

Knowing What We Understand

Abstract: How does understanding relate to knowledge? I argue that the answer differs for two central kinds of understanding. Understanding why something happened is a particularly good way of knowing why. Cases in which someone learns the reason from testimony without understanding it show only that some knowledge falls short; and what it lacks is typically not more information, but better connections among what one already knows. Understanding a phenomenon or a subject matter is different. It need not consist in knowing explanations, and what connects one's knowledge of it is often a model or theory that one uses without believing it, such as an idealised scientific model. Such models are not mere stepping stones: they are part of what the understanding consists in. Understanding a subject matter therefore requires knowing some facts about it, but it can reach further than knowledge, provided one's models fit their target well enough.

Keywords: understanding; knowledge-why; objectual knowledge; explanation; idealisation.

Word Count: 9997

1. Introduction

Understanding is said in many ways. One might understand quantum mechanics, the London underground, or combustion (objectual understanding). One might understand *what* water is, or what it is to boil (understanding-what); *why* water boils under certain conditions (understanding-why); or *how* to boil water (understanding-how). The recent attention to understanding in epistemology makes one question pressing: *how does understanding relate to knowledge?* Any answer must take these varieties into account, since nothing guarantees that the same answer holds for all of them. Yet much of the debate has proceeded as if a verdict about one variety, usually understanding-why, settled the matter for the others.

This paper argues for an asymmetry. A natural generalisation of reductionist views of understanding-why holds that each variety of understanding is knowledge of the corresponding variety—understanding-why just is knowledge-why, objectual understanding just is objectual knowledge, and so on—provided that this knowledge is, in a sense to be clarified, good enough. Schematically:

Graded Reductionism. For each variety of understanding U_k , there is a corresponding variety of knowledge K_k such that, for every subject x and context C , x U_k -understands in C iff x 's K_k -state meets the contextually relevant threshold on a quality profile Q .

I argue that *Graded Reductionism* holds for understanding-why but fails for objectual understanding. Two ideas drive the argument. *First*, that knowledge comes in better and worse forms. It improves not merely when one knows more, but depending on *how well one knows*: on the strength of one's evidence, on how what one knows is integrated, and on how closely one's representations fit what they represent. Integration matters most: what separates understanding from mere knowing is how what one knows hangs together. *Second*, that integration need not be supplied by further knowledge, but is often supplied by models and frameworks that one accepts without believing, as with idealised models in science. Where understanding-why is concerned, this makes no difference to the reduction: whatever raises its quality, understanding why p still consists in knowing an answer to the question why p . But objectual understanding has no such answer. Understanding an object consists partly in grasping how it is organised, and where the organising structure is accepted rather than known, the resulting state need not be knowledge of any kind. Understanding-why is high-quality knowledge-why; objectual understanding outruns knowledge.

Part I (§§2–5) concerns understanding-*why*. Its correlate is knowledge-*why*, which is tied to propositional knowledge by a truism: one knows why p just in case, for some q , one knows

that *p because q*, where ‘because’ is read non-evidentially. The main challenge to reductionism comes from testimony. A child told by a firefighter that faulty wiring caused a fire thereby knows why the fire happened, yet need *not* understand why. I argue that knowledge-*why* varies in quality, and that understanding-*why* is knowledge-*why* of sufficiently high quality. Testimonial cases then show only that some knowledge-why falls short of understanding, *not* that none reaches it. The view accommodates the linguistic data behind the objection without giving up the truism, and it improves on the reductive strategies of Sliwa (2015) and Grimm (2014). I set aside the converse challenge from epistemic luck, which others have addressed on the reductionist’s behalf.

Part II (§§6–9) concerns objectual understanding. §6 argues, against Dellsén (2020), that objectual understanding does *not* require grasping explanatory dependencies. Knowledge of laws and essences, non-explanatory proofs, and ethnographic descriptions of unfamiliar classifications all advance understanding without exhibiting any dependence. So the result of Part I does not carry over automatically. §7 takes up the debate between Kvanvig (2003) and Elgin (2009) on whether objectual understanding is factive. I distinguish the target of understanding from the vehicles through which it is reached, and argue that where a vehicle—an idealised model, a false but fitting theory—integrates what one knows, it is not merely a means to understanding but partly constitutes it. Objectual understanding is therefore not factive in Kvanvig’s sense, but *anchored*: the facts it organises must be known, while the organising structure need only fit its target. §8 considers the best knowledge-based candidate for objectual understanding, *objectual knowledge*: a sui generis kind of knowledge, not limited to acquaintance (as it is usually discussed), which draws on knowledge-that, -what, -why and -how. Objectual knowledge supplies the anchors of understanding, and objectual knowledge of sufficiently high quality suffices for it; but understanding an object does *not* require knowing it to a corresponding degree. §9 states the resulting account, shows how it handles the testimony challenge at the objectual level, and

compares it with the knowledge-based account of Kelp (2015) and with the views of Elgin and Dellsén.

Part I: Understanding-why

2. Reductionism about understanding-why and the challenge from testimony

The simplest reductive view identifies understanding-why with knowing-why:

Reductionism. For every proposition p and subject x , x understands why p if and only if x knows *why* p .

Reductionism has had many sympathisers (Salmon 1989, Kitcher 2002, Lipton 2004, Strevens 2013, Grimm 2014, Sliwa 2015, 2017). Yet many philosophers have come to reject it, and some go further, holding that understanding-*why* is a distinctive cognitive state (e.g. Elgin 2009, Hills 2016; cf. Kvanvig 2003).

It helps to split the biconditional in two:

Necessity. For every proposition p and subject x , if x understands *why* p , then x knows *why* p .

Sufficiency. For every proposition p and subject x , if x knows *why* p , then x understands *why* p .

Objections to *Reductionism* typically fall into two kinds, which offer counterexamples to *Necessity* and *Sufficiency*, respectively:

Epistemic Luck. Knowledge-*why* is undermined by epistemic luck, whereas understanding-*why* is not (Pritchard 2009, Hills 2009, cf. Kvanvig 2003).

Testimony. ‘Leo knows *why* p , but he does not understand *why* p ’ is not only felicitous but, in some contexts, true. Paradigmatically, one may gain knowledge-*why* by testimony and yet lack understanding-*why* (Pritchard 2009, 2010; Hills 2009: 100, 2016).

These two objections do not threaten *Reductionism* equally. What reductionists care about is not the unrestricted biconditional but a constitutive claim: understanding-why *just is* a form of knowing-why. That claim needs *Necessity*. It does *not* need unrestricted *Sufficiency*. It is enough that knowing-why, *in the right way*, suffices for understanding-*why*. This is how the instance of *Graded Reductionism* for understanding-*why* works (§1): it keeps *Necessity* and replaces *Sufficiency* with a qualified condition. The question raised by *Testimony*, then, is not whether *every* case of knowing *why* is a case of understanding *why*--I concede that it is not--,but whether the gap between them has to be filled by something other than knowledge, or a restricted quality of knowledge-*why* qualifies.

