

LEEN SPRUIT

BRUNO'S USE OF EXPERIENCE IN CONTEXT*

«Importune sensus omnes abnegare»

De immenso, III, 3

«Nunc iterum sensus, mentis revocata sub alas»

De immenso, IV, 18

Bruno's rejection of Aristotelian natural philosophy developed through two stages, an initial materialism¹ and his later acquaintance with Copernicus' work. The latter was clearly decisive. A most peculiar, definitely extensive, reading of Copernican astronomy led Bruno to the central conception of his natural philosophy, namely, that of a physically homogeneous, infinite universe. Of course, he did not have rich empirical evidence for this view. The infinity of the universe was argued for on basis of speculative considerations, mostly derived from the Neoplatonic tradition.² Engaged in a critical analysis of contemporary science, Bruno developed also a series of physical theories, loosely deriving from the central thesis of the infinite, physically homogeneous universe, but in turn meant to support this view or to argue for its appropriateness. The relativity of motion and weight, and the rejection of the traditional doctrine of the four elements are cases in point. In developing these views, Bruno appealed frequently and in various ways to observation and experience. And even though his conclusions mostly stem from theoretical considerations, Bruno is convinced that his views are acceptable and reasonable also on empirical grounds.

* I am grateful to Guglielmo Tamburrini for his pertinent criticisms.

¹ Cf. *De la causa, principio et uno*, ed. G. Aquilecchia, Torino 1973, pp. 93-94.

² See M. A. GRANADA, *Il rifiuto della distinzione fra potentia assoluta e potentia ordinata di Dio e l'affermazione dell'universo infinito in Giordano Bruno*, «Rivista di storia della filosofia», XLIX, 1994, pp. 495-532; and ID., *L'infinité de l'univers et la conception du système solaire chez Giordano Bruno*, «Revue des sciences philosophiques et théologiques», LXXXII, 1998, pp. 243-275.

The role of observation and experience in Bruno is controversial. According to Helène Védrine, for example, Bruno did not take in serious account observation.³ By contrast, Antoinette Mann Paterson and Luciana de Bernart stressed the importance of experience and observational data for Bruno's philosophical reflections.⁴ The roots of this controversy are in Bruno's writings. In his works one can find several figures illustrating single experiments, and many times he invoked (sense) experience, as supporting evidence for his cosmological views.⁵ He reasoned on phenomena based on observation, and reflection on the apparent motions of heavenly bodies permeates his works.⁶ At the same time, however, Bruno stressed the deceptive role of the senses. Section 2 offers a sketch of Bruno's psychology of cognition in outline, emphasizing the value of sense perception. Here also the distinction between appearances and things themselves, and the relation between sense and reason are scrutinized.

An assessment of Bruno's views on observation and experience requires an analysis not only of his views on sense experience in general, but also of the relation between Bruno's natural philosophy and contemporary astronomy. During the second half of the sixteenth century, astronomical observational data started to play a crucial role in discussions of natural philosophy. It is a commonplace that contemporary astronomy was crucial for the development of Bruno's cosmology. Equally important from a doctrinal point of view is the fact that astronomy depended for its explananda on sense perception: it analyzed only what could be 'seen'. Though highly mathematized, astronomy was more 'empirical' than most traditional natural philosophy. Therefore, the relation between astronomy and natural philosophy, summarized in section 1, offers a privileged perspective for analysing observation and experience in Bruno's philosophical research. In this context, also Bruno's view of «scientiae mediae» is analyzed. Finally, section 3 examines Bruno's reflections on the role of experience in natural philosophy.

³ H. VÉDRINE, *La conception de la nature chez Giordano Bruno*, Paris 1967, pp. 197, 216.

⁴ A. MANN PATERSON, *The Infinite Worlds of Giordano Bruno*, Springfield-Illinois 1970, pp. 90 and 101; L. DE BERNART, *Immaginazione e scienza in Giordano Bruno. L'infinito nelle forme dell'esperienza*, Pisa 1986, p. 134: Bruno rejects blind empiricism, not the senses as such; cf. ID., *Bruno e i 'fondamenti' filosofici della teoria copernicana*, «Nouvelles de la République des Lettres», XIII, 1994, pp. 47-74:54.

⁵ See, for instance, *De immenso*, V.8, BOL I,II 144-145.

⁶ *De immenso*, IV.5, BOL I,II 25.

1. ASTRONOMY AND NATURAL PHILOSOPHY

Bruno was acquainted with past and contemporary astronomy.⁷ In *De immenso*, he quoted and cited, among others, Tycho Brahe, Girolamo Fracastoro, Helysius, Gemma, Röslin, Cardano, and Levi ben Gerson.⁸ Even though he paid some attention to the more properly scientific contents of contemporary astronomy, most likely he did not master its technical and mathematical aspects.⁹ Renaissance astronomy was a highly formalized science grounded in sophisticated mathematical techniques and Bruno's polemics against the use of mathematics in physical science is well-known.¹⁰ According to Bruno, mathematics should have a 'physical', that is, illustrative function, namely, as «segno».¹¹ As a consequence, he was critical of mathematical astronomy and its calculations based on observations of (combinations of) motions.¹² Bruno did not reject the existence of geometrically describable regularities in the heavens. However, he denied the existence of perfect circular orbits,¹³ and regarded geometrical regularities only as surface manifestations of underlying causes, that is, of the vital principles moving stars and planets.¹⁴ Evidently, he

⁷ See *La cena de le ceneri*, ed. G. Aquilecchia, Torino 1955, p. 10, regarding the observations of Eudoxus, Callipus, Hipparchus, and Menelaus Romanus; *De l'infinito*, dial. III; and *Oratio valedictoria*, where Bruno praises the German astronomers and scientists.

⁸ See *De immenso*, I.4, BOL I,I 219-221; III.5, BOL I,I 360; III.6, BOL I,I; IV.13, BOL I,II; IV.10, BOL I,II 53; VI. 19-20, BOL I,II 227-235. Cf. also R. STURLESE, *Su Bruno e Tycho Brahe*, «Rinascimento», XXV, 1985, pp. 309-333.

⁹ Cf. E. McMULLIN, *Bruno and Copernicus*, «Isis», LXXVIII, 1987, pp. 55-74.

¹⁰ *La cena de le ceneri*, cit., p. 148: «Senza cognizione il saper computare [...] è un pasatempo da pazzi»; *Camoer. acrot.*, BOL I,I 155: physical bodies are not to be identified with «vanae mathematicorum species». Cf. the attack on idle sophist algebra and computation in *Sig. sigill.*, BOL II,II 214. For the contrast between mathematical and physical approaches in science and philosophy, see also *De la causa*, ed. cit., p. 19, *Infinito*, BDI 479, and *De immenso*, III.3, BOL I,I 340; V.5, BOL I,II 138.

