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A Circle Without a Circle: Ehrenfried Walther von Tschirnhaus's Natural Scientific Method

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In his *Medicina mentis* (1686/87; 2nd ed. 1695), Ehrenfried Walther von Tschirnhaus claims to have found an 'intermediary path' between *a priori* and *a posteriori* methods in natural philosophy—a three-step method of introspection, deduction, and experimentation. In this paper, I offer a systematic reconstruction of this method, showing how it was developed in the context of Tschirnhaus's complex exchanges with Spinoza and Leibniz during the mid-1670s and early 1680s concerning an originally Cartesian problem, namely what I call 'the problem of causal equivocity', according to which a single effect can be explained *a priori* by a multitude of possible causes. Contrary to both Leibniz and Spinoza, Tschirnhaus's three-step method proposed a distinctly non-metaphysical solution to this problem, in conformity with his ambition to develop an epistemological foundation for the conduct of experimental natural science.

Keywords: Tschirnhaus; Leibniz; Spinoza; Descartes; hypothesis; experiment; early modern philosophy; rationalism; empiricism; causation

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1. Introduction

The first edition of *Medicina mentis* (1686/87), the principal philosophical work of Ehrenfried Walther von Tschirnhaus (1651–1708), was subtitled 'an attempt at authentic logic wherein the method of discovering unknown truths is discussed'.[1] The second edition (1695) replaced that with 'general precepts of the art of discovery'. These subtitles are telling of the origin, scope, and general aim of the work. In the vein of the 'art of thinking' of the Port-Royal logicians, Tschirnhaus wanted to develop a single framework to serve simultaneously as a first philosophy, a logic, a theory of knowledge, and a general method (Corneanu and Vermeir 2022; Bayle 1686: 1330–31). In this paper, I am interested in the historical genesis and systematic construction of this 'art of discovery', with particular emphasis on how Tschirnhaus believed to have found an 'intermediary path' between *a priori* and *a posteriori* methods in natural philosophy.[2] This path takes the form of a three-step method of introspection, deduction, and experimentation. It is best understood, I argue, as a solution to an originally Cartesian problem of natural philosophy. This is what I call 'the problem of causal equivocity', according to which a single effect can be explained *a priori* by a multitude of possible causes. I also show how Tschirnhaus developed this solution in constant, critical dialogue with two alternative solutions to the same problem offered by his two most important philosophical interlocutors during the period from about 1675 to 1682 when he first conceptualised and wrote the initial draft of the *Medicina mentis*, namely Spinoza and Leibniz. Contrary to both Leibniz and Spinoza, Tschirnhaus's three-step method provides a distinctly

1. I use the following abbreviations: DESCARTES: AT = Descartes 1996; CSMK = Descartes 1985–1991. HUYGENS: CHO = Huygens 1888–1950. LEIBNIZ: A = Leibniz 1923–; GP = Leibniz 1875–1890; GM = Leibniz 1849–1960; SPINOZA: C = Spinoza 1985–2016; G = Spinoza 1925. For the *Ethics*, I only indicate in the main text the 'geometrical' reference with the customary abbreviations, e.g., E2p17s is the scholium to proposition 17 in the second part of the *Ethics*. TSCHIRNHAUS: MM = Tschirnhaus 1695 (MM [86/87] indicates the first edition of 1687). For purposes of translation and navigating between the first and second editions, I have profited from the excellent edition and French translation by Jean-Paul Wurtz (Tschirnhaus 1980). Dates of letters and texts are indicated in both the Julian and Gregorian calendars when the cited editions do so, e.g., 27.7/6.8.1682, for the letter from Tschirnhaus to Leibniz of 27 July (Julian) or 6 August (Gregorian) 1682. Unless otherwise indicated, translations are my own. I am grateful to Sophie Roux and Pablo Montosa Molinero and two anonymous reviewers for their comments and corrections.

2. Tschirnhaus puts his *ars inveniendi* in the service of a whole range of logical, psychological, epistemological, moral, and pedagogical tasks. Approaches to his *ars inveniendi* as other than a method for natural philosophy are entirely possible. One important alternative, often cited in the literature, relates to his therapeutic and pedagogical understanding of philosophy as *medicina mentis*, through which he contributes to the *cultura animi* tradition (Corneanu 2012: 46–78). Corneanu does not study Tschirnhaus in her book; however, a chapter co-written with Vermeir (2022) refers to Tschirnhaus frequently and goes some way towards this goal. See also Giglioni (2016), esp. the brief discussion of Tschirnhaus on 200–201.

non-metaphysical solution to this Cartesian problem and gives a central role to experimental natural science.

I will proceed as follows. Sections 2 and 3 are dedicated to context. Most existing interpretations of the three-step method focus on Tschirnhaus's later reception in the early German Enlightenment, Wolff in particular. Here, as I explain in section 2, I want to read it in the context of its initial elaboration, particularly the period from 1675, when the idea of writing a *medicina mentis* first appeared in Tschirnhaus, to 1682, when a first draft of the treatise was completed. In section 3, I examine Tschirnhaus's intense interactions with Descartes, Spinoza, and Leibniz during that period. Section 4 proceeds to introduce and reconstruct in some detail the three steps of Tschirnhaus's method and the four first principles upon which it is founded. This lays the groundwork for discussing how Tschirnhaus solves the problem of causal equivocity, which I see as the principal philosophical motivation for the method. In section 5, I thus explain the problem of causal equivocity, how it arises in Descartes, and how Tschirnhaus's closest interlocutor at the time, namely Leibniz, responded to it. In sections 6 and 7, I turn to Tschirnhaus, showing how his solution compares with those of his two principal interlocutors, Leibniz and Spinoza. Finally, in section 8, before concluding, I explain how Tschirnhaus's recourse to hypothesis and experiment contributes to his original solution to the problem of causal equivocity.

2. Questions of Context

As a philosopher, Tschirnhaus is difficult to categorise. Straddling two centuries, he stood centrally in the late seventeenth-century reception of Cartesianism but was also a key figure in the early eighteenth-century German Enlightenment. Beyond philosophy, his interests were broad and eclectic: he was a mathematician who invented several named theorems and operations; a natural philosopher and experimentalist with a particular interest in burning mirrors and the fabrication of porcelain; and a philosopher of education who wrote an influential tract promoting a pedagogy putting the emphasis on the pleasure of learning (Tschirnhaus 1700; cf. MM II 237–253; Klüger 1913; Richter 1960). As Descartes, he put his trust in the capacities of the individual mind liberated from common prejudices and stressed the importance of independent, personal discovery (Bayle 1686: 1330–33; Lærke, forthcoming). But he was also an active promoter of collaborative science, a member of the *Académie des sciences*, and himself attempted to establish a small scientific academy in Saxony (Fontenelle 1740; Wollgast 1988: 25–26; Teich 1960; Wiemers and Wiemers 1996). Today often associated with a subversive Spinozist 'radical Enlightenment', he nonetheless interacted and worked closely with leading Pietists such as Philipp Jakob Spener

(Wollgast 1988: 26–27; Whitmer 2015: 20–36). All these divergent and sometimes seemingly contradictory aspects of Tschirnhaus's philosophical and scientific activities not only place him at the point of transition between different doctrines, schools, and epochs, but also at the intersection of a great many different disciplines, including mathematics, logic and epistemology, natural philosophy, moral philosophy, mathematics, and pedagogy.

Tschirnhaus's uncertain place in the history of philosophy has spawned a particularly diverse commentary literature. Philosophical readings of Tschirnhaus's work, systematic and close to the texts, are relatively rare.[3] Most studies are more contextual in scope and character. Two general contexts dominate. The first is Tschirnhaus's complicated relations to Spinoza and Spinozism, studied, for example, by Winfried Schröder (1987) and Jonathan Israel (2001: 637–41; 2023: 1092–1100). The second is his impact on the early German Enlightenment, in particular his relations to Leibniz, Thomasius, Wolff, and Gottsched. Excellent recent contributions include work by Stefanie Buchenau (2013: 28–30, 39–41), Enrico Pasini (2016), and Corey W. Dyck (2021). Some studies manage to combine both contexts. For example, in his important 1988 booklet on *Ehrenfried Walther von Tschirnhaus und die deutsche Frühaufklärung*, Siegfried Wollgast places Tschirnhaus at the origin of the German Enlightenment along with four other thinkers: Leibniz, Pufendorf, Thomasius, and Wolff. At the same time, however, he also stresses the role Tschirnhaus played in the dissemination of Spinozism in Northern Europe, depicting him as the 'first German Spinozist' (Wollgast 1988: 18, 21). It is also worth mentioning the French scholar Jean-Paul Wurtz, who published a magnificent French translation of the *Medicina mentis* with a rich apparatus of notes and appendixes, and a series of studies exploring Tschirnhaus's Spinozist heritage and his polemics with Thomasius (Tschirnhaus 1980; Wurtz 1980, 1981a, 1981b, 1988). Finally, a recent set of impressive studies by a group of researchers based at the University of Barcelona carefully reassess aspects of Tschirnhaus's relations to Descartes and Spinoza, but also address his engagement with the German tradition from Clauberg to Thomasius.[4] This variety of available historical approaches should encourage any student of Tschirnhaus to exercise particular care in choosing a context, and in motivating and explicating that choice.

One central instance of Tschirnhaus keeping a foot in each of two distinct—even opposing—philosophical camps and historical contexts is this: on the one hand, he insists that 'true physics' (*vera physica*) has to be built from the ground up from *a priori* principles; on the other hand, he maintains that the conduct of

3. For some exceptions, see Van Peursen (1993); Schönfeld (1998); Sanna (1999); Savini (2021); Ragni (2022).

4. Montosa Molinero and Sales Vilalta (2019/2020); Sales Vilalta (2021); Granada (2021); Montosa Molinero (2021); Montosa Molinero (2022); Granada and Montosa Molinero (2021, 2022).

'natural science' (*scientia naturalis*) has to be rooted in experience and experimental practices; indeed, he explicitly claims to have found an 'intermediary path' between these two approaches (MM III 88, 280, 290). For this reason, in a recent contribution, Corey W. Dyck describes Tschirnhaus's philosophy as an 'experimental Cartesianism', implicitly placing him in the lineage of thinkers such as Henricus Regius, Jacques Rohault, and Burchard de Volder (Dyck 2021: 18).[5] The assessment is, I believe, correct. Dyck, however, only uses the insight to better situate Tschirnhaus in relation to Wolff. He makes little effort to understand the context in which this experimental Cartesianism took shape or to retrace its genesis. This is what I will undertake here, with particular emphasis on the way that Tschirnhaus situated himself in relation to a specific problem in natural philosophy—the Cartesian problem of causal equivocity—which he shared with Spinoza and Leibniz, but to which he proposed an original non-metaphysical solution, very different from theirs.[6]

The approach calls for two remarks.

First, I do not claim that Descartes, Spinoza, and Leibniz represent the full context for understanding the genesis of Tschirnhaus's natural scientific method. A full contextual analysis would have to consider his relations to a great number of other minor and major thinkers, including Hermann Schuller, Pieter van Gent, Georg Mohr, Christiaan Huygens, Nicolas Malebranche, Jacques Rohault, Edme Mariotte, Henry Oldenburg, Nicolas Steno, Francesco Redi, and Alfonso Borelli, to mention just some of them. Still, I believe the ground-structure of Tschirnhaus's method is best understood as the result of his complex engagement with Descartes's texts and his personal relations with Spinoza and Leibniz at a relatively early stage in his intellectual development, notably during the years from 1675 to 1682.

