Language as Scientific Instrument: a Preliminary Digital Analysis of Christiaan Huygens’ Last Writings and Correspondence

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ABSTRACT
This essay focuses on a digital text analysis with AntConc computational linguistics tool in order to find, list and compare the most important key word occurrences and their collocations in some of Christiaan Huygens last writings, from 1686 to 1695 and posthumous. The greatest attention is payed to three key words – Animus, Potentia and Lex – related to the themes of God’s power, divine and human intelligence, probabilistic epistemology, natural theology and plurality of worlds. In addition, these key words are used to select the letters written by Huygens to the most important of his contemporaries on the same topics. This challenge firstly involves demonstrating that his last writings on philosophical and theological reflections on mechanistic philosophy are not an anomaly within Huygens’ wider work, and secondly showing that these are indications of Huygens’ involvement in a number of theoretical debates in the second half of the seventeenth century.

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KEYWORDS
History of Science; Christiaan Huygens; Digital Text Analysis; Lexicon; AntConc corpus analysis tool.

CITATION
Introduction. Underlying Problems in the History of Ideas

Christiaan Huygens: a Thinker Hard to Place?

Compared to the impressive 22 volumes of the *Œuvres Complètes* (Huygens 1888-1950),\(^1\) which makes available most of the correspondence and writings of the Dutch scientist Christiaan Huygens, few studies are devoted to his work (Mormino 1993). During the two conferences\(^2\) for the 350\(^{th}\) anniversary of Huygens’ birth, many historians of science questioned this odd gap in critical literature in view of the common critical judgment that Huygens’ works are among the most relevant of his time. The reasons might be that the exegesis produced by the editors of the *Œuvres Complètes* apparently explored the main research issues (Gabbey 1980) and that their rich commentary had a paralyzing effect on historians of science (Hall 1980). However, most significant studies over the last twenty years have highlighted Huygens manuscripts kept in Leiden, showing how the national edition is not unquestionable and, on the contrary, how the formation of dogmatic interpretations of the Dutch scientist’s activity is the consequence of the adoption of “non-neutral” editorial criteria (Mormino 2003). In fact, the reconstruction performed by the editors has often hidden the context and process of his discoveries, outlining the image of a scientist who can easily solve a problem that seems to be clear from the beginning and, consequently, ignoring the fundamental features of his research. Emphasis on the published works at the expense of the ongoing drafts might be one of the main reasons why most of the critical studies have focused on aspects, as various as they are specialized, of Huygens’ scientific activity (Yoder 1998). Therefore, only two studies reconstruct the epistemology underlying his speculation as predetermined by a supposed “Cartesianism” (Elzinga 1972) or by a lack of systematic thought (Burch 1981).

The problem related to the philosophical structures that support his scientific investigations remains unsolved and it is still difficult to articulate Huygens’ conceptually autonomous and coherent vision, denied by various historians of science. On the one hand, the image of a scientist engaged only in the collection and analysis of facts and far from metaphysical concerns contributed to devaluing its importance by promoting only the appreciation of his still valid scientific results and his commitment to a “modern” mathematical analysis of the physical world (Mach 1883, Cassirer 1907). On the other hand, the unresolved issue of his belonging to scientific Cartesianism, even if “heterodox” (Koyré 1965), led to the conclusion that Huygens’ thought lacked a philosophical foundation. According to these scholars, Huygens was an exception in his time: a problem-solver detached from the methodological, philosophical and theological debate that took place around him. However, some more recent studies have argued that Huygens was a thinker who did not easily fit the predetermined and opposed categories, such as Cartesianism and English Empiricism, which historiography would

\(^{1}\) From now on, this editorial edition is shortened to OC followed by the volume number in Arabic numerals.

employ. This attitude might be one of the main causes of the silence surrounding these last writings inspired by a greater reflective vocation (Bos 1982, Chareix 2003).

Therefore, from an historical point of view, we can remark that Huygens’ philosophical role has not yet been satisfactorily defined. The same understanding of his major work of this period, namely the *Cosmotheoros* (1698), and in particular the most speculative Book I, was widely discussed by critical literature between the 1970s and 1990s. It was either regarded as the product of a mature wisdom (Hooykaas 1979, Andriesse 1993) or of a natural weakening (Romein 1977, Hall 1980) of the Dutch scientist’s intellectual capacity.

My research follows and supports the thesis, consolidated by the most recent critical studies, of the revaluation of the philosophical purpose in Huygens’ last writings, which was also in continuity with the scientific method of his previous works.

**Why the Very Last Writings?**

Having considered the different positions of these scholars, I selected those of Huygens’ last writings that seem characterised by a relevant presence of speculative reflections showing both his rationality model and his attitude towards religion. In this way, they are able to undermine the commonplace view of a scientist detached from genuine philosophical concerns. These texts are both published works and unpublished materials, such as handwritten and undated *folia*, notes, preparatory studies and appendices, dating to a period between 1686 and 1695. This period is particularly relevant in the evolution of Huygens’ thought because of two notorious historical events: the Revocation of the Edict of Nantes and the publication of Newton’s *Principia mathematica*.