I focus on *Testimony*, for two reasons. First, the reductionist response to *Epistemic Luck* has been developed elsewhere, and I have little to add. In brief, the luck present in the standard cases is compatible with knowledge, and luck affecting the *source* of testimony should be distinguished from luck in the *evidence* the testimony provides (Grimm 2006, Khalifa 2013a, Sliwa 2015, 2017). Second, intuitions about the luck cases are unstable, as that debate shows, whereas the intuition that the testimonial knower lacks understanding is robust. *Testimony* is the more pressing challenge.

I develop a reply to *Testimony* that has received little attention. It concedes the objector’s data while still keeping reductionism. The linguistic intuitions taken to count against the view turn out to be ones the reductionist can predict. §3 presents the case against *Sufficiency*.

3. Testifying against Sufficiency

I shall not dispute that knowledge, including knowledge-*why*, can be transmitted by testimony. Nor shall I dispute that transmitted knowledge-*why* can fall short of understanding-*why*. The standard case is this:

Faulty Wiring. A parent and their young child watch a house burn down. Both wonder what caused the fire. On the firefighter's testimony, both come to believe that it was caused by faulty wiring. (Sliwa 2015: 64–5, after Pritchard 2009)

As Pritchard puts it:

He [the child] has no conception of how faulty wiring might cause a fire, so we could hardly imagine that merely knowing this much suffices to afford him understanding of why his house burned down. Nevertheless, he surely knows that his house burned down because of faulty wiring, and thus also knows why his house burned down. (Pritchard 2009: 38; see also Hills 2009: 100)

The second sentence of the quotation relies on a principle that I shall take as a working assumption about ordinary *why*- and *because*-ascriptions:

Truism. For every p and every subject x : x knows why $p \leftrightarrow$ for some q , x knows that $(p \text{ because } q)$.

The principle captures a basic feature of our practice with *why*- and *because*-constructions (Bromberger 1966; Groenendijk & Stokhof 1982; Lawler 2019, §3; cf. Grimm 2014: 330–1). I shall keep it throughout. The argument against *Sufficiency* can then be stated using the child's situation alone:

P₁. By being told that the fire occurred because a faulty wire sparked, the usual conditions for the transmission of knowledge being met (a reliable source, no defeaters, and so on), the child comes to know that the fire occurred because a faulty wire sparked.

P₂. *Truism*.

C₁. The child knows why the fire occurred. (P₁, P₂)

P₃. The child does not understand why the fire occurred.

C₂. *Sufficiency* is false: some thinkers know why *p* without understanding why *p*. (C₁, P₃)

I accept this argument. As §2 noted, C₂ refutes *unrestricted Sufficiency*, not the claim that understanding-*why* is a form of knowing-*why*. But the case supports a stronger argument, which draws on the parent as well as the child:

P₁. The parent and the child both know *why* the fire occurred, in virtue of knowing the same proposition: that the fire occurred because a faulty wire sparked.

P₂. The parent understands why the fire occurred; the child does not.

P₃. If understanding-*why* is a form of knowing-*why*, then any difference in understanding-*why* requires a difference in knowing-*why*.

C₁. The parent and the child do not differ in their knowing-*why*, with respect to this situation. (P₁)

C₂. Understanding-*why* is *not* a form of knowing-*why*. (P₂, P₃, C₁)

Call this the *Comparative Argument*. If sound, what separates parent from child must be something other than knowledge: a distinctive grasp (Grimm 2014), or a set of cognitive abilities (Hills 2016). This is the argument the reductionist has to answer, and the weak point is C₁. Sliwa (2015) rejects it on the ground that the parent knows *more* about why the fire occurred: more *because*-propositions, and so fewer open epistemic possibilities. I reject the argument on broader grounds. Even when two subjects know the same *because*-propositions, their states of knowing-*why* may differ in quality, responsive to different factors. §4 argues that they do, and §5 argues that the broader ground is needed.

4. Knowing better

4.1 Comparatives

We compare knowers. A physicist knows *better than* the parent why the house burned down. I know that my eyes are watering because I am chopping onions, and so I know why they are watering, but a chemist knows *more*, and knows it *better* (Grimm 2014). These comparatives separate the two sides of the *Truism*:

(1) The physicist knows better than the parent *why* the house burned down.

(2) #The physicist knows better than the parent *that* the house burned down because the faulty wire sparked.

(1) is felicitous and plausibly true. (2) sounds odd (cf. Hills 2016; Dretske 1981a: ch. 5). It does not help to point out that the right-hand side of the *Truism* is existentially generalised: ‘for some *q*, the physicist knows better than the parent *that* the house burned down because *q*’ sounds no better.¹

The same pattern is familiar from knowledge-*how*, where comparative ascriptions are natural although the corresponding knowledge-*that* ascriptions are not, and no one takes this to refute principles akin to *Truism* linking the two (Stanley 2005: ch. 2; Pavese 2017). Nor should the contrast between (1) and (2) refute the *Truism* itself. The *Truism* is a biconditional. It does not *identify* the state of knowing why *p* with any state of knowing that *p because q*, so substitution may fail in comparative contexts without threatening its truth.

Equally, one should not infer solely from (1) that knowledge-*why* is gradable in the semantic sense, i.e. that ‘knows why’ takes a degree argument.² A comparative may work on a different parameter. ‘Martin makes a better cheeseburger than Leo’ does not make *being a*

¹ This is compatible with knowledge-why and understanding-why differing in the modifiers they accept: ‘Ada knows completely why *p*’ sounds off, whereas ‘Ada understands completely why *p*’ is felicitous (see Hills 2016).

² Compare attributions of fear, doubt and the like, which accept a range of degree modifiers and so more clearly suggest gradability. If knowledge that *p because q* itself admits of some variation along the lines sketched in the text, as contextualist or knowledge-how-based accounts might allow (DeRose 1992; Hetherington 2011), the strategy becomes even easier to implement.

cheeseburger gradable. It compares the quality of two cheeseburgers and, derivatively, the skills that produced them. Likewise, ‘knows better why’ may compare the quality of two states of knowing why. That is the claim I need, and it is weaker than gradability: *states of knowing why may vary in quality, even when they rest on the same because-knowledge*. It is no accident that such comparisons come more naturally with ‘knows why’ than with ‘knows that’. To know *why* is to know an answer to a question, and answers can be more or less complete, and better or worse, along several epistemic and pragmatic dimensions (Groenendijk & Stokhof 1982; Pavese 2017).

The view does not, however, depend on comparative data. In my own--admittedly informal--experience, speakers hesitate over ‘knows better/more ... why’, though they reject ‘knows better/more ... that ... because ...’ somewhat consistently. The pattern seems not to be peculiar to English. The comparatives serve to introduce the view. What it requires is only that states of knowing *why* may differ in ways not exhausted by *what* one knows.