Second, if Tschirnhaus learned much from these philosophers, it is not my aim to reduce his doctrine to this (or any other) set of 'influences' or 'sources'.[7] It is rather to show how Tschirnhaus's art of discovery emerged from a historical configuration or constellation of philosophical positions, or what one might call a 'philosophical controversy', within which his doctrine took shape through learning and borrowing from the others, but also through modifying, criticising, and opposing them (Lærke 2014: 11–46). The problem of causal equivocity lies at the heart of that controversy as the one central issue to which each of them provided a different systematic solution. Tschirnhaus's three-step method was his.

5. Dyck provides no reference, but the expression is today well entrenched in the commentaries (Dobre and Nyden 2013; Roux 2013: 47–51; Ragland 2014; Strazzoni 2018: 127–130; Dobre 2019). None of these other studies do, however, mention Tschirnhaus.

6. For a paper stressing the Leibniz and Spinoza contexts, but comparing with Clauberg rather than Descartes, see Sales Vilalta (2021: 389–402).

7. For an otherwise valuable study that takes that approach, see Narváez (2020).

3. Tschirnhaus among Descartes, Spinoza, and Leibniz

The *Medicina mentis*, first published along with a shorter treatise entitled *Medicina corporis*, reflects Tschirnhaus's whole intellectual profile and development. The first edition, with the Latin polished by his Dutch friend Pieter van Gent, was published in 1686 (with 1687 on the title page).[8] It was reedited in a substantially expanded edition in 1695, including corrections and additional sections written in response to objections made by Christiaan Huygens in private correspondence and public accusations of Spinozism made by Thomasius in his *Monats-Gespräche*.[9] According to Fontenelle's posthumous *Éloge*, Tschirnhaus was planning an additional third edition at the time of his death in 1708 (Fontenelle 1740: 206–7).

The initial conception of the work can, however, be traced as far back as to the mid-1670s. Admittedly, in the preface to the first edition, Tschirnhaus himself dates his ambition to articulate a personal philosophy even further back to an eventually aborted attempt to publish a flawed manuscript when he was only 18 years old (around 1669, the year after he began studying in Leiden), followed by a promise to himself not to publish anything before he was at least 30 years old (so no earlier than 1681—a promise that he kept) (MM [86/87], Preface, 1r). There are no indications, however, that this first youthful attempt was framed as a *medicina mentis et corporis*. While discussing with Leibniz in late 1675 or early 1676, Tschirnhaus referred to Spinoza's philosophy as being '*de Medicina Mentis, de medicina corporis*', expressions that figure nowhere in Spinoza's extant texts (A VI, iii, 384/Leibniz 2001: 41–43). A first draft of the *Medicina mentis* was completed in 1682 when Tschirnhaus circulated it among fellow academicians in Paris (Tschirnhaus to Leibniz, 27.5.1682, A II, i, 828; Tschirnhaus to Huygens, 30.8.1683, CHO VIII 472).[10] These indications suggest that Spinoza's philosophy played a central role in the initial conception of the project of a *Medicina mentis* and that the core argument of the book was conceived and drafted in the period between 1675 and 1682, even if several years passed before a further revised and corrected text was published (MM [86/87] Preface, 1r).

Reading Tschirnhaus's treatise in the context of its original conception thus requires that we focus on his most important philosophical interlocutors during that specific period. Who were those interlocutors? Tschirnhaus himself dodges

8. On the relations between Tschirnhaus and Van Gent, see Reinhardt (1911); Steenbakkers (1994: 35–50); Proietti and Licata (2013); Evangelista (2014).

9. See Huygens to Tschirnhaus, 10.3.1687 (CHO IX 111–125); for the entire public exchange between Thomasius and Tschirnhaus, see Thomasius (1690).

10. The *Medicina corporis*, however, was written later. According to Tschirnhaus's own recollections, he 'began to write on the conservation of health [*de conservanda sanitate*, i.e., the *Medicina corporis*] in the middle of the tumult of Paris', here referring to the trip he undertook in 1682 (Tschirnhaus to Huygens, 30.8.1683, CHO VIII 472).

the question. Much later, in the preface added to the second edition of 1695, he places his treatise in the context of the work of four other philosophers, including Descartes's *Discours de la méthode* (1637), Antoine Arnauld's *Logique ou l'art de penser* (1662) (Nicole is not mentioned), Nicolas Malebranche's *La Recherche de la vérité* (1674–1675) and, finally, Edme Mariotte's *Essai de logique* (1678) (MM Preface, 3v). This short list of figures does illuminate some of the background for Tschirnhaus's philosophy. A closer look at Tschirnhaus's biography and correspondence does, however, quickly reveal that the list is a strategic rewriting of his own pedigree, and that those four figures were in fact not—or at least not all of them—Tschirnhaus's most important interlocutors in the key period from 1675 to 1682. Those were, or so I claim, Descartes, Spinoza, and Leibniz.

Tschirnhaus became well acquainted with Descartes's philosophy while studying in Leiden in 1668–1674, if not earlier. His early familiarity with Descartes's texts and embrace of the Cartesian philosophy are evident from his first exchanges with Spinoza. Moreover, during his first two stays in Paris, in 1675–1676 and 1682, he obtained privileged access to Descartes's unpublished writings via Claude Clerselier, the executor of Descartes's literary estate, and obtained manuscript copies of both *La Recherche de la vérité* and the *Regulae* which he shared and discussed with Leibniz.[11] Tschirnhaus's original Cartesianism became more relative throughout his career as his own thought developed, to such an extent that he at one point proudly declared to have become a Cartesian 'heretic' (Tschirnhaus to Leibniz, 27.5.1682, A II, i, 828–829). But he never completely abandoned Descartes, and many of his most fundamental philosophical intuitions are broadly Cartesian.[12]

Tschirnhaus was reluctant to acknowledge his debt publicly, but Spinoza also clearly exerted a decisive influence (Wurtz 1981b; Pätzold 1999). Indeed, the list of four other names in the 1695 preface was, I suspect, compiled partly in response to the accusation of crypto-Spinozism made by Christian Thomasius after the publication of the first edition, as an attempt to drown out the (justified) impression of Spinozism and give the work a more respectable pedigree (Wurtz 1980, 1981a). Spinoza is referred to nowhere in the *Medicina mentis*, except obliquely as the author of a geometrical reconstruction of Descartes's philosophy (MM II 184). Yet Tschirnhaus fooled no one. The Dutch Jew is manifestly present everywhere in the terminology, individual arguments, and global structure of

11 Tschirnhaus copied out the manuscript of Descartes's *Recherche de la vérité* while still in Paris in December 1676, and sent a copy to Leibniz (A II, i, 431–444). Tschirnhaus sent Leibniz a partial manuscript of the *Regulae* at the end 1682 or in early 1683, made from a now lost copy. When Tschirnhaus himself got hold of this text is not clear, but it was most likely during his second stay in Paris in 1682. See Tschirnhaus to Leibniz, 27.7/6.8.1682 (A II, i, 831); and Breger (1983).

12. See, e.g., MM Preface, 3r; II, 69, 82, 177–180, 187; III, 291 (philosophy); 84, 96, 105, 108, 111–116 (mathematics).

the work. Tschirnhaus first met Spinoza personally through mutual friends—a group which also included Hermann Schuller, Pieter van Gent, and Ameldonk Blok—in late 1674 while studying law in Leiden (Vermij 1988, 1991; Steenbakkers 1994: 35–36). This was late in Spinoza's life, and Tschirnhaus did not remain long in Holland thereafter, indeed only a few months. He never belonged to Spinoza's inner circle. Nonetheless, Tschirnhaus conducted an important correspondence with Spinoza in 1674–1676, partly mediated through Schuller. Schuller also facilitated the limited distribution of manuscript copies of Spinoza's writings provided by Van Gent, a scribe (Steenbakkers 1994: 38–39). As one of the beneficiaries of this system, Tschirnhaus travelled Europe in the late 1670s with copies of the yet unpublished *Ethics*, some original letters, and perhaps other texts, discussing Spinoza's philosophy with Oldenburg in London, Leibniz in Paris, and Steno in Rome, hereby contributing importantly to the first dissemination of Spinoza's philosophy outside the Dutch Republic (Spinoza 2011; Spruit and Totaro 2011: 17–19; Lærke 2011, 2017).

The *Medicina mentis* hardly mentions Leibniz, except for some remarks on his genius as a mathematician (MM II 113, 186). Yet Leibniz was a privileged interlocutor of Tschirnhaus for over three decades. On Henry Oldenburg's recommendation, Tschirnhaus first contacted Leibniz when arriving in Paris in October 1675 after visiting London.[13] They struck up a close friendship that lasted until Tschirnhaus's death in October 1708, and entertained an extensive correspondence from 1676 onward on matters mostly mathematical but also philosophical.[14] Of particular importance for the *Medicina mentis*, however, was the early period they spent together in Paris in 1675–1676. As Leibniz wrote Vincent Placcius in 1690 about their relationship: 'We were once very close in Paris, and he acknowledges that this was when he advanced the most. Therefore, a large part of what he reports agrees with my opinions' (A II, ii, 342).[15] During that period, the two Germans were inseparable. They explored the Parisian intellectual scene, delved into the Cartesian manuscripts at the home of Clerselier, and discussed Spinoza's philosophy extensively. Leibniz likely had a hand in the part of Tschirnhaus's correspondence with Spinoza written from Paris; it contains important clues to the topics of their common discussions (Goldenbaum 1994; Lærke 2008: 392–405; Montosa Molinero 2021, 2022). Leibniz's philosophical fragments from the period, known today as the *De summa rerum*, also offer

13. Writing to Oldenburg on 18/28 December 1675, Leibniz thanked him for 'sending Tschirnhaus to us is a token of your friendship, for I take great delight in his company and recognize outstanding ability in the youth' (A III, i, 37/Loemker 1989: 165). Leibniz was about five years older than Tschirnhaus.

14. For the complete correspondence (1676–1706), see Leibniz (1899: 311–526); also in A II, i–x.

15. See also Leibniz to Placcius, 10/20.5.1687 (A II, ii, 197–198); Leibniz to Huygens, 3/13.11.1690 (A II, ii, 350–351).

rich impressions of the philosophical laboratory they built together during that period.[16] As already noted by Carl Gerhardt, the nineteenth-century German Leibniz editor, Leibniz's writings from the late Paris period contain 'numerous signs of them working together; we find Tschirnhaus's writing next to Leibniz's on the same sheets of paper' (Leibniz 1847–1860: IV, 421; Foucher de Careil 1862: 119n2; Montosa Molinero 2021: 416).

