration of medicine that *presupposes* a theorem from geometry:

> (**T19**) The why differs from the fact [*lit*. the that] in another way, insofar as each is studied by a different science (*epistēmēs*). These are the cases which are related to each other in such a way that one falls under (*hupo*) the other, such as optics to geometry, mechanics to solid geometry, harmonics to arithmetic. […] Also many of the sciences (*epistēmōn*) which do not fall under one another are related in this way, like medicine to geometry. For it is up to the doctor to know that circular wounds heal more slowly, and up to the geometer to know why.
>
> Ἄλλον δὲ τρόπον διαφέρει τὸ διότι τοῦ ὅτι τῷ δι'ἄλλης ἐπιστήμης ἑκάτερον θεωρεῖν. τοιαῦτα δ'ἐστὶν ὅσα οὕτως ἔχει πρὸς ἄλληλα ὥστ'εἶναι θάτερον ὑπὸ θάτερον, οἷον τὰ ὀπτικὰ πρὸς γεωμετρίαν καὶ τὰ μηχανικὰ πρὸς στερεομετρίαν καὶ τὰ ἁρμονικὰ πρὸς ἀριθμητικὴν [...] πολλαὶ δὲ καὶ τῶν μὴ ὑπ'ἀλλήλας ἐπιστημῶν ἔχουσιν οὕτως, οἷον ἰατρικὴ πρὸς γεωμετρίαν· ὅτι μὲν γὰρ τὰ ἕλκη τὰ περιφερῆ βραδύτερον ὑγιάζεται, τοῦ ἰατροῦ εἰδέναι, διότι δὲ τοῦ γεωμέτρου. (*Post. An.* I.13, 78b34-79a16, *passim*)

(T19)'s example goes as follows. A circular wound heals more slowly than a non-circular one. This fact is studied within medicine. Yet when it comes to explaining why circular wounds heal more slowly, medicine needs to appeal to some fact belonging to geometry (79a13-16). So when it comes to the fact that circular wounds heal more slowly, medicine contains the claim *that* this is the case but geometry allows us to explain *why* this is the case.

Let us spell this point out more slowly. Geometry explains facts about circular figures, and thus includes demonstrations such as the following:

Geometrical demonstration of circularity

Equidistant points from the centre belongs to circular.

Greater surface/perimeter ratio belongs to equidistant points from the centre.

So,

Greater surface/perimeter ratio belongs to circular.

This demonstration accounts for the fact that circular figures have a greater surface/perimeter ratio than figures of a different shape. They have a greater surface than other figures because all of their points are equidistant from the centre.

(T19) assumes that for some geometrical reason circular wounds heal slowly. This is because the demonstration of the fact that circular wounds heal slowly depends on considering them *insofar as* they are circular. So the cause of this fact has to be is individuated within geometry, namely the science that is concerned with circularity. We thus get the following demonstration:

Medical demonstration of circular wounds

Greater surface/perimeter ratio belongs to circular (wound). *[From geometry, necessarily true]*

Slower to heal belongs to greater surface/perimeter ratio. *[From medicine, true for the most part]*

So,

Slower to heal belongs to circular (wound). *[Medicine, true for the most part]*

This demonstration *presupposes*, or borrows, a theorem from geometry—that a circular thing has a higher surface/perimeter ratio—and applies it to a relevant restricted domain within medicine—the domain of circular wounds.[57] Thus we have a demonstration which belongs to medicine but which contains a middle term, the term that denotes the *explanans*, which is derived from an another science. Because of this, Aristotle claims that the doctor knows *that* circular wounds are slower to heal, the but geometry is the one who knows *why* (79a14-16).[58]

[57] We agree with Barnes (1994: 160) that this demonstration violates the criteria of *Posterior Analytics* I.7, according to which a science should not cross into another (75b3-6). But we disagree that this is a problem for Aristotle's account of kind-crossing, and rather think that it falls under the range of acceptable exceptions Aristotle quickly refers to at 75b6. For accounts of kind-crossing in Aristotle, see Hankinson (2005) and Steinkrüger (2018).

[58] In principle, one may consider whether it is possible to borrow merely a term from another science, rather than an entire theorem. In the present cause, the question is whether one could borrow the middle term from geometry, but still use a major and minor term that merely belong to medicine. Yet in addition to the fact that

As (T19) makes clear (79a14-79a16), the relation between geometry and medicine is importantly *different* from the relation which is in place between sciences like arithmetic and harmonics. The harmonics-arithmetic pair is for Aristotle an example of a science *falling under* (*hupo*) another (78b34-78b36). We understand the relationship of falling under thus:

> (*Falling under*) A science S *falls under* another science S* whenever *all* of the demonstrations of S borrow a theorem from S*.