¹¹ In *Sig. sigill.*, BOL II,II 196-197, mathematics is said to mediate between the sensible and insensible realms. For discussion, see L. DE BERNART, *Immaginazione e scienza*, cit., p. 148.

¹² See *La cena*, cit., pp. 90-93, 98, 106, 190-91 and 209; *Camoer. acrot.*, BOL I,I 171; *De immenso*, III.6, BOL I,I 361-364; III.10, BOL I,I; V.5, BOL I,II 132 and 138; and VI.2, BOL I,II.

¹³ See *La cena*, cit., p. 165; *Orat. valed.*, BOL I,I 19; *Camoer. acrot.*, BOL I,I 145, 168, 182-183, and 186; *Articuli adv. math.*, BOL I,III 74; *De immenso*, III.6-7, BOL I,I 361-372.

¹⁴ *La cena*, cit., 150: the Earth moves «per vivo senso et raggione»; cf. pp. 169 and 208; *Camoer. acrot.*, BOL I,I 186: «Haec circulatio non geometrica, sed physica est»; cf. ID., p. 170-71; *De immenso*, III.3, BOL I,I 340; III.8, BOL I,I 377; IV.15, BOL I,II 85-86.

was interested in the dynamics rather than in the mathematical kinematics of celestial bodies.¹⁵

The doctrinal context of Bruno's polemics against the mathematical approach in natural science must be sought for in the specific place assigned to astronomy in university curricula, and, more precisely, in the historical relation between mathematics and astronomy, on the one hand, and natural philosophy and cosmology, on the other. This section offers a brief reconstruction of these relations, pointing out how the specific relationship between astronomy and philosophy affected the early reception of Copernicus. Then Bruno's views on (mathematical) astronomy and the value of astronomical observations are discussed.

From Antiquity to the Renaissance astronomers were primarily concerned with predicting and determining planetary and stellar positions. The goal of theoretical astronomy was generally identified as the reduction of the apparent celestial motions to combinations of uniform circular motions. By contrast, the nature of the heavens and the causes of its motions were studied by natural philosophers, who were rarely competent in technical astronomy.¹⁶ Ptolemaic mathematical astronomy employed a great variety of sophisticated technical devices, such as, eccentric circles, equants and epicycles, needed merely to save the appearances, irrespective of the real path of a planet. This was clearly at odds with the physical approach of Aristotelian cosmology.¹⁷ Various strategies were designed to evade the potential conflict between a predictively powerful mathematical astronomy and the orthodox natural philosophy of the heavens. Many authors, including Peter of Ailly, Peurbach and

¹⁵ See *La cena*, cit., 191: «Ma il suo scopo versa circa la natura et verificazione del soggetto di questi moti».

¹⁶ For the historical origins of this distinction, see F. KRAFFT, *Physikalische Realität oder mathematische Hypothese? Andreas Ostander und die physikalische Erneuerung der antiken Astronomie durch Nicolaus Copernicus*, «Philosophia naturalis», XIV, 1973, pp. 243-275: 256f. See also the recurring distinction between mathematicians and physicists in Sacrobosco and his commentators; cf. *The "Sphere" of Sacrobosco and Its Commentators*, ed. L. Thorndyke, Chicago 1949, pp. 148, 260, and 295-296. This boundary was eroded only exceptionally. Levi ben Gerson is a case in point. This medieval astronomer emphasized his belief that astronomy must be investigated by a scholar thoroughly familiar both with natural philosophy and mathematics. See B. R. GOLDSTEIN, *Levi ben Gerson on astronomy and physical experiments*, in S. UNGURU (ed.), *Physics, Cosmology and Astronomy, 1300-1700. Tension and Accommodation*, Dordrecht 1991, pp. 75-82.

¹⁷ This potential conflict is underscored also by Bruno; cf. *De immenso*, III.3, BOL I, 340, and III.7, BOL I, 370-371.

Clavius, accepted both.¹⁸ Other types of strategy were developed, including (1) the rejection of Ptolemaic astronomy and the attempt to design a truly Aristotelian alternative,¹⁹ or (2) a specific kind of scepticism regarding astronomical hypotheses and astronomical conceptual tools. For our present concerns, the second type is of particular interest.²⁰

During the Renaissance, many prefaces of astronomical works expressed doubts about or denial of the reality of the eccentrics, epicycles and equants employed by astronomers.²¹ These doubts led to moderate and more radical forms of scepticism. In his famous preface to Copernicus' *De revolutionibus*, Osiander argued that astronomical hypotheses were not articles of faith, but simply the basis of computation, devices for representing observed phenomena.²² This set the frame for the so-called Wittenberg interpretation of Copernicanism regarding the latter merely as a set of predictive planetary models, rather than as a cosmological system.²³ More radical positions were developed by Peter Ramus, putting forward an astronomy without hypotheses,²⁴ and by Frischlin, who held that the true nature and motion of heavenly bodies are inaccessible to us.²⁵

¹⁸ N. JARDINE, *The Birth of History and Philosophy of Science. Kepler's A Defence of Tycho Against Ursus with Essays on its Provenance and Significance*, Cambridge 1984, p. 231.

¹⁹ Averroes, inspiring Nifo and Achillini, and Albitruji, inspiring Fracastoro and Amico are cases in point for the first strategy. See also F. KRAFFT, *Physikalische Realität oder mathematische Hypothese?*, cit., p. 268, for Fracastoro, Amico, Ibn Al-Haitham, Averroes, Delfino and Della Torre. See M. DI BONO, *Copernicus, Amico, Fracastoro and Tusi's device. Observations on the use and transmission of a model*, «Journal for the History of Astronomy», XXVI, 1995, pp. 133-154, for Amico and Fracastoro. Cf. N. JARDINE, *The Birth of History*, cit., p. 226 f.

²⁰ For still different strategies, see N. JARDINE, *Scepticism in Renaissance astronomy: A preliminary study*, in R. H. POPKIN & CH. B. SCHMITT, *Scepticism from the Renaissance to the Enlightenment*, Wiesbaden 1987, pp. 83-102.

²¹ Albert of Brudzewo and Dondi are cases in point; cf. M.-P. LERNER, *Tre saggi sulla cosmologia alla fine del Cinquecento*, Napoli 1992, p. 18. For the rejection of the celestial orbs by Cusanus and Pontanus, see N. JARDINE, *The significance of the Copernican orbs*, «Journal for the History of Astronomy», XIII, 1982, pp. 168-194.