The greatest attention is paid to the main work of this period, namely the *Cosmotheoros* – edited posthumously in 1698 by his brother Constantijn – which I compared to some unpublished writings that, in a different way, may be considered as its preparatory drafts. Most of them were collected by the *Œuvres Complètes* editors in the XXI volume, with the thematic title of *Cosmologie*. Several of them have astronomical themes and issues related to the plurality of worlds and their inhabitants; some add considerations about natural theology and divine and human intelligence; and others focus on reflections related to humankind as microcosm, to society, life and death, and desire of glory. In addition, I selected some other unpublished works, which were collected in other volumes, regarding Huygens’ thoughts on perception, in particular related to the functioning of the eye, the sense of sight and of hearing, associated with his theory of musical consonants.

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3 OC 21, Cosmotheros.
5 OC 21, Astronomica Varia 1690-1691, De probatione ex verisimili, Verisimilia de planetis, Insolutum spectaculum.
6 OC 21, Pensees Meslees, Que penser de Dieu, De rationi impervijs, Quod animalium productio.
7 OC 21, Appendice aux piéces ‘De rationi imperviis, De gloria, De morte.
8 OC 13, De l’œil et de la vision.
9 OC 19, Rapports des longueurs des cordes consonnantes; OC 20, Pièces sur le chant antique et moderne, Théorie de la consonance.
During the analysis of these writings on cosmological, theological and epistemological themes, I also took into account his works related to physical experiments both preceding\textsuperscript{10} and contemporaneous\textsuperscript{11} to the considered period with special regard to those parts in which Huygens remarks upon methodological issues and criticises some ancient and modern philosophical approaches. In these writings on physics, emerges a theory of mechanistic motion, which in Huygens’ mature thought can be defined as “atomistic” (Mormino 2012, 63–109). This poses an interpreting problem in his conception of the teleology of Nature discussed in the \textit{Cosmotheoros} and its preparatory writings. Fabien Chareix described Huygens’ last years of work as “la période critique” (Chareix 2003, 10) because Huygens failed to complete his draft of a unified theory on movement. However, Gianfranco Mormino’s analysis of the \textit{Codex Hugeniorum 7A} showed how the Dutch scientist comes to an integration of the circular motion within the class of relative movements, founding the laws of mechanics in a unique relative movement. Moreover, from the correspondence with Leibniz has come to light not only Huygens’ conception of matter but also, thanks to the stimulus of Newton’s work, his attempt to convert scattered ideas about movement, strength, distance or cosmic system into a consistent and “hyperphysical” way of thinking (Mormino 1998). This attempt led the Dutch scientist to write: “Non est mathematice difficilis materia, sed physice aut hyperphysice”\textsuperscript{12}. This expression, dating back to about 1688, bears witness to a Huygens’ coherent attitude in being able to connect his physical-theological rhetoric with the evaluation of his mechanistic philosophy.

Therefore, having considered that Huygens’ epistemology makes use of the divine design argument, I tried to highlight his theological understanding of natural order as well as the consequent relationship between God and Nature, terms that are often synonymous in his works. My attempt follows the thesis of those scholars claiming that, in the course of the seventeenth century, the collapse of the medieval symbolic interpretations of nature would raise fundamental questions about the meaning of nature itself: divine design, providence and teleology would be elements of a wider metaphysical debate on the new mechanical conceptions of nature (Harrison 1998, Funkenstein 1986). In this respect, I chose also to analyse Huygens’ correspondence with prominent thinkers involved in this debate. Hence emerges not only his interest in the main post-Cartesian philosophical-scientific controversies but, above all, his consideration of his \textit{Cosmotheoros} as in no way disconnected from his previous scientific work: even though he recognises its particular form and content, he refers to it in several letters as “un petit traité en matière philosophique”.\textsuperscript{13} As well, Mormino pointed out the importance of the last correspondence that would reveal Huygens’ attention to epistemological issues. According to the Dutch thinker, science does not concern the possible but only the existing;

\textsuperscript{10} OC 16, De motu corporum ex percussione, Pièces et fragments concernant la question de l’existence et de la perceptibilité du ‘mouvement absolu’, Extrait d’une Lettre de M. Hugens à l’Auteur du Journal.

\textsuperscript{11} OC 19, Traité de la Lumièrè; OC 21, Discours de la cause de la pesanteur.

\textsuperscript{12} OC 16, Pièces et fragments concernant la question de l’existence et de la perceptibilité du ‘mouvement absolu’, 213. See also: Portfolio L, 5 in which Huygens firstly wrote “metaphysice” and then corrected it with “hyperphysice”.

\textsuperscript{13} Letter to Leibniz, OC 10, n. 2894, 29th May 1694, 609 (my emphasis): “Cette attente m’a donc fait differer longtemps de vous escrire. Apres cela sont venu des etudes nouvelles un petit traité en matiere Philosophique”. See also the letter to Marquis de l’Hôpital: OC 10, n. 2842, 24th December 1693, 577.
thus, an endless variety of Creation must not be assumed a priori but it is necessary to rely on experience and, in its absence, on a probabilistic evaluation (Mormino 2012).

Comparing Corpