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Watching the Heavens with a 'Rooted Heart': The Mystical Basis of Aztec Astronomy

James Maffie

Abstract. Aztec epistemology maintained that humans acquire knowledge of reality mystically using their hearts, not their five senses. What, then, was the epistemological status of observational astronomy? Aztec epistemology assigned a privileged role to mystical knowledge and an ancillary, propaedeutical role to observational astronomy. The epistemological evaluation of observational claims in Aztec astronomy occurred within a context of mystically rooted metaphysical, religious, and astrological background assumptions. These played an essential role in the epistemology of Aztec astronomy.

I. Introduction

The study of nature by pre-Columbian Mesoamericans enjoyed empirical and practical success in a variety of areas including medicine, botany and zoology. In no area, perhaps, did they enjoy greater success in this respect than in astronomy. Mesoamericans excelled at astronomy, and their astronomies achieved remarkable empirical accuracy, predictive success and mathematical precision. Aztec astronomy was no exception. Aztec astronomy was deeply indebted to Mayan astronomy, although Aztec astronomers did not passively absorb Mayan thought. Rather, they transformed Mayan astronomy in the process of adapting it to their own practical and theoretical ends.

Aztec astronomers followed celestial and terrestrial patterns to anticipate the future, accommodating themselves to the rhythms of the cosmos. They saw themselves as actively contributing to the continued existence of the cosmos and considered it important to live well-balanced lives. They believed the movement of time through place was identical with the processual unfolding and self-presenting of the sacred, and that following this movement helps bring humans closer to the sacred in every respect – existentially, aesthetically, morally, and epistemologically. Aztec culture accordingly assigned astronomers a very high level of prominence and prestige in religious, political, economic and even personal affairs.

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This paper will examine two puzzles regarding the epistemology of Aztec astronomy. First, Aztec epistemology maintained that humans attain knowledge of sacred reality mystically using their *yollo* ('heart'), not their five senses. What, then, was the *epistemological* status and role of empirical observation in Aztec astronomy? Did Aztec *tlamatinime* ('knowers of things' or 'philosophers'[1]) regard mystical knowledge and empirical astronomy as epistemologically incompatible? Second, Aztec astronomy was deeply embedded within a broader context of metaphysical, religious and astrological assumptions, motivations and uses. What role did these play in the *epistemology* of Aztec astronomy?

Sections II, III and IV of this paper review key features of Aztec metaphysics and epistemology most relevant to Aztec astronomy. I will keep my discussion brief as I have discussed these matters in more depth elsewhere.[2] Sections V, VI and VII summarise Aztec astronomy, philosophy of time-place, and calendarics. Section VIII explores the role and epistemological status of observation in Aztec astronomy, while

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1 I follow Miguel León-Portilla, in his book *Aztec Thought and Culture: A Study of the Ancient Nahuatl Mind*, Jack Emory Davis, trans. (Norman: University of Oklahoma Press,1963), [hereafter León-Portilla, *Aztec Thought and Culture*], in translating *tlamatinime* as 'sages' or 'philosophers'. Typically priest-poets and priest-astronomers, *tlamatinime* reflected upon the nature and structure of reality, the source of knowledge, etc.

2 See James Maffie, 'Why Care about Nezahualcoyotl? Veritism and Nahua Philosophy', *Philosophy of the Social Sciences,* 2002, Vol. 32, pp. 73-93 [hereafter Maffie, 'Why Care about Nezahualcoyotl?']; ''We Eat of the Earth and the Earth Eats Us': The Concept of Nature in pre-Hispanic Nahua Thought', *Ludis Vitalis* 2002, Vol. X, no. 17, pp. 5-20 [hereafter Maffie, 'We Eat of the Earth']; 'To Walk in Balance: An Encounter between Contemporary Western Science and Pre-Conquest Nahua Philosophy', in *Science and other Cultures: Philosophy of Science and Technology Issues*, Robert Figueroa and Sandra Harding (eds). Routledge: New York, 2003), pp. 70-90 [hereafter Maffie, 'To Walk in Balance']; 'Flourishing on Earth: Nahua Philosophy in the Era of the Conquest', *The Nahua Newsletter* 2005, Vol. 40, pp. 18-23 [hereafter Maffie, 'Flourishing on Earth']; 'Aztec Philosophy', *The Internet Encyclopedia of Philosophy*, 2005, available at http://www.iep.utm.edu/a/aztec.htm (last accessed 31 March 2009) [hereafter Maffie, 'Aztec Philosophy']; 'The Centrality of Nepantla in Conquest-era Nahua Philosophy', *The Nahua Newsletter* 2007, Vol. 44, pp. 11-31 [hereafter Maffie, 'The Centrality of Nepantla'].

section IX examines the contextualist epistemology of Aztec astronomy. Section X discusses the bearing of recent research in cognitive psychology upon our understanding of Aztec astronomy. Conclusions are presented in Section XI.

Aztec astronomy does not fit neatly into contemporary 'circum-Mediterranean-derivative (cMd)' scientific and philosophical categories and distinctions such as astronomy vs. religion vs. astrology vs. mythology vs. numerology.[3] In this paper the phrase 'time-place reckoning' will be used to refer to a conceptually interrelated constellation of activities, including observing, counting, measuring, interpreting, giving an account of and creating an artistic-written record (*amatl*) of various patterns of time and place. Aztec time-place reckoning included: *tonalpohualli* ('reckoning the days') or reckoning the days of the 260-day cycle; *xiuhpohualli* ('reckoning the years') or reckoning the days of the 360+5-day cycle; *xiuhmolpilli* ('binding the years') or reckoning the 52 years of the 'calendar round'; reckoning the 65 'years' of the cycle of *Quetzalcoatl* (the Venusian cycle); and reckoning other cycles in celestial and terrestrial processes. The Nahuatl word *pohua* means 'to count, to reckon, to read, to recount, to relate, to give account of, to assign something'.[4] Reckoning time thus involved more than merely observing, counting and recording the number of days in celestial cycles. It also involved interpreting, divining, calculating, giving an account of and prognosticating their significance.

Aztec philosophy conceived time and place as a single, seamless and continuous whole. In order to highlight the difference between cMd and Aztec concepts of time and space, I refer to the Aztec's concept as 'time-

3 Gerardo Aldana, *The Apotheosis of Janaab' Pakal: Science, History and Religion at Classic Maya Palenque* (Boulder, CO: University Press of Colorado, 2007), [hereafter Aldana, *Apotheosis of Janaab' Pakal*], p. 3. Scholars have long argued the term 'Western' along with the binary, 'West vs. non-West', are simply too vague as to be useful. Many have proposed others such as 'North vs. South' and '1st world vs. 3rd world'. Unfortunately, these are inadequate, too. I think 'circum-Mediterranean-derivative' works the best. The reader should note that this term refers to historically constituted schools of thought and discursive traditions, not to the ethnicity, gender, nationality or residence of their practitioners. See Sandra Harding, *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies* (Bloomington: Indiana University Press, 1998) [hereafter Harding, *Is Science Multicultural?*], for the relevant argument.

4 Francis Karttunen,*An Analytical Dictionary of Nahuatl* (Austin: University of Texas. 1983), p. 201.

place', and refer to those individuals who studied it, 'time-place reckoners' (*cahuipouhqui*). Aztec *ilhuica tlamatilizmatinime*, 'those knowledgeable in the ways of heaven', were responsible for keeping Aztec society in balance with the cosmos. The 1524 *Coloquios y Doctrina Cristiana* contains the following indigenous description of Aztec time-place reckoners:

> The observers, those who concern themselves with the course and the systematic movements of the heavens ... they guide us, they show us the way. They determine how the year falls, how the reckoning of the destinies and the days, and each one of the complete counts follow their paths. They occupy themselves with this, for it is their task, their commission, their duty: the divine word.[5]

By referring to these activities as 'time-place reckoning' rather than 'astronomy', 'astrology', or 'ethnoastronomy', I hope to create a conceptual space for understanding Aztec activities *emically* (in Aztec terms) rather than *etically* (in contemporary cMd terms).[6]

II. Aztec metaphysics

The founding claim of Aztec metaphysics is the monistic thesis that there exists a single, dynamic, vivifying, eternally self-generating and self-regenerating, sacred power, energy or force – what the Aztecs called *teotl*. *Teotl* is ultimate reality. *Teotl* is non-personal, non-minded, non-

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5 *Coloquios y Doctrina Cristiana*, quoted in and translated by Miguel León-Portilla and Earl Shorris (eds), *In the Language of Kings* (New York: Norton, 2001), p. 320.

6 In this way I also hope to avoid the connotations the latter carry as well as sidestep such issues as whether Aztec time-place reckoning was 'real' astronomy, 'real science', 'primitive astronomy', or 'mere ethnoastronomy'. The customary use of the notion of ethnoastronomy is ethnocentric since it starts from two assumptions: (1) Western astronomy (science) provides the benchmark by which all other cultures' astronomies (sciences) are to be measured and understood; and (2) Western astronomy is astronomy simpliciter (Western science, science simpliciter), –rather than another ethnoastronomy (or ethnoscience). For related discussion, see Harding, *Is Science Multicultural?*

agentive, and non-intentional. *Teotl* is not a deity, person, or subject who possesses power in the manner of a king or tyrant. Rather, *teotl is* power: an always active, actualised and actualising, ever-flowing energy-in-motion. As the single, all-encompassing life-power of the cosmos, *teotl* creates the cosmos and everything that happens in the cosmos. Elizabeth Hill Boone writes, 'The real meaning of [*teotl*] is ... a concentration of power as a sacred ... force'.[7] The multiple deities in state-sanctioned Aztec religion were [accordingly] merely *teotl*, 'separated, as it were by the prism of human sight, into its many attributes'.[8]

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7 Elizabeth Hill Boone, *The Aztec World* (Washington DC: Smithsonian Books, 1994), p. 105.

8 Irene Nicholson, *Firefly in the Night: A Study of Ancient Mexican Poetry & Symbolism*. (London: Faber & Faber, 1959), pp. 63-64.