4. Three Steps: Introspection, Deduction, Experimentation

Having established the context for Tschirnhaus's initial conception of his art of discovery, let us now turn to the method for natural philosophy that it develops. In the conclusion to the *Medicina mentis*, the author boasts to have found 'a path in a way intermediary between those taken by all philosophers until now, some of whom considered that all knowledge should be derived *a priori* from reason alone, and the others that it should rather be *a posteriori* from experience' (MM III 290). A similar claim appears in the preface to the 1695 edition, where he announces that he has 'found an easy path, simple to take, and so to speak intermediary between those taken by all previous philosophers' (MM Preface, 7r). I am not the first to recognise that understanding this 'intermediary path' is key to Tschirnhaus's method (Wurtz 1988; Buchenau 2013: 28–31; Dyck 2021: 18–20). To gain a deeper understanding of how it works and what motivates it, a detailed reconstruction of the method as it was developed in the context of its original elaboration is, however, required. This has not been undertaken previously.

What does this path or method consist in, and how does one follow it? Tschirnhaus summarises it as follows:

> [A]ccording to my opinion, we must indeed begin *a posteriori* and then, moving forward, everything must be derived only *a priori*, and then finally every singular [truth] should be confirmed everywhere by evident experiments; and this should be continued until we return again to the first experiences that we had assumed at the beginning, and according to the same order, and thus the whole circle of philosophy is complete without a circle. (M III 290)

The method has three steps: (1) we take our point of departure in general principles of mind and reason that we obtain *a posteriori*, through introspection; (2) we

16. On the *De summa rerum* papers, see Lærke (2020). A minor research industry exists on the relations between Leibniz, Spinoza, and Tschirnhaus in the mid-1670s, mostly focusing on Leibniz's reception of Spinozism, including, e.g., Kulstad (2002); Lærke (2008: 361–73, 392–421); Lærke (2011, 2018); Olesti (2021).

move forward with our reasoning *a priori* by inferring particular propositions from initial, general definitions and axioms, through deduction; (3) we confirm the results of our reasoning by testing them *a posteriori*, through experimentation. Let us take a closer look at each of these steps.

4.1. Step I: Introspection

The first step, a fundamentally Cartesian one, establishes the first principles of knowledge from introspection, i.e., *a posteriori* from inner experience:

> [W]e should begin in particular with those experiences which can be had almost at any moment, which it requires no work to have, and which are absolutely free from error; that is, we should begin with the experiences we have within ourselves, and especially the primary ones among those which exist in us. (MM III 290–291)

This initial exercise of self-reflection yields the following first principles:

> 1. I am aware of various things […]. 2. Some [things] affect me well, others badly […]. 3. There are certain things I can conceive, others that I can in no way conceive […]. 4. Finally, I notice certain things by the external senses, and also some by internal imaginations and passions. (MM Preface, 6v)

Together, these four principles express 'the entire nature of man' (MM III 295). They encompass the mental tools—four 'distinct faculties', as Stefanie Buchenau puts it—that we as human beings initially have available when searching for truth, i.e., the cognitive access we have to the world and the innate resources we have available for exploring and structuring the information we obtain (Buchenau 2013: 28–30, here 30).[17] Since he understands them also as 'first principles', i.e., principles beyond which we cannot go, they also indicate that Tschirnhaus's entire doctrine is confined to the exploration of human experience and knowledge (MM Preface, 6v). In other words, this doctrine has no

17. Buchenau's brief account of the three-step method includes an excellent analysis of the initial *a posteriori* step. It does not address the second *a priori* step (deduction from general principles) and says very little about the third *a posteriori* step (experimental confirmation). However, she does offer some remarks about how Tschirnhaus thought about the use of instruments in experimentation, not based on the *Medicina mentis*.

ambition to develop an ontology or metaphysics, which Tschirnhaus rejects as useless speculation:

> *I offer you nothing but the first philosophy. Some like to call this metaphysics, but because so many people spin out a lot of useless speculations about it, it is usually despised by most of the learned […] I would like you to know that* in this first philosophy of mine I will exhibit all those things which must be known first of all by a man who has a serious mind to acquire wisdom for himself. (MM Preface, 4v–5r; italics original)

This key passage unambiguously states Tschirnhaus's anti-metaphysical commitment. I fundamentally disagree with Massimiliano Savini, who oddly cites this same passage as confirming (rather than the contrary) a conception of 'first philosophy' as 'metaphysics', using this reading to place Tschirnhaus's work 'inside the history of ontology' as a late critical contribution to German scholastic metaphysics (Savini 2012: 148–49, 153, 158). Framing the four principles as 'fundamental ontological principles', Savini never addresses their *a posteriori* provenance or Tschirnhaus's description of them as encompassing the 'nature of man'. By contrast, Sales Vilalta is entirely correct in emphasising Tschirnhaus's 'open and direct rejection of metaphysics', his 'anti-speculative vocation', and the fact that he 'abandons the consideration of metaphysics as *Philosophia prima*' (Sales Vilalta 2021: 400–401).[18]

With this in mind, what is the meaning and provenance of Tschirnhaus's four principles?

Stipulating that we are 'aware of various things' has Cartesian resonances: it evokes Descartes's description of the thinking 'I' in the *Meditations* as 'a thing that doubts, understands, affirms, denies, is willing, is unwilling, and also imagines and has sensory perceptions' (AT VII 28/CSMK II 19). We can also hear echoes of discussions with Leibniz on first truths at the time they were together in Paris. Hence, in several texts from that time, Leibniz states that the 'great variety in our thoughts' is an 'absolute truth', and that the proposition 'I have such and such appearances' belongs among the 'primary truths'.[19] Most importantly, however, principle 1 also creates some distance between Tschirnhaus and Descartes by what it does *not* say about primary awareness: it says nothing

18. See also Tschirnhaus's extraordinary letter to Leibniz of 17 April 1678, where, before endorsing and proposing a full reconstruction of the opening propositions of Spinoza's *Ethics* and demonstration of God, he also cautions that 'this is not a time for me to delight in metaphysics' and 'whatever I now affirm about such things, I place merely among conjectures and probabilities' (A III, ii, 70).

19. Leibniz to Simon Foucher, 1675 (A II, i, 388), and Leibniz, *De veritatibus, de mente, de Deo, de universo*, April 1676 (A IV, iii, 508/Leibniz 1992: 56–57). See also Lærke (2019).

about self-awareness. For Descartes, of course, clear and distinct awareness of self, as expressed in the *cogito*, forms the very paradigm of a clear and distinct conception. However, as Tschirnhaus stresses in a 1682 letter to Leibniz, he does not understand self-awareness as something that is 'better known than any other thing', but rather as something obscure, similar to the experience of pain (A II, i, 828–829). The pedigree of the position is mixed. It is reminiscent of Spinoza's view that 'the idea that constitutes the nature of the human mind is not, considered in itself alone, clear and distinct' (E2p28s), but also of Malebranche's critique of the *cogito*, according to which we have no clear idea of our own minds but only imperfect knowledge of it through consciousness (Malebranche 1997: III.vii.4, 237–239). It explains why, as we shall see, Tschirnhaus shall not refer to the *cogito* or its alleged clarity and distinctness as a criterion of truth or certain knowledge.

Principle 2—that some things affect me well, others badly—is practical in scope. Tschirnhaus uses it to explain our motives for engaging in philosophy and to determine what it contributes to our happiness. It establishes that our affective life, i.e., our experience of how external things affect us, is the fundamental principle of moral philosophy. The immediate contextual background for this principle is twofold. First, it is Descartes's *Passions de l'âme* (1649) and the correspondence with Elisabeth which Tschirnhaus studied alongside Leibniz as early as 1676 in Paris. Second, it is Spinoza's *Ethics*, in particular Parts 3 and 4 concerned with affects and human servitude. I discuss in some detail Tschirnhaus's understanding and use of this principle elsewhere and shall leave it to one side here (Lærke [forthcoming]).

Principle 3—that there are certain things I can conceive, others that I can in no way conceive—lays the groundwork for the criterion of truth and certain knowledge that Tschirnhaus shall give instead of the *cogito*, namely conceivability: 'the unique and first principle regarding the true and the false' is that 'we can conceive certain things while we cannot conceive certain others in any way' (MM II 37). It is also the fundamental principle of Tschirnhaus's logic. But what does it require for something to be conceivable, and how do we ascertain that we do in fact conceive it? We do so, Tschirnhaus argues, by retracing the production of the thing in our mind. In other words, ascertaining a thing's conceivability requires a genetic definition showing how it can be produced: 'Clearly, every definition of a singular thing must always include this thing's primary mode of formation, which I will call the *generation* of a thing. For to truly conceive a thing is nothing but an action or the formation of some thing in the mind' (MM II 67). Tschirnhaus most likely adopted this genetic understanding of conceivability as early as his first exchanges with Spinoza in 1674–1675. Particularly significant here is Spinoza's response in a January 1675 letter to a question from Tschirnhaus about definitions, where he states that 'to know which of the many ideas of a

thing is sufficient for deducing all its properties, I pay attention to one thing only: that the idea or definition of the thing expresses the efficient cause'.[20] Spinoza defends this principle of causal definition as early as the *Tractatus de intellectus emendatione*, using as his example the definition of a circle as a line rotating around a fixed point (§94–96, G II 34–35/C I 39–40). The principle, however, is not original to him, with Hobbes being a likely original source. Hence, in a passage of *De corpore*, using the exact same example, Hobbes explains that 'definitions of things, which may be understood to have some cause, must consist of such names as express the cause or manner of their generation, as when we define a circle to be a figure made by the circumduction of a straight line in a plane'.[21]

Finally, principle 4—that we notice certain things either through the external senses or through internal imaginations and passions—is concerned with how the external world intervenes in our mental life. It emphasises the non-metaphysical character of Tschirnhaus's experimental Cartesianism. This principle came later to Tschirnhaus than the others. The first known version of his list of first principles, included in a May 1682 letter to Leibniz written at the time when Tschirnhaus was circulating a first draft of the *Medicina mentis* among the members of the *Académie des sciences* in Paris, included only principles 1 to 3 (Tschirnhaus to Leibniz, 27.5.1682, A II, i, 828–829/A III, iii, 623). Principle 4 suggests a form of natural philosophical phenomenalism not unlike that already found among philosophers in the circles round Marin Mersenne, such as Pierre Gassendi whom Tschirnhaus cites in this context (more precisely, he cites François Bernier's *Abrégé* of Gassendi's philosophy, MM II 89). Considering the timing of Tschirnhaus's introduction of the principle, i.e., after 1682, we can also identify another, more precise context for principle 4, namely Mariotte's 1678 *Essai de logique*, referenced by Tschirnhaus in the preface to the second edition (MM Preface, 3v). In his *Essai*, Mariotte lays down phenomenalist principles of experience and truth which are very close to Tschirnhaus's, namely, that 'no matter how the things that fall under our senses appear to us, it is true that it appears to us like that' and that 'the pleasures and pains that we feel, we truly feel them, regardless of what their causes are' (Mariotte 1992: I, xii, 19; liv, 35).[22] When Tschirnhaus circulated the first draft of the *Medicina mentis* for commentary in 1682, Mariotte

20. Spinoza to Tschirnhaus, 01.1675, Letter 60 (G IV 270–271/C II 432–433); cf. Tschirnhaus to Spinoza, 01.1675, Letter 60, G IV 269/C II 431. See also note 213 by Wurtz in Tschirnhaus (1980: 271–72); Wurtz (1988: 201–3); Narváez (2020: 126).