In these cases, the science below always applies theorems from the upper science above (79a14-79a16). For example, each demonstration of harmonics relies on a theorem of arithmetic. Since a theorem contains two of the three terms involved in a demonstration, and the middle term is repeated in both premises, if a demonstration takes a theorem from another science it takes the middle term from that science. So, harmonics merely provides arithmetic explanation of phenomena concerning sounds. This is why Aristotle states that subordinated sciences like harmonics never state the why (78b35-79a13).

Yet the case of medicine and geometry is *not* a case of a science falling under another (79a13-16). Aristotle does not make explicit why. But after saying that this is a different case, he gives us one case of a demonstration from medicine which borrows a theorem from geometry. So he seems to allow that *some* of the demonstrations of medicine rely on geometry. We therefore suggest characterizing this presupposition-relation as follows:

> (*Presupposing*) A science S *presupposes* another science S* whenever *some but not all* of the demonstrations of S use theorems from S*. When this is the case, S does not fall under S*.

Although there are demonstrations that rely on middle terms from geometry, medicine also contains demonstrations that do not rely on geometry. The only part of medicine that falls under geometry is the set of medical demonstrations that use geometrical theorems.[59]

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this route would, as far as we can tell, lead to insurmountable clashes with Aristotle's restrictions on kind-crossing from *Posterior Analytics* I.7, the example of (T19) contains a reference to circularity in a term other than the middle term. Accordingly, it seems to us that the most natural interpretation of the passage is that some sciences borrow premises from other sciences.

[59] The distinction between falling under and presupposing tends to be overlooked in the literature. For a nice exception, see Pfeiffer (2018: ch.4). Pfeiffer recognizes that there must be a subordination relation weaker than

So much for medicine and geometry. We now have in place the resources we need in order to reconsider the relation between medicine and biology$_h$. The case of medicine and biology$_h$, we suggest, is *a special case of presupposing*. We have already seen that these two sciences differ in terms of their subject matter: one considers health *qua*-due-to-art and the other considers health *qua*-due-to-nature. In *De Respiratione*, Aristotle adds that medicine take *principles* from biology:

> (**T20**) But as to health and disease, not only the doctor but also the natural scientist must appropriately state the causes. The extent to which they differ, and investigate different things, must not escape us; since the facts show that the subject matter is at least to some extent conterminous. For the smart and curious doctors mention some things from natural science, and claim to take the principles from it; whereas the most accomplished scientists developing their investigation of nature, complete it with the principles of medicine.
>
> Περὶ δὲ ὑγιείας καὶ νόσου οὐ μόνον ἐστὶν ἰατροῦ ἀλλὰ καὶ τοῦ φυσικοῦ μέχρι του τὰς αἰτίας εἰπεῖν. ᾗ δὲ διαφέρουσι καὶ ᾗ διαφέροντα θεωροῦσιν, οὐ δεῖ λανθάνειν, ἐπεὶ ὅτι γε σύνορος ἡ πραγματεία μέχρι τινός ἐστι, μαρτυρεῖ τὸ γινόμενον· τῶν τε γὰρ ἰατρῶν ὅσοι κομψοὶ καὶ περίεργοι λέγουσί τι περὶ φύσεως καὶ τὰς ἀρχὰς ἐκεῖθεν ἀξιοῦσι λαμβάνειν, περὶ φύσεως πραγματευθέντων οἱ χαριέστατοι σχεδὸν τελευτῶσιν εἰς τὰς ἀρχὰς τὰς ἰατρικάς. (*De Resp.* 480b22-30)[60]

Here 'principles' plausibly refers either to ultimate causes (those that are not in turn taken to be caused by something else) or to the indemonstrable premises that individuate these cases, namely those from which all demonstrations proceed (*Met* Δ.1 1013a16, *Post. An.* I.2 72a7-15). On either option, Aristotle commits to the claim that medicine takes from biology at least some of the indemonstrable premises (*archai apodeixeôs*, *Post. An.* I.2 72a7) of its demonstrative system.[61] For instance, a doctor sometimes reasons about the fact that heat is

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falling under, and convincingly argues that the science of nature and geometry must relate by virtue of a weak subordination relation—but he does not commit to a full characterization of this relation.