This view of Aztec metaphysics is defended in my previous publications: Maffie, 'Why Care about Nezahualcoyotl? Veritism and Nahua Philosophy'. *Philosophy of the Social Sciences,* 2002, Vol. 32, pp. 73-93; Maffie, ''We Eat of the Earth and the Earth Eats Us': The Concept of Nature in pre-Hispanic Nahua Thought'. *Ludis Vitalis*, 2002, Vol. X no. 17, pp. 5-20; Maffie, 'To Walk in Balance: An Encounter between Contemporary Western Science and Pre-Conquest Nahua Philosophy', in *Science and other Cultures: Philosophy of Science and Technology Issues*, Robert Figueroa and Sandra Harding, eds. (New York Routledge, 2003), pp. 70-90; Maffie, 'Flourishing on Earth: Nahua Philosophy in the Era of the Conquest', *The Nahua Newsletter*, 2005, Vol. 40, pp. 18-23; Maffie, 'Aztec Philosophy', *The Internet Encyclopedia of Philosophy*, 2005, available at http://www.iep.utm.edu/a/aztec.htm [last accessed 31 March 2009]; Maffie, 'The Centrality of Nepantla in Conquest-era Nahua Philosophy', *The Nahua Newsletter*, 2007, Vol. 44, pp. 11-31.

The success of the present argument concerning Aztec time-keeping does not rest upon accepting my thesis concerning *teotl*. For example, my argument succeeds mutatis mutandis if one accepts instead León-Portilla's characterisation of Aztec metaphysics in terms of *Ometeotl* (in León-Portilla, *Aztec Thought and Culture)*. For further discussion of *teotl,* see Davíd Carrasco and Scott Sessions, *Daily Life of the Aztecs: People of the Sun and Earth* (Westport, CT: Greenwood Press, 1998), [hereafter Carrasco and Sessions, *Daily Life*]; Eva Hunt *The Transformation of the Hummingbird: Cultural Roots of a Zinacatecan Mythical Poem*. Ithaca: Cornell University Press, 1977), [hereafter Hunt, *Transformation of the Hummingbird*; Arild Hvidtfeldt, *Teotl and *Ixiptatli: Some Religious Conceptions in Ancient Mexico*. Copenhagen: Munksgaard, 1958); Jorge Klor de Alva, 'Christianity and the Aztecs', *San Jose Studies,* 1979, Vol. 5, pp. 7-21; John D. Monaghan, 'Theology and History in the Study of Mesoamerican

Teotl's ceaseless changing and becoming, its ceaseless generating-and-regenerating of the cosmos, is one of ceaseless self-transformation-and-self-retransformation. The cosmos and all its contents are *teotl's* self-presentation and self- transformation. *Teotl'*s becoming therefore represents a particular kind of becoming: transformative becoming; its moving and processing are self-transformative moving and processing; and its power is thus transformative power. *Teotl* created as well as continually recreates, permeates and encompasses the cosmos. That which humans ordinarily regard as sun, earth, mountains, plants, etc., is generated by *teotl, from teotl*, as one aspect, facet or moment of its eternal process of self-generation-and-regeneration. *Teotl* is thus more than the unified totality of things; it is everything and everything is it.

Process, motion, becoming and transformation are essential attributes of *teotl*. *Teotl* is better understood as ever-flowing and ever-changing energy-in-motion rather than as a static deity, being, or entity. Since identical with *teotl*, the cosmos is also properly understood as ever-flowing and ever-changing energy-in-motion. As the single, all-encompassing life force of the cosmos, *teotl* animates and vitalises the cosmos. The cosmos is thus an animated, living process – not a lifeless, static object. Cosmos, sun, earth, mountains, rivers, etc., are processive and animated. Because animated, *teotl* and hence the cosmos are regarded as subjects, as 'thou's (rather than 'it's).[9]

Regions', in *Supplement to the Handbook of Middle American Indians*, Vol. 6 (Austin: University of Texas Press, 2001), pp. 24-49; Kay A. Read, *Time and Sacrifice in the Aztec Cosmos* (Bloomington: Indiana University Press., 1998), [hereafter Read, *Time and Sacrifice*]; Alan R. Sandstrom, *Corn Is Our Blood: Culture and Ethnic Identity in a Contemporary Aztec Indian Village* (Norman: University of Oklahoma Press, 1991), [hereafter Sandstrom, *Corn Is Our Blood*]; and Richard F. Townsend, *The Aztecs* (London: Thames and Hudson, 1972).

9 For related discussion, see Philip P. Arnold, *Eating Landscape: Aztec and European Occupation of Tlalocan* (Niwot, CO: University Press of Colorado, 1999), [hereafter Arnold, *Eating Landscape*]; Louise M. Burkhart, *The Slippery Earth: Nahua-Christian Moral Dialogue in Sixteenth Century Mexico (*Tucson: University of Arizona Press, 1989) [hereafter Burkhart, *The Slippery Earth*]; Diego Durán, *The Book of the Gods and Rites and the Ancient Calendar*, Fernando Horcasitas and Doris Heyden, trans. (Norman: University of Oklahoma Press, 1971), [hereafter Durán, *The Book of the Gods*] pp. 290,456; and Henri Frankfurt and H.A. Frankfurt, 'Myth and Reality', in *The Intellectual Adventure of Ancient Man*, Henri Frankfurt, H.A. Frankfurt, John Wilson, Thorkild

Teotl presents itself in multiple aspects, preeminent among which is duality. This duality takes the form of the cyclical alternation, non-Zoroastrian dialectical tug-of-war, and mutual interaction of contrary yet mutually interdependent, mutually arising and mutually complementary paired opposites or polarities. These dualities include being and not-being, order and disorder, life and death, and light and darkness. Life and death, for example, are mutually arising, interdependent and complementary aspects of one and the same process. The ceaseless, cyclical alternation and dominance of these dualities produces the diversity and momentary arrangement of the cosmos. Finally, although each moment in a cycle consists of the dominance of one or other paired opposite, in the long run a cycle manifests an overarching, diachronic and dynamic balance. Short-term imbalances are woven together to form long-term balance. I refer to this view as dialectical complementary dualism.[10]

Teotl's ceaseless process of generating-and-regenerating the cosmos is one of ceaseless self-transformation-and-retransformation. The cosmos is thus *teotl's* self-transmutation – not its creation *ex nihilo*. Aztec *tlamatinime* conceived this process in two closely interrelated ways. First,

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Jacobsen, and William A. Irwin, eds. (Chicago: University of Chicago Press, 1946), [hereafter Frankfurt and Frankfurt, 'Myth and Reality'], pp. 3-30.

10 For discussion of dualism in Aztec thought, see Burkhart, *The Slippery Earth*; Nigel Davies, 'Dualism as a Universal Concept: Its Relevance to Mesoamerica,' in *Mesoamerican Dualism/Dualismo Mesoamericano*, R. van Zantwijk, R de Ridder, and E. Braahuis (eds.) (Utrecht: RUU-ISOR, 1990) pp. 8-14; Alfredo López Austin, *The Human Body and Ideology: Concepts of the Ancient Nahuas*, Vols. I and II, Bernard and Thelma Ortiz de Montellano, trans. (Salt Lake City: University of Utah Press, 1988), [hereafter López Austin, *The Human Body*]; López Austin, *The Rabbit on the Face of the Moon: Mythology in the Mesoamerican Tradition,* Bernard and Thelma Ortiz de Montellano, trans. (Salt Lake City: University of Utah Press, 1996), [hereafter López Austin, *The Rabbit on the Face of the Moon*]; López Austin, *Tamoanchan, Tlalocan: Places of Mist,* Bernard and Thelma Ortiz de Montellano, trans. (Niwot: University Press of Colorado, 1997), [hereafter López Austin, *Tamoanchan, Tlalocan*]; John D. Monaghan, 'The Person, Destiny, and the Construction of Difference in Mesoamerica', *RES,* Spring 1998, Vol. 33, [hereafter Monaghan, 'The Person, Destiny'], pp. 137-146; and Barbara Tedlock, *Time and the Highland Maya*, revised ed. (Albuquerque: University of New Mexico Press, 1992), [hereafter Tedlock, *Time and the Highland Maya*].

they saw *teotl* as an artistic force that eternally fashions and refashions itself into and as the cosmos. The cosmos is *teotl's in xochitl, in cuicatl* ('flower and song'). The Aztecs use the expression *in xochitl, in cuicatl* to refer specifically to the composing and performing of song-poems and generally to artistic, creative and symbolic activity, such as singing poetry and painting-writing. A contemporary Nahua song-poem from the state of Veracruz reads:

> I sing to life, to man
> and to nature, the mother earth;
> because life is flower and it is song,
> it is in the end: flower and song[11]

As *teotl's* 'flower and song', the cosmos is *teotl's* grand, artistic-symbolic self-presentation; its ongoing work of performance art. Secondly, they conceived *teotl* as a shamanic force that eternally transforms itself. The cosmos is *teotl's* self-transforming *nahual* ('disguise' or 'mask').[12] Aztec *tlamatinime* thus commonly characterised earthly existence as consisting of pictures painted-written by *teotl* upon its sacred *amoxtli* (or 'canvas'). Aquiauhtzin, for example, characterises the earth as 'the house of paintings'.[13] Xayacamach writes, 'your home is here, in the midst of the paintings',[14] while Nezahualcoyotl writes, 'We live only in Your painting

11 Quoted in and translated by Sandstrom, *Corn Is Our Blood*, p. 229.

12 See Peter T. Furst, 'Shamanistic Survivals in Mesoamerican Religion', *Actas del XLI Congreso Internacional de Americanistas*, Vol. III (Mexico: Instituto Nacional de Anthropologia e Historia, 1976), pp. 149-157; Willard Gingerich, '*Chipahuacanemiliztli*, 'The Purified Life', in the Discourses of Book VI, Florentine Codex', in *Smoke and Mist: Mesoamerican Studies in Memory of Thelma D. Sullivan*, Part II, J. Kathryn Josserand and Karen Dakin, eds. (Oxford: British Archaeological Reports, 1988), [hereafter Gingerich, *Chipahuacanemiliztli*], pp. 517-44; and Bernard Ortiz de Montellano, *Aztec Medicine, Health and Nutrition* (New Brunswick: Rutgers University Press, 1990), [hereafter Ortiz de Montellano, *Aztec Medicine*].