21. Hobbes, *Concerning Body* [Lat. 1655/Eng. 1656], I, vi, §13 (Hobbes 1839–1854: I, 81–82).

22. It should be noted that the first part of Mariotte's *Essai*, where these principles are developed, was in fact largely plagiarised from a text by Roberval, unpublished at the time. The reference to Mariotte will thus ultimately also lead us back yet again to the Mersenne circle. It is also worth noting that, via Leibniz, Tschirnhaus may very well have had access to a manuscript version of the first part of the *Essai de logique* as early as 1676. On this complicated dossier, see Rochot (1953: 38–43); Gabbey (1986: 204–44); Roux (2011); Lærke (2026: 208, 210–14).

(along with Gallois) was among the few people who obliged, referring Tschirnhaus back to the *Essai* for clarification (Tschirnhaus to Leibniz, 27.5.1682, A II, i, 828/A III, iii, 622). The subsequent introduction of principle 4 may have been Tschirnhaus's response to that suggestion.

4.2. Step II: Deduction

The second step, i.e., to derive everything *a priori*, consists in deducing propositions about particular things from initial definitions or general principles.[23] This part of the method is constructive and modelled upon mathematics: 'the very first precept of this method is that we always begin with the simplest, and then gradually proceed to the more complex', just as one does in 'the study of mathematics' which 'perfectly illustrate the idea of the most perfect method' (MM III 277).

We begin with general definitions: 'to perfect a science, one must begin with definitions or, as is also said, principles' (MM II 111). General definitions are, for example, those we have of extension, movement, rest, and the like. Next, from the definitions we move on to construct general axioms. These are formed when we 'consider exactly the definitions themselves, that is to say, carefully consider all the relations which can obtain between the elements of any one definition' (MM II 117–118; cf. MM II 122–123). Axioms include, for example, natural laws specifying the general relations between 'fixed and mobile [elements], and movement' (MM II 118). Finally, by combining general definitions and axioms, we can derive less general propositions, and from those, even less general ones, moving all the way down to specifying the relations among particulars. From this, we obtain a complete framework through which all possible things can be conceived. In other words, we conceive '*a priori* the generation of all things by means of the elements of physics' (MM II 88).

This whole deductive framework constitutes the basis of what Tschirnhaus calls his *scientia generalis* (MM II 204). The notion of a 'general science' has Leibnizian resonances, but apart from the name, it is to Spinoza's use of the geometrical method that we must turn to understand the nature and origin of this second step. Indeed, questions of an *a priori* method of discovery was already a central topic of Tschirnhaus's in-person conversations with Spinoza in Holland in late 1674, and he clearly learned from his interlocutor: 'When I was with you', he wrote Spinoza in January 1675, 'you indicated to me the method you use for finding truths not yet known. By experience I know that this Method is

23. In recent work, Narváez emphasises the close connection between Tschirnhaus's theory of definitions and his method (see Narváez 2020: 109–28). I agree, but it is important to note that it concerns only part of that method, namely step 2 out of 3.

very excellent, and still very easy, as far as I have understood it' (Letter 59, G IV 269/C II 431).[24] Tschirnhaus has two aspects of Spinoza's method in mind. First, as we already know, it is the idea that discovery must begin from initial definitions that are genetic, i.e., that express the proximate cause of the definiendum. Second, it is the idea of proceeding geometrically in the deduction of other, more specific definitions from such initial, general definitions. Let us briefly consider how each of these aspects of Spinoza's theory appear in Tschirnhaus.

The principal difficulty in relation to the *a priori* deduction of such a framework, Tschirnhaus explains in the *Medicina mentis*, is how to form the initial definitions: 'the most universal problem [is] how to discover all the definitions or first concepts' (MM II 162; cf. Bayle 1686: 1335–36). The importance and difficulty of first definitions is also a point Tschirnhaus later addressed in a response to a query from Christian Wolff (Schönfeld 1998: 72). But the question had already repeatedly come up in his correspondence in the 1670s. We have already considered his exchanges with Spinoza about real definitions in 1674–1675. Moreover, in a letter of April 1677, written only a couple of months after Spinoza died, Tschirnhaus endorsed a 'method which proceeds by definitions' in demonstrating the existence of God and of what follows from God, specifying that the primary definition that 'our deceased [i.e., Spinoza] delivered seems to me the most adequate' (A III, ii, 69–70). Finally, Tschirnhaus returns to the point in an April 1678 letter to Leibniz where he affirms that philosophical truth can be investigated by means a method similar to that of algebra, although 'definitions of things must first be given, which require a sufficiently perspicacious mind', and declares having 'never seen more excellent precepts for forming them than those of Mr. Spinoza' (A III, ii, 613). In this letter, Tschirnhaus points to the *Tractatus de intellectus emendatione*, which he at that point had only just received and read, clearly alluding to the passages where Spinoza explains how 'right way of discovery is to form thoughts from some given definition' (§94, G II 39/C I 34).

But this is not all. In the *Ethics*, Spinoza shows how, once initial definitions and axioms have been conceived and articulated, we can proceed to deduce

24. These remarks are sometimes taken to refer to Spinoza's *Tractatus de intellectus emendatione*, §§ 96–97 (G II 35/C I 39–40; see, e.g., C II, 430n). Generally, Tschirnhaus's philosophy, especially the idea of writing a 'medicine of the mind', is often seen as inspired by the *Tractatus* (see, e.g., Wurtz 1981a: 64; Buchenau 2013: 29n48; Narváez 2020: 112–13, 117–18). Tschirnhaus himself later speaks of his own draft treatise as *tractatus quem conscripsi de Emendatione Intellectus* (Tschirnhaus to Huygens, 11.9.1682, CHO VIII, 386). It is, nonetheless, a conjecture to adopt with caution. Tschirnhaus's adoption of Spinoza's method and theory of real definition, as well as his own project for a *medicina mentis*, predate Spinoza's death. However, according to Tschirnhaus's own testimony in the *Eilfertiges Bedencken* of 1688, he 'only got his hands on this treatise [i.e., the *Tractatus de intellectus emendatione*] after the author's death' (reedited in Thomasius 1690: 775). The information is corroborated by a letter to Leibniz of April 1678 (A II, i, 613). See also Pätzold (1999: 341–44); Lærke (2017: 196–97).

other things from them. This is, of course, what Spinoza *does* throughout this entire work *more geometrico demonstrata*. But it is also the method or procedure he *explains* specifically in his rudimentary theory of 'common notions'. Common notions form the basis of the so-called 'second kind of knowledge', an adequate form of knowledge also described as 'reason' (E2p40s1). Reason differs from the first, inadequate kind of knowledge, called 'imagination', but also from the third, superior kind of knowledge, called 'intuition'. Reason and common notions are 'the foundations of our reasoning' and 'the foundations of philosophy'.[25] Contrary to intuitive knowledge, which is concerned with individual essences, 'the foundations of reason are notions … which explain those things that are common to all, and which (by P37) do not explain the essence of any singular thing' (E2p44s; cf. E2p38). Common notions, Spinoza explains, are formed when our mind 'regards a number of things at once, to understand their agreements, differences, and oppositions' (E2p29s). To illustrate his thought, he refers to the previously established Lemma 2, inserted after E2p13: 'all bodies agree in that they involve the concept of one and the same attribute (by D1), and in that they can move now more slowly, now more quickly, and absolutely, that now they move, now they are at rest'. As this suggests, the appropriate sensible properties for forming adequate common notions are, under the attribute of extension, causal or mechanical properties related to motion and rest. Spinoza's idea is that, when it comes to understanding the world of bodies, we should begin with those properties that experience teaches us are common to all bodies, namely extension, movement, and rest, and then derive from these universal common notions particular or 'proper' common notions, i.e., causal properties common to many or some bodies only, until we finally arrive at those that are common to only two bodies, i.e., the common notions that are the least common.[26] Once we have concluded that whole deductive process, we will have adequately grasped how, causally, 'from the necessity of the divine nature [follows] infinitely many things in infinitely many modes', as we can paraphrase the central proposition E1p16.[27]

25. E2p40s1; Spinoza, *Tractatus theologico-politicus*, XI (G III 179/C II, 271); see also Lærke (2024: 61–63); Lærke (2025: 90–92).

26. Spinoza's distinction between 'universal' and 'proper' common notions is reminiscent of Hobbes's distinction between common and proper names (*Concerning Body*, I, ii, §9, in Hobbes 1839–1854: I, 19–20) but also echoes standard scholastic distinctions between the common, the proper, and the most proper (*communiter, proprie et magis proprie*), from Porphyry's treatment of the predicables in *Isagoge*, chap. III. For good examples of the scholastic distinction between *communia* et *propria* in works demonstrably known by Spinoza, see Keckermann (1611: 178–87, 234); Heereboord (1665: 120); cf. Servaas van Rooijen (1889: 180).

27. The deductive derivation of the particular from the general is the central topic of the last four letters exchanged between Spinoza and Tschirnhaus, after the latter declared having 'great difficulty conceiving how the existence of bodies, which have motions and shapes, is demonstrated a priori' (Tschirnhaus to Spinoza, 2.5.1676, Letter 80, G IV 331/C II 484; see also Letters 81–83). In Letter 82, Tschirnhaus declares E1p16 'nearly the most important proposition in Book I' (G IV, 3334/C II 485).

The second step of Tschirnhaus's method works in much the same way. First, we must acquire 'general knowledge from which we draw the same truth about the common nature of several things' (MM II 203). As is clear from Tschirnhaus's assertion that only genetic or causal definitions are real, only causal properties can serve as an appropriate basis for determining such 'common natures'.[28] These common natures, also called 'common truths', Tschirnhaus claims, 'are much easier to discover' than particular ones, for they 'are inferred from something common either to all particular objects, or to the greatest number possible among them', and 'for this reason are more easily observed' (MM II 204). What he has in mind are the simplest properties shared by all bodies, and the most general natural laws. Next, 'this process must be continued until such a kind of genera are reached, with which the remaining beings have nothing in common, but which are observed or conceived to have a singularly different nature, or a different generation' (MM II 73). In this way, working our way down from most universal to more specific differences and similarities, we pursue 'knowledge of more truths that [particular natures] have in common with other natures' (MM II 205). Throughout the entire process, the causal or genetic criterion for establishing commonalities and making distinctions applies (MM II 71). Eventually, we thus acquire knowledge of how 'all things are distinguished from each other according to the different ways in which they are generated' (MM II 233–234).

4.3. Step III: Experimentation

The last step in Tschirnhaus's method serves to 'confirm' or 'corroborate' our *a priori* reasoning by using experiments to show how specific effects follow from determinate causes. Together, steps 2 and 3 constitute the whole of 'physics':

> By physics, I understand nothing but the knowledge of the universe, demonstrated *a priori* by the exact method of mathematics, and corroborated *a posteriori* by the most evident experiments, convincing the imagination itself. (MM III 280)

In these assertions, it is tempting to hear echoes of an author whom Tschirnhaus does not mention in this specific context but whose work he cites approvingly elsewhere in the *Medicina mentis*, namely Jacques Rohault and his 1671 *Traité de physique*—a book that Tschirnhaus owned no less than three copies of at the time the catalogue of his library was established (Rohault 1671; Granada and Montosa 2021: entries 575, 626, 1016, 2048). In the *Medicina mentis*, Tschirnhaus credits

28. False general definitions, Tschirnhaus explains, result when our imagination misleads us into taking different things to be similar (MM II 166; cf. E2p40s2).