4.2 Dimensions of quality

Which dimensions are involved? I shall work with four, without claiming that the list is complete:

- **Quantity:** how many relevant because-propositions one knows about *p* (cf. Treanor 2013; Sliwa 2015).
- **Evidence:** the strength and kind of support for one’s knowing why. Examples are testimony one cannot assess, as against evidence one can weigh oneself (cf. Dretske 1981b).
- **Integration:** how one’s knowing why *p* is connected with one’s other doxastic states. This includes whether one’s knowledge is fragmented (Egan 2021), and whether it is modally robust, i.e. whether one can tell how the explanandum would vary under nearby changes (cf. Lawler 2016: 234; Kelp 2021: ch. 4).

- ***Fit***: how closely one’s representation matches its target in grain and precision.

Representing the cause of the fire as ‘some electrical fault’ fits it less closely than representing it as ‘a short circuit in the wire behind the bedroom wall’, and that in turn fits it less closely than representing how current arcing across damaged insulation heated the surrounding material past its ignition point (cf. Dellsén 2020).

Integration is not explanatory by definition. The connections may be inferential, modal or classificatory. This will matter in Part II.

Fit should not be confused with truth. Truth is a property of propositions, and it does not come in degrees: ‘some electrical fault caused the fire’ is exactly as true as the more detailed descriptions above, though it fits the fire less closely. Fit is a relation between a representation, propositional or not, and its target, and it does come in degrees: it measures how much of the target’s structure the representation captures, and at what grain. The two can come apart in both directions. A coarse truth fits poorly, and a representation that is strictly false can fit well. Kepler’s elliptical orbits are, strictly speaking, false, since the planets perturb one another; but they fit the actual orbits better than Copernicus’s circles, and better than the true but coarse claim that the planets move around the Sun. In the case of understanding-why, where what is known must be true, *Fit* ranks true answers by their grain and precision. It will matter in Part II that *Fit* can also rank representations that are not true at all.

4.3 Refined Sufficiency

Understanding-*why*, then, is not just *any* knowing *why*, but knowing why of *sufficiently high quality*:³

³ Both the relevant dimensions and the threshold may vary with context. We should distinguish the claim that knowledge (or knowledge ascription), and correspondingly understanding, is itself context-dependent from the claim that the comparative expressions used in such locutions are context-sensitive. The former is controversial; the latter is not. See e.g. Stanley 2005: ch. 2.

Refined Sufficiency. For every p , subject x and context C : if x knows why p , and x 's state of knowing why p meets the contextually relevant threshold on a quality profile Q (specified in understanding-free terms along the four dimensions of §4.2), then x understands why p in C .

The parenthetical clause blocks trivial readings on which Q just amounts to understanding. Q is a *profile*: no single dimension tracks every relevant difference in every context, and how the dimensions are weighed may vary with context and, perhaps, with subject matter (see fn.3). Together with *Necessity*, *Refined Sufficiency* gives the instance of *Graded Reductionism* for understanding-why (§1). The resulting view allows understanding-why to be gradable: one understands better as the quality of one's knowledge-*why* improves. The chemist who knows that damage to the onion's cells releases enzymes, that these react with sulfur-containing aminoacid derivatives, and that syn-propanethial-S-oxide results, does not merely have understanding *in addition to* this knowledge. Her understanding *consists in* it.

4.4 The parent and the child

We can now answer the *Comparative Argument* of §3. I grant P_1 : parent and child know the same because-proposition. But, as the case is presented, their states of knowing-*why* differ in quality. The parent can situate the information that a faulty wire sparked within a minimal causal model: sparks can ignite nearby combustible material; ignition is likelier in the presence of carpet or fabrics and the absence of prompt suppression; household voltage suffices to make such sparks hazardous. She can therefore say how the outcome would have varied had the power been cut, had there been no combustibles, or had the fire been contained at once. The child can answer none of these what-if questions.

A friend of Sliwa (2015) will reply that this is just a difference in *quantity*: the parent knows further propositions. But consider:

Fragmented Parent. A second parent knows every proposition the first does: that faulty wiring can spark, that sparks ignite fabrics, and so on. She too is told that the fire occurred *because* a faulty wire sparked. But in the shock of the moment she does not bring her general knowledge to bear on the testimony. Asked whether the fire would have started had the power been cut, she has no idea.

The two parents know the same propositions, yet the second, at that moment, understands less well why the fire occurred. What she lacks is not a further proposition but *integration*: her pieces of knowledge are stored separately. It might be objected that she lacks one further proposition after all, namely the counterfactual. But whether she is in a position to know it depends on whether what she already knows is integrated. Treating the counterfactual as one more item on the list moves the difference elsewhere without removing it. The quality of knowing why is therefore not exhausted by what one knows, and C_1 does not follow from P_1 .

4.5 Knowing why without understanding why

This also explains the data behind *Testimony*. That

- (5) The child knows *why* the house burned down, but does *not* understand *why* it did.

is felicitous, and plausibly true, is no evidence against *Refined Sufficiency*. Compare:

- (6) She is a good player, but no grandmaster.

- (7) She is fairly confident of it, but does not fully believe it.

Neither implies that grandmasters are not good players, or that no degree of confidence amounts to full belief. In each case, the second term sets a higher standard within the context. Likewise, (5) ascribes knowledge-*why* of low quality, which falls short of the standard ‘understands’ sets (cf. Sliwa 2015: 70; 2017: 538–9). The reductionist can accept the argument of §3 in full. To refute

Refined Sufficiency, the objector would need to show that even high-quality knowledge-why falls short of understanding. Testimonial cases, whose subjects have knowledge-why of low quality, cannot show this.

5. Comparison with other reductive approaches

Two reductive responses to *Testimony* come closest to the present view: Sliwa's (2015, 2017) and Grimm's (2014).

Sliwa. Sliwa's formulation of the objection is essentially the *Comparative Argument* of §3. She rejects its C₁. Before the testimony, the parent already knows more than the child, and so has fewer epistemic possibilities open. After it, the two differ in their propositional knowledge about why the house burned down, understood as the set of because-propositions each knows. The proponent of *Refined Sufficiency* can accept all of this: Quantity is one dimension of the quality profile Q. But on Sliwa's view it is *the only one*. The asymmetry between knowers must be explained solely by which because-propositions they know. Sliwa (2017: esp. §4) develops a closely related view, on which understanding-why is knowing why of a high enough standard. The standard, however, is still fixed by content: by *which* epistemic possibilities one's propositional knowledge rules out.

Fragmented Parent (§4.4) above shows why this is too narrow. The two parents know the same propositions, rule out the same possibilities, and still differ in how well they understand why the fire occurred. A view on which the quality of knowing why supervenes on *what is known* cannot register the difference. *Refined Sufficiency* registers it as a difference in *Integration*. This preserves the *Truism*. Knowing *why* is still a matter of knowing *that p because q*. What the propositions known do not determine is the *quality* of that knowing.