13 *Cantares mexicanos,* fol. 10r., in Miguel León-Portilla, trans. *Fifteen Poets of the Aztec World* (Norman: University of Oklahoma Press,1992), [hereafter León-Portilla, trans., *Fifteen Poets*], p. 282.

14 *Cantares mexicanos,* fol. 11v., in León-Portilla, trans., *Fifteen Poets*, p. 228.

here, on the earth ... we live only in Your book of paintings, here on the earth'.[15]

III. The defining problematic of Aztec thought

The Aztecs regarded human life on earth as one filled with pain, sorrow and suffering. The earth's surface was an inescapably treacherous place. Its name, *tlalticpac*, means literally 'on the point or summit of the earth', suggesting a narrow, jagged, point-like place surrounded by constant dangers.[16] The Nahuatl proverb, *Tlaalahui, tlapetzcahui in tlalticpac*, 'It is slippery, it is slick on the earth', was said of a person who had lived a morally upright life but then lost her balance and fell into moral wrongdoing, as if slipping in slick mud.[17] Humans lose their balance easily while walking upon the earth and as a consequence suffer pain, hunger, thirst, torment, disease and madness. Aztec *tlamatinime* conceived the *raison d'être* of philosophy as providing practical answers to what they saw as the central question of human existence: How can humans walk in balance and so flourish upon the earth? This existential situation-*cum*-question defines the *problematic* framing not only Aztec philosophical inquiry generally but also Aztec time-place reckoning specifically.

In order to attain some measure of well-being, humans must maintain their balance. Maintaining balance involved humans accommodating themselves to the cosmos. However, the Aztecs conceived accommodation actively, not passively. Humans accommodate themselves to the cosmos not by quietistically acquiescing to the cosmos, but by causally contributing to and co-participating with the cosmos in its future unfolding. Human balance and cosmic balance are interdependent, and humans must contribute to the latter on pain of slipping into ill-being. The Aztecs thus saw their universe as a 'participatory universe' and their relationship with it as one of 'compelling mutuality'.[18]

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15 *Romances de los senores de Nueva Espana*, fol. 35r., in León-Portilla, trans., *Fifteen Poets*, p. 83.

16 Translation by Michael Launey, quoted in Burkhart, *The Slippery Earth*, p. 8.

17 For further discussion, see Burkhart, *The Slippery Earth*, and Gingerich, *Chipahuacanemiliztli*.

Finally, since humankind was 'merited' or 'deserved' into existence through sacred sacrifice, humans are born indebted to the sacred and bear the moral-cum-religious obligation to participate in the continuation and renewal of the cosmos. Humans repay this debt through ritual activities such as 'flower and song' (i.e., artistry, song-poems), autosacrifice, and the sacrifice of plants, animals, and humans. Humans were created for the purpose of maintaining the vitality of the universe through these activities. They were bound by an ethics of reciprocity.[19]

IV. Aztec time-place reckoning

The Aztecs pursued empirically accurate, predictively successful, and mathematically precise time-place reckoning because they believed doing

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18 I borrow these phrases from Johannes Wilbert, 'Eschatology in a Participatory Universe: Destines of the Soul among the Warao Indians of Venezuela', in *Death and the Afterlife in Pre-Columbian America*, Elizabeth Benson, ed. (Washington DC: Dumbarton Oaks, 1975), pp. 163-189. The idea of participation is defended in Arnold, *Eating Landscape:* León-Portilla, *Aztec Thought and Culture*; León-Portilla, 'A Reflection on the Ancient Mesoamerican Ethos', in *World Archaeoastronomy*, Anthony F. Aveni, ed., (Cambridge: Cambridge University Press, 1989), [hereafter León-Portilla, 'A Reflection'], pp. 219-226; León-Portilla, 'Those Made Worthy by Sacrifice', in *Symbol and Meaning Beyond the Closed Community: Essays in Mesoamerican Ideas*, Gary H. Gossen, ed. (Albany: Institute for Mesoamerica Studies, 1993), [hereafter León-Portilla, 'Those Made Worthy'], pp. 41-64; Read, *Time and Sacrifice*; and Richard F. Townsend, *State and Cosmos in the Art of Tenochtitlan*. Studies in Pre-Columbian Art and Architecture, no. 20 (Washington DC: Dumbarton Oaks, 1979).

19 See Johanna Broda, 'Astronomy, *Cosmovisión* and Ideology in Pre-Hispanic Mesoamerica', in *Ethnoastronomy and Archaeoastronomy in the American Tropics*, Anthony F. Aveni and Gary Urton, eds. (New York: The New York Academy of the Sciences, 1982), [hereafter Broda, 'Astronomy, *Cosmovisión* and Ideology']. pp. 81-110. See also: Burkhart *The Slippery Earth*; Davíd Carrasco, 'The King, the Capital, and the Stars: The Symbolism of Authority in Aztec Religion', in *World Archaeoastronomy*, Anthony F. Aveni, ed. (Cambridge: Cambridge University Press, 1989), pp. 45-54; Carrasco and Sessions, *Daily Life*; León-Portilla, *Aztec Thought and Culture*; León-Portilla, 'A Reflection'; León-Portilla, 'Those Made Worthy'; Read, *Time and Sacrifice;* and Bernardino de Sahagún, *Florentine Codex: General History of the Things of New Spain*, 12 vol., Arthur J. O. Anderson and Charles Dibble, trans. (Santa Fe: School of American Research and University of Utah, 1953-82) [hereafter Sahagún, *Florentine Codex*].

so yielded vital information concerning the ritual-ceremonial calendar and landscape. In order to participate successfully in the renewal of the cosmos, humans needed to know the precise time-place to perform such activities. The Aztecs thus conceived the *raison d'être* of time-place reckoning in terms of the foregoing human existential problematic. Time-place reckoning was no idyll, theoretical pastime, for upon its accuracy and precision depended the future well-being of humankind and cosmos. As Miguel León-Portilla writes, 'to exist for the Mesoamericans one had to observe the sky'.[20]

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20 León-Portilla, 'A Reflection', p. 225. See also Arnold, *Eating Landscape*: Anthony F. Aveni, 'The Role of Astronomical Observation in the Delineation of World View: A Center and Periphery Model', in *The Imagination of Matter: Religion and Ecology in Mesoamerican Traditions*, Davíd Carrasco, ed. (Oxford: BAR International Series 515, 1989), [hereafter Aveni, 'The Role of Astronomical Observation'], pp. 85-102; Aveni, 'Mapping the Ritual Landscape: Debt Payment to Tlaloc during the Month of Atlcahualo', in *To Change Place: Aztec Ceremonial Landscapes*, Davíd Carrasco, ed. (Niwot, Colorado: University Press of Colorado, 1991), [hereafter Aveni, 'Mapping the Ritual Landscape'], pp. 58-74; Aveni, *Conversing with the Planets: How Science and Myth Invented the Cosmos*. New York: Times Books, 1992), [hereafter Aveni, *Conversing with the Planets*]; Aveni, 'Moctezuma's Sky: Aztec Astronomy and Ritual', in *Moctezuma's Mexico: Visions of the Aztec World*, Davíd Carrasco and Eduardo Matos Moctezuma, eds. (Niwot, Colorado: University Press of Colorado, 1992), [hereafter Aveni, 'Moctezuma's Sky:'], pp. 149-158; Broda, 'Astronomy, *Cosmovisión* and Ideology'; Broda, 'Templo Mayor as Ritual Space', in *The Great Temple of Tenochtitlan: Center and Periphery in the Aztec World*, Johanna Broda, Davíd Carrasco, and Eduardo Matos Moctezuma, eds. (Berkeley: University of California Press, 1987), [hereafter Broda, 'Templo Mayor'], pp. 61-123; Broda, 'Geography, Climate and the Observation of Nature in Pre-Hispanic Mesoamerica', in *The Imagination of Matter: Religion and Ecology in Mesoamerican Traditions*, Davíd Carrasco, ed. (Oxford: BAR International Series 515, 1989), [Broda, 'Geography, Climate and the Observation of Nature'], pp. 139-149; Broda, 'The Sacred Landscape of Aztec Calendar Festivals: Myth, Nature and Society', in *To Change Place: Aztec Ceremonial Landscapes*, Davíd Carrasco (ed). Niwot: University Press of Colorado, 1991), [hereafter Broda, 'The Sacred Landscape'], pp. 74-120; Broda, 'Astronomical Knowledge, Calendrics, and Sacred Geography', in *Astronomies and Cultures*, Clive N. Ruggles and Nicholas J. Saunders, eds. (Niwot: University Press of Colorado, 1993), [hereafter Broda, 'Astronomical Knowledge'], pp. 253-295; Burkhart, *The Slippery Earth*, Carrasco and Sessions, *Daily Life*; Read, *Time and* Sacrifice; and Sahagún, *Florentine Codex*.