Rohault for having given 'examples of remarkable clarity' of how 'the common man, and even common philosophers, confuse imaginable and real things in unbelievably many ways' (MM II 177). But Tschirnhaus's doctrine resembles Rohault's in deeper ways, especially concerning the role they each grant experiment in natural philosophy. Hence, for Rohault as for Tschirnhaus, 'in order to proceed in the right way in the search for natural things, one must necessarily bring together these two means of knowledge, and join together reasoning and experience', while those who refuse to join experiment to reasoning 'deprive themselves of the best means of finding out new discoveries, and of confirming their own arguments' (Rohault 1671: Preface, 5r; cf. Roux 2013: 54).

The idea of understanding the method in natural philosophy as a double inferential movement, *a priori* from a known effect to a possible cause and then *a posteriori* from a possible cause to a known effect, is, however, original neither to Rohault nor to Tschirnhaus. They both inherit it from Descartes.[29] The challenge is to explain how this inferential movement is not circular and unproductive.[30] For, as already noted by Wilhelm Windelband, it is not immediately clear what, on such a view of experiment, step 3 really contributes to discovery, how it increases our knowledge, or how it helps further determine the truth (Windelband 1922: I, 509). Some strands of older secondary literature, summarised and critically assessed by Jean-Paul Wurtz, attempt to salvage Tschirnhaus's position by comparing his conception of 'confirmation' to modern conceptions of experimental determination (Wurtz 1988: 196–201; cf. Horn 1955: 140; Winter 1960: 25; Winter 1977: 13; Stiehler 1960: 87; Wollgast 1988: 39). Unconvinced, Wurtz argues against such readings that Tschirnhaus did not, in fact, really consider experiment to contribute anything to the discovery and determination of the truth, but that it was merely 'about clearly illustrating and making a discovered truth more familiar to the imagination' (Wurtz 1988: 195, 200–201; cf. MM II, 186–187).

At first sight, Wurtz's analysis is compelling. The talk of experimental 'corroboration' or 'confirmation' shared by Tschirnhaus and Rohault could indeed suggest that, for them, experiment mostly serves to illustrate insights otherwise obtained *a priori*. Descartes, too, refers to experiment and experience to exemplify and confirm the laws of nature (Schönfeld 1998: 74; Dear 2001: 93–94). If, however, that is the only purpose experiment serves, it does not do sufficient epistemic work to justify Rohault's claim that experiment is 'the best means of finding out new discoveries', or to justify Tschirnhaus's claim to have found an intermediary path between *a priori* and *a posteriori* approaches to natural phi-

29. Jacobo Zabarella already proposed something like this with his *regressus* method (Roux 1998: 223–24).

30. Avoiding a methodological circle of this kind was also a problem Descartes had to address and indeed did address in the *Discours de la méthode*, VI, and in his 1638 correspondence with Morin (AT VI 76/CSMK I 150; AT II 198/CSMK III 106–107). See Roux (1998: 225–26).

losophy—experiment would remain secondary and entirely subordinated to deduction.

Another solution is, however, available. As Daniel Garber and Sophie Roux have shown, in the *Discours de la méthode,* Descartes already mobilises experiment not only to illustrate causal explanations deduced *a priori* but also, and more importantly, to help pick out the correct one among several conceivable causal explanations of a given natural phenomenon (Garber 2000: 91–93; Roux 1998: 223–24; Dear 2001: 134). As we shall study below in more detail in sections 5–7, Tschirnhaus adopts a similar strategy. The experimental corroboration of geometrically deduced propositions represents more than just *a posteriori* re-approval of *a priori* physics, because it is the step that allows us to pick out the right one among possible causal explanations of a given thing. It is therefore only through experimental confirmation that we finally grasp things 'physically' or 'really', as Tschirnhaus calls it. As we shall explain in much more detail below, this is also why Tschirnhaus describes his method as a 'circle without a circle' (MM III 290; cf. MM III 295).

The overall construction of Tschirnhaus's three-step method now comes into view. First, the basic perimeters of human experience and knowledge should be derived from our common experience of our own mental life; these 'first principles' are 'easy for me to explore within myself at any moment' (MM Preface, 6v). Next, proceeding within the parameters of these general principles, we should infer *a priori* the ways in which all conceivable things can be produced. We begin with general definitions and axioms based on the most general 'common truths'. These we obtain from considering causal properties that all things have in common, such as movement and rest, and from establishing common principles, such as very general natural laws. From these universal truths, common to all things, we then derive other, more particular properties and principles common only to some or a few things. Finally, we confirm *a posteriori* these *a priori* deductions by testing them through experiment, now moving in reverse, beginning with the least common properties we observe among only a few things, going all the way back to the most general properties pertaining to all things. This third step allows us to distinguish real from merely conceivable modes of production and, eventually, confirm the validity of the 'common truths' that served as the point of departure for the *a priori* deduction in step 2, as the principles of 'true physics'.

Much in this account requires deeper inquiry, especially with regard to the exact conceptual problems that motivate each of its steps and how Tschirnhaus's solution to Descartes's problem compares with those proposed by each of his closest interlocutors, Leibniz and Spinoza. Exploring these problems and their solution is what I will undertake in the following sections. In sections 5 and 6, the aim is to determine more precisely the exact problem in the *a priori* deduction of causal explanations that Tschirnhaus's step 3—the appeal to experiment—is

eventually designed to address, namely the Cartesian problem of causal equivocity, and how his approach compares with those of Spinoza and Leibniz. In section 7, before concluding, I will explain in more detail how Tschirnhaus's recourse to hypothesis and experiment constitutes his original solution to the problem.

5. Descartes, Leibniz, and Causal Equivocity

Let us first consider in more detail the Cartesian problem of causal equivocity, how it arises, and how Tschirnhaus's closest interlocutor, namely Leibniz, responded to it.

In *Discours de la méthode*, Descartes acknowledges that one cannot explain a given effect from the most general principles of nature alone, because those principles are broad enough to accommodate different possible ways of producing one and the same thing. In short, we cannot univocally assign a cause to a given effect *a priori*, because one and the same effect can be genetically conceived as produced by several causes:

> But I must also admit that the power of nature is so ample and so vast, and these principles so simple and so general, that I notice hardly any particular effect of which I do not know right away that it can be deduced from the principles in many different ways; and my greatest difficulty is usually to discover in which of these ways it depends on them. (AT VI 64–65/CSMK I 144 [modified]; cf. Garber 2000: 92–93; Roux 1998: 224)

Descartes addresses this problem as an epistemological one concerning our possible knowledge of the existing world. To resolve it, he sees no other solution than to take recourse to experience and experiment: 'I know no other means to discover this than by seeking further observations whose outcomes vary according to which of these ways provides the correct explanation' (AT VI 65/CSMK I 144). The issue reappears in Part III of the *Principles of Philosophy* where, in Article 4, he points out how 'the principles which we have so far discovered are so vast and so fertile' because 'countless effects which we take to be producible from the self-same causes' (AT IXB 81–82/CSMK I 249). Here, too, Descartes suggests that recourse to experience is necessary: Article 4 is entitled 'Phaenomena and experiments [*Phænomenis, sive experimentis*] and their use in philosophy' (AT IXB 81–82/CSMK I 249; translation modified). Finally, while discussing a related issue about the material organisation of the world addressed in Articles 46 and 47, Descartes writes that 'since there are countless different configurations which God might have instituted here, experience alone must teach us which configu-

rations he actually selected in preference to the rest' (AT VIII 101/CSMK I 257). As a general rule, Descartes does however allow that 'by the operation of these laws matter must successively assume all the forms of which it is capable', suggesting that picking out the right cause of a given effect is a question of establishing the right order in which the different options are produced rather than choosing among them (AT VIII 103/CSMK I 258; cf. Carraud 2000: 57–79; Lærke 2018; Montosa Molinero 2021: 418–19).

It is likely, I think, that the passages about causal equivocity from the *Discours de la méthode* and the *Principia philosophia* were a central topic in the discussions Tschirnhaus and Leibniz had about Descartes while in Paris in 1675–1676. The problem was certainly on Leibniz's radar at the time. Hence, in a fragment named *Meditatio de principio individui* of April 1676, he considers how one and the same square can be produced either by two rectangles or by two triangles:

> We say that the effect involves its cause; that is, in such a way that whoever understands some effect perfectly will also arrive at the knowledge of its cause. For it is necessary that there is some connection between a complete cause and the effect. But on the other hand, there is this obstacle: that different causes can produce an effect that is perfectly the same. (A VI, iii, 490/Leibniz 1992: 51)

Leibniz did not have a satisfactory solution to the issue in 1676. However, contrary to Descartes who approached the problem mostly as an epistemological issue regarding *our* possible knowledge of the world and *our* inability to univocally assign a cause to each effect, Leibniz saw it as a logical or metaphysical issue about possible and real worlds, to be resolved by means of logical or metaphysical principles.

While in Paris with Tschirnhaus, Leibniz was mostly exploring the possibility of mathematically or logically demonstrating the correlation between cause and effect, or what he also described as a 'principle of equipollence' between the full cause and the entire effect.[31] For example, around May–June 1676, Leibniz wrote Claude Perrault that he 'now thinks [he could] account in a satisfactory way for the laws of movement by means of entirely geometrical demonstrations, without making use of any supposition or principles of experience' (A II, i 418). In a July 1676 letter to Edme Mariotte, he asserted that one could find 'the last cause' of natural effects and that the physical laws of movement depend 'entirely on a metaphysical and geometrical truth' (A II, i, 27). In the seminal *De arcanis motus et mechanica ad puram geometriam reducenda* from mid-1676, Leibniz even sug-

31. See Leibniz, *De catena mirabilium demonstrationum de summa rerum*, 2/12.1676 (A VI, iii, 584/Leibniz 1992: 107); *De aequipollentia cause et effectus*, 1677–1678 [?] (A VI, iv, 1963–1964).

gested that it was possible to conceive of causal relations as logically necessary and ultimately grounded in identity because 'every demonstration takes place through their resolution into identical propositions'. Therefore, he continued, 'it is necessary that in the end, 'cause' and 'effect' wind up perfectly resolved into the same thing' (edited in Hess 1978: 203). All these texts suggest an agenda of uncompromising *a priori* physics. Leibniz, however, never managed to fulfil that agenda. He constantly hit upon intractable problems, most importantly the problem of causal equivocity as described in the *Meditatio de principio individui*.