This also places the view relative to a strategy Sliwa considers and sets aside: denying that knowing-why reduces to propositional knowledge at all. She says that would yield at best a ‘modest reductionism’ (2015: 67). *Refined Sufficiency* is not modest in this sense. It posits no non-propositional knowledge-why; it only denies that propositional content exhausts the epistemic profile of a knowing state.

Sliwa’s response to the linguistic data is also more fragile than the one offered here. She suggests that ‘S knows why *p*’ is ambiguous, in testimonial contexts, between knowing *that some sentence* ‘*p* because *q*’ is true and knowing-*why* *p* proper (2015: 70–1). On the first reading, ‘the child knows why, but does not understand why’ is true but harmless. On the second, it is false, since the child has some understanding (69–70). We may grant that knowledge ascriptions sometimes tolerate parrot-like learning (cf. Hawthorne 2003: 68ff.). But the intuition that the child lacks understanding survives even when the parrot reading is set aside. The objector can concede that a richer version of the case might support ascribing limited understanding to the child, and still insist on the intuition about the original case (cf. Lawler 2016: 232). *Refined Sufficiency* needs no ambiguity. On a single reading, (5) ascribes knowledge-*why* of low quality and denies that it meets the higher standard (§4.5).

Grimm. Grimm (2014: 332) argues that there is more than one way of knowing a cause. Some suffice for understanding and others do not. The propositional model, on which S knows the cause of it being the case that *p* just in case S knows *that p* because *q* (330–1), is but one of them. The way that suffices for understanding involves a grasp of ‘the modal relatedness of the terms of the causal relata’ (335–6; cf. Grimm 2006). His discussion is framed in causal terms, but I take it to extend to reasons why more generally. Grimm’s view shares with *Refined Sufficiency* the idea that knowing-why varies. But, as Sliwa notes, it gives away too much. If the paradigmatic form of knowing-why, knowing that *p* because *q*, does not suffice for understanding, securing sufficiency requires positing a distinctive grasp that marks off a privileged subclass of knowledge-why. That

costs reductionism one of its main attractions: a parsimonious taxonomy of cognitive states.

Refined Sufficiency keeps what is right in Grimm's proposal. Grasping modal relatedness is what the *Integration* dimension, in its modal-robustness aspect, measures: the parent's ability to say how the outcome *would* vary, had the power been cut. Crucially, it treats this as a feature of the very state of knowing-why, *not* as a further state.

The two views thus fall on either side of *Refined Sufficiency*. Sliwa restricts the relevant differences to what is known; Grimm locates them in a state beyond propositional knowledge. *Refined Sufficiency* locates them in how well one knows. It is deliberately open about the dimensions that make knowing why better or worse, and that openness suits the variety of cases in which we do, and do not, ascribe understanding. Part II argues that the same approach does not extend to objectual understanding.

Part II: Objectual understanding

6. Objectual understanding without explanation

If objectual understanding were a form of understanding-why, Part I would already settle how it relates to knowledge. Understanding combustion would be understanding-why combustion occurs, or why it has the features it has. By *Refined Sufficiency*, that is knowing-why of sufficiently high quality, and *Graded Reductionism* would extend to objectual understanding. This section argues that the shortcut is not available. Objectual understanding does not require understanding-why, nor, against Dellsén (2020), the grasp of explanatory dependencies more generally.

The shortcut has distinguished support. Strevens (2013: 510) holds that 'an individual has scientific understanding of a phenomenon just in case they grasp a correct scientific explanation of that phenomenon'. Strevens is concerned with scientific understanding, but the thought

generalises naturally: to understand combustion is to grasp *why* it occurs (see Dellsén 2020: §4 for further references). Two versions suggest themselves:

Simple Account I. S understands X $\leftrightarrow$ S knows why X exists/occurs, or, for some contextually salient feature F of X, S knows why X is F.

Simple Account II. S understands X $\leftrightarrow$ S grasps why X exists/occurs, or, for some contextually salient feature F of X, S grasps why X is F.

Account I is what Part I would need; a graded variant would add that the knowing why meets the threshold on Q. Since knowing-*why* p plausibly entails grasping *why* p, any counterexample to the left-to-right direction of II is a counterexample to that of I. We may therefore focus on II.

Dellsén (2020) argues that the left-to-right direction fails, in three ways. First, some things we understand have *no* explanation, such as coincidences and indeterministic events.

Understanding them cannot consist in grasping why they occur, since there is nothing to grasp (2020: §5). Second, one may understand X through what X *explains* rather than what explains X. Bohr’s model of the atom advanced our understanding of atoms by explaining why atoms emit radiation at the wavelengths given by the Rydberg formula (2020: §6). Third, one may understand X by grasping an explanatory *independence*. Galileo’s experiments showed that the acceleration of falling bodies does not depend on their mass, and thereby advanced the understanding of both mass and gravity (2020: §7). I accept these cases.

In place of the simple account, Dellsén proposes:

Dependency Modelling Account. S understands a phenomenon X iff S grasps a sufficiently accurate and comprehensive dependency model of X (or of its contextually relevant parts). (2020: 1268)

A dependency model represents the network of explanatory dependence relations in which X stands. Understanding improves as the model becomes more accurate and more comprehensive (2020: *ibid.*). The account handles all three cases. An inexplicable event is represented as depending on nothing. What X explains, and what X is independent of, are parts of X's dependency profile. The account also makes understanding gradable, as §4 argued it should be.

Still, the account ties objectual understanding to explanation-*why*: the dependence relations it models are explanatory ones (Dellsén 2020: e.g. 1269). However, understanding may advance without any dependence being grasped. Three kinds of case stand out.

Status. Learning that water is *essentially* H₂O, or that *it is a law that* nothing travels faster than light, advances one's understanding of water and of light. Laws and essences play roles in explanation, but grasping that p is necessary, essential or lawlike is not grasping any such role. The claim that it is would at least need an argument.

Mathematics. Many proofs are non-explanatory: their premises do not explain their conclusion. Proofs by *reductio* are the standard example. Cantor's theorem, in its usual *reductio* proof, still advances our understanding of sets. The independence of the parallel postulate from Euclid's other axioms advances our understanding of geometry and space, though no one expects the other axioms to explain the postulate, or to share an explanation with it. The equivalence of the axiom of choice with e.g. Zorn's lemma and the well-ordering theorem advances our understanding of the set-theoretic universe, without indicating any explanatory role for any of them. Limitative results such as Tarski's theorem on the undefinability of truth advance our understanding of truth, although their proofs exhibit no network of dependencies; interpretations of one theory by means of another—arithmetic by set theory, for instance—advances understanding, but again need not boil down to any dependence among the theories.

Classification. The Balinese calendar distinguishes days by their qualitative character: it classifies what kind of day a day is, not which day it is (Geertz 1973). For someone who is not Balinese, learning this advances their understanding of Balinese time-reckoning, and arguably of time-reckoning in general, by contrast with their own. No dependency is exhibited, only a way of dividing things up. Such discoveries are a familiar source of understanding in anthropology: much of what ethnography teaches consists less in explaining unfamiliar practices than in showing how they carve up a domain differently (Holbraad & Pedersen 2017).