V. The nature of time-place

Aztec metaphysics conceives time-place along with its various rhythms as the self-presenting and unfolding of *teotl*. Time and place form a single dimension – what I call 'time-place'.[21] The four cardinal directions were simultaneously directions of time and place. Spring equated with east, summer with south, etc. East and west were also defined in terms of the sun's cyclical rising and setting: east as *tonalquizayampa* ('the place from which the sun habitually emerges'); west as *tonalpolihuiyampa* ('the place where, or towards which, the sun habitually perishes'). Weeks, months, years and year-clusters all had spatial directions. Time-place did not consist of a uniform succession of qualitatively identical moments; nor was it a neutral frame of reference abstracted from terrestrial and celestial processes. Time-place was concrete, quantitative and qualitative. It was 'incarnate'[22] in the rhythms and cycles of the cosmos; embodied in the constant changes taking place in people and things. Different time-places bore different forces, colours, meanings, personalities and qualities. The Aztecs, like the Classical Maya and contemporary Quiche' Maya, 'were interested not only in the quantities of time but also in its qualities, especially its meaning for human affairs'.[23] The quantitative dimensions of time-place were inseparable from its qualitative and

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21 I call this 'time-place' rather than the more familiar 'spacetime' in order to further distance the Aztec notion from the contemporary cMd scientific notion. Gordon Brotherston and Dawn Ades characterize time and space as a single 'space-time dimension' (quoted in Franz Tichy, 'Order and Relationship of Space and Time in Mesoamerica: Myth or Reality?' in *Mesoamerican Sites and World-Views*, 1981, [hereafter Tichy, 'Order and Relationship'], p. 217; Mercedes de la Garza writes, 'time was the dynamic force of space', in her chapter 'Time and World in Maya and Nahuatl Thought,' in Marcelo Dascal (ed.), *Cultural Relativism and Philosophy North and Latin American Perspectives* (Leiden: E.J. Brill, 1991), [hereafter Garza, *Cultural Relativism*], pp. 105-127. See also Read, *Time and Sacrifice*. The similarity between the Aztec metaphysics and conception of time-place, on the one hand, and that of Spinoza, on the other, merits further exploring but exceeds the scope of this essay.

22 I borrow this from Lawrence Sullivan's characterization of Inca calendrics (in Sullivan, 'Astral Myths Rise Again: Interpreting Religious Astronomy', *Criterion*, 1985, Vol. 22, p. 110). See also Read, *Time and Sacrifice*.

23 Tedlock, *Time and the Highland Maya,* p. 1.

semiotic dimensions. Consequently, questions of time-place 'quickly exceed[ed] the limits of mathematically describable time and involve[d] questions of timelessness, destiny, divination, religious ritual, and cosmology, all of which [had] qualitative or symbolic dimensions'.[24]

Aztec time-place numbers possess quantitative, qualitative and semiotic properties. As Aldana puts it in his study of Classic Maya astronomy, time-place numbers 'have personality along with computational functionality'.[25] Numbers are not, *contra* Platonism, abstract entities existing outside of space and time. The numbers three, seven, and ten to thirteen, for example, were judged propitious; the numbers six, eight, and nine, unpropitious. Days were assigned numbers and thus possessed personalities and qualitative properties. Days bearing the number thirteen, for example, were auspicious since they embody order; days bearing the number nine were inauspicious since they embody disorder. Numbers, their manifold properties and their manifold inter-relationships (including qualitative and semiotic inter-relationships) define and help explain the rhythms and cycles of the cosmos.[26] Reckoning the significance of time-place obviously requires an intimate understanding of these various attributes. Numerology, i.e., deciphering the qualitative and semiotic properties of time-place numbers, periods and cycles, played an essential role in Aztec time-place reckoning. Thus, as Michael Coe notes, 'Numerology ruled supreme in Mesoamerica, allying their astronomy much more closely with that of Mesopotamia than with the Greeks, whose obsession was geometry'.[27]

One of the most striking time-place self-presentations of the sacred is the cyclical movement of the sun. Its daily rising and setting along with the regular alternation between day and night, and light and dark, are obvious signs of the processivism and dialectical complementary dualism

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24 Tedlock, *Time and the Highland Maya*, p. 3.

25 Aldana, *Apotheosis of Janaab' Pakal*, p. 196; see also p. 197.

26 Of Classic Maya astronomy, Aldana writes, the personalities of numbers rather than their purely quantitative properties 'determined the working of the cosmos'. (in *Apotheosis of Janaab' Pakal*, p. 197).

27 Michael Coe, 'Native Astronomy in Mesomerica', in *Archaeoastronomy in Pre-Columbian America*, Anthony F. Aveni, ed. (Austin: University of Texas Press, 1975), p. 30.

of nature. Equinoxes and solstices also present these properties. When Aztec *tlamatinime* looked upon the heavens, they saw an overarching cosmic balance revealed in the myriad cycles that meshed with the regular movement of the sun. This balance served as the basis of rituals, the sacred calendar that organised the ritual year and the principle from which was derived the orientation of the great ceremonial spaces in which sacred rituals took place. The eternal, dialectical movement of *teotl* is also observable in the regular and endlessly repeating cycle of generation, death and regeneration of life. This manifests itself as the sun's and moon's cycles of birth, death, and rebirth, the changes in the seasons and, finally, the cycle of birth, death, and rebirth in the life processes plants, animals and humans. Generation, death and regeneration are simply three moments in one and the same process: the ceaseless self-transformation of *teotl*.

Finally, each time-place bears a unique *tonalli* or 'day-time-destiny', i.e., a general cosmic force suffusing the earth's surface and determining a person's set of innate character predispositions. Each carries a unique 'burden' which it conveys to the processes, events, people, and things falling under it. Each day carries its own *tonalli*, and each *tonalli* carries its own causal influence upon the earth. Everything happening on the earth and in humans' lives, from birth to death, is influenced by *tonalli*. Correctly apprehending the specific *tonalli* for any given time-place is consequently essential for humans' successfully balancing upon the earth and participating in the continuing existence of the Age of the Fifth Sun. The causal influence of *tonalli* upon every aspect of human existence, and hence the paramount importance of correctly apprehending the relevant *tonalli* operating at any given time-place juncture, cannot be overemphasised.[28]

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28 For further discussion, see Aveni, *Skywatchers: A revised and updated version of Skywatchers of Ancient Mexico* (Austin: University of Texas Press, 2001), [hereafter Aveni, *Skywatchers*]; Gordon Brotherston, 'Astronomical Norms in Mesoamerican Ritual and Time-Reckoning', in *Archaeoastronomy in the New World*, Anthony F. Aveni, ed. (Cambridge: Cambridge University Press, 1982), pp. 109-142; Brotherston, 'Zodiac Signs, Number Sets, and Astronomical Cycles in Mesoamerica', in *World Archaeoastronomy*, Anthony F. Aveni, ed. (Cambridge: Cambridge University Press, 1989), pp. 276-288; Brotherston, 'Native Numeracy in Native America', *Social Epistemology*, 2001, Vol. 15, pp. 299-318; Garza, *Cultural Relativism*); Hunt, *Transformation of the Hummingbird*; León-Portilla, *Aztec Thought and Culture*, López Austin, López

VI. The two calendars

Aztec time-place reckoners concentrated upon two main calendars, the *tonalpohualli* or 260-day ritual count, and the *xiuhpohualli* or 360+5-day count. The two calendars combined to form the 52-year calendar round.[29] The *tonalpohualli* consisted of twenty groups of numbered and named days. Each group had its own symbolic significance and personality. It is widely believed by scholars that the *tonalpohualli* had no astronomical correlation. The Aztecs used the *tonalpohualli* for purposes of divination, prophecy, astrology, religious recordkeeping and to ascertain the specific *tonalli* reigning at any given time-place. The *tonalpohualli* count served as the foundation for a complex series of ritual associations. Individual days were considered auspicious, inauspicious or neutral. A special group of *tlamatinime,* called *tonalpouhqui*, were skilled in divining the significance of the *tonalpohualli* and used it to prognosticate the most auspicious times for important ritual and practical ceremonies and events, including baptisms, initiating war and celebrating weddings. They also used the calendar for prognosticating the *tonalli* or 'destiny' of individuals based upon their ritually assigned birthdays.

The *xiuhpohualli* or 360+5-day annual solar calendar cycle consisted of 360 days arranged in eighteen sections or 'months' of twenty days

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Austin, *The Human Body*; López Austin, *Tamoanchan, Tlalocan*; Monaghan, 'The Person, Destiny'; and Read, *Time and Sacrifice*.

29 The following discussion is indebted to Aveni 'Mapping the Ritual Landscape'; Aveni, *Conversing with the Planets*: Aveni, *Skywatchers*; Broda, 'Astronomy, *Cosmovisión* and Ideology'; Broda, 'The Sacred Landscape'; Broda, 'Astronomical Knowledge'; Brotherston, *A Key to the Mesoamerican Reckoning of Time: The Chronology Recorded in Native Texts*, *British Museum Occasional Paper No. 38* (London: British Museum, 1982); Gordon Brotherston and Dawn Ades, 'Mesoamerican Description of Space I: Myths, Stars and Maps, and Architecture', *Ibero-Amerikanisches Archiv* 1975, Vol 1 No 4, pp. 279-305; Durán, *The Book of the Gods*; Eloise Quiñones Keber, *Codex Telleriano-Remensis: Ritual, Divination and History in a Pictorial Aztec Manuscript* (Austin: University of Texas Press, 1995), [hereafter Quiñones Keber, *Codex Telleriano-Remensis*]; Susan Milbrath, 'A Seasonal Calendar with Venus Periods in the Codex Borgia 29-46', in *The Imagination of Matter: Religion and Ecology in Mesoamerican Traditions*, Davíd Carrasco, ed. (Oxford: BAR International Series 515, 1989), pp. 103-121; López Austin, *The Human Body*; López Austin, *The Rabbit on the Face of the Moon*; López Austin, *Tamoanchan, Tlalocan*; and Tichy, 'Order and Relationship'.

(each divided into five-day weeks) plus five dangerous 'empty' days (*nemontemi*) between the old and new years. Each month enjoyed its own special public ceremony associated with the agricultural cycle and devoted to such things as rain and fertility. The Aztecs employed the *xiuhpohualli* for practical and religious purposes.

The 260-day calendar combined with the 365-day calendar to form a major cycle of 18,980 days or 52 years, called the *xiuhmolpilli* ('the binding of the years') or 'calendar round'. Every two of these cycles, or 104 years, overlapped with the 65 'years' of the cycle of Quetzalcoatl or Venusian cycle. Each day of the 52-year calendar round possessed a unique combination of characteristics that derived from the two preceding calendars. This unique combination repeated itself every 52 years. The ending and beginning of this 52-year cycle was considered a vital moment in the renewal of the universe. The Aztecs marked the occasion with the New Fire Ceremony (performed precisely when the Pleiades reached zenith at midnight) which was designed to assist in the beginning of the new 52-year cycle and thus in the renewal of the cosmos for another 52 years.