²² N. JARDINE, *The Birth of History*, cit., pp. 86-91.

²³ See P. K. MACHAMER, *Fictionalism and realism in 16th-century astronomy*, in *The Copernican Achievement*, ed. R. S. Westman, Berkeley-L. A. 1975, pp. 346-353; R. S. WESTMAN, *The Melanchthon circle, Rheticus, and the Wittenberg interpretation of the Copernican theory*, «Isis», LXVI, 1975, pp. 165-193; ID., *Three responses to Copernican theory: Johannes Praetorius, Tycho Brahe, and Michael Maestlin*, in R. S. Westman (ed.), *The Copernican Achievement*, cit., pp. 285-345.

²⁴ See N. JARDINE, *The Birth of History*, cit., pp. 234, 266-268; M.-P. LERNER, *Tre saggi sulla cosmologia*, cit., chap. I.

²⁵ Cf. N. JARDINE, *Scepticism in Renaissance astronomy*, cit., pp. 90-91. A similar position was developed by Nicole Oresme in the 14th century.

Copernicus' astronomy and natural philosophy were still fairly traditional.²⁶ Yet, his rearrangement of the planetary system contained the seeds of a radical transformation. Most remarkably, Copernicus held that a sound astronomical theory did more than merely permitting the computation of predictions, asserting implicitly that the astronomer makes more substantive claims about the physical world. Thus, he saw how urgent was the need to integrate mathematical astronomy into physics. The early reception of Copernican theory was strongly conditioned by the astronomer's disciplinary role within the university.²⁷ In the Aristotelian scheme, astronomy had an uncertain place as «*scientia media*» between the theoretical and the practical sciences.²⁸ And in medieval and Renaissance university curricula, astronomy was regarded as a propaedeutic discipline, since it belonged to the quadrivium of the liberal arts.²⁹ This explains why Wittenberg astronomers could appreciate Copernicus' work as a useful set of auxiliary mathematical hypotheses, convinced that there was no urgency about the issue of a cosmological choice. Caspar Peucer, for example, suggested that Copernicus and Ptolemy were geometrically equivalent. Tycho Brahe praised Copernicus as astronomer, but he regarded the cosmological and physical implications of his views as utterly absurd.³⁰ And Michael Maestlin, although fully accepting the new planetary arrangement, was disinclined to develop further the physical implications of Copernican hypotheses. It was not until the late 16th century, that several natural philosophers and astronomers became convinced of the *physical* truth of the Copernican system and of the wisdom of his injunction that technical astronomers should reform their art upon true physical principles. During these

²⁶ See, among others, N. JARDINE, *The significance of the Copernican orbs*, cit., p. 183; *Planetary Astronomy from the Renaissance to the Rise of Astrophysics, Part A: Tycho Brahe to Newton*, eds. R. Taton & C. Wilson, Cambridge 1989, p. vii.

²⁷ R. S. WESTMAN, *The astronomer's role in the sixteenth century: a preliminary study*, «History of Science», XVIII, 1980, pp. 105-147; for a critical examination of this essay, see N. JARDINE, *The significance of the Copernican orbs*, cit., pp. 168-194.

²⁸ See R. D. MCKIRAHAN, *Aristotle's subordinate sciences*, «British Journal for the History of Science», XI, 1978, pp. 197-220.

²⁹ See N. JARDINE, *Scepticism in Renaissance astronomy*, cit., p. 85.

³⁰ Also Tolosani held that Copernicus was deficient in physical and dialectical science; see N. Jardine, *The significance of the Copernican orbs*, cit., 168; M. A. GRANADA, *Giovanni Tolosani e la prima reazione romana di fronte al "De revolutionibus": la critica di Copernico nell'opuscolo "De coelo et elementis"*, in *La diffusione del copernicanesimo in Italia 1543-1610*, eds. M. Bucciantini & M. Torrini, Firenze 1997, pp. 11-35.

years, the demarcation between astronomy and natural philosophy was steadily eroded by authors, such as Patrizi and Bruno, who ventured into territories traditionally reserved for mathematical astronomers. Thus, the distinction between astronomy and physics lost its force, the grounds of natural philosophy came under scrutiny, and a new sort of realism developed. Finally, Kepler saw how urgent was the need to integrate mathematical astronomy into physics. In his astronomy the mathematical treatment yielded an actual orbit in space.³¹ And in his *Defence of Tycho*, he showed that the defence of a particular theory of the universe requires one to distinguish between different kinds of hypotheses employed by astronomers, and that the choice between observationally equivalent hypotheses cannot be made without appeal to evidence from disciplines outside astronomy.³² From the beginning of the seventeenth century, also traditional astronomers qualified themselves as competent to treat physical questions.³³

In his cosmology, Bruno crossed the traditional borderlines between astronomy and natural philosophy, thus developing a precise position in the contemporary debate on the relation between these two disciplines. This explains his critical view of contemporary astronomy and enables us to shed some light on one aspect of his views of observation and experience.

In *Acrotismus*, Bruno attacked the Aristotelian concept of the 'middle sciences', including astronomy, optics, and harmony.³⁴ Bruno rejected the very idea of scientific disciplines which are presumed to mediate be-

³¹ J. NORTH, *The Fontana History of Astronomy and Cosmology*, London, 1994, pp. 118, 283 and 309-311.

³² R. S. WESTMAN, *The astronomer's role in the Sixteenth century*, cit.; N. JARDINE, *The Birth of History*, cit.

³³ See P. DEAR, *Jesuit mathematical science and the reconstitution of experience in the early seventeenth century*, «Studies in History and Philosophy of Science», XVIII, 1987, pp. 133-175: 165-166.