These cases share a moral. Understanding X can be advanced by knowledge about X that is *not* knowledge of what X depends on, or of what depends on X, or about X's dependence profile at all. Objectual understanding is therefore not limited to understanding-why, nor to explanatory understanding more broadly (also contra Khalifa 2013b, 2017). The cases correspond to the forms of *Integration* distinguished in §4.2: modal, inferential and classificatory. This suggests that the dimensions of quality found in Part I apply here as well. What it leaves open is whether objectual understanding, like understanding-why, consists in knowledge of some other kind. §7 argues that it does not.

7. Understanding through accepted structures

Graded Reductionism would make objectual understanding a form of knowledge, and since knowledge is factive, objectual understanding would be factive too. This is the counterpart, for objectual understanding, of *Necessity* in Part I, and it is where the reductionist programme meets the most prominent objection in the literature. Since 'understands' here takes a singular-term rather than a proposition, we first need to say in what sense objectual understanding could be *factive*.

Kvanvig (2003) offers an answer:

Objectual understanding is, of course, not straightforwardly factive, for only propositions can be true or false. Still, the uses I wish to focus on are ones in which facticity is in the background. For example, to understand politics is to have beliefs about it, and for this objectual understanding to be the kind of interest here requires that these beliefs are true. (2003: 191)

Call the beliefs about X that make up one's understanding of X in Kvanvig's sense one's *constitutive* beliefs. Kvanvig's proposal is then:

Factivity. For all x and X: if x understands X, then x's constitutive beliefs about X are (by and large) true.

The qualification reflects Kvanvig's (2009) concession that peripheral falsehoods may be tolerated. Elgin (2009: 324) disputes this, on two grounds. First, false theories may improve understanding. Copernicus's theory improved on Ptolemy's, and Kepler's on Copernicus's; each gave a better understanding of planetary motion, yet each was by and large false. Second, science relies on idealisations. We understand the behaviour of gases through the ideal gas law, which we know no actual gas satisfies.

A reductionist answers both points with one distinction, between the attitudes that *constitute* understanding, and the attitudes we *use* to reach it. The latter need not be beliefs: they may be acceptances, suppositions, or working assumptions (Cohen 1989). Call them *instrumental* attitudes.

The reductionist's reply runs as follows. In calculating the Earth's orbit, we treat the Sun and the Earth as point masses and ignore the other planets; in calculating a projectile's trajectory, we ignore air resistance. These assumptions are false, but they are merely instrumental. They are not taken at face value when we form the beliefs they help us reach, and those beliefs—about

the orbit or trajectory within a margin of error, or about which factors make no appreciable difference (cf. Strevens 2008)—are true. Falsity, on this reply, belongs among the *means* of understanding, never among its *constituents*, and the constitutive beliefs may amount to knowledge, even when they are reached through acceptances or through false beliefs (Warfield 2005). The most developed version of this reply is Lawler’s (2021) extraction view: idealisations enable understanding, even indispensably, but only the truths extracted from them belong to its content.

The reply is right about the beliefs, but it misidentifies what understanding consists in. Recall the lesson of *Fragmented Parent* (§4.4): what separates understanding from mere knowing is largely not a further proposition, but *Integration*, the way what one knows hangs together. What integrates a chemist’s knowledge of gases? She knows many true things about them: that their pressure rises with temperature at constant volume, that they diffuse, that they deviate from Boyle’s law at high pressure. What ties these facts together, for her, is the kinetic model: gases as swarms of point particles in elastic collision, a model she knows to be false and does not believe. Remove the model and she is left with a list, much like the reader of *Popular Science* below (§9). Keep it, and the facts become intelligible as manifestations of a single structure. The model is thus not merely a route to her understanding, to be discarded once the true beliefs are in place. It is what makes her true beliefs an understanding of gases rather than a mere collection of truths about them.

Why is the model constitutive of the chemist’s understanding, rather than instrumental, as the point masses were in the calculation of the Earth’s orbit? A test separates the two roles: ask what is lost if the vehicle is removed once the true beliefs are in place. When the astronomer drops the assumption that the Sun and the Earth are point masses, nothing is lost. She still knows the orbit within the margin of error, and her understanding of it is unaffected, because the assumption did no work beyond producing that result. When the chemist drops the kinetic model, by contrast, she keeps every fact she knew, but they no longer hang together. She can no

longer say why pressure and temperature co-vary, why deviations from Boyle's law appear at high pressure rather than at low, or what to expect of a gas she has never examined. What is lost is exactly what the fragmented parent lacked: not a proposition, but *Integration*. A vehicle is instrumental when understanding survives its removal; it is constitutive when understanding is exercised through it.

The same holds far from chemistry. Population geneticists understand how the genetic make-up of populations changes by reference to the Hardy–Weinberg equilibrium: the state in which allele frequencies remain constant in an infinitely large, randomly mating population subject to no selection, mutation or migration. No actual population is in that state, and none could be, since no population is infinite. Yet selection, drift, mutation and migration are understood as so many departures from it, and the observed changes in real populations are organised as combinations of these departures. Remove the equilibrium, and the geneticist retains her data on allele frequencies, but loses the frame within which the data count as the effects of distinct evolutionary tendencies. Here too, understanding is exercised through a structure that is not believed to be true of anything actual.

Lawler's view is designed for this case. She grants that an idealisation may be indispensable, but only in the process of obtaining understanding: like a ladder, it need not be taken along once the truths are extracted (2021: §§6–8). I agree with part of this. Nothing the chemist believes about gases is false, and the removal test gives Lawler's verdict wherever a vehicle can be discharged, as with the point masses. But where the model integrates what one knows, the ladder image fails, for two reasons. First, the truths extracted are, in Lawler's own central case (the ideal gas law), *comparisons*: that gases behave approximately as the model says, within specifiable limits. Their content refers to the model, so retaining them requires retaining one's command of how, within it, pressure, temperature and volume depend on one another. Second, extraction is never finished. *Integration* includes being able to tell how things would vary under changes not yet

considered (§4.2); where the model is indispensable for access to such truths, as Lawler allows, as in the Hardy–Weinberg case, that ability is exercised through it. Remove the model, and what remains is a finite stock of extracted truths: a list, as §4.4 argued. Lawler herself notes that extraction typically yields elements of a systematic account, rarely the account itself (§6.3). What makes them an account is *the structure* they were extracted from. That structure is *not* merely instrumental. And accepting a structure is not knowing it, since it is not believed, let alone known to be true.

Objectual understanding can thus be partly constituted by a false structure, even when every belief that belongs to it is true. But truth still constrains it. The facts that an accepted structure integrates must be known, since otherwise nothing about X is understood; and the structure itself must fit its target closely enough, as measured by the dimension of *Fit* (§4.2). Call this ‘anchored factivity’:

Anchored Factivity. For all x and X: if x understands X, then

- (i) x knows a sufficient body of facts about X, and
- (ii) any structure through which x integrates these facts, whether believed or merely accepted, fits X closely enough by the standards of the context.