VII. Aztec epistemology

Aztec epistemology maintained that humans become knowledgeable of reality by becoming rooted (*neltiliztli*), i.e., by rooting their intellectual, emotional, imaginative and physical dispositions deeply and firmly in the sacred, *teotl*.[30] Knowing consists of cognising that is well-rooted in *teotl*. Humans acquire knowledge of *teotl a priori* by means of a *yolteotl* or '*teotlised* heart', i.e., a heart charged with *teotl's* sacred force.[31] They do

30 I defend this interpretation of Aztec epistemology in previous publications (Maffie, 'Why Care about Nezahualcoyotl?'; 'To Walk in Balance'; 'Flourishing on Earth'; 'Aztec Philosophy'; and 'The Centrality of Nepantla'). The success of the present argument concerning Aztec time-keeping does not rest upon accepting my interpretation of Aztec epistemology. León-Portilla (in *Aztec Thought and Culture*) and Gingerich argue that knowledge is a consequence of artistically mediated, apriori acquaintance with the sacred (see 'Heidegger and the Aztecs: The Poetics of Knowing in Pre-Hispanic Nahuatl Poetry', in *Recovering the Word: Essays on Native American Literature*, B. Swann and A. Krupat, eds. (Berkeley: University of California Press, 1987), [hereafter Gingerich, 'Heidegger and the Aztecs'], pp. 85-112. On either interpretation, knowledge of the sacred is apriori.

not do so empirically by means of the five senses. The heart's understanding of *teotl* is the fruit of 'flower and song', i.e., artistically and ritually induced mystical, sacred presence. Human knowing is the flower of an organic-like process consisting of *teotl's* sap-like burgeoning, unfolding and blossoming within a person's heart. In this manner, *teotl* directly discloses and unconceals itself.

The non-empirical knowability of *teotl* is further supported in two ways. First, the Aztecs distinguished sensible from insensible aspects of reality. The distinction is epistemological, not metaphysical. The insensible transcends the five senses and so cannot be accessed empirically. It can only be known via mystical awareness. Second, the empirical unknowability of the sacred is suggested by one of the many *difrasismos* or metaphorical couplets assigned to *teotl's* supreme mythological manifestation, *Ometeotl* ('Two-God' or 'Lord of Duality'). *Ometeotl* was commonly called *Yohualli-ehecatl* ('night and wind'), meaning 'invisible (like the night) and intangible (like the wind)'.[32]

VIII. What is the epistemological status of observation in Aztec time-place reckoning?

Since Galileo, cMd historians and philosophers of science have commonly portrayed empirical science on the one hand, and mysticism (and religion generally) on the other, as epistemologically incompatible.[33] Aztec *tlamatinime*, by contrast, saw no incompatibility between mystical knowledge of reality and empirically informed time-place reckoning. Their reasons were twofold.

First, observational time-place reckoning served as a *propaedeutic* for mystical understanding. Careful observation and tracking of the rhythms of time-place suggested the nature of *teotl*, and in so doing helped prepare

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31 López Austin, *The Human Body*; See also Gingerich, 'Heidegger and the Aztecs', and León-Portilla, *Aztec Thought and Culture*.

32 León-Portilla, *Aztec Thought and Culture*, pp. 91-93.

33 For discussion, see Peter Godfrey-Smith, *Theory and Reality: An Introduction to the Philosophy of Science* (Chicago: University Press of Chicago, 2003), [hereafter Godfrey-Smith, *Theory and Reality*]; Klee, *Introduction to the Philosophy of Science: Cutting Nature at its Seams* (Oxford: Oxford University Press, 1997), [hereafter Klee, *Introduction*]; and John Losee, *Philosophy of Science: A Historical Introduction*, 3rd ed. (Oxford: Oxford University Press, 1993), [hereafter Losee, *Philosophy of Science*].

and eventually 'root' one's heart for sacred understanding. However such observations were *not* by themselves capable of 'rooting' one's heart and hence *not* capable of yielding sacred knowledge. In short, Aztec epistemology assigned a foundational epistemological role to mystical knowing and an ancillary role to observational time-place reckoning.[34] The processivism, self-transformation, overarching balance, and dialectical complementary dualism of *teotl* were *suggested* by a variety of natural phenomena but nowhere more vividly than in the rhythms of time-place. As *teotl's* self-presentations, they served as signs of *teotl's* sacred 'eurhythmy', as Eloise Quiñones Keber puts it.[35] Their propaedeutical value notwithstanding, such empirical signs and wonders were not epistemologically qualified either to underwrite or to gainsay the claims of mystical knowledge.

Second, observational time-place reckoning yielded vitally important, practical information concerning the 'when' and 'where' (or 'when-where') for performing ritual activities such as the New Fire Ceremony. While such information and activities helped sustain and renew the cosmos as well as 'root' one's heart in *teotl*, they were not epistemologically qualified to yield or gainsay mystical knowledge. Sensory observation was not sufficient for sacred knowledge. In sum, Aztec *tlamatinime* resolved the apparent incompatibility between the mystical and the empirical by assigning a privileged, foundational role to mystical knowing and a supportive, ancillary role to empirical observation.

IX. What role did metaphysics, religion, numerology, and astrology play in the epistemology of Aztec time-place reckoning?

Traditionally, cMd ethnoastronomers and archaeoastronomers have approach the astronomies of other cultures and times by distinguishing

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34 For a similar view among nineteenth-century Hopi, see Stephen McCluskey, 'Transformations of the Hopi Calendar', in Ray A. Williamson, ed., *Archaeoastronomy in the Americas* (Los Altos: Ballena Press, 1981), pp. 173-191. A structurally similar solution to this puzzle in cMd philosophy of science was proposed by Plato and Aristotle. It holds that observational astronomy and empirical science generally serve as a propaedeutic – but not a substitute – for *a priori* rational insight into the nature of reality. For discussion, see Losee, *Philosophy of Science*.

35 Quiñones Keber, *Codex Telleriano-Remensis*, p. 242.

their culturally universal, 'observational' and genuinely 'scientific' foundation from their culturally variable, 'astrological', 'mythological' and 'religious' motivations, interpretations, explanations and uses.[36] Clive Ruggles and Nicholas Saunders, for example, analyse ethnoastronomies into three 'essentially' distinct 'stages': 'observation', 'perception' and 'use'.[37] 'Observation' is 'universal' and hence not 'culture-specific'. Perception is the 'process ... of making sense of and attaching meaning [or 'significance'] to particular observations'.[38] It is 'culture-specific' because 'guided' and 'channeled' by variable cultural, political and economic factors.[39] Finally, the political and ideological 'use' of

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36 For example, see Clive Ruggles and Nicholas Saunders, 'The Study of Cultural Astronomy', in *Astronomies and Cultures* (Niwot: University Press of Colorado, 1993), [hereafter Ruggles and Saunders, 'The Study of Cultural Astronomy'], pp. 1-30; Jonathan Reyman, 'The Nature and Nurture of Archaeoastronomical Studies', in *Archaeoastronomy in Pre-Columbian America*, Anthony F. Aveni, ed. (Austin: University of Texas Press, 1975), pp. 205-215; Stanislaw Iwaniszewski, 'Exploring Some Anthropological Theoretical Foundations for Archaeoastronomy', in *World Archaeoastronomy*, Anthony F. Aveni, ed. (Cambridge: Cambridge University Press, 1989), [hereafter Iwaniszewski, 'Anthropological Theoretical Foundations'], pp. 27-37. and Ray A. Williamson, 'North America: A Multiplicity of Astronomies'. In *Archaeoastronomy in the Americas* (Los Altos: Ballena Press, 1981), [hereafter Williamson, 'North America'], pp. 61-80. Notable exceptions to this approach include Aldana, *Apotheosis of Janaab' Pakal*; Aveni, *Empires of Time* (New York: Basic Books, 1989), [hereafter Aveni, *Empires of Time*]; Aveni, 'The Role of Astronomical Observation'; Aveni, 'Mapping the Ritual Landscape'; Aveni, *Conversing with the Planets*; Aveni, 'Moctezuma's Sky'; Aveni, *Skywatchers*; Billie Jean Isbell, 'Culture Confronts Nature in the Dialectical World of the Tropics', in *Ethnoastronomy and Archaeoastronomy in the American Tropics*, *Annals of the New York Academy of Sciences*, vol. 385, Anthony F. Aveni and Gary Urton, eds. (New York: The New York Academy of the Sciences, 1982), [hereafter Isbell, 'Culture Confronts Nature'], pp. 353-363; León-Portilla, *Time and Reality in the Thought of the Maya*, in Charles L. Boiles, Fernando Horcasitas, and Miguel León-Portilla, trans. (Norman: University of Oklahoma Press, 1988), [hereafter León-Portilla, *Time and Reality*]; and Tedlock, *Time and the Highland Maya*.

37 Ruggles and Saunders, 'The Study of Cultural Astronomy', p. 4.

38 Ruggles and Saunders, 'The Study of Cultural Astronomy', p. 2.

observations and perceptions is 'culture-specific'.[40] In his study of indigenous North American ethnoastronomies, Ray Williamson writes:

> What is surely clear is that in spite of the identical nature of astronomical appearances, individual tribes responded to them rather differently. Hence they developed a multiplicity of astronomies, each emphasizing observations which best fit particular circumstances.[41]

Stanislaw Iwaniszewski likewise distinguishes observable astronomical phenomena' from their cultural selection and transmission.[42]

Johanna Broda, one of the foremost expositors of Aztec astronomy, appears to share this approach.[43] Broda advocates studying Aztec astronomy using 'a broad historical approach that analyzes science as a body of exact knowledge embedded in a social context subject to change'.[44] She distinguishes the empirical 'observation of nature'[45] and 'observational content'[46]of celestial phenomena from their cosmological, social, religious and ideological 'transformation' and 'explanation'.[47] 'Astronomical observations' became 'immersed in myth and ritual' through a variety of 'mental and social processes' and in so doing 'leav[e] behind the terrain of "objective" scientific knowledge'.[48]

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39 Ruggles and Saunders, 'The Study of Cultural Astronomy', p. 4.