[60] *De Sensu* contains a passage that makes ultimately the same point: "And it is also up to the natural scientist to grasp the first principles of health and disease, for neither health nor disease can occur in lifeless things. For this reason, most inquirers into nature and those doctors who pursue their art more philosophically are closely related: while the former bring their inquiry up to the things that medicine is concerned with, the latter begin from things that pertain to the investigation of nature." ("Φυσικοῦ δὲ καὶ περὶ ὑγιείας καὶ νόσου τὰς πρώτας ἰδεῖν ἀρχάς· οὔτε γὰρ ὑγίειαν οὔτε νόσον οἷόν τε γίγνεσθαι τοῖς ἐστερημένοις ζωῆς. διὸ σχεδὸν τῶν περὶ φύσεως οἱ πλεῖστοι καὶ τῶν ἰατρῶν οἱ φιλοσοφωτέρως τὴν τέχνην μετιόντες, οἱ μὲν τελευτῶσιν εἰς τὰ περὶ ἰατρικῆς, οἱ δ'ἐκ τῶν περὶ φύσεως ἄρχονται." *De Sensu* I.1 436a17-436b1.) In translating this passage, Bolton (2018: 282) takes 'most' to scope over both 'τῶν περὶ φύσεως' and 'τῶν ἰατρῶν'. We are not sure that this is the most natural reading.

[61] That these are not just premises but indemonstrable premises is further confirmed by the fact that in the parallel passage in *De Sensu* (cf. fn54) Aristotle says that medicine takes its *first* principles (τὰς πρώτας ἀρχάς, 436a17-18) from biology. Sometimes he uses 'principle' to refer to indemonstrable premises; other times he uses it to refer to one of the terms contained within an indemonstrable premise (cf. Malink: 2017 for further discussion of this point). Yet it is unclear how a science could merely borrow a term denoting X from another

required to heal (cf. *Met*. Z.7 1032a27-1032b21). The demonstration he seems to have in mind is something like the following:

> Warmth belongs to health. *[From biology, true of necessity]*
> Rubbing belongs to warmth. *[From medicine, true for the most part]*
> So,
> Rubbing belongs to health. *[Medicine, true for the most part]*[62]

This demonstration assumes a biological account of health—i.e., that health is some sort of warmth in a body—and then demonstrates that rubbing belongs to health. Although it pertains to medicine, it presupposes a claim from biology. In this sense, *medicine starts where biology ends*: the premises medicine borrows from biology, such as the claim that health is a balance of heat and cold in the body or the claim that an eye is such and such an organ, play a special role in that they act as principles from which other things are derived.

§8. One sense in which *technē* is productive

We have seen that for Aristotle states that *technē* is the account of a given product, and it qualifies as knowledge of that product. We have also seen that the relevant knowledge is a body of knowledge about the product which can be modelled as set of FMP-demonstrations. Shortly after telling us that *technē* is an account of the product, *Metaphysics* Z.7 continues thus:

> (**T21**) The healthy [patient] comes to be when one thinks (*noêsantos)* in this way. Since health is this (*todi*), necessarily if [the patient] is to be healthy, this must be present — say, a uniform state—and if that, heat. And one keeps thinking in this way, until one gets to a final thing

science without also borrowing an entire theorem stating what X is. For helpful elucidations of different uses of the term '*archê*' in Aristotle, see Mann (2011) and Malink (2017). Note that (T20) does not clarify whether *all* of the principles of medicine come from biology, or whether only *some* of them do (the definite article at 480b24 is not enough to settle this). We shall leave this issue open, and assume that medicine takes at least *some* of its first principles from biology.

[62] Cf. *Met*. Z.7 1032b6ff. We go back to this demonstration and the passage we extrapolate it from in §8. Note that in this demonstration the middle term is not an efficient cause. Aristotle allows for the middle term to pick up different kinds of causes (cf. *Post. An.* II.11; for an account, see Mignucci: 1996) and here plausibly the middle term picks up the formal cause. It should also be mentioned that the first premise of the rubbing as stated in the main text represents for Aristotle a rough-and-ready definition of health, and he allows that strictly speaking heat is a part of health, and health is a certain balance of heat and cold in a body (cf. *Met*. Z.7 1032b19-1032b21). But when dealing with an over-cold body, for a doctor assuming that health is heat in the body will do.