³⁴ *Camoer. acrot.*, BOL I,1 106: «Si Astronomiam, Perspectivam et Harmonicam physicae partes fassus esset Aristoteles, nemo illum naturalem philosophiam perfecisse existimare potuisset. Atqui cur has inter mathematicam et physicam medias appellabimus disciplinas, cum inter abstractum a materia, et cum materia conjunctum, medium imaginari nequeamus? Nonne et Aristoteli physica est linea quam Perspectivus accipit? Nonne physicum accipit circulum, et quandoque lineam et figuram Astrologus, ubi (sive imaginata sint haec, sive realia, sive intrinseca, sive extrinseca sphaeris ipsa dicantur) semper cosmicam materiam respiciunt». Cf. ARISTOTLE, *Physics*, 193b22-194a12: optics, harmony and astronomy are the most physical of mathematical sciences.

tween the realm of the natural world and that of the ideal structures. Physical science should regard nature as *material* reality. A scientific methodology which does not take into account the material character of natural reality, cannot adequately account for it, generating only idle and empty abstractions. Now, mathematical astronomy does not capture nature, since it abstracts from its materiality.³⁵

Crucial in Bruno criticism of the 'middle sciences' is the fact that they are not concerned with the 'things themselves', but are grounded merely upon the appearances of things.³⁶ On the basis of the apparent size of the luminous bodies, mathematicians are able to calculate eclipses. However, they are not able to capture the real sizes and effective distances of celestial bodies.³⁷ Not only astronomy, but also other disciplines, traditionally regarded as 'middle sciences', such as optics, were criticised by Bruno.³⁸ According to Bruno, traditional optics should be replaced by a (still hypothetical) «vera optica et geometria», presumably endowed with the means for measuring planetary and stellar distances.³⁹

Bruno's attack unto the traditional 'middle sciences' did not invest the pragmatic use of their observations.⁴⁰ However, Bruno emphasized that he intended to look «with his own eyes». Indeed, so he argues with the aid of a metaphor, for winning a war, fighting alone is not sufficient, one needs to master military art. Thus, observational results need to be interpreted, because appearances become intelligible solely in the 'eyes of reason'.⁴¹ Bruno did not reject the mathematicians' theories as such. His aim is an adequate picture of «la natura et verificazione del soggetto di questi moti»,⁴² or, as he asserted in *De gli eroici furori*, to develop a «natural and physical discourse».⁴³ Bruno's attacks against contemporary

³⁵ See *La cena*, cit., pp. 90-93, 98, 106, 190-191 and 209; cf. *De immenso*, III.10, BOL I, I 393 and 395: «canones astronomicas cum natura nihil habere communem»; and VI.2.

³⁶ As we will see in the next section, the idea of the phenomenal character of natural reality is crucial in Bruno's epistemology.

³⁷ *De immenso*, V.5, BOL I, II 138.

³⁸ Cf. *La cena*, cit., p. 73, regarding the «vanità del studio di prospettivi e optici circa la determinazione della quantità di corpi luminosi»; cf. pp. 151-152, where Bruno is ironical about optical and perspectivist scientists.

³⁹ *Ivi*, p. 151.

⁴⁰ See *ivi*, p. 105. Moreover, in Wittenberg, Bruno read the astronomical observations of the landgrave William of Kessel; cf. R. STURLESE, *Su Bruno e Tycho Brahe*, cit.

⁴¹ *La cena*, cit., pp. 90-92.

⁴² *Ivi*, p. 191.

⁴³ *Furori*, BDI 932; cf. *De la causa*, ed. cit., p. 115.

mathematical science as well as against Aristotelian methodology are functional to his developing a philosophical naturalism. To the contribution of sense experience in the reconstruction of natural philosophy we now turn.

2. SENSE AND REASON

2.1. Human soul and natural reality

In *Sigillus sigillorum*, Bruno developed two views which set the frame for his psychology of perception and cognition: the theory of the three 'worlds', i.e. the divine mind, natural reality, and the human soul, and his doctrine of the essential unity of the human soul. Bruno's view of the three worlds entailed that the human soul is hooked to the natural world as well as to its ideal origin and structure.⁴⁴ In the same context, he rejected the traditional faculty psychology. The human mind is integrated in a sort of cosmic dynamics, and the various mental capabilities must be seen as manifestations of a unitary force.⁴⁵ *A fortiori*, human mind is itself a dynamic entity, which either upon the impinging of external stimuli or spontaneously develops sensible and intellectual representations.⁴⁶ The specific position of human mind excludes both Aristotelian abstraction as well as traditional Platonic innatism.⁴⁷ By nature, the mind is oriented towards the natural world and its ideal structure.⁴⁸ The basic idea of Bruno's doctrine of the three worlds is that

⁴⁴ For the theory of the three worlds, see *Sig. sigill.*, BOL II,II 164-165; *Orat. valed.*, BOL I,I 14-15; *Camoer. acrot.*, BOL I,I 81; *De imag. comp.*, BOL II,III 89-90, 94, 101, 198; *De magia*, BOL III 403; *Thes. de magia*, BOL III 458; *Lampas trig. stat.*, BOL III 206; *De minimo*, BOL I,III 136.

⁴⁵ *Sig. sigill.*, BOL II,II 172-179; *Lampas trig. stat.*, BOL III 52-53: «intellectualis vis insita omnibus»; cf. *De vinculis*, BOL III 692.

⁴⁶ This view is connected with Bruno's postulate of the universal principle of life, designed to explain the actual behaviour of natural reality, including men, animals, celestial bodies etc.

⁴⁷ See *Sig. sigill.*, BOL II,II 185. Cf. *De immenso*, VIII.8, BOL I,II 309-310, for a rejection of separate ideas. However, a certain form of innatism is suggested in *De imag. comp.*, BOL II,III 118 and in *Lampas trig. stat.*, BOL III 51. For discussion, see my *Il problema della conoscenza in Giordano Bruno*. Napoli 1988, pp. 83f. and 312f.

⁴⁸ See, for example, *De imag. comp.*, BOL II,III 101: «Ita animus sensusque noster species eatque favores quosdam immediate a superno mundi sibi procurat, comparat et recipit, quosdam vero per medium rerum naturalium atque sensibilium». Cf. *De umbris idearum*, ed.

mental states represent external states or events by virtue of their common, ideal origin.

The distinction between the ideal core of reality and its concrete, transitory manifestations is reflected at the mental level. The contrast between physical and ideal shadows, and between sensible and intelligible intentions or species pervades Bruno's works.⁴⁹ Sensible representations regard natural reality, as it appears to the senses, while intelligible representations capture its intelligible core. The primary object of the human soul (the 'third' world) is the 'second' or natural world. Natural reality is seen by Bruno as a continuously varying chain of events and processes, which are ruled by unchanging structures.⁵⁰ Thus, sensible forms are «*vestigia idearum*».⁵¹ And, in this sense, they represent a primary reflection of the ideal world, while the sensible representations are just reflections of these «*vestigia*».⁵² Now, natural philosophy does not regard 'phantastic shadows' (the sensible representations of the natural world), but intends to capture the «*things themselves*».⁵³ In contrast with Aristotelian physics, Bruno held that a physical object should not be characterized by those features which can possibly make it an object of direct sense-perception. The structures of physical reality are not directly accessible to sense-perception.⁵⁴ Man lives in a phenomenal world, and only gradually he can become aware of the things themselves. Bruno did not eliminate the psychological faculties *tout court*,

R. Sturlese, Firenze 1991, pp. 77-78; *De immenso*, I.1, BOL I,I man participates in the intelligible and the sensible world. In *De immenso*, VIII, BOL I,II 288-289, Bruno asserted that the truth is in the things, and that it knocks on every door: it touches the senses and the intellect.