40 Ruggles and Saunders, 'The Study of Cultural Astronomy', p. 4.

41 Williamson, 'North America', p. 79f.

42 Iwaniszewski, 'Anthropological Theoretical Foundations', p. 29.

43 See Broda, 'Astronomy, *Cosmovisión* and Ideology'; Broda, 'Templo Mayor'; Broda, 'Geography, Climate and the Observation of Nature'; Broda, 'Astronomical Knowledge'.

44 Broda, 'Astronomical Knowledge', p. 254.

45 Broda, 'Astronomical Knowledge', p. 254.

46 Broda, 'Geography, Climate and the Observation of Nature', p. 139.

47 Broda, 'Astronomy, *Cosmovisión* and Ideology', pp. 100-101.

'Calendrics and astronomy *are* [consequently] *not* identical, since the calendar, as a human creation, constitutes as much a scientific achievement a social system' (Broda's emphases).[49] Broda likewise distinguishes 'the observation of nature' from 'cosmovision'. She defines the former as 'the systematic and repetitive observation of the phenomena of the natural environment that permits us to make predictions'[50], the latter, as 'the structured view in which ancient Mesoamericans combined their notions of cosmology into a systematic whole'.[51]

Broda analyses Aztec time-place reckoning into five, epistemologically distinct 'dimensions':

(1) The astronomical 'dimension' consisting of 'objective' scientific knowledge: the pursuit of an empirically accurate and predictively successful record of the regularities of celestial phenomena. This is exclusively empirical.
(2) The mathematical 'dimension' consisting of the pursuit of a mathematically precise record of the regularities of celestial phenomena.
(3) The astrological 'dimension' consisting of the reading, divining or interpreting of the meaning of celestial phenomena and cycles, and subsequent dispensing of practical advice based thereupon.
(4) The religious, theological and mythological 'dimension': the ultimate end of Aztec time-place reckoning was understanding sacred reality as well as participating with the cosmos through ritual.
(5) The social, political or ideological 'dimension': the use of time-keeping in the service of social, political and ideological ends such as underwriting the social-political hierarchy and militarism of Mexico-Tenochtitlan.[52]

As Broda interprets Aztec time-place reckoning, the 'objective', 'astronomical' and 'scientific' dimension (dimension [1] above) is *epistemologically prior to* and *independent of* the 'calendrical' dimension

48 Broda, 'Astronomy, *Cosmovisión* and Ideology', p. 100.

49 Broda, 'Astronomical Knowledge', p. 257,

50 Broda, 'Astronomical Knowledge', p. 254.

51 Broda, 'Astronomy, *Cosmovisión* and Ideology', p. 81.

52 Broda, 'Astronomy, *Cosmovisión* and Ideology'; Broda, 'Astronomical Knowledge'.

(dimensions [3] through [5]), i.e., the religious, astrological, metaphysical and ideological motivations, explanations, interpretations and uses of priests, diviners and state ideologues. 'Objective' scientific observations were 'transformed' by state ideologues and priests into an empirically and hence scientifically ungrounded *cosmovisión*. Although Broda agrees that Aztec time-place reckoning was 'intimately'[53] 'embedded'[54] in dimensions (3) to (5), she conceives the latter dimensions as *epistemologically extraneous accretions*. They played *no* epistemological role in the 'objectively observational', 'genuinely scientific', 'astronomical' foundation of Aztec time-place reckoning. Consequently, they need play no role in our scholarly understanding of the *epistemology* of Aztec time-place reckoning conceived as genuinely scientific, astronomical activity. Rather, to the degree Aztec time-place reckoners did *good* science – and this they clearly did by Broda's lights – they did not permit metaphysical, religious, etc., factors to influence their observations. Metaphysical, religious, etc., factors were epistemologically *post facto*, extraneous add-ons, invented by well-intentioned yet misguided priests, ill-intentioned state ideologues, deceitful diviners, and charlatans.[55]

I refer to this approach as 'the positivist approach' in light of its many affinities with twentieth-century positivist philosophy and history of science.[56] The methodological approach of Broda – as well as and

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53 Broda, 'Astronomy, *Cosmovisión* and Ideology', p. 100.

54 Broda, 'Astronomical Knowledge', p. 54.

55 See Broda, 'Astronomy, *Cosmovisión* and Ideology'. The attitude that diviners and astrologers were ill-intentioned charlatans is adopted by Durán, The Book of the Gods; Sahagún, *Florentine Codex*, and H. J. Rose, 'Divination (Introductory and Primitive)', in *Encyclopedia of Religion and Ethics*, Vol. I, James Hastings, ed. (New York: Charles Scribner's Sons, 1913-1927), pp. 775-780.

56 For discussion of positivism in the history and philosophy of science, see James R. Brown, ed., *Scientific Rationality: The Sociological Turn* (Dordrecht: Reidel, 1984), A. F. Chalmers, *What Is this Thing Called Science?* 2nd ed. (Indianapolis: Hackett Publishing, 1994), [hereafter Chalmers, *What Is this Thing Called Science?*]; Godfrey-Smith, *Theory and Reality*; Klee, *Introduction*; Losee, *Philosophy of Science*; and Lawrence E. Sullivan, 'Astral Myths Rise Again: Interpreting Religious Astronomy', *Criterion*, 1983, Vol. 22, pp. 12-17.

Ruggles and Saunders – shares in common with twentieth-century positivism a number of key tenets. First, it upholds an empiricist epistemology regarding science which claims that the only evidence in favor of the truth or falsity of factual claims is empirical evidence. Non-empirical factors such explanatory power and simplicity possess at most non-probative, pragmatic value. Second, it claims observation is non-interpretive, non-theoretical, theory-neutral and culturally universal. Third, it embraces a set of interrelated distinctions: 'context of discovery' (the genesis of belief) vs. 'context of justification' (the epistemological validation of belief); 'external' history vs. 'internal' history of science; external factors vs. 'internal' factors in science; and the psychology, sociology, etc., of science vs. the epistemology or 'reconstruction' of science.

Distinguishing science from its cultural context is standard fare for positivist history and philosophy of science. Cultural factors (e.g., religion, economics, politics, etc.) enter undeniably into the choice of having a science, the choice of what problems science tries to solve, the selection of what aspects of nature to observe, and the uses to which scientific results are put. But they do not enter into the *epistemology* of scientific decision-making as such, i.e. the evaluation of observational claims, assessment of evidence, and validation of theory-choice by scientific standards. As 'external' factors, religion, politics, etc., have the potential to guide, underwrite and motivate science; as 'internal' factors, they only obstruct and corrupt science. In short, science and religion (metaphysics, politics, etc.) do not mix *epistemologically speaking*.

I contend, however, that balkanising Aztec time-place reckoning into various 'dimensions' that presuppose philosophical categories propounded by (some) modern cMd epistemologists of science but alien to Aztec epistemology (a) fails to capture the activity of Aztec time-place reckoning, (b) violates the internal coherence of time-place reckoning, and (c) thus prevents us from appreciating the *Aztec's* epistemology of time-place reckoning. Echoing Anthony Aveni's warning, we must not fashion the epistemology of Aztec time-place reckoning after our own (idealised) image of the epistemology of modern cMd astronomy;[57] doing so is anachronistic and ethnocentric.

Broda's work has profoundly advanced our understanding of the relationship between Aztec time-place reckoning and its broader cultural context, and nothing I say here gainsays that achievement. Having said

57 Aveni, *Skywatchers,* p. 4.

that, I submit that Broda's contextualism falls short. Although willing to contextualise time-place reckoning 'externally', she is unwilling to contextualise it 'internally'. She refuses to contextualise dimensions (1) and (2) as well the very *epistemology* of time-place reckoning. In what follows I endeavor to correct this shortfall by extending contextualism into these areas. I argue Broda's positivism blinds her to the *contextualist* nature of the *epistemology* of time-place reckoning and thus causes her to misunderstand the very *heart* of time-place reckoning; the *double entendre* is intentional, seeing as the heart is the organ of knowing according to Aztec epistemology.

According to a contextualist understanding of the epistemology of Aztec time-place reckoning, metaphysics, religion, numerology, etc., are essential not only to understanding how, why and by whom time-keeping was pursued, guided and transformed; they are also essential to understanding how time-place reckoning claims were themselves *epistemologically* evaluated and validated. Aztec time-place reckoning implemented a *contextualist* epistemology rather than a positivist-style, *foundationalist* epistemology as suggested by Broda.[58] For starters, Aztec epistemology assigned a privileged role to mystically derived, metaphysical knowledge and a subordinate role to empirical observation. Time-place reckoners epistemologically evaluated putative observational claims against their background metaphysical knowledge. Observational claims were neither self-evident nor independently justified. Epistemologically acceptable empirical claims about the nature of celestial phenomena had to square with epistemologically prior, mystically based metaphysical theses such as monism and dialectical complementary dualism. While the testimony of the senses might help illustrate and enrich mystical understanding, it could *not* gainsay it. When observational results did not square with background metaphysics, time-place reckoners revised them and continued looking until they found observational results that did square with it. In the language of positivism, metaphysics figured essentially in both the 'external' *and* 'internal' history of time-place reckoning. Aztec time-place reckoning was therefore not built upon a theory-neutral observation base. Metaphysical, religious, astronumerological, etc., claims cut all the way down.

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58 For related discussion, see Klee, *Introduction,* and Godfrey-Smith, *Theory and Reality*.