> which one can make. Then from this point onward the process is called 'making' —the one towards being healthy.
>
> Γίγνεται δὲ τὸ ὑγιὲς νοήσαντος οὕτως· ἐπειδὴ τοδὶ ὑγίεια, ἀνάγκη εἰ ὑγιὲς ἔσται τοδὶ ὑπάρξαι, οἷον ὁμαλότητα, εἰ δὲ τοῦτο, θερμότητα· καὶ οὕτως ἀεὶ νοεῖ, ἕως ἂν ἀγάγῃ εἰς τοῦτο ὃ αὐτὸς δύναται ἔσχατον ποιεῖν, εἶτα ἤδη ἡ ἀπὸ τούτου κίνησις ποίησις καλεῖται, ἡ ἐπὶ τὸ ὑγιαίνειν. (*Met*. Z.7, 1032b6-10)

Aristotle here considers the reasoning a doctor needs to undertake in order to make a patient healthy. There are two stages to the doctor's performance. Stage-1 is at the level of thinking: the doctor thinks the problem through and infers what she needs to do to restore health. Stage-2 is the actual action, or set of actions, the doctor performs. The action the doctor performs is the one indicated as the conclusion of her train of thought.

The context suggests that (T21) aims at showing how technical knowledge can lead one to bring about a given product. We take the reference to 'this' (*todi*) at 1032b6 and 1032b7 to refer to kinds, rather than particulars. The doctor starts off thinking about what kind of thing health is and then reasons backwards.[63] Since being healthy amounts to uniformity in a body, she must make the patient's body uniform. To get uniformity, one requires heat. So the doctor has to warm up the patient.

In (T21), the doctor's train of thought seems to be deliberative, rather than demonstrative. The level of deliberations and the level of demonstrations are importantly *distinct*. The level of deliberations is the level at which one considers what specific action(s) to perform (cf. *EN* III.3 1112b8-9). For instance, a doctor engages in deliberation in deciding what to do to heal particular patient. So the level of deliberation concerns particulars. By contrast, the level of demonstrations merely concerns universals. When one aims at spelling out some of the demonstrations of a science—if one ever does—one tries to find out premises and conclusions with terms that only denote universals. Demonstrative reasoning is syllogistic, since demonstrations are syllogisms. But we make here *no* assumption about the structure of the kind of reasoning one engages into when deciding what to do, and how exactly this leads to action. So, among other things, we leave open that this reasoning may not be, or at least need not be, inferential.

[63] Aristotle claims that "[a]s in the contemplative sciences the hypotheses are the starting points, so in the productive sciences the end is the starting point and hypothesis" ("[ὥ]σπερ γὰρ ταῖς θεωρητικαῖς αἱ ὑποθέσεις ἀρχαί, οὕτω καὶ ταῖς ποιητικαῖς τὸ τέλος ἀρχὴ καὶ ὑπόθεσις", *EE* II.11 1227b28-30; see also 30-33). This suggests that the principles of a *technê* state the goal of the *technê*. In the case of medicine, they state what health is.

The reason why we make no assumption about deliberative reasonings is the following. On this occasion, we do not wish to account for how one goes from possessing a *technē* to actually bringing about a product. So we do not aim at clarifying how *technai* are productive in the sense of leading us to act (nor do we assume that they are productive in this sense). Our focus here is the content of technical knowledge. Accordingly, our goal is to clarify a different sense in which *technai* are productive, namely the sense in which the very content of technical knowledge makes *technai* qualify as productive sciences.

Thus in considering (T21) our only assumption will be this. Since in the context of (T21) Aristotle wants to show that the process of production ultimately depends on technical knowledge, and this knowledge is at the level of universals, the passage at least implicitly assumes that in deliberating the doctor *in some sense* relies on technical knowledge of universals.[64] The passage is thus of interest to us because it gives us grounds to extrapolate the demonstration in terms of which one can model such technical knowledge. We suggest that the piece of technical knowledge to be associated with the doctor's reasoning in the passage can be modelled by means of the following demonstration:

Health Demonstration

Heat belongs to uniform.

Uniform belongs to being healthy.

So,

Heat belongs to being healthy.

The demonstration starts from an account of the product: what being healthy is—a uniform state in the body. It also assumes what is required for a uniform state to hold—the presence of heat. It follows that one is healthy when heat is present.

(T21) states that the doctor's thinking can continue (1032b8-10). This suggests there is further knowledge the doctor can in some sense rely on when figuring out how to heal the patient. Aristotle goes back to this point some lines later:

[64] The question of how exactly the doctor relies on this knowledge when deliberating is of course a very interesting one, but not one that we can settle here. For a discussion that is relevant for the sake of addressing this further question, see Callard (ms). Callard (ms) shows that at *Pr. An.* II.21 67a12-16 Aristotle implies that if one knows that every triangle contains angles equal to two right angles, then in some sense one already knows of each particular triangle that it contains angles equal to two right angles. See also Coope (forth). For a recent account of deliberation in Aristotle (and further references), see Callard (forth).