Anchored Factivity is weaker than Kvanvig’s *Factivity*, since the integrating structure may be false. It is stronger than the view that understanding requires only theories that are ‘true enough’ (Elgin 2017), since the anchoring facts must be *known*. Truth is required of one’s *anchors*, and fit of one’s structures, with respect to the target of understanding, X itself; the *vehicles* need not be true.

What, then, does the falsity of an accepted structure contribute? Sullivan and Khalifa (2019) argue that idealisations owe their epistemic value to what they get right, and that their false components add only convenience. I accept the first claim: on *Anchored Factivity*, a structure earns its place by fitting, that is, by matching the way its target is organised (§4.2), never by being false. But what the structure contributes is *not* convenience. It contributes *Integration*, which Part I

argued is what separates understanding from mere knowing; and since the structure fits, the connections it supplies track real ones. Nor does it follow that the chemist's state is knowledge after all. That a structure fits in certain respects does not make it approximately true, nor does it make those respects propositions she separately knows. What she knows is that the structure fits, within limits. What integrates her knowledge is the structure itself, which she accepts as a whole and does not believe (see further §8).

Back to the historical cases: Copernicus believed in circular orbits, and his belief was false. On the reductionist reading, his understanding of planetary motion consisted only in what he got right—that the Earth orbits the Sun, and that retrograde motion is an appearance produced by the Earth's own motion—while his false beliefs merely lowered its quality. This underdescribes his achievement. What Copernicus offered was a structure within which a large body of known observations became intelligible at once. That structure, not only its true components, integrated what he knew, and it fitted planetary motion better than Ptolemy's, though less well than Kepler's. Successive theories yield better understanding because their structures fit their target better, while anchoring the same or more known facts. Elgin is right that such understanding can be partly constituted by falsehood. What *Anchored Factivity* adds is that the falsehood lies in the *structure*, never in the *anchors*.

The same distinction clarifies talk of understanding theories. 'S understands quantum mechanics' may ascribe understanding of the theory itself: knowing its principles, what follows from them, its paradigmatic applications. Or it may ascribe understanding, by means of the theory, of *what the theory is about*. (Understanding X by means of a theory plausibly requires understanding the theory in the first sense.) In the second sense, the theory serves as an integrating structure, and it need *not* be true, only fitting. This yields a principled verdict on apparent understanding of things that do not exist, such as phlogiston, the ether, or the vast conspiracy of which we are all victims. One can understand phlogiston theory, or the conspiracy

theory, in the first sense. But one cannot understand phlogiston itself: there is nothing for one's anchors to be true of, and nothing for a structure to fit. *Anchored Factivity* thus rules out what an unrestricted non-factive view would have to allow.

Why does the argument not extend to Part I? Why-explanations also rely on idealisations: one explains why a gas's pressure rose using the ideal gas law, and the model may integrate one's knowledge-why as it integrates the chemist's knowledge of gases. The difference lies in what understanding-why is understanding *of*. A why-question has an answer, and understanding why *p* requires knowing it: that *p* because *q*, for some *q*. An accepted model can raise the quality of that knowing, above all its *Integration*, as the parent's background knowledge raised the quality of hers; but the state it raises remains a state of knowing-why *p*. Objectual understanding has no such answer. There is no proposition one must know in order to understand gases, over and above the facts one's understanding is anchored to; there is only the representation of gases as organised one way rather than another. When that organisation is supplied by a merely accepted structure, it is part of what one's understanding consists in, and the state is not knowledge. This is the asymmetry: in understanding-why, accepted structures may improve knowledge-why without displacing it; but they can partly constitute objectual understanding without the resulting state being knowledge.

8. Objectual knowledge

If objectual understanding is not knowledge-why, and can be partly constituted by accepted structures, is there still a kind of knowledge to which it stands as understanding-why stands to knowledge-why? The best candidate is the kind of knowledge that, like objectual understanding, takes an object rather than a proposition: *objectual knowledge*. This section characterises it and argues that it plays two roles. It supplies the anchors that *Anchored Factivity* requires, and, when of

sufficiently high quality, suffices for objectual understanding. However, it is not necessary for the latter.

Objectual knowledge is expressed with a singular-term complement: knowing Paris, knowing Obama. English marks it poorly, but many languages mark it lexically: German ‘kennen’ as against ‘wissen’, French ‘connaître’ as against ‘savoir’. It is usually discussed in connection with acquaintance. Farkas (2019) argues that knowing an individual or an object in this sense is, at bottom, being acquainted with it. For the cases she considers, this may be right. But ‘kennen’ and ‘connaître’ also apply where acquaintance is neither needed nor enough. One can know the Eiffel Tower well, knowing its history, how and why it was built, without having seen it. One can *know* a theory, or a field, in the same sense: ‘sie kennt die Quantenmechanik’. Conversely, someone who was acquainted with the tower daily may know it far less well than a historian of engineering.

We focus on objectual knowledge in this broader sense:

Objectual Knowledge. S knows X iff S has a body of knowledge concerning X that is organised around X, where the body may include acquaintance with X, knowledge *that* X is F, knowledge *why* X is F, and knowledge *how* to deal with X.

Objectual knowledge in this sense is *sui generis* in two respects. It is *not* a species of knowledge-*that*, knowledge-*why*, knowledge-*how* or acquaintance, but draws on all of them. And it is not simply the conjunction of its constituents, since whether a body of knowledge is organised around X, and how well, is a feature of the whole. That is where *Integration* applies.

Two features make objectual knowledge thus understood the natural knowledge-based candidate. First, it accommodates the cases of §6. Knowing that water is essentially H₂O, knowing Tarski’s theorem, and knowing how the Balinese classify days are all pieces of

knowledge-*that* about their objects, and each improves one's knowledge of them. Acquaintance can contribute too. Knowing pain partly by having felt it plausibly improves one's knowledge of pain, and with it one's understanding of pain, though it may not be necessary for understanding pain. Second, objectual knowledge clearly varies in quality. 'She knows London better than I do' and 'he knows the subject well' are entirely natural. The comparative data that §4.1 found somewhat unstable for 'knows why' are robust here.

One alternative should be set aside. Perhaps objectual understanding relates to the other varieties of understanding as objectual knowledge relates to the other varieties of knowledge: understanding X would consist in enough understanding-why, -how and -what concerning X.⁴ Two considerations tell against this. First, much of what advances objectual understanding is knowledge-*that*, and there seems to be no corresponding variety of understanding. Ascriptions of the form 'S understands that p' usually express concession ('I understand that you are busy') or acceptance, or else report a grasp of linguistic meaning. The §6 cases, knowing status or classification, would therefore have no understanding-based counterpart. Second, acquaintance can contribute to objectual understanding, and acquaintance is not a variety of understanding. Objectual knowledge is thus the better candidate for a knowledge-based correlate of objectual understanding.