> Broda's artificial distilling of time-place reckoning into different 'dimensions' consequently blinds us to the epistemological interdependency of these various 'dimensions'. Dimensions (3) and (4), for example, are not only essential to understanding *why* the Aztecs pursued time-place reckoning, *what* problems they believed needed solving, in relation to the sociology, psychology, and political economy of Aztec day-keeping. They are also essential to understanding *how* time-place reckoners went about epistemologically justifying their decisions, claims and beliefs regarding the celestial (dimensions [1] and [2]). Dimensions (3) and (4) are, therefore, not mere *post facto* accretions superimposed upon an epistemologically respectable foundation of 'real astronomy' or 'real science' by charlatans, priests, etc. Rather, as Eva Hunt aptly observes, 'scientific, empirico-mathematical investigations' and 'mythic symbolism' are 'warp and woof of the same ideological fabric';[59] or, borrowing from North American philosopher of science Willard van Orman Quine, they are strands in one and the same 'web of belief'.[60] In short, Broda's 'astronomical dimension' – like Ruggles and Saunders' 'observational stage' – is shot through with epistemologically prior metaphysical and religious background assumptions. Aztec time-place reckoning was, as León-Portilla put it when characterising Classic Maya time-place reckoning, 'a unique form of *mathematicized* religion and mythology' (León-Portilla's emphasis).[61]

Let's examine more closely Broda's 'astronomical dimension'. I contend Aztec metaphysics (e.g., its processivism, animism and dialectical complementary dualism) is present on the ground floor of astronomical observation and that Aztec astronomical observation is therefore ineliminably theory-laden and interpretive. Metaphysics permeates and shapes Aztec celestial observation in a number of ways.

(1) First, because Aztec metaphysics conceives celestial phenomena to be various facets of *teotl's* self-presentation, Aztec time-place reckoners considered themselves to be directly observing the sacred when observing

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59 Hunt, *Transformation of the Hummingbird*, p. 137.

60 Willard Van Orman Quine, *From a Logical Point of View* (New York: Harper & Row, 1953).

61 León-Portilla, *Time and Reality*, p. 99.

the celestial. They took themselves, for example, to be directly observing *Quetzalcoatl*, *Tonatiuh*, etc., i.e., various deified aspects of *teotl*. As Javier Galicia Silva remarks regarding contemporary Nahuas, '*tetzahuitl* (the portentous) is not merely a symbolic expression but a direct experience of that spiritual being from which it flows'.[62] And as León-Portilla remarks regarding Classic Maya time-place reckoning, the interrelationships between various aspects of time were conceived as 'something coming from the divinity and somehow part of its very being'.[63] Indeed, the heavens of the time-place reckoner were one and the same with the heavens of the metaphysician, numerologist, diviner and priest. Observing the heavens was simultaneously a religious-cum-astronomical-cum-astrological activity.

Aztec time-place reckoners did not distill skywatching into theoretically neutral observations and experiential images on the one hand, and religious and metaphysical interpretations on the other. They did not have theoretically neutral observations or sense experiences that they subsequently explained in terms of theoretical metaphysical or religious posits (as positivist-style ethnoastronomy would have us believe). Metaphysical and religious interpretation were not an epistemologically idle afterthought, as if time-place reckoners said to themselves, 'Observe that bright sensory image above. Let's inferentially explain it as a deity whom we will henceforth call *Quetzalcoatl*'. The Aztecs did not first follow the stars, and then only later come to believe in them. Rather, they believed in the stars from the outset. That they did so helps explain why they began observing the stars in the first place. They considered the stars to be meaning-bearing sacred entities or forces *worthy* of observation.

Metaphysical and religious interpretation were not, therefore, epistemologically subsequent, extraneous 'stages' or 'dimensions' superimposed upon scientifically respectable, pure empirical data. Rather, like their commoner contemporaries, Aztec time-place reckoners embraced what we might call 'common sense supernatural realism' regarding the animistic and sacred. When they looked at terrestrial and

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62 Javier Galicia Silva, 'Religion, Ritual, and Agriculture among the Present-day Nahua of Mesoamerica', in *Indigenous Traditions and Ecology: The Interbeing of Cosmology and Community*, John A. Grim, ed. (Cambridge: Harvard University Press, 2001), p. 307.

63 León-Portilla, *Time and Reality*, p. 28.

celestial phenomena, they believed themselves to be looking at animated entities, divinities, the sacred – just as the common sense realism of (most) Westerners has them looking at lifeless meteors, planets and stars. It was a feature of Aztec common sense that the world is animated and sacred.

(2) Celestial observation was also shaped by dialectical complementary dualism. Billie Jean Isbell argues, for example, that the Aztecs conceived the sun (*Tonatiuh*) and Pleiades (*Tianquiztli*) as two dialectically opposed yet mutually interdependent entities or forces. They associated both with opposing yet dialectically interdependent climatological processes. The disappearance of the Pleiades and the shadowless moment of zenith passage of the sun on May 17 announced the rainy season. The appearance of Pleiades at the zenith and the sun at nadir on November 18 announced the dry season. As a consequence of *conceiving* the sun and Pleiades in this manner, time-place reckoners *perceived* the sun and Pleiades in this manner.[64]

The metaphysical belief that various parts of nature undergo a life cycle consisting of dialectically complementary stages also shaped celestial observation. Time-place reckoners conceived and consequently perceived the sun in a variety of ways: during winter solstice, as the 'tired' or 'dying' sun who needed to be ritually cajoled back into movement; during sunset, the 'dying' or 'ripe' sun; and during sunrise, the newly reborn, infant sun. They saw the dialectically interdependent birth, death and rebirth of Quetzalcoatl each time they perceived Venus appearing in the morning sky, disappearing in the western sky, and again reappearing in the morning sky.[65]

(3) Time-place reckoning was by Aztec lights cut from the same epistemological cloth as reading sacred books. Walter Mignolo contends Aztec *tlamatinime* made no epistemological distinction between looking at celestial phenomena and understanding their meaning, on the one hand, and looking at painted-written pictoglyphs and understanding their meaning, on the other. Both activities were interpretively 'thick', semiotic interactions. One 'read' (i.e., interpreted, divined, and

64 Isbell, 'Culture Confronts Nature', p. 354.

65 See Aveni, *Conversing with the Planets*, p. 69; and Hunt, *Transformation of the Hummingbird*, p. 138.

recounted) the meaning of the patterns of the heavens in the same sense as one read the meaning of patterns of painted-written pictoglyphs. Indeed, recall that the Aztecs commonly referred to the heavens as teotl's 'sacred canvas' (*amoxtli*), 'book of paintings' and 'house of paintings'.[66]

Celestial patterns bore meaning and information just as did the pictoglyphs painted-written by Aztec sage-artists in their sacred books. In order to read-interpret-divine the pictoglyphs painted-inscribed by *teotl* upon the sacred pages of the heavens, upon the walls and ceiling of *teotl's* grand, cosmic 'house of paintings', one needed first to learn how to read-count-interpret-reckon (*pohua*) their sacred language. Only the literate, those possessing a mystical understanding of *teotl* yielded by a *teotlised* heart were able to read-count-interpret the sacred painting-writings of the heavens. Aztec time-place reckoning was thus more akin epistemologically speaking to what Western thinkers would consider reading-interpreting a painting, dance performance, poem or operatic performance than to reading a discursive essay in *Science* or the *Journal of Philosophy*. *Teotl's* sacred cosmic text is performed in 'flower and song', i.e., a non-logocentric and non-discursive language consisting of artistic symbols, colors, numbers, and glyphs, not assertive sentences composed of alphabetically transcribed, spoken Nahuatl words.

(4) Aztec philosophy conceived time-place reckoning as a dialogue or conversation with the sacred.[67] As Aveni remarks, 'When a living universe is your home and all parts of your world pulse harmoniously, then you talk to the stars and they talk back to you'.[68] Time-place reckoning involved putting questions to *teotl* and trying to understand *teotl's* responses. If this is so, two things would appear to follow. First, one converses with that which one perceives as a 'thou' rather than an 'it'.[69] Second, conversing with the heavens involves both an empirical

66 Walter D. Mignolo, 'Signs and their Transmission: The Question of the Book in the New World', in *Writing Without Words: Alternative Literacies in Mesoamerica and the Andes*, Elizabeth Hill Boone and Walter D. Mignolo, eds. (Durham: Duke University Press, 1994), pp. 220-270.

67 See Aveni, *Conversing with the Planets*; León-Portilla, *Time and Reality*; and Sandstrom, *Corn Is Our Blood*.

68 Aveni, *Conversing with the Planets*, pp. 131-132.

component (viz. the physical stimulation of one's sensory organs) and non-empirical component (viz. the intellectual deciphering of the stimulation). Celestial patterns are conceived as signs from a living (albeit non-intentional) being. As *teotl's* 'flower and song', they are rich with meaning regarding the nature of *teotl*. As we saw earlier, the Aztecs said of their time-place reckoners, 'They occupy themselves with this, for it is their task, their commission, their duty: the divine word'. In order to understand the 'divine word' written in the movements of time-place, one needed first to know how to read *teotl's* sacred language. And this prior knowledge was non-empirical.

(5) Finally, Aztec time-place reckoners *conceived* the heavens as vivified and animated and, as a consequence, *perceived* the heavens as vivified and animated. I suggest how one perceives that which one believes to be animate differs from how one perceives that which one believes to be inanimate. One perceives the former as a 'thou', the latter as an 'it'.

Let's turn now to Broda's 'astrological dimension'. I suggest time-place reckoning was simultaneously empirical observation, religion, and astrology. It involved not only observing the properties and motions of the sacred but also divining their significance for human behavior. As Aveni points out, 'The common sense of [nonscientific cultures] endorsed the logical attachment between human and celestial affairs – each part of a single, whole, and animate universe'.[70] Indeed, the 'astronomical dimension' was epistemologically interdependent with the 'astrological dimension'. The Aztecs saw celestial and terrestrial realms – including human affairs and human body – as metaphysically continuous and causally interconnected. Tracking the cycles of time-place thus required tracking these cycles in both terrestrial and celestial realms. Time-place reckoners treated celestial claims as having logical consequences for terrestrial claims and regarded the observation of

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69 For supporting argument, see Arnold, *Eating Landscape:*, Aveni, *Conversing with the Planets*; Barbara Deloria, Kristen Foehner, and Sam Scinta, eds., *Spirit and Reason: The Vine Deloria, Jr., Reader* (Golden: Fulcrum, 1999); and Frankfurt and Frankfurt.