> (**T22**) The maker (*to poioun*) and that whence begins (*archetai*) the process of becoming healthy, if it happens by *technē*, is the form that is in the soul: but if it happens spontaneously, then it is from whatever starts the making of the maker from *technē*, just as in healing presumably the starting point [of the process of becoming healthy] is from heating (and this one makes by rubbing).
>
> Τὸ δὴ ποιοῦν καὶ ὅθεν ἄρχεται ἡ κίνησις τοῦ ὑγιαίνειν, ἂν μὲν ἀπὸ τέχνης, τὸ εἶδός ἐστι τὸ ἐν τῇ ψυχῇ, ἐὰν δ'ἀπὸ ταὐτομάτου, ἀπὸ τούτου ὅ ποτε τοῦ ποιεῖν ἄρχει τῷ ποιοῦντι ἀπὸ τέχνης, ὥσπερ καὶ ἐν τῷ ἰατρεύειν ἴσως ἀπὸ τοῦ θερμαίνειν ἡ ἀρχή (τοῦτο δὲ ποιεῖ τῇ τρίψει). (*Met*. Z.7, 1032b21-26)[65]

This passage considers not just healings due to medicine but also those that happen spontaneously. We shall bracket the latter. As far as healing by medicine goes, Aristotle claims, the doctor produces heat in the patient—say, by rubbing. The reference to rubbing adds another layer to the thinking the doctors entertains. This is enough for us to extrapolate a further demonstration which models knowledge on which the doctor's reasoning relies:

> ***Rubbing Demonstration***
>
> Rubbing belongs to heat.
>
> Heat belongs to healthy.
>
> So,
>
> Rubbing belongs to healthy.

The demonstration starts off assuming that rubbing brings about heat. We also know from the demonstration above that heat comes with health. From these two premises it follows that rubbing brings about health.[66]

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[65] Primavesi's edition currently reads 'τὸ' instead of 'τοῦ' at 1032b22, following A^b and an Arabic translation. So here they go against their tendency to favor E and J. The τοῦ-reading remains supported by α which in turn depends on E and J. We are inclined to prefer it, following Ross (1924, *ad loc*.). Ultimately our interpretation of the passage is compatible with Primavesi's version of the text too.

[66] Although plausibly practical reasonings are often informal and thus not syllogistic, it is worth pointing out that it is not very difficult to spell out syllogisms that piggyback on technical demonstrations. For instance, a syllogism that replaces 'healthy' with a particular patient, like Billy, leads to the following reasoning:

> *Rubbing Syllogism with Particulars*
> Rubbing belongs to heating.
> Heating belongs to Billy.
> So,
> Rubbing belongs to Billy.

The conclusion of this syllogism describes the particular action that the doctor, if she wishes to cure Billy and Billy is sick because of being too cold, has to perform on Billy so to heal him: rubbing Billy. Again this is not enough to imply that when deciding what to do to heal Billy a doctor actually engages in this syllogistic

Note that the rubbing demonstration has as one of its premises the conclusion of the heating demonstration above. Together, they give us a short chain of demonstrations:

Uniform belongs to healthy. Heat belongs to uniform.

Heat belongs to healthy. Rubbing belongs to heat.

Rubbing belongs to healthy.

The conclusion of this chain corresponds to a step in the doctor's production of health in a patient. The process of health is one in which rubbing brings about heat, which in turn brings about the uniform state of the patient, which is health. So the doctor aims at bringing about heat and to do so she performs rubbing.

We can now start to see at least one sense in which Aristotle takes technical knowledge to be productive. This is the sense in which this knowledge is *production-guiding*. Steps in the chain of demonstrations above nicely correspond to the set of stages that have to come about for someone to become healthy: rubbing, presence of heat, and the presence of a uniform state. These steps in turn can guide us to flesh out the steps that are required to bring about a specific outcome. The knowledge we just illustrated with demonstrations is knowledge on which a doctor relies in order to figure out she needs to rub a patient who is too cold.[67] How exactly she relies on this knowledge is an important question to pursue, but we shall not aim at settling it here. We confine to claiming that at least one of the senses in which technical knowledge is *productive* is the following: its demonstrations provide us with recipes that break down the steps for bringing about a given product.[68]

Interestingly enough, the richness of the demonstrative body of knowledge of a *technē* allows one to explain why someone who has *technē* (as opposed to mere expertise) is *flexible*,

reasoning. More arguments would be needed to establish as much, if at all. The question of whether this syllogism qualifies as a practical syllogism is stays open too.