Is it the correlate? In one direction, yes. High-quality objectual knowledge suffices for objectual understanding, as §9 will show: a chemist whose knowledge of combustion is broad, well supported, integrated and fitting understands combustion, whether or not models played a part in reaching it. In the other direction, no. The chemist of §7 understands gases partly through a model she does not believe. Her objectual knowledge of gases, the body of what she knows about them, is extensive and well anchored, but what integrates it is not itself knowledge. By the

⁴ I thank [omitted] for this suggestion.

standards of Q, her understanding outstrips her knowledge: she understands gases better than she knows them. Objectual knowledge is necessary for objectual understanding only in the weak sense that *Anchored Factivity* requires, not to the degree that the understanding itself attains. This is where the parallel with Part I breaks down. *Necessity* held for understanding-why; its objectual counterpart fails.

One might press for symmetry. §7 allowed that an accepted model may raise the quality of knowledge-why, above all its *Integration*; why may it not equally raise the quality of objectual knowledge, so that the chemist's understanding of gases is simply objectual knowledge of high quality? The answer lies in where the integrating structure sits. A state of knowing why p is a single propositional state. Its *Integration* is a matter of how it is connected to one's other doxastic states, and these may include acceptances, just as its *Evidence* may include testimony one cannot assess. The model stands *outside* the knowing and raises its quality. Objectual knowledge, by contrast, is a body of states organised around X, and its organisation is a constitutive *part* of it. When the organising structure is accepted rather than known, it is a constituent of the body, not merely something the body is connected to; and a body with a constituent that is not known is *not* a body of knowledge. The same model can thus raise the quality of knowledge-why while partly constituting objectual understanding.

9. Anchored understanding

We can now state the account. Its sufficiency half parallels §4.3:

Refined Objectual Sufficiency. For every subject S, object X and context C: if S knows X, and S's objectual knowledge of X meets the contextually relevant threshold on a quality profile Q (specified in understanding-free terms), then S understands X in C.

Its necessity half does not. In its place stands the following:

Anchored Understanding. For every subject S, object X and context C: S understands X in C iff S has objectual knowledge of X, and S's objectual knowledge of X, together with any structures, believed or merely accepted, through which S integrates it, meets the contextually relevant threshold on Q.

Refined Objectual Sufficiency is the special case in which every integrating structure is itself known. The profile Q has the same dimensions as in Part I, now applied to a body of knowledge together with the structures that organise it:

- ***Quantity:*** how much of what there is to know about X one knows.
- ***Evidence:*** how well supported the constituents are.
- ***Integration:*** how well the constituents are connected with one another and organised around X, whether by further knowledge or by structures one accepts. The connections may be explanatory, but they may also be modal, inferential or classificatory (§6).
- ***Fit:*** how closely one's representation of X, including any structure one accepts, matches X itself.

As with understanding-*why*, the testimony challenge returns, and the same response carries over. Consider:

Popular Science. A reader learns from a reliable popular science book that combustion is a reaction between a fuel and oxygen; that it releases heat and light; that it requires fuel, oxygen and a source of ignition; that its products typically include carbon dioxide and water. She comes to know all this solely by testimony. A chemist knows the same propositions, and much more.

The reader knows something about combustion; in the relevant sense, she knows combustion, if thinly. Yet 'she knows a fair amount about combustion, but she doesn't understand it' is

felicitous and, plausibly, true. The diagnosis is that of §4. Her objectual knowledge is not only poor in *Quantity*. It rests on testimony she cannot assess, which is a weakness in *Evidence*. And its constituents are unconnected: she cannot say why removing oxygen puts out a fire, or what would change if the fuel were different, which is a weakness in *Integration*. A fragmented variant, of a student who has memorised the same facts along with many more for an examination but has never related them, shows again that *Quantity* is not enough. What the chemist has, and the reader lacks, is in part better objectual knowledge; but in part it is the command of models, such as the collision model of reaction rates, through which the chemist structures what she knows. The testimony challenge thus receives the same kind of answer as in Part I: the reader falls short on the dimensions of Q, not for lack of some further mental state. But in Part I the parent's advantage lay entirely in better knowledge, whereas the chemist's lies partly in models she accepts without believing them.

The closest rival here is Kelp's knowledge-based account (Kelp 2015; 2021). On Kelp's account, maximal understanding of a phenomenon is fully comprehensive and maximally well-connected knowledge thereof, and outright understanding is knowledge that approximates this closely enough by contextual standards. The present view agrees that objectual understanding comes in degrees and that connectedness is central to it. It differs in three ways. First, Kelp's knowledge is propositional, whereas objectual knowledge may also draw on acquaintance and know-how. Second, Kelp's connections are, as I read them, explanatory, whereas *Integration* also covers the non-explanatory connections of §6. Third, and most importantly, on Kelp's account the connections must themselves be known. The chemist of §7 is a counterexample: her understanding of gases is well connected, but what connects it is a model she does not believe.

Elgin's view (2009; 2017), and non-factivism more generally (de Regt 2017; Potochnik 2017), are the closest allies. They agree that understanding can be partly constituted by falsehoods that are 'true enough'. The present account adds two constraints that Elgin's lacks:

the anchoring facts must be known, which rules out understanding of phlogiston; and understanding is graded along a profile of which *Fit* is only one dimension. Dellsén's account, finally, is close in a different way. His measures of understanding, the accuracy and comprehensiveness of a dependency model, correspond to *Fit* and *Quantity*, and his models, like the structures of §7, need not be true. But they are restricted to dependencies, and so cannot accommodate the cases of §6. In each case, the rival takes one or two dimensions of Q, or one kind of content, and treats it as the whole story.

10. Conclusion

How does understanding relate to knowledge? This paper has argued for an asymmetry. *Graded Reductionism*—the view that each variety of understanding is knowledge of the corresponding variety, of sufficiently high quality—holds for understanding-why but fails for objectual understanding. Knowledge varies in quality along several dimensions: how much one knows, how well supported it is, how well integrated, and how closely it fits its object. Integration matters most, and the asymmetry arises because integration can be supplied by structures one accepts without knowing them.

For understanding-why *p*, the correlate is knowledge-why, linked by the *Truism* to knowing *that p because q*, for some *q*. The challenge from *Testimony* shows, correctly, that not every case of knowing *why* is a case of understanding *why*. It does *not* show that understanding-*why* is anything other than knowing *why*. The child who knows on the firefighter's word why the house burned down has knowledge-*why* of low quality. The parent has better knowledge-*why*, and not only because she knows more: as the case of the fragmented parent shows, the difference lies partly in *how well* one knows. This lets the reductionist predict the felicity of 'the child knows why, but does not understand why', without positing an ambiguity (Sliwa) or a further state of grasping (Grimm), and without giving up the *Truism*.