70 Aveni, *Conversing with the Planets*, p. 202. See also Arnold, *Eating Landscape:* Durán, *The Book of the Gods*; Tedlock, *Time and the Highland Maya*; León-Portilla, *Time and Reality*; and Ortiz de Montellano, *Aztec Medicine*.

terrestrial phenomena as one way of evaluating celestial claims. Celestial claims had to square with terrestrial events, and conversely. In short, the Aztecs made no epistemological distinction between what we call 'astronomy' and 'astrology'.

CMd ethnoastronomers commonly characterise Aztec astronomy as 'skywatching' and as a 'horizon astronomy'.[71] Although certainly true, these characterisations do not go far enough. Aztec time-place reckoners followed regularities between celestial phenomena and a host of terrestrial phenomena including horizontal location, seasonal cycles, agricultural cycles, life cycles, meteorological phenomena (e.g., winds, rains, drought) and variations in flora and fauna. Conceiving Aztec time-place reckoning narrowly as a 'horizon astronomy' fails to capture all of this. For the Aztecs, astronomy is one aspect of the general observation of unfolding of the sacred taking place all around humans. I thus suggest it is more accurate to characterise Aztec time-place reckoners as 'earth-sky watchers'.

Finally, the positivist approach suggests the 'mathematical dimension' (dimension 2) is epistemologically distinct from metaphysics, religion, etc. This, too, violates the epistemological integrity of Aztec time-place reckoning. As we have seen, time-place is identical with the sacred. The quantitative aspects of time-place are one of the ways the sacred presents itself. To study the mathematical properties of temporal-spatial rhythms is to study the sacred. Mathematics and religion were ultimately one. I thus suggest Aztec time-place reckoners adjusted their mathematical 'counts' until they found cycles and regularities that not only intermeshed with one another but also cohered with the metaphysical, astrological, etc., implications of their reckonings as well as their mystical metaphysical background beliefs about the qualities of numbers and the dynamic harmony of the cosmos. The epistemological assessment of a specific time-place reckoning was theory-dependent, and if it did not square with their metaphysical views, I suggest Aztec time-place reckoners revised or even rejected it. Both quantitative and qualitative properties of numbers were relevant in such matters.

In sum, although assiduously attentive to the testimony of the senses, Aztec time-place reckoning was *epistemologically integrated* within a broader context of epistemologically privileged mystically based, metaphysical, religious, numerological and astrological background

71 See, for example, Aveni, *Skywatchers*.

assumptions. It thus contained both empirical and non-empirical elements. The non-empirical element was *epistemologically* prior to the empirical and consisted of mystical metaphysical conceptualisation and theory. Yet the non-empirical element was nevertheless *temporally* concomitant with the empirical since it helped shape empirical percepts so as to make them an observation *of* something. What the Aztecs saw when looking at the heavens was the joint product of empirical percept and mystical concept. Knowledgeable time-place reckoning was theory-laden and interpretively 'thick' from the 'get go'.

X. Discussion

The thesis that Aztec time-place reckoning was theory-laden is an instance of a more general thesis of contemporary cognitive psychology: how one sees 'x' is shaped by one's beliefs about 'x'. Based upon the findings of the New Look movement in psychology (e.g., by R. L. Gregory and others), historians and philosophers of science such as Paul Feyerabend, R. N. Hanson and Thomas Kuhn argued that what an observer sees (i.e., her visual experience when looking at an object) is not uniquely determined by the image on her retina. What she perceives depends partly upon her past experiences, beliefs, expectations, training and inner physiological state. One and the same retinal image may be thus interpreted in different ways, depending upon the perceiver's background beliefs, training, etc. In short, observation is ineliminably theory-laden.[72] Hanson, for example, argues Tycho Brahe and Johannes Kepler saw two different things when viewing a sunrise, even though they shared congruent (if not identical) retinal images. A geocentricist, Brahe saw a moving sun gradually rising over the horizon of a stationary earth. A heliocentricist, Kepler saw a stationary sun gradually revealed by a rotating earth. Kuhn likened the switch from geocentric to heliocentric observation to the 'Gestalt switch' that occurs when one views ambiguous figures such as the duck/rabbit. [73] In short, seeing (perception

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72 The preceding summary is indebted to Chalmers, *What Is this Thing Called Science?* pp. 25-27.

73 For further discussion, see Chalmers, *What Is this Thing Called Science?*; Godfrey-Smith, *Theory and Reality*; Alvin Goldman, *Epistemology and Cognition* (Cambridge: Harvard University Press, 1986), [hereafter Goldman, *Epistemology and Cognition*]; Alvin Goldman, *Philosophical Applications of*

or observation) is not identical with the physical irradiation of the retina. It is active, interpretive, and intelligent – not passive, theory-neutral, or unthinking. Hanson put the point nicely: 'There's more to seeing than meets the eyeball'.[74] In the case of Aztec seeing, the 'more to seeing than meets the eyeball' was furnished by their mystically based, metaphysical, religious, etc., beliefs.

The question regarding the theory-ladenness of observation has been reformulated in recent debates as follows: are perceptual systems penetrable by cognitive assumptions? Proponents such as Paul Churchland contend perceptual systems are penetrable by both low level background information (e.g., grammatical information in the case of interpreting speech) as well as high level background information (such as scientific and metaphysical theories).[75] Opponents such as Jerry Fodor admit perceptual systems are penetrable by low level background theory. (Hence if Aztec metaphysical beliefs such as dialectical complementary dualism qualify as low level cognitive assumptions, then there seems to be no question about their penetrating Aztec time-place reckoning!) Fodor defends, however, the insularity of perceptual systems from high level background theory, claiming that perceptual systems are modular, i.e., segregated from other parts of the brain (in particular, those containing theoretical information such as scientific theories) by a barrier that blocks out higher level information. Churchland has responded to Fodor by adducing further empirical research showing that theoretical information may in fact penetrate perception as a consequence of lengthy regimens of practice, training and conditioning – indeed, precisely the kind of lifelong regimen time-place reckoners underwent in the *calmecac* (the Aztec school responsible for educating future philosophers, priests, and time-place reckoners). Although not easily or immediately penetrable, perceptual systems appear to be diachronically penetrable by higher cognitive assumptions. Other studies demonstrate the presence of top-down processing in sense perception in which higher-level beliefs,

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Cognitive Science (Boulder: Westview Press, 1993), [hereafter Goldman, *Philosophical Applications*]; and Klee, *Introduction*.

74 Norwood Russell Hanson, *Patterns of Discovery: An Inquiry into the Conceptual Foundations of Science* (Cambridge: Cambridge University Press, 1958), [hereafter Hanson, *Patterns of Discovery*], p. 7.

75 Goldman, *Philosophical Applications*, p. 34; see also pp. 181-188. The following discussion is indebted to Goldman, *Epistemology and Cognition*.

expectations, memories and background information influence how cognisers interpret low-level perceptual units. In a recent survey of the relevant psychological literature, Alvin Goldman concludes:

Cognitive psychologists generally believe that perception uses a mixture of bottom-up and top-down processing. The occurrence of the latter is the basis for the widely made claim that perception is 'intelligent'. All one's knowledge about the world – or a lot of it, at any rate – can aid the construction of a percept.[76] In sum, while recent findings in cognitive psychology do not logically entail the truth of my interpretation of Aztec time-place reckoning, I submit they do favor it.

Finally, if the foregoing argument above is sound, then Aztec time-place reckoners and contemporary cMd astronomers do *not* see (in the epistemological sense of 'see') the same things when looking at the sky. While cMd astronomers see an array of lifeless and meaningless objects when looking at the solar system, Aztec time-place reckoners saw vivified entities, 'flower and song', and the cyclical unfolding of *teotl*. While cMd astronomers see the Sun and Venus, Aztec time-place reckoners saw *Tonatiuh* and *Quetzalcoatl*. This observational relativity obtains even if cMd and Aztec skywatchers share congruent (if not identical) retinal images, share identical visual fields, and make identical sketches of what they see, for as Hansen remarks, 'there is a difference between a physical state and a visual experience'.[77] Epistemological seeing involves more than just being visually stimulated; it involves the *way* in which one sees. And the way in which one sees depends upon one's background beliefs. Analogously, literate and illiterate do not see (in the epistemological sense) the same thing when looking upon one and the same written text. The illiterate sees meaningless shapes and marks, the literate, meaning bearing symbols and signs (i.e., language). In sum, epistemological seeing is interpretive, theory-dependent, and relative.

The foregoing does not, however, logically entail the relativity of seeing in the *de re* sense. Electromagnetic radiation originating from the one and the same object (*re*) causally impacts the retinas of Aztec and cMd skywatchers alike, resulting in congruent (if not identical) retinal images. In this sense, cMd and Aztec skywatchers *do* see the same object: Venus according to cMd scientific ontology, *Quetzalcoatl* according to Aztec. Analogously, literate and illiterate see *de re* the same thing.

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76 Goldman, *Epistemology and Cognition*, p. 187.

77 Hanson, *Patterns of Discovery*, p. 8.

Furthermore, the foregoing does not logically entail an ontological relativism of the sort commonly attributed to Thomas Kuhn.[78] Although Aztecs and cMd skywatchers inhabit different 'lived', experiential or phenomenal worlds, I do not claim – nor does it logically follow from what I've argued – that they literally inhabit different metaphysical worlds or realities.

In sum, do Aztec and cMd skywatchers see the same thing? Yes *and* no. *De re* speaking, yes: both are causally impinged upon by one and the same object. Epistemologically speaking, no: each sees something different since their seeing is influenced by their respective background theories.

XI. Conclusion

Long before Europeans imposed their calendar upon México, the indigenous peoples of Mesoamerica counted and negotiated time and place according to calendars of their own making. Aztec time-place reckoning represents one way in which humans have understood their surroundings, themselves, and their relationship with their surroundings; one that did not eventuate in cMd-style science.

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78 See Klee, *Introduction,* and Godfrey-Smith, *Theory and Reality*, for relevant discussion.