[67] One can equally envisage more complex reasonings, when the procedure requires several steps on the artisan's part—say, in order to build a house, or perform surgery.

[68] Johansen (2017: 125) also points out that the *logos* involved in *technai* must be akin to a recipe but does not provide an account of how such a *logos* can be recipe-like.

in the sense that it can bring about the best possible product under the available conditions (cf. *Rhet*. I.1 1355b12-14, *PA* II.14 658a23-24, *GA* II.6 744b15-16). The relevant demonstrations of a house, for instance, clarify what type of features the relevant materials must have, and all the different ways in which a given material can be worked to make a house. So once someone who has the art of building to the right degree is aware of the conditions—e.g. what kind of materials she can use, what kind of atmospheric pressure the house will need to resist, and so one, she will be able to spell out the best house she can produce with the relevant materials.[69]

The demonstrative structure of technical knowledge also allows one to account for Aristotle's claim that *technai* are productive of contraries (*Met.* Θ.2 1046b4-7, *Met.* Z.7 1032a32-b6). For instance, we can now explain why Aristotle thinks that the art of medicine is knowledge that is productive of both sickness and health. As we have seen, Aristotle spells this out by claiming that in virtue of knowing the form of X an artisan somehow also knows its contrary, the lack of X. Given that to know the form of X amounts to possessing a demonstrative body of knowledge about X, this means that in virtue of possessing this body of knowledge about X the artisan also possesses a demonstrative body of knowledge about not-X. How so?

Let us consider the example of health once again. Aristotle thinks that sickness is lack of health in a body. Now knowing how to bring about health—say, in virtue of grasping the *Rubbing Demonstration* we spelt out above—puts one in a position to spell out how to make a healthy person sick. Here is why. Since being sick is the contrary of being healthy, and heating (a patient) makes the patient healthy, then the contrary of heating (the patient) brings sickness upon the patient. The contrary is cooling. So cooling leads to sickness. But then whatever process leads to cooling (say, putting under ice) makes people sick:

Sickness Demonstration (with positive copulas)

Cooling belongs to sickness.

Putting under ice belongs to cooling.

So,

Putting under ice belongs to sickness.

[69] Coope (forth) points out that the fact that *technai* deal with things that tolerate exceptions impacts the artisan's need to be flexible in a further sense: unlike a student of nature, an artisan needs to deal with exceptional cases.

Since for Aristotle 'sickness (of the body)' sickness is 'not-health (in the body)', and 'not-health (in the body) belongs to B' is equivalent to 'health (in the body) does not belong to B', one can also frame the *Sickness Demonstration* thus:

> ***Sickness Demonstration (with a negative copula)***
> Cooling does not belong to health.
> Putting under ice belongs to cooling.
> So,
> Putting under ice does not belong to health.[70]

But then, when possessing a demonstrative body of technical knowledge about health, one can also figure out technical demonstrations concerning its contrary, namely sickness. Accordingly, when one has the art of medicine one derivatively has productive knowledge of sickness. Demonstration(s) pertaining to sickness will give us an insight into the steps that one needs to perform in order to make people sick. We conclude that thinking of *technē* as demonstrative explains not only why this knowledge qualifies as productive, but also why it is productive of contraries.

§9. Are non-contemplative sciences really sciences?

One may raise the question of whether the productivity of technical knowledge implies that this knowledge is not scientific after all. For Aristotle, some sciences aim at grasping what something is for the mere sake of doing so. These sciences are contemplative (*theōrētikai epistēmai*). A contemplative science is merely directed at knowing its subject matter, and is not defined in terms of some further goal. This category includes not only strict sciences, like mathematics and astronomy, but also the sciences of nature (*Met.* E.1 1025b18ff; cf. *Met*. K.8

[70] We followed Aristotle's practice of giving (most of) his examples of demonstration with indefinite premises. This is not to say that we do not think that Aristotle assumes that premises should be disambiguated so to have a clearly quantified copula. We are inclined to think that he is in fact likely to have to held such a view, and that he often states his premises in the form of indefinite premises practice merely for quickness of exposition. If this is turns out to be correct, one can further precisify the demonstration just illustrated in the main text in such a way as to get a demonstration in *Celarent*. For helpful remarks about demonstrations with conclusions with negative copulas, see Malink (ms: §2) and Ferejohn (1991: 131-138).

1064a10ff).[71] Thus mathematics is merely directed at contemplating mathematical truths, rather than also at producing mathematical objects. Similarly, natural scientists are merely interested in contemplating nature, rather than at producing natural things. By contrast, the ultimate goal of technical knowledge is production. An artisan aims at grasping things in order to bring the product about. So the fact that *technai* are productive bodies of knowledge entails that these bodies of knowledge are not contemplative.