For objectual understanding, the correlate cannot be knowledge-why, pace suggestions to the contrary. Understanding a phenomenon, a mechanism or a subject matter can be advanced by knowing its modal status, what follows about it, or how it is classified, as well as by knowing what it depends on. The natural knowledge-based candidate is objectual knowledge: a sui generis kind of knowledge, not reducible to acquaintance, which organises knowledge-that, -why and -how, and possibly acquaintance, around its object. High-quality objectual knowledge suffices for objectual understanding, and the testimony challenge gets the same answer as in Part I. But understanding an object does not require knowing it to a corresponding degree. Idealised models and false but fitting theories do not merely lead to understanding; where they integrate what one knows, they partly constitute it. Objectual understanding is therefore anchored rather than factive: its anchors must be known, its structures need only fit. Successive false theories yield better understanding because their structures fit their target better.

References

- Bromberger, S. (1966). Why-Questions. In R. G. Colodny (ed.), *Mind and Cosmos: Essays in Contemporary Science and Philosophy*. Pittsburgh: University of Pittsburgh Press, 86–111.
- Cohen, L. J. (1989). Belief and Acceptance. *Mind* 98(391): 367–389.
- de Regt, H. (2017). *Understanding Scientific Understanding*. OUP.
- Dellsén, F. (2020). Beyond Explanation: Understanding as Dependency Modelling. *British Journal for the Philosophy of Science* 71(4): 1261–1286.
- DeRose, K. (1992). Contextualism and Knowledge Attributions. *Philosophy and Phenomenological Research* 52(4): 913–929.
- Dretske, F. (1981a). *Knowledge and the Flow of Information*. Cambridge, MA: MIT Press.
- Dretske, F. (1981b). The Pragmatic Dimension of Knowledge. *Philosophical Studies* 40(3): 363–378.

- Egan, A. (2021). Fragmented Models of Belief. In C. Borgoni, D. Kindermann and A. Onofri (eds), *The Fragmented Mind*. Oxford: Oxford University Press, 108–134.
- Elgin, C. Z. (2009). Is Understanding Factive? In A. Haddock, A. Millar and D. Pritchard (eds), *Epistemic Value*. Oxford: Oxford University Press, 322–330.
- Elgin, C. Z. (2017). *True Enough*. Cambridge, MA: MIT Press.
- Farkas, K. (2019). Objectual Knowledge. In J. Knowles and T. Raleigh (eds), *Acquaintance: New Essays*. Oxford: Oxford University Press, 260–276.
- Geertz, C. (1973). Person, Time, and Conduct in Bali. In *The Interpretation of Cultures*. New York: Basic Books, 360–411.
- Grimm, S. R. (2006). Is Understanding a Species of Knowledge? *British Journal for the Philosophy of Science* 57(3): 515–535.
- Grimm, S. R. (2014). Understanding as Knowledge of Causes. In A. Fairweather (ed.), *Virtue Epistemology Naturalized*. Synthese Library 366. Cham: Springer, 329–345.
- Groenendijk, J. and Stokhof, M. (1982). Semantic Analysis of Wh-Complements. *Linguistics and Philosophy* 5(2): 175–233.
- Hawthorne, J. (2003). *Knowledge and Lotteries*. Oxford: Clarendon Press.
- Hetherington, S. (2011). *How to Know: A Practicalist Conception of Knowledge*. Malden, MA: Wiley-Blackwell.
- Hills, A. (2009). Moral Testimony and Moral Epistemology. *Ethics* 120(1): 94–127.
- Hills, A. (2016). Understanding Why. *Noûs* 50(4): 661–688.
- Holbraad, Martin & Pedersen, Morten Axel (2017). *The ontological turn: an anthropological exposition*. New York: Cambridge University Press.

- Kelp, C. (2015). Understanding Phenomena. *Synthese* 192(12): 3799–3816.
- Kelp, C. (2021). *Inquiry, Knowledge, and Understanding*. Oxford: Oxford University Press.
- Khalifa, K. (2013a). Understanding, Grasping and Luck. *Episteme* 10(1): 1–17.
- Khalifa, K. (2013b). Is Understanding Explanatory or Objectual? *Synthese* 190(6): 1153–1171
- Khalifa, K. (2017). *Understanding, Explanation, and Scientific Knowledge*. Cambridge: Cambridge University Press.
- Kitcher, P. (2002). Scientific Knowledge. In P. Moser (ed.), *The Oxford Handbook of Epistemology*. Oxford: Oxford University Press, 385–408.
- Kvanvig, J. L. (2003). *The Value of Knowledge and the Pursuit of Understanding*. Cambridge: Cambridge University Press.
- Kvanvig, J. L. (2009). Responses to Critics. In A. Haddock, A. Millar and D. Pritchard (eds), *Epistemic Value*. Oxford: Oxford University Press, 339–351.
- Lawler, I. (2016). Reductionism about Understanding Why. *Proceedings of the Aristotelian Society* 116(2): 229–236.
- Lawler, I. (2019). Understanding Why, Knowing Why, and Cognitive Achievements. *Synthese* 196(11): 4583–4603.
- Lawler, I. (2021). Scientific Understanding and Felicitous Legitimate Falsehoods. *Synthese* 198(7): 6859–6887.
- Lipton, P. (2004). *Inference to the Best Explanation*. 2nd edn. London: Routledge.
- Pavese, C. (2017). Know-How and Gradability. *Philosophical Review* 126(3): 345–383.
- Potochnik, A. (2017). *Idealization and the Aims of Science*. Chicago: University of Chicago Press.

- Pritchard, D. (2009). Knowledge, Understanding and Epistemic Value. *Royal Institute of Philosophy Supplement* 64: 19–43.
- Pritchard, D. (2010). Knowledge and Understanding. In D. Pritchard, A. Millar and A. Haddock, *The Nature and Value of Knowledge: Three Investigations*. Oxford: Oxford University Press, 66–88.
- Salmon, W. (1989). Four Decades of Scientific Explanation. In P. Kitcher and W. Salmon (eds), *Scientific Explanation*. Minnesota Studies in the Philosophy of Science 13. Minneapolis: University of Minnesota Press, 3–219.
- Sliwa, P. (2015). IV—Understanding and Knowing. *Proceedings of the Aristotelian Society* 115(1): 57–74.
- Sliwa, P. (2017). Moral Understanding as Knowing Right from Wrong. *Ethics* 127(3): 521–552.
- Stanley, J. (2005). *Knowledge and Practical Interests*. Oxford: Oxford University Press.
- Strevens, M. (2008). *Depth: An Account of Scientific Explanation*. Cambridge, MA: Harvard University Press.
- Strevens, M. (2013). No Understanding without Explanation. *Studies in History and Philosophy of Science* 44(3): 510–515.
- Sullivan, E. and Khalifa, K. (2019). Idealizations and Understanding: Much Ado About Nothing? *Australasian Journal of Philosophy* 97(4): 673–689.
- Treanor, N. (2013). The Measure of Knowledge. *Noûs* 47(3): 577–601.
- Warfield, T. A. (2005). Knowledge from Falsehood. *Philosophical Perspectives* 19: 405–416.