⁴⁹ See, for example, *De umbris*, ed. cit., pp. 37-38, and 40; *Sig. sigill.*, BOL II,II 171; *Lampas trig. stat.*, BOL III 206.

⁵⁰ *De la causa*, cit., p. 79; *De immenso*, VI.6, BOL I,II 181; *De vinculis*, BOL III 691: «Res in universo ita sunt ordinatae, ut in quadam coordinatione consistant, ita ut continuo quodam quasi fluxu ab omnibus progressio fieri possit ad omnia». For an analysis of the theme of the eternal «*vicissitudine*» in Bruno, see N. BADALONI, *La filosofia di Giordano Bruno*, Firenze 1955, chap. I.

⁵¹ *Cantus*, BOL II,I 235; *Sig. sigill.*, BOL II,II, 162; *De la causa*, ed. cit., pp. 61-63, 65, and 110; *Furori*, ed. cit., pp. 1049, 1123, and 1159; *De imag. comp.*, BOL II,III 94 and 98; *De minimo*, BOL I,III 149; *De vinculis*, BOL III 684; *Thes. de magia*, BOL III 463.

⁵² *De imag. comp.*, BOL III 98: «Tertio succedit mundus rationalis, nempe rerum universitas in intentione, qui speciebus a physicis rebus abstractis coalescit, et propter minorem entitas rationem plus ab ideali veritate distat quam vestigium, et ideo iure optimo umbrae notione concipitur».

⁵³ *La cena*, cit., p. 165.

⁵⁴ *De umbris*, cit., p. 37.

but rather relativized neat distinctions between them. The faculties are related in various ways to natural reality as cognitive object. The senses record the world as it appears to them, without interpreting it.⁵⁵ In this capacity lies their value and limit.

2.2. Appearances and illusions

Frequently, Bruno asserts that the senses may deceive us.⁵⁶ Indeed, as we saw above, sense perception captures phenomenal and not physical objects. Many astronomical phenomena, including distance, luminosity, motion or size of a celestial body, are involved.⁵⁷ A particularly enlightening example of an appearance yielding an illusion is the perception of cosmic distances. The relativity of distance perception is crucial in Bruno's defence of the infinite universe, in *Cena*⁵⁸ and other works.⁵⁹ Other pertinent instances of sensory illusions are a fixed point of reference for motion,⁶⁰ absolute standards for heavy and light,⁶¹ and the existence of a centre or horizon of the universe.⁶²

Correct information about the natural world cannot depend on the senses alone. And uninterpreted sensory data may lead us far astray.⁶³

⁵⁵ *De umbris*, cit., p. 102; *Sig. sigill.*, BOL II,II 172; *De imag. comp.*, BOL II,III 120; *Lampas trig. stat.*, BOL III 227; *De vinculis*, BOL III 644.

⁵⁶ *Sig. sill.*, BOL II,II 212-13; *La cena*, cit., p. 205; *Infinito*, BDI 369-370; *De immenso*, I.3, BOL I,I 209-211, 214-215.

⁵⁷ See *Camoer. acrot.*, BOL I,I 184, on the deceptive role of the senses in astronomy, especially regarding the apparent positions and motions. For discussion of this point, see P. R. BLUM, *Aristoteles bei Giordano Bruno*, München 1980, pp. 44-45, and 124-25, notes 146-154.

⁵⁸ *La cena*, cit., p. 151: apparent luminosity is not an adequate basis for the measurement of celestial distances; see pp. 152-163 for the polemics with Epicurus about the apparent distance of the Sun; see also pp. 190 (Mars) and 205 for the relativity of distances.

⁵⁹ *Infinito*, BDI 438; *De immenso*, I.3, BOL I,I 210; I.4, BOL I,I 214; I.5, BOL I,I 219; III.1, BOL I,I 313-15; III.2, BOL I,I 321f; III.4, BOL I,I 344, 347; III.8, BOL I,I 374; IV.5, BOL I,II 26; IV.17, BOL I,II 92-93; V.4, BOL I,II 128-132.

⁶⁰ For the relativity of motion, see *Infinito*, BDI 447; *De immenso*, III.2, BOL I,II 329. For the medieval background of this discussion, see E. GRANT, *Planets, Stars, & Orbs. The Medieval Cosmos, 1200-1687*, Cambridge 1996 (first edition 1994), p. 640.

⁶¹ *La cena*, cit., p. 211; *Camoer. acrot.*, BOL I,I 110, 186-90; *De immenso*, VI.4, BOL I,II 174-180.

⁶² For the illusions of centre and of horizon, see *La cena*, p. 100; *Articuli adv. math.*, BOL I,III 75 and 77; *De immenso*, III.3, BOL I,I 334.

⁶³ For example, *De immenso*, III.2, BOL I,I 329: sense perception suggests that the Sun and the planets circle around the Earth.

The deception by the senses is not inherent to their function, however, which is announcing the world as it appears to them.⁶⁴ Strictly speaking, they cannot fail, because errors can only be committed in the rational elaboration of sensory information; for example, when we presume that the intentions are the things themselves.⁶⁵ Sense perception is to a certain degree informationally encapsulated, that is, it is largely independent of the organism's beliefs and goals. The senses as such are cognitively impenetrable and this ensures their relative reliability. They mirror the appearances and in this they cannot fail. Although they often yield an incorrect picture of natural reality, sensible representations may be useful to sharpen our knowledge of the world.⁶⁶ However, the ideal patterns underlying sensory representations are captured only by the superior faculties.⁶⁷

The senses deceive us when their information is not adequately interpreted. What is to blame, however, is only reason.⁶⁸ Thus, only a cooperation between senses and rational thought guarantees an adequate picture of nature.⁶⁹ In his cosmological works, Bruno emphasized that the scrutiny of the natural world is to be attributed to a «senso regolato»⁷⁰ or to sense and reason.⁷¹ Indeed, on the one hand, he stressed

⁶⁴ See *Sig. sigill.*, BOL II,II 173; *De imag. comp.*, 120; see also *De vinculis*, BOL III 644: «sensus enim sunt veluti ostia seu portae seu fenestrae». For the recurrent terminology of «apparentia» and «apparire» in Bruno's cosmology, see: *La cena*, pp. 75, 166, 184, 192, and 204; *Infinito*, BDI 435 and 471; *Articuli adv. math.*, BOL I,III 77; *De immenso*, III.1, BOL I,I 317; III.4, BOL I,I 346; II.8, BOL I,I 375; *De vinculis*, BOL III 687. See also *Thes. de magia*, BOL III 485.