It was only later, partly motivated by his efforts to counter Spinoza's necessitarianism, that it gradually dawned upon Leibniz that his inability to demonstrate the principle of equipollence logically or mathematically was in fact not a failure, but a positive result to be fully embraced as an opportunity to argue for an additional moral or natural theological component to ground the principle metaphysically. As Leibniz writes in §11 of the much later *Principes de la nature et de la grâce* of 1714:

> The supreme wisdom of God has first made him choose those laws of movement that best fit and agree with the abstract and metaphysical reasons … The action is always equal to the reaction, and the entire effect is always equivalent to its full cause … I have found … that these laws in no way depend on the principle of necessity, like the logical, arithmetical and geometrical truths, but on the principle of suitability [*le principe de convenance*], i.e. the choice of wisdom. And this is one the most efficient and tangible proofs of the existence of God for those who can deepen such matters. (GP VI, 603)

This metaphysical argument rests on a distinction between conception and causation: on the one hand, we have possible beings all *conceived* in God's understanding; on the other hand, we have actual beings *caused* by God on account of him willing the best. The actually existing world, Leibniz argues, is the one where each entire effect is metaphysically coordinated with its full cause by a providential God who chooses only one among all the possible causes for each effect, namely the most 'suitable' one.[32] This providential argument allows Leibniz to metaphysically restore the univocity of causation, while at the same time opposing the necessitarian position of Spinoza, according to which, ultimately, only one succession of causes and effects is possible, namely the real one (E1p33). These insights began to take shape throughout the last years of the 1670s (Garber 2006; Lærke 2015). Not coincidentally, around the same time, Leibniz also began

32. What Leibniz takes to be the criteria of suitability, i.e., of the best possible causal path for nature to take, is a research topic in its own right that we need not engage with here.

criticising what he saw as the necessitarian Spinozist consequences of Article 47 of Descartes's *Principles*, Part III, i.e., the Cartesian assumption that matter will successively take all the forms of which it is capable. It became one of his key criticisms of Descartes for decades to come.[33]

Leibniz's thinking about causal equivocity thus eventually took a distinctly metaphysical turn, with the choice between the various conceivable causal paths for producing a given effect being determined by God's omniscient and good nature. But this ingenious solution first emerged out of Leibniz's failure to resolve the problem of causal equivocity by means of purely mathematical or logical models of causation that he initially explored while with Tschirnhaus in Paris.

6. Tschirnhaus, Spinoza, and Causal Equivocity

Let us now turn to Tschirnhaus and the way in which he tackles the problem of causal equivocity. Doing so requires that we first take a step back and return to the two consequences Tschirnhaus drew from his principle 3, namely, that conception equals true conception (understanding is always true understanding) and that true conception equals genetic or causal conception (true understanding is always causal understanding).

Leibniz later accused Tschirnhaus of having appropriated his principle of conceivability or possibility from Leibniz himself without due recognition. As he wrote to Vincent Placcius in May 1687:

> At first [Tschirnhaus] was a Cartesian, but while he was in Paris we frequently exchanged about establishing some better foundations, and first of all about the difference between nominal and real definitions, which consists in this, that from a real definition we recognise whether a thing is possible or not; on this foundation he rightly builds a large part of his meditations. (A II, ii, 197–198)

This was a longstanding claim of Leibniz. He already noted it in his annotations on a letter from Tschirnhaus written in April 1678.[34] Moreover, he returned to the

33. For some examples, see Leibniz to [?], 1679 (A II, i, 778–779); Leibniz to Philipp, 01.1680 (A II, i, 786); *Notata quaedam G. G. L. circa vitam et doctrinam Cartesii*, April–June 1693 (A VI, iv, 2057–2065); Leibniz to Nicaise, 15.2.1697 (GP II, 562–663). For commentary, see Lærke (2018); Carraud (2000).

34. See Tschirnhaus to Leibniz, April/May 1679, A III, ii, 721/725: '[I]t is established that the … mark of a perfect and adequate definition consists in the fact that it is always expressed through a proximate efficient cause; indeed, as you maintain yourself, once that has been perceived, there can no longer be any doubt as to whether it is possible'. Leibniz notes: 'Hence, the foundations

issue several times later, over many years, writing to Huygens in October 1690 that 'I had certain philosophical notions that later I saw reappear in his *Medicina mentis* … M. D. T. has built part of his *Medicina mentis* on this reflection that one must seek to know the possibility of notions' (A II, ii, 350–351), and again in June 1695 that 'Tschirnhaus profited from some of my meditations, and more than he thinks himself. This said, I gather that he did not realise it and that is why I do not accuse him of lack of sincerity' (A III, vi, 420).

Now, when referring to the distinction between 'real' and 'nominal' definitions in the 1687 letter to Placcius, Leibniz alludes to a doctrine he first made public in the 1684 article entitled *Meditationes de cognitione, veritate, et ideis*, according to which the hallmark of a real definition is that it makes known the possibility of the definiendum. Genetic or causal definitions figure prominently among such real definitions.[35] There are clear convergences between these views and those of Tschirnhaus. Leibniz had exposed this theory to Tschirnhaus in private correspondence long before it was published.[36]

Nonetheless, Leibniz's accusations come through as unfair, even disingenuous. We have already seen that Tschirnhaus most likely developed his own understanding of the relations between causation, conceivability, and definition in exchanges with Spinoza that predated his arrival in Paris. Leibniz knew this. He very likely read, and certainly heard of, Spinoza's letter to Tschirnhaus of January 1675 which explicitly states the principle of genetic definition. Moreover, in his annotations on Spinoza's Letter 12 that Tschirnhaus communicated to him, Leibniz extracts the view that 'we commonly say that we understand things when we conceive of their generation, or the manner in which they are produced'.[37] Besides, as we have seen, it is not unlikely that Spinoza's principle of genetic definition was inherited from Hobbes,[38] and Leibniz was entirely aware of this possible common source: 'Every property', Leibniz writes in a fragment dated February–April 1676, 'which includes the efficient cause, or generation, of the thing, suffices for discovering all of its attributes, indeed, whatever contains

of his *Medicine of the Mind* are clear from my [principles]'. To this, he juxtaposes a passage from Tschirnhaus's letter where the latter admits having 'freely confessed to many people during my travels to never having had conversations more useful than the ones I had with you' (A III, ii, 723/725).

35. Leibniz, *Meditationes de cognitione, veritate, et ideis*, 1684 (A VI, iv, 589–590). The doctrine also appears in several texts not published during Leibniz's lifetime, e.g., *De Synthesi et analysi universali seu arte inveniendi et judicandi*, 1683–1685 [?] (A VI, iv, 542–543); *Discours de métaphysique*, 1686 (A VI, iv, 1568); *Nouveaux essais sur l'entendement humain*, 1703–1705, III, iii, § 18, and iv, §4–7 (A VI, vi, 293–294, 296–297).

36. Leibniz to Tschirnhaus, 05.1678, in Leibniz 1898: 381/Loemker 1989: 194. See also Leibniz to Tschirnhaus, 12.1679 (A II, i, 783–784).

37. Leibniz, *Communicata ex literis domini Schulleri*, 02.1676 [?] (A VI, iii, 275).

38. Hobbes, *Concerning Body* [Lat. 1655/Eng. 1656], I, vi, §13 (Hobbes 1839–1854: I, 81–82).

the generation of the thing, as Hobbes puts it'.[39] Under these circumstances, it is hard to believe that Leibniz genuinely thought Tschirnhaus had learned his understanding of causation, conceivability, and definition from Leibniz himself.

Still, Leibniz's accusing letters, along with other available texts regarding their exchanges in Paris, show that Leibniz and Tschirnhaus developed their respective doctrines of definition, conception, and causation in close interaction with each other, and largely in response to Descartes and Spinoza. Moreover, as we shall see when getting into the finer details of their discussion, Leibniz may have had something more specific in mind when complaining. Before getting to that point, however, we need to take a closer look at Tschirnhaus's principles in comparison with Leibniz's. For, despite their similarities, they do not in fact defend the exact same views.

Both Tschirnhaus and Leibniz maintain that causal definitions are necessarily real: they express the possibility of a thing by indicating how the thing can be produced. Contrary to Tschirnhaus, however, Leibniz does not maintain that real definitions must necessarily be causal. He does not associate conceivability as closely with causation as Tschirnhaus does (MM II 67–68). A short exchange can illustrate the point. In 1679, Tschirnhaus wrote to Leibniz that he did 'not value definitions that express only the properties of the thing defined and not its efficient cause', and that 'clearly perfect or adequate definitions consist in this, that they always express the efficient cause'. Responding to this, Leibniz noted in the margins: 'Every definition that shows the possibility is good, even without the efficient cause'.[40] For Leibniz, it appears, the primitive criterion of conceivability is not causal, but logical. Causal definitions are always real, in the sense of truly expressing the nature of the defined.[41] The reverse does not hold, however, because the ultimate ground of truth should be understood not in causal but logical terms: 'A real definition is one from which we see that the defined thing is possible, and implies no contradiction'.[42] His reasoning opens up a space for true conception of uncaused things. This applies, for example, to God whom we must conceive as an uncaused being that necessarily exists in

39. Leibniz, *Aufziechnungen*, 02–04.1676 (A IV, iii, 388). For Leibniz's possible sources, see, in addition to the passage from *De corpore* already cited, Hobbes, *Principia et problemata aliquot geometrica* [1674] (Hobbes 1839–1845: V, 156): 'Now there are definitions of two kinds: on the one hand, those which clearly indicate the nature of the thing, and on the other, those which also explain the cause or manner of generation. But those definitions which define the causes and contain the mode of generation are the most useful for the advancement of science'; and Hobbes, *Examinatio et emendatio mathematicae hodiernae* [1660] (Hobbes 1839–1845: IV, 87).

40. For both quotes, see Tschirnhaus to Leibniz, 04–05.1679 (A III, ii, 721).

41. See Leibniz, *Meditationes de cognitione, veritate, et ideis*, 11.1684 (A VI, iv, 589–590); *Discours de métaphysique*, 1686, art. 24 (A VI, iv, 1569).

42. Leibniz, *Specimen inventorum de admirandis naturae generalis arcanis*, 1688 [?] (A VI, iv, 1617).

virtue of its concept alone, an *ens a se* which is not *causa sui*.[43] But, in a different sense, being conceivable but uncaused is also the status of all merely possible things, which can be understood as conceivable beings whose actual existence God chooses not to cause. Such conceivable uncaused beings, pure *possibilia*, are of course crucial for Leibniz's mature natural theology (for my own analysis, see Lærke 2008: 788–95).

For Tschirnhaus, by contrast, true conception cannot be separated from the conception of causes because truly conceiving something just *is* conceiving its cause. This principle underlies Tschirnhaus's entire epistemology. Moreover, as he indicates in passing, it also extends into modal metaphysics for 'there is no other difference between being and non-being than there is between the possible and the impossible, or between what can and what cannot be conceived' (MM II 36–37). Within such a framework, where causation, conception, possibility, and being are all coextensive, uncaused possible worlds such as Leibniz's appear both inconceivable and impossible. One gets the impression that Tschirnhaus is edging toward something like Spinoza's necessitarian position, according to which the possible and the real coincide. In any case, this is what Pablo Montosa Molinero suggests in a recent paper that attributes to Tschirnhaus a theory of 'plenitude' similar to the one enshrined in Spinoza's assertion in E1p16 that 'everything which can fall under an infinite intellect' follows from 'the necessity of the divine nature'; a theory according to which 'no possibility remains unrealised' (Montosa Molinero 2021: 417, 425). There are, however, differences between Spinoza and Tschirnhaus in the way they tackle the Cartesian problem of causal equivocity that I believe ultimately make such an analysis untenable.