It is worth considering whether the fact that technical knowledge is not contemplative disqualifies it from being a science. There is an extent to which this is a terminological issue. *If* one assumes that only contemplative knowledge is scientific, then *technē* does not qualify as a science. But if one assumes that, for a body of knowledge to count as scientific, it ought to be demonstrative, and if technical knowledge is demonstrative, then *technē* qualifies as a science. But then, the question arises of which of Aristotle's notions of knowledge should we ultimately regard as scientific, if any: demonstrative knowledge or contemplative knowledge?

It is no coincidence that our argument brings the question of which kind of Aristotelian knowledge qualifies as scientific to the fore. Scholars have tended to assume that all the bodies of knowledge that are demonstrative are *also* contemplative.[72] Accordingly, in the literature it has been a given that for Aristotle the bodies of knowledge that deserve the title of sciences are at the same time contemplative *and* demonstrative. Yet an upshot of our argument is that there are demonstrative bodies of knowledge that are *not* contemplative—such as *technai*. If so, the notion of demonstrative knowledge is broader than that of contemplative knowledge. Once we keep these two notions apart, the question of which of these two notions of knowledge, if any, is scientific knowledge comes to the fore.

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[71] Sometimes Aristotle uses 'contemplative science' more narrowly, so to only refer to contemplative strict sciences (cf. *PA* I.1 639b24-29). But this is because in some contexts he uses '*epistēmē*' only for demonstrative bodies of knowledge that contain only claims that are true of necessity. Reeve (2000: 35ff) states that Aristotle has a problem of consistency when it comes to the notion of contemplative sciences, since he allows for natural sciences to count as contemplative despite the fact that they are not true of necessity (see also Colaner: 2015, 38ff). The solution to this worry is that Aristotle uses 'contemplative science' more or less broadly in different contexts. Sometimes he uses this expression to include contemplative sciences that look at what holds for the most part, namely the sciences of nature (cf. *Met*. E.1 1025b26ff; *Met.* E.2 1026b6ff, *Met.* K.7 1064b1-6; *Top*. B.6 145a14-16). Yet other times he uses the expression 'contemplative science' in a narrower sense, so that it only refers to sciences concerned with what holds of necessity, and therefore excludes the sciences of nature (cf. *PA* I.1 639b24-29, *EE* II.11 1227b28-32).

[72] See Johansen (2017), Johansen (forth), and Coope (forth) for authors who make this assumption while discussing *technai*. See Lorenz & Morison (forth) and Bronstein (2016: ch.4) for recent examples of authors who make this assumption within the broader context of discussing Aristotle's theory of knowledge.

We do not claim that one *has to* dub any of Aristotle's notions of knowledge as 'scientific'. There is after all something implicitly anachronistic in calling an Aristotelian body of knowledge a 'science'. Etymologically, the term 'science' comes from the Latin *scientia*—which is in itself not obviously connected to Aristotle's epistemological taxonomy. The notion of science currently associated with the English term 'science' has further developed on independent grounds. So we can see reasons for not dubbing any Aristotelian type of knowledge as scientific. The reader who prefers *not* to call any Aristotelian body of knowledge a science can just our point to simply be that *technai* are demonstrative bodies of knowledge. But for the reader who does wish to crown with the title of 'science' one of Aristotle's forms of knowledge, we suggest crowning demonstrative bodies of knowledge. Nowadays science is more closely related to rigorous methodology than to pursuing an inquiry merely for its own sake.[73] Assuming that Aristotle's contemplative bodies of knowledge are the only ones that one should consider as scientific obscures the fact that in his view there are non-contemplative disciplines that are structurally just as rigorous.

§10. Conclusion: a consistent picture of *technē* as a non-strict science

We have argued that for Aristotle a *technē* is a demonstrative body of knowledge of a given kind of product. If Aristotle's theory of demonstration delivers his theory of what a science looks like, then *technai* ought to be sciences too. More specifically, *technai* are non-strict sciences, namely sciences including generalizations about universals that are true either of necessity or for the most part. In this respect, *technai* are analogous to natural sciences. But unlike natural sciences, *technai* are productive in that they break down the steps an artisan has to follow to bring about a product. The claim that *technai* are sciences might sound strange if one assumes that all sciences for Aristotle are contemplative, in the sense of merely directed at grasping their object. But an upshot of the claim that *technai* are demonstrative is precisely that there are demonstrative bodies of knowledge that are not contemplative. To the

[73] That is presumably why people are often unhappy to think of philosophy as scientific but are generally happy to consider scientific disciplines like engineering to be scientific—even the art of coding falls under 'computer *science.*' Note that Aristotle had his own independent reasons for distinguishing sciences in terms of their goals, and thus setting contemplative and technical knowledge apart. In his view, what is instrumental is less valuable. By highlighting that technical knowledge is not instrumental but contemplative knowledge is, he can rank contemplative sciences and *technai* at different points of a goodness scale (cf. *EN* X.7-8).

extent that one is willing to take demonstrative knowledge to correspond to Aristotle's version of scientific knowledge, then, one has to accept that *technai* are sciences too.