⁶⁵ *Thes. de magia*, BOL III 481-82; *De magia*, BOL III 449.

⁶⁶ *Infinito*, BDI 370; *De immenso*, VII.1, BOL I,II 244.

⁶⁷ *De immenso*, II.9, BOL I,I 289: the nature of form is not accessible to the senses. Cf. *Camoer. acrot.*, BOL I,I 97: «caetera quae sensum communem et imaginationem pulsant [...] non vera appellabat».

⁶⁸ *De immenso*, III.1, BOL I,I 316: «Non ideo visus mentitur; defectus rationis; III.2, p. 329: «Et ut sensum sensus instruit; immo sensu follestem sensusmetipse corrigit; et urget ne sibi principium tribuatur erroris illud, quod a ratione potius imbecillitate profinitur».

⁶⁹ *De immenso*, I.3, BOL I,I 211: «Edoceat, ceu principiis tibi cognitionis / Debeat objectis conlatis pluribus esse. / Atque facultatum variis currentibus una / Testibus; est enim diversis innita rebus / Lux veri, et veluti tenebrarum splendet ab ore».

⁷⁰ *La cena*, cit., pp. 101 and 204; *De la causa*, cit., pp. 64 and 106; *Infinito*, BDI 347, 445, and 467. Cf. *De umbris idearum*, cit., pp. 37-38 for «sensus purgatus» and *Sig. sigill.*, BOL II,II 198, for «regolata fides».

⁷¹ *La cena*, cit., p. 212; *Infinito*, BDI 350, 433, 446, 500, 515 and 516; *De immenso*, I.10, BOL I,I 236; II.9, BOL I,I 288; III.3, BOL I,I 329; III.5, BOL I,I 352; III.7, BOL I,I; IV.5, BOL I,I 25 and 28; V.7, BOL I,II 40; V.9, BOL I,II 148; VII. 12, BOL I,II 273 and VII.17, BOL I,II 279.

that the senses have a limited reach. Single observations may deceive us and many things are unobservable, simply because too distant.⁷² Also the infinite universe cannot be observed.⁷³ However, on the other hand, Bruno held that sense experience may support abstract conclusions. For example, the infinite is not contradicted by the senses.⁷⁴ And, most remarkably, the sense of sight, with its capability to go beyond any presumed horizon, suggests the infinity of the universe.⁷⁵

3. EXPERIENCE AND OBSERVATION

It has been pointed out that pre-modern, Scholastic uses of 'experience' in natural philosophy usually had the form of selective presentation of instances, illustrating conclusions generated by abstract philosophizing, rather than providing an empirical basis for testing just these general conclusions. Experiment became a characteristic feature of natural philosophy only in the seventeenth century.⁷⁶ In broadest terms, this picture must be accepted, and applied to Bruno as well. Indeed, in his cosmological works, empirical results are used more often for the purpose of illustrating and supporting – rather than testing – theories. At the turn of the century, however, 'experience' slowly developed a new meaning. Experience as an element of scholastic natural philosophy was expressed by means of universalised statements about how things usually occur. As an element of non-scholastic, natural philosophical discourse, experience increasingly took the form of statements describing specific events. To statements such as «heavy bodies fall», everybody could assent through common experience embodied in authoritative texts. In the case of individual events this common assent could not be anticipated. However, although not immediately evident, also the singular experience could provide evidence.⁷⁷ This section offers a summary review of the role of experience in traditional philosophy, examin-

⁷² Stellar motion is a case in point; cf. *De immenso*, I.5, BOL I,I 220-221.

⁷³ *De immenso*, I.4, BOL I,I 214.

⁷⁴ *De immenso*, I.13, BOL I,I 250.

⁷⁵ *De immenso*, I.1, BOL I,I 204; I.4, BOL I,I 217; cf. *Infinito*, BDI 374.

⁷⁶ See CH.B. SCHMITT, *Experience and experiment. A comparison of Zabarella's view with Galileo's in De motu*, «Studies in the Renaissance», XVI, 1969, pp. 80-138; P. ROSSI, *The Aristotelians and the moderns. Hypothesis and nature*, «Annali dell'Istituto e Museo di storia della scienza di Firenze», VII, 1982, pp. 3-27.

⁷⁷ See P. DEAR, *Jesuit mathematical science*, cit., pp. 133-34.

ing the role of the new astronomy in the constitution of a new concept of experience (subsection 1). Subsection 2 analyzes the role of observation and experience in Bruno, in the broader context of the developing concept of experience.

3.1. *Experience in philosophy and astronomy*

In scholastic philosophy, the term 'experience' designated a universal statement of fact, supposedly constructed from the memory of many singular instances. Experience taught how nature usually behaved; it did not consist of knowledge of individual events, because such events might be anomalous. By virtue of its universality, experience might form a premise in a scientific demonstration. Thus, experiential statements could not play a role in scientific discourse unless they were universal.⁷⁸ Scholastic *regressus* theory, for example, was concerned with the establishment of principles from phenomena and with the subsequent confirmation of those principles by verification of their consequences. To be fully adequate, empirical premisses needed to command assent because they were evident, not because of particular events adduced in their support. In a sense, the Aristotelian model of a science implied that scientific knowledge must be 'intersubjective', consisting of truths perfectly graspable by all. Singular experiences were not public; consequently, they were not suitable elements of scientific discussion.

In the course of the 16th century, with the rise of the new astronomy, the view of experience and of the importance of data changed. The peculiarities of observational data in astronomy did not intrude themselves into considerations of the role of experience in natural philosophy so long as astronomy was cordoned off from philosophy. Astronomy had in fact always provided potential anomalies for an orthodox Aristotelian view of experience in natural philosophy, because it employed data consisting of isolated observations made at particular times and places. In terms of the construction of a genuine scientific theory, the observable celestial phenomena needed to be general statements. Phenomena, then, are not simply appearances in heaven; they are evident, a part of common experience, such as, for example, the rising and setting of the Sun, the Moon and the stars. Taking into account singular experiences

⁷⁸ See P. DEAR, *Totius in verba. Rhetoric and authority in the early Royal Society*, «Isis», LXXVI, 1985, pp. 145-161:148-49.

might lead to serious problems, namely to blurring the disciplinary boundaries between astronomy and natural philosophy. Indeed, the observations of the nova in 1572 and of the 1577 comet prompted many astronomers and philosophers to question Aristotelian cosmology, leading to the definite dissolution of the latter in the seventeenth century.⁷⁹

3.2. Experience and argument

The shift towards a more modern concept of experience, occurring at the turn of the century, can be traced also in Bruno. Frequently, Bruno appeals to experience to underpin his physical and cosmological theories.⁸⁰ These references to and uses of experiences reveal both traditional and innovative aspects. In the traditional mode, he uses experiences just to illustrate abstract conclusions. But in many cases the empirical content of his experiences is not derived from authoritative texts, nor were they expressed as universal statements causing immediate assent. Thus, his experience had to be made transparent to the readers in order to convince them of its veracity. Bruno attempted to establish the legitimacy of his experience in long reports of events, using also specific rhetorical techniques to make empirical statements acceptable in a philosophical discourse.