Spinoza does not think that Descartes's problem of causal equivocity can resist rational analysis. Such analysis, he argues, will eventually reveal that 'any thing which is finite and has a determinate existence can neither exist nor be determined to produce an effect unless it is determined to exist and produce an effect by another cause, … and so on, to infinity' (E1p28). As reason proceeds geometrically in the deduction of adequate notions, from the conception of universal causes toward particular ones, it will also progressively narrow down the causal path through which a given thing can be produced to a single, determinate one. In the end, only one remains. Spinoza is metaphysically committed to the idea that all things are fully determined with regard to their causes and effects, leaving no room for causal indeterminacy: 'In nature there is nothing contingent, but all things have been determined … to exist and produce an effect in a certain way' (E1p29). But he is also epistemologically committed to the idea that any concep-

43. See Leibniz, *De formis seu attributis Dei*, 04.1676 (A VI, iii, 514/Leibniz 1992: 71). Leibniz also grapples with this question of God's self-grounding in his annotations to Spinoza's Letter 12 on the infinite, also from around April 1676 (A VI, iii, 275); it is a major topic in texts surrounding his first reading of the *Ethics* in January 1678 (A VI, iv, 1360, 1372, 1779, 1772; Lærke 2008: 625–80).

tion of several possible causes of a single thing must be inadequate, or result from our ignorance of some causal determination: 'a thing is called contingent only because of a defect of our knowledge … the order of causes is hidden to us …. So we call it contingent or possible' (E1p33s). Adequate knowledge of a given thing will necessarily establish one single set of causes which establish that thing as either necessarily existing or necessarily non-existing, but never as possible or contingent: 'It is of the nature of reason to regard things as necessary, not as contingent' (E2p44). In other words, Descartes's epistemological problem of causal equivocity has no metaphysical foothold but corresponds only to a particular state of ignorance which always can be overcome by reason, at least in principle.

For Tschirnhaus, by contrast, Descartes's problem of causal equivocity *does* resist rational analysis. In the *Medicina mentis*, this is most explicit from his discussion of the relative status of truth in mathematics and physics. Mathematics, he argues, offers the paradigmatic example of the benefits offered by an *a priori* approach to 'natural science' (MM III 280). Mathematics alone manages to liberate us from prejudice and shows us how to establish first principles that are truly known (MM III 277–278). Mathematicians, however, are only concerned with the study of 'rational beings', i.e., with conceivable relations between things. They do not deal with 'real beings' or 'physical beings' (MM II 76–77). By contrast, in the realm of the real beings studied by physics, 'because of the many definitions or generations of a conceivable thing we can find here, usually a great many demonstrations of the same thing are given' (MM III 281). Hence, even the most complete genetic account of a given thing provided through mathematical, i.e., geometrical, *a priori* deduction does not, it seems, preclude other possible genetic explanations of that same thing, or deprive the latter explanations of what Tschirnhaus calls their 'being'. In fact, attributing 'being' to something serves not at all to distinguish it from the merely possible, but only from the impossible: 'those things which we truly conceive with our minds are by nature possible [*in rerum natura possibilia esse*]; and those which we cannot conceive are impossible' (MM II 52). Within the realm of being, we must thus distinguish between merely conceivable or possible 'rational beings' and real 'physical beings'. Emerges here something strikingly similar to the distinction between possible being (*ens*) and actual existence (*existens*) that governs Leibniz's modal philosophy from the late 1670s onwards, according which things 'possible in their own nature' (*possibile sua natura*) have being regardless of whether they are also caused to actually exist.[44] The only difference is that Tschirnhaus offers no metaphysical resources for distinguishing between the two.

44. Leibniz, *De libertate et necessitate*, 1680–1684 [?] (A VI, iv, 1447); *De libertate a necessitate in eligendo*, 1680–1684 [?] (A VI, iv, 1452); see also Lærke (2008: 817–43).

This crucial point finds further confirmation in the way Tschirnhaus responds to an objection put forward by Christiaan Huygens in a March 1687 letter. 'If one can easily concede', Huygens writes, 'that what is true can and should be conceived in the mind, one should not acknowledge the necessity of conversion, namely that whatever can be conceived is true'. In fact, Huygens continues, 'this notion of yours seems to refer only to the first principles of mathematics and physics but to not concern our judgment about those things, especially in physics, which are inferred as consequences from what was known beforehand' (CHO IX 123). For Huygens, Tschirnhaus's principle of truth only establishes abstractly what *can* be true and not what really *is* true. It does allow one to distinguish what is abstractly possible, i.e., the object of mathematics, from what is concrete and real, i.e., the object of physics.

In his reply, Tschirnhaus readily concedes the point: 'I admit that what is conceived is not always true in the physical sense. Nonetheless, it can be true mathematically or abstractly, or by the help of active imagination' (12.05.1687, CHO IX 136). To accommodate the criticism nonetheless, he introduced an additional distinction between what is 'false' and what is merely 'unknown' in the 1695 edition of the *Medicina mentis* (MM II 57).[45] However, in his immediate reply to Huygens as well as in the 1695 edition, Tschirnhaus never abandons but insists on the equation between truth and conceivability, arguing that it follows from the definition of the understanding as a faculty:

> You [i.e., Huygens] grant me that whatever is true can and should be conceived; so I am granted that we have a faculty for conceiving the true; but this faculty as such will not be able to conceive any falsehood, for falsehood cannot be conceived, and so what is conceived by this faculty will always be true. Consequently, the necessity of the conversion must be acknowledged, namely, that whatever can be conceived is true. (Tschirnhaus to Huygens, 12.5.1687, CHO IX, 136)

The co-extensivity of truth and conception is analytically derived from the very definition of the faculty of understanding. For Tschirnhaus, truly conceiving something, i.e., with the understanding, and conceiving something truly, i.e.,

45. Making a similar objection, Thomasius argued that Tschirnhaus's theory failed to account for the epistemic status of sensible or physical things and that he therefore opened himself to a charge of scepticism (Thomasius 1690: 418–19). In response, Tschirnhaus introduced a somewhat mysterious distinction between 'forming a concept' and truly 'conceiving' in the 1695 edition (MM II 57). The distinction appears in a substantial revision of a passage of the first edition (MM [86/87] II, 44–45) which Tschirnhaus claimed had been mangled by Pieter van Gent who revised the manuscript before printing.

correctly, are just one and the same thing. And such true conception is what distinguishes understanding from other mental operations or 'thoughts', like sensation and imagination (Tschirnhaus to Huygens, 12.5.1687, CHO IX 136). At the same time, by conceding that one can distinguish the merely unknown from the false, Tschirnhaus acknowledges that there is a difference between asserting that something is true in the sense of actually being the case, and asserting that something is a true conception, as opposed to an inconceivable or impossible one. However, he offers Huygens no logical or metaphysical resources for making the distinction. This same point applies to the question of possible causes of certain effects. *A priori*, it is impossible to know which causal path among all the conceivable ones available nature really takes to produce this or that effect. Causal equivocity remains *a priori* irreducible. Hence, if Tschirnhaus does indeed equate causation and conceivability, like Spinoza, he nonetheless, contrary to Spinoza, does not reduce the possible to the real. Instead, he distinguishes possible being from impossible non-being, while at the same time distinguishing possible being from the real, which he in turn equates with the physical.

It is, I suggest, in these exact distinctions that we perhaps find a reason why Leibniz later felt unacknowledged. For, against Spinoza, Tschirnhaus agrees with Leibniz that, when it comes to determining the causal path that nature takes, there is an irreducible gap between the possible and the real, or what Tschirnhaus also casts as a difference between the 'abstract' and the 'physical', where the former is the domain of mathematics and the latter the domain of natural science. As in Leibniz, the problem of causal equivocity thus pervades the entire domain of the conceivable in Tschirnhaus. We dispose of no logical or mathematical tools to determine whether the conceivable causal explanations of things we deduce are merely abstractly or rationally true, or whether they are really and physically true. Contrary to Leibniz, however, Tschirnhaus does not consider the problem as a metaphysical one and shall not attempt to resolve it as such. He offers no elaborate metaphysical theory comparable to Leibniz's natural theology to navigate these distinctions, no *a priori* criteria of 'suitability' or 'bestness'. Instead, he shall stay within the limits of the epistemological approach that already transpired from the first principles established in step 1 of his method. As we recall, rather than 'spinning out useless speculations', he preferred to focus on 'those things which must be known first by a man who has a serious mind to acquire wisdom for himself' (MM Preface, 4v–5r). Accordingly, in Tschirnhaus, causal equivocity is framed not as a problem of ontology but as a problem of human knowledge. And he shall turn to a very human *a posteriori* resource to resolve it, namely *experiment*. This forms the third step in Tschirnhaus's method, to which we shall now finally return to offer a more detailed analysis.

7. The Use of Hypothesis and Experiment

The experimental aspect of Tschirnhaus's doctrine is most clearly articulated in the context of his discussion of the use of *hypotheses* in natural philosophy. Why that is the case requires an explanation.

As we have seen, Tschirnhaus's account of how the understanding geometrically deduces truths *a priori* from initial definitions and axioms is redolent of the account of knowledge acquisition from reason and common notions that one can find in the second part of Spinoza's *Ethics*. There is, however, a hypothetical aspect to Tschirnhaus's account that is decidedly non-Spinozist. Spinoza, of course, is no stranger to using hypothesis in demonstration. A great many of his geometrical reconstructions of Descartes's *Principles of Philosophy* involve reference to hypothesis.[46] The same applies to the *Ethics*, where many demonstrations use arguments *ex hypothesi*.[47] None of these uses of hypothesis in demonstration do, however, imply that the initial principles of deduction or the propositions eventually derived from them are not apodictic. In fact, Spinoza never speaks of any aspect of his own philosophy as being hypothetical, never presents any definition or axiom as hypothetical, and never embraces a conclusion that he deems merely hypothetical.[48] As he proclaims to Albert Burgh: 'I know that [the philosophy] I understand is true. Moreover, if you ask how I know this, I will reply: in the same way you know that the three Angles of a Triangle are equal to two right angles' (Spinoza to Burgh, late 1675/early 1676, Letter 76, G IV 321/C II 475; modified).

Tschirnhaus, by contrast, requires experimental corroboration of all deductions as soon as we leave the realm of mathematical 'rational beings' and ask about the production of 'real beings'. Because of the problem of causal equivocity that Tschirnhaus inherits from Descartes, *a priori* deductions in the end only

46. See Spinoza, *Principles of the Philosophy of Descartes*, II, prop. 7 and prop. 8 (G I 196–197/C I 274); prop. 16 (G I 204/C I 279); prop. 21 (G I 209/C I 282); prop. 24–30 (G I 211–218/C I 284–289); prop. 32 (G I 220/C I 220); prop. 36–37 (G I 223–224/C I 292–294).

47. Demonstrations in the *Ethics* that at some point appeal to hypothesis include: E1p21d, E2p13L4d, E2p18d, E2p37d, E3p15d, E3p16d, E3p17d, E3p17c2d, E3p32d, E3p40d, E3p40c1–c2, E3p42d, E3p43d, E4p12d, E4p14d, E4p15d, E4p31d, E4p51d2, E4p68d, and E5p11d.