We conclude that Aristotle has a consistently strong notion of *technē* as a non-strict science throughout his theoretical and epistemological writings. In fact, this picture is compatible with the ethical writings too. In Book 6 of the *Nicomachean Ethics*, Aristotle clearly denies that *technē* is knowledge (*epistēmē*) (1140b31-1141a1). But, in that context, knowledge only concerns what holds of unqualified necessity:

> (**T23**) For we all suppose that what we know is not capable of being otherwise; of things capable of being otherwise we do not know, when they have passed outside our observation, whether they are or not the case. Therefore, the object of knowledge is of necessity. Hence, it is eternal; for things that are of necessity in the unqualified sense are all eternal, and things that are eternal are ungenerated and imperishable.
>
> Πάντες γὰρ ὑπολαμβάνομεν, ὃ ἐπιστάμεθα, μηδ'ἐνδέχεσθαι ἄλλως ἔχειν· τὰ δ'ἐνδεχόμενα ἄλλως, ὅταν ἔξω τοῦ θεωρεῖν γένηται, λανθάνει εἰ ἔστιν ἢ μή. ἐξ ἀνάγκης ἄρα ἐστὶ τὸ ἐπιστητόν. ἀίδιον ἄρα· τὰ γὰρ ἐξ ἀνάγκης ὄντα ἁπλῶς πάντα ἀίδια, τὰ δ'ἀίδια ἀγένητα καὶ ἄφθαρτα. (*EN* VI.3, 1139b19-1140b24)

This passage appeals to a notion of knowledge (*epistēmē*) whose objects are necessary, eternal, and imperishable (1140b23-24).[74] Shortly after (T23), at 1140b27, Aristotle relates this notion of knowledge to the one he develops in the initial part of the *Posterior Analytics* (*Post. An*. I.2 71b9ff). That is to say, here '*epistēmē*' stands for the kind of scientific knowledge that pertains to strict sciences. When Aristotle denies that *technai* are knowledge a bit later, he has the same notion of knowledge in mind. This is why he justifies the claim that *technai* is not knowledge by saying that it concerns what can be otherwise (*EN* VI.6, 1140b35-1141a1). But then, his point here is that *technai* are not strict sciences.

Since *technai* are non-strict sciences, it is not surprising that within the context of *Nicomachean Ethics* VI.3-6 Aristotle claims that they fail to qualify as sciences. It is only when he uses a notion of scientific knowledge that covers things that hold for the most part

[74] Aristotle's wording in (T23) is reminiscent of the start of the *Posterior Analytics* (esp. *Post. An.* I.2). In both places, the relevant necessity is described as unqualified (*haplōs*, 1140b24; cf. *Met*. Δ.5 1015b6ff). Elsewhere this notion of necessity with that of hypothetical necessity (*ex hypotheseôs*) which in turn is related to the natural sciences and *technai* (cf. *Phys*. II.9 19b33-200a14; see also *PA* I.1 639a12-32 and *EE* II.11 1227b28-32). For helpful reconstructions of Aristotle's account(s) of hypothetical necessity, see Cooper (1987, 2004: ch.4), Charles (1988), and Byrne (2002).

that *technai* can qualify as sciences.[75] So one can do justice to the ethicall passages that treat *technai* as sciences without rendering the *corpus* inconsistent. Overall, we hope to have offered an interpretation that has considerable textual support, affords a unified and consistent picture of Aristotle's conception of *technē*, and helps one to see how epistemically robust Aristotle takes *technai* to be.

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[The current draft includes direct references to only some of these pieces.]

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[75] Thus we agree with Reeve (1992: 13-17) when he claims that the notion of *epistēmē* in play within *EN* VI.3-6 is rules out that the sciences of nature count as *epistēmai*. Note that *EN* VI.10 1142b34-114a4—our (T7) in §4—adopts a broader notion of *epistēmē* that includes *technai* and therefore plausibly extends to natural sciences too.

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