In *Lampas triginta statuarum*, Bruno formulated a fairly traditional definition of experience as «collectio multorum particularium et exercitiorum».⁸¹ Elsewhere, however, Bruno referred to phenomena and events

⁷⁹ Recall that Tycho Brahe regarded astronomy as an art, rather than as a science; cf. *Opera omnia*, eds. I. L. E. Dreyer e.a., Amsterdam 1972, vol. V, pp. 117-118; vol. VI, p. 145-46; vol. VII, p. 238.

⁸⁰ *Infinito*, BDI 445: «Perché vogliamo appoggiarci a vane fantasie, dove la esperienza istessa ne ammaestra?» (regarding the difference between luminous and reflecting celestial bodies); *Infinito*, BDI 447: «[...] come han notato gli antichi e moderni veri contemplatori della natura e come per esperienza ne fa manifesto in mille maniere il senso, non possiamo apprendere il moto se non per certa comparazione e relazione a qualche cosa fissa». See also *De magia*, BOL III 454; *Theses de magia*, BOL III 463: «ex rerum experientia manifestum est»; cf. *Id.*, pp. 477, 478, and 483; *De immenso*, IV.3, BOL I,II 21: «Hoc, quotidiana iugue experientia, sensus docet, qui quae propinquius gyrania et in directum deambulantia moveri novit, eminus eodem ordine mota atque mensura, fixa manere iudicabit»; *Id.*, VI.22, p. 240: «Altera, nam, velut est dictum, clarissima constant / Experimenta, quibus propria tantum e regione / Istius appulsus speciei in partibus extat».

⁸¹ *Lampas trig. stat.*, BOL III 148: «Est experientia, utpote collectio multorum particularium et exercitiorum; unde inductionum et exemplorum ratiocinia deduci possunt»; cf. *Id.*, pp. 3-4: «Experientiam enim seu peritiam sequitur ars atque scientia, inertiam vero et

which cannot be traced back to standard texts, which were controversial, and in some cases framed by reports of personal experiences. From his climbing the Vesuvius in his early days, for example, Bruno derived an argument for the essential relativity of the perception of distance at a cosmic level.⁸² A discussion of a specific case, namely Bruno's dissolution of the traditional theory of elements, reveals some essential features of Bruno's ideas about the use of experience in philosophical discourse.

In *De l'infinito* and *De immenso*, Bruno attempted to show that the traditional doctrine of the four elements, based on a presumed hierarchy between earth, water, air and fire, is not tenable. He held that all worlds were composed of the same four elements and that the four elements were not distinguishable with respect to their presumed place or weight. Indeed, water and fire are present also in the innermost regions of the Earth, fire cannot burn without water, and air penetrates all bodies.⁸³ Bruno argued for this view at different levels. That the other worlds are composed of the same four elements known here on Earth, cannot be observed. Indeed, the physical homogeneity of the universe is merely argued for on the basis of a speculative consideration, namely a presumed analogy between the Earth and the other worlds.⁸⁴ In this case, Bruno used arguments that were reasonable in the light of the knowledge of the time, in the hope that what seems to be radically new, will have unsuspected elements in common with what is familiar.⁸⁵ Against the hierarchical order of the elements a garden variety of arguments is formulated. Also in this case, Bruno used purely speculative principles, in particular the coincidence of contraries.⁸⁶ Personal authority («illustri e dotti») is invoked as well.⁸⁷ More important for present purposes, Bruno justified his theories also on the basis of physical con-

imperitiam casus atque fortuna». Cf. T. AQUINAS, *Summa theologiae*, ed. P. Caramello, 3 vols., Torino 1952-1963, I, q. 64, a. 1.

⁸² *De immenso*, III.1, BOL I,I 313-315.

⁸³ *Infinito*, BDI 451-467; *Camoer. acrot.*, BOL I,I 75 and 178; *Articuli adv. math.*, BOL I,III 73; *De immenso*, IV.18; V.11; VI.12-17.

⁸⁴ *Infinito*, BDI 451-452.

⁸⁵ For discussion, see J. D. NORTH, *Science and analogy*, in *The Universal Frame. Historical Essays in Astronomy, Natural Philosophy and Scientific Method*, London 1989, pp. 285-310.

⁸⁶ *Infinito*, BDI 464; cf. *De immenso*, VII.10, BOL I,II 267: «Age ergo, respice naturae vultum, vide ut ubique et undique contraria conspirent, concordent, uniantur; comprende ut nusquam contrariorum unum sine altero consistere possit».

⁸⁷ *Infinito*, BDI 468.

siderations, involving the characteristic features of the elements. He appealed to every day experience,⁸⁸ to specific observations,⁸⁹ and also to a «universal experience».⁹⁰ The latter is strictly connected to the abstractly and jointly invoked experience and reason, associated to the «senso regolato»,⁹¹ and to the «truth of nature».⁹² Also the recurring presumed experiences or thought-experiments should be mentioned in this context.⁹³

The long reports of universal, specific or presumed experiences, which pervade Bruno's philosophical works all have a precise aim: to support his uncommon and often revolutionary physical and cosmological theories. Most of the experiences to which Bruno referred were universal or derived from daily life. They were uncontroversial and meant to cause immediate assent. However, many of his theories, such as the relativity of the perception of distance and weight, and the doctrine of the four elements, are also argued for on the basis of observations and experiences that were uncommon and in conflict with generally accepted views and intuitions of his days.⁹⁴ Uncommon or controversial experiences required specific rethorical artefices designed to make them fully acceptable to the reader. In these cases, Bruno used various types of strategy. Generally, presenting the reports of potentially controversial appearances and observations, he attempted to mimick the supposed clarity of universal, uncontroversial experiences, invoking frequently universal principles or the (rather abstract) testimony of sense and reason. Thus, specific experiences were presented as general unproblematic statements of how things behaved. Most of the time, however, contro-

⁸⁸ See the frequently recurring formulations, such as, «veggiamo» in *Infinito*, BDI 451, 453, and 459-460. An example is the presence of water in the regions below the Earth.