48. 'Hypothesis' figures in the *Tractatus de intellectus emendatione* but only in a brief footnote, where Spinoza addresses what others—in this case, astrologers—have proposed as hypotheses about celestial movements (§57, note y (G II 22/C I 26). In the correspondence, hypothesis only comes up in a letter to Oldenburg about Boyle, and here only to deny one such hypothesis: Spinoza does not see 'why [Boyle] calls the impossibility of a vacuum a hypothesis, since it follows very clearly from the fact that nothing has no properties' (Spinoza to Oldenburg, 17.27.7.1663, Letter 13, G IV 65/C I 209). The only place where Spinoza himself addresses in any detail the nature and function of hypothesis is in the preface to Part III of the *Principles of the Philosophy of Descartes*, where he presents Descartes's views as presented in the *Principles* III, art. 42–44, and IV, art. 204–206, to explain that, for Descartes, good hypotheses should be non-contradictory, simple, easy, and fully explain the effects (G I 227/C I 295).

suggest conceivable modes of production. As in Descartes, experiment is tasked with picking out the real ones. Hence, as one moves back through the deductive chain in a process of selection and confirmation, even the initial definitions and axioms, the general and common truths that form the point of departure for deduction, eventually become subject to experimental confirmation. In other words, the whole *a priori* deductive framework developed in step 2 begins to sound conspicuously like it is conceived as entirely hypothetical.

Tschirnhaus's explicit remarks on hypothesis tend to confirm the point. His considered view on hypothesis is not fully articulated until the second edition of the *Medicina mentis*, but he already offers some important pointers in the first. Here is what he has to say in the 1686/87 edition:

> The particular nature of a thing does not always need be known in advance; it is enough to know what it has in common with several others, even if, of course, obtaining the same effect does not require associating exactly the same things, but other [associations] are possible; in this case, we should choose those whose nature seems either simpler to the understanding, or more obvious to the senses. And here too, the nature of all the things thus associated in agreement need not always be known *a priori*, provided that they are known *a posteriori* through a clear experience. From this, hypotheses arise, which certain people employ for their demonstrations. (MM II 130)

The idea is the following. To understand a given thing, we do not necessarily require a full description from the outset. We only need to identify, *a priori* or *a posteriori*, some general causal features that it has in common with other things, or 'observe points common to a certain number of generations', which will allow us to subsume them under broader 'kinds' of generation (MM II resp. 88 and 85). From there on, we can proceed from the general causes toward increasingly particular effects, at each stage establishing an increasingly restricted common causal framework, moving from the universal toward the particular (MM II 85).

Now, at each stage of the deduction, several possibilities exist for associating a given general cause to more particular effects, because 'other associations are possible'. In other words, causal equivocity manifests itself at every turn. However, Tschirnhaus suggests, among the possible ways of 'associating' a general cause to a particular effect, the simplest and most obvious option should be initially adopted as a hypothesis. This hypothesis then serves as a guide for the experimental exploration of causes and the organisation of appropriate experiences. We first test the simplest hypothesis and then, if it fails, move on to the second-simplest hypothesis, and so on, until we reach the one that accounts for all the actual effects and predicts no others. This procedure, in which several

hypotheses are systematically tested one after the other, from the simplest to the most complex, Tschirnhaus contrasts with the disordered approach of 'common empiricists' who, unguided by any hypothesis at all, only too often end up with defeatist, sceptical declarations that, ultimately, 'nature is inscrutable' (MM II 87).[49]

In the 1686/87 passage, Tschirnhaus does not appear particularly committed to this use of hypothesis. He simply explains what the use of hypothesis favoured by 'certain people' amounts to. In the 1695 edition, however, he includes an additional section dedicated to hypotheses about the nature of fermentation, which, he explains, can serve to 'illustrate [his] precepts' (MM II 150):

> But here it is well worth noting that, if we have only acquired knowledge of the general natures that are common to most things, we must proceed very cautiously in order not to draw conclusions that are more universal than what the premises permit. The means by which this can be avoided, I will explain by a special example, since it is of great importance. Whoever considers well what has been said until now about the true nature of fermentation, will not deny that these things present themselves with a great appearance of truth. However, since these things have been deduced from natures that [fermentation] has in common with many other things, in order that no error is made, certain particular experiments must be conducted, and attention must be paid to whether each and every effect occurring in these particular experiments can be fully explained from the previously given hypothesis. (MM II 148)

The example he goes on to develop is a tale of caution. Tschirnhaus's first hypothesis is that fermentation can be explained by the general principle that air 'precipitates itself with great force into all the places left by other bodies' (MM II 146). Having confirmed this principle in relation to other phenomena, he is initially led to expect that, by it, 'it can be easily explained how fermentation is produced and what is the cause of all its effects' (MM II 147; cf. 145–146). To confirm this, an experiment is undertaken. It consists in extracting plant juices, putting them in a recipient made of thick glass, and covering it with an elastic membrane. After some days, the membrane curves upward. This effect conforms to the initial hypothesis that fermentation should be explained through the natural motion of air. However, the hypothesis does not explain the accumulation of sediments at the bottom of the container (MM II 149). Consequently, he concludes, 'the previously mentioned hypothesis about fermentation, even

49. See also MM II 88, where Tschirnhaus explains how, for the empirics, 'reasoning does not enter into the organisation of experiments'.

if it appears with great certainty, is not correct' and several other experiments based on alternative, more complex hypotheses must be tested before, eventually, the 'true nature of fermentation' can be discovered (MM II 149–150). In the event, Tschirnhaus introduces an additional principle from Descartes's *Principles of Philosophy*, IV, art. 18, concerned with the separation of bodies observed in the purification of liquids, or sedimentation. In Descartes, this principle is one of the primitive forces through which bodies are generally produced (AT VIII 362–363).

As it appears from the example, the simplicity and obviousness cited as the criteria of selection among possible hypotheses are merely criteria of priority, not criteria of truth. As a matter of priority, we should first consider the most simple and obvious explanation. But experimental testing is required to determine whether we should also adopt it as true. If the hypothesised cause fails to account fully for the entire effect, we should move on to a less obvious and more complex explanation. This was necessary in relation to the case of fermentation, where the principles of air had to be supplemented with the principles of sedimentation in a more intricate hypothesis to explain more comprehensively all the features of the phenomenon:

> [I]f we do not want to be deceived by this in the search for the true cause of some effect, some distinction must be drawn between experiments, and those which include the whole generation and way of production must preferably be chosen before the rest, so that we can observe later whether the hypothesis we have formed can explain all the phenomena that have occurred. (MM II 148–149)

We now understand better the role of hypothesis and experiment. Hypothesis is used to establish an order of priority for experimentally exploring possible modes of production of a given thing, beginning with those hypotheses that rest on the easiest and simplest principles. However, that one should first adopt a possible hypothesis based on considerations of facility and simplicity of explanation, does not provide a criterion of choice. It only provides an order of priority in which possible hypotheses can best be explored experimentally, until we finally hit upon the one that offers the most comprehensive and complete explanation of the entire effect. This account of hypothesis is consistent with the idea that the third, experimental step in Tschirnhaus's method is designed as an *a posteriori* response to the problem of causal equivocation that arises from the *a priori* deduction of causal explanations and genetic definitions in step 2. Experiment is required simply because, by reason of causal equivocity, *a priori* deduction will always allow for several conceivable hypotheses, and experiment must therefore be undertaken to determine which one is real.

8. Conclusion

I have reconstructed Tschirnhaus's *ars inveniendi* and its intermediary path between *a priori* and *a posteriori* natural philosophy as a method that initially emerged from his interactions with the philosophies of Descartes, Spinoza, and Leibniz in the mid- and late 1670s. The method has three steps. The first step, an *a posteriori* exercise in introspection, provides us with two kinds of information. First, it tells us what kind of access we have to the world, namely via external sensations and internal imaginations and passions. Second, it tells us what primitive, innate resources we have for understanding them, namely our ability to evaluate whether they affect us well or badly (the foundation of moral philosophy), and our ability to distinguish between conceivable and inconceivable things (the foundation of logic and epistemology). These first principles set the perimeters for what Tschirnhaus's method is intended to explore and the tools available for exploring it. It is within these perimeters of inquiry that Tschirnhaus then goes on to develop a method of investigation for 'natural science', i.e., his 'true physics'.

The true physics proper is formed by steps 2 and 3 combined. As Tschirnhaus indicates, these two steps form a *circulus absque circulo*. It *is* a circle because it first geometrically deduces propositions *a priori* from initial general definitions and axioms and then works its way back again *a posteriori* through these deductions, at each step confirming the propositions by means of experiment, eventually returning to the initial definitions and axioms. But it is also *not* a circle, because step 2 proceeds according to deductive paths that are conceivable, i.e., possible, and therefore true in their own right, but not the only conceivable ones. This gives rise to the problem of causal equivocity: among the conceivable paths available, it is impossible to pick out *a priori* the one that accounts for the actual production of a given 'real' or 'physical' thing. For Tschirnhaus, only experiment can determine that by confirming which conceivable deductive path, or hypothesis, can account for the entire phenomenon in the simplest way. He thus follows Descartes who, as we recall, also considered that the only available path to the 'correct explanation' of a natural phenomenon among several was an *a posteriori* one, i.e., 'seeking further observations' (AT VI 64–65/CSMK I 144).

It is by this third experimental step and the approach to the problem of causal equivocity that it represents, that Tschirnhaus's position within the broadly Cartesian tradition stands out in relation to his two main philosophical interlocutors, Spinoza and Leibniz. Both Spinoza and Leibniz offer solutions to the problem of causal equivocity which are metaphysical in scope. Spinoza neutralises the issue by establishing a strict equivalence between conception and causation, denying the possibility of conceivable but uncaused things, and maintaining that any equivocity in causal explanations always stems from inadequate

conception, i.e., from ignorance of the determining causes. Leibniz, for his part, dissociates conceivability from causation, and elaborates on that basis a strong metaphysical distinction between conceivable series of things conceived by God (possible worlds), and a conceivable series of things which is also caused by God (the actual world.) This distinction between conception and causation underlies his entire mature natural theology, and the idea that God conceives all possible worlds but only wills the best. Tschirnhaus, by contrast, follows Spinoza in equating conception and causation, but draws very different consequences from it. For Spinoza, the ultimate, metaphysical consequence of the equation is his necessitarian denial of possible worlds, or the idea that the only truly conceivable world is the one in fact caused to exist. The only truly conceivable causes of a given thing are the determinate ones which necessarily and precisely determine its existence or non-existence. Tschirnhaus, by contrast, seems to draw from that same equation of conception and causation that a phenomenon can be equally conceived through any of its possible causes, causation being irreducibly equivocal. *A priori* deduction of truth—i.e., step 2 of his method—is consequently indifferent to the distinction between possible being and physical reality which, perhaps learning from Leibniz, Tschirnhaus nonetheless maintains exists. However, contrary to Leibniz, rather than pondering the metaphysical aspects of the problem, Tschirnhaus focuses on the epistemological consequences of the view, namely our lacking ability to univocally pair effects to causes through logic and mathematics alone when pursuing natural philosophical explanations. For that, the use of experiment must be mobilised. Hence, in conformity with the phenomenalist, non-metaphysical outlook on natural philosophy enshrined in the principles 1 and 4 developed in step 1 of his method, rather than engaging in any metaphysical 'speculation' comparable to Leibniz's natural theology, Tschirnhaus seeks out an experimental solution to what he saw mostly as an epistemological problem. And it is exactly in virtue of this experimental solution to the problem of causal equivocity that Tschirnhaus is justified in claiming to have found an intermediary path between *a priori* and *a posteriori* approaches to natural philosophy.

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The author has no competing interests to declare.

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