⁸⁹ *Infinito*, BDI 453: «Oltre che il simile si vede, nelle gocce impolverate, pendenti e consistenti sopra il pieno». Also astronomical observations are used; see *Camoer. acrot.*, BOL I,1 75, art. 62: «Experientia non solum ex cometarum crinibus, comis, barbibus, et caudis, sed etiam ex omni parte demonstrat, ignem non magis sursum, quam quoquo versum moveri». *De immenso*, IV.9, BOL I,11 49: sunlight reflected by an ice-crystal has different colours, which reveals that the sun is composed of various elements.

⁹⁰ *Infinito*, BDI 460.

⁹¹ See *Infinito*, BDI 455 and 461; see also section 2 for the role attributed by Bruno to sense and reason in natural philosophy.

⁹² *Infinito*, BDI 455; cf. p. 462: «né per natura si verifica, né per ragione si prova ed argumenta».

⁹³ See *Infinito*, BDI 458: earth needs water for coagulation; *De immenso*, VI.15: the hollow trunk of a living tree is presumed to be warmer than that of a dead one.

⁹⁴ Cf. *Infinito*, BDI 459: «principio ancora non conosciuto né visto».

versy, or the threat of controversy, demanded more radical measures, and at the same time it placed greater emphasis on discrete events as justification for assertions. In these cases, Bruno often proceeded to direct questioning the claims and assumptions of traditional philosophy.

For traditional natural philosophy, experience taught how nature usually behaved. It did not consist of knowledge of discrete events. Expressed as a universal statement, it supplied items regarding phenomena, that were known to all, and thus evident. In this sense, it might be used by natural philosophy to confirm abstract conclusions. Also Bruno invoked experience to demonstrate or, more often to suggest, something to be the case, not to test a hypothesis or to derive sets of comparable data. However, his new cosmology involved particular ways of generating and using experiential data which created problems for the characterization and presentation of his physical theories. He needed to develop techniques for turning private experiences into evident empirical suppositions to be used in philosophical demonstrations. Bruno did not pave the way towards the formulation of a scientific methodology designed to incorporate singular experiences and discrete events into properly accredited knowledge about the world. For Bruno, experience is sensory knowledge about an aspect of the world, which establishes its legitimacy in the specific form of argumentation it is involved. Uncommon and controversial experiences may cause assent by virtue of specific rhetorical techniques.

4. CONCLUSION

It has become a commonplace to emphasize that Bruno's cosmology was largely dependent on Copernicanism and on strictly theoretical considerations. Now, Copernicanism constitutes a typical example of the underdetermination of theory by evidence. Indeed, current empirical evidence failed to decide between Copernican and Ptolemaic astronomy.⁹⁵ Yet, Copernicus implicitly asserted the right of the astronomer

⁹⁵ The movement of the Earth was empirically demonstrated only by the pendulum of Foucault, as regards the daily revolution, and by the discovery of stellar parallax in the early 19th century for the orbital revolution. See A. A. MIKHAILOV, *On the quest of direct proofs of the Earth's motion*, in *Copernicus, Yesterday and Today*, eds. A. Beer & A. Strand, Oxford 1975, pp. 165-169. Recall, moreover, that still Leibniz regarded Copernicanism and Ptolemaic theory as empirically adequate, but literally inconsistent. Both are descriptions of phe-

to make claims about the physical world, while Bruno put forward the relevance of empirical data underpinning his specific physical theories derived from his doctrine of a physically homogeneous, infinite universe.

Bruno's natural philosophy contributed to the rupture of the disciplinary boundaries between a highly complex, mathematical astronomy and a descriptive, physical cosmology. Bruno not only rejected a mathematical approach in science and philosophy, but he also mistrusted sense perception. However, he did not exclude a pragmatic and argued for use of astronomical data in natural philosophy, and he thus argued for a reconstitution of a rationally underpinned experience of an ever-changing world.

In his physical theories, such as the relativity of the perception of motion, and the physical homogeneity of the universe, Bruno attempted to set up criteria to distinguish the apparent from the real. To overlook the processes that are responsible for perception, means to deny the distinction between physical and phenomenal object. Physical objects are direct reflections of ideas. They are captured as phenomenal objects by physical shadows or sensible species and intentions. These sensible representations are 'shadows of shadows' and thus most distant from the ideal structures of reality. Bruno argued that knowledge cannot be built up from perceptual structures free from interpretation; the nature of things is something to be apprehended by rational inference. In turn, cognition is not the discernment of regularities in an unadulterated stream of experience. Cognition should intervene in experience, because the sensory data are trustworthy only when they are properly interpreted.

For the traditional natural philosopher, writing his commentaries on Aristotle, the grounding of the physical facts in experience was guaranteed by their generality. Experimental statements did not play a role in philosophical discourse unless they were universal. Also for Bruno, the relevance of empirical facts is never *a priori*. In this sense, he explicitly rejected a spectator theory of knowledge. Observational statements are not meaningful unless they are connected with theories. The cosmological debate proved indeed that previously accepted theories were involved in the formulation, acceptance and refutation of observational statements.⁹⁶ Bruno's theoretical arguments include the full range of ar-

nomena, not of the reality, since the universe is neither geocentric nor heliocentric. Cf. I. HACKING, *Why motion is only a well-found phenomenon*, in *The Natural Philosophy of Leibniz*, eds. K. Okruhlik & J. R. Brown, Dordrecht 1985, pp. 131-150: 140.

⁹⁶ The debate on comets is a case in point.

chitectonic, harmonic and dynamical considerations. Notice, however, that his theories are to be seen as 'rational beliefs', rather than as a systematic body of hypotheses related to a systematic practice of prediction, observation and instrumentation.⁹⁷ Bruno's appeal to experience is not meant to originate previously unknown conclusions, but rather to establish support or test the accuracy and appropriateness of convictions held beforehand. On other occasions, experiential data are a mere corroborative device for the purpose of persuasion. Thus, experience is always *constructed*. Observational and philosophical terms cannot be distinguished clearly. And the empirical impact cannot be isolated. Indeed, in Bruno's works, there is an intense interplay between theoretical considerations, observational data and rhetorical techniques.

⁹⁷ Recall that the conception of a theory as a systematic body of hypotheses with an associated domain of relevant evidence is not to be found in 16th-century philosophical and scientific writings. Cf. N. JARDINE, *The Birth of History*, cit., pp. 34 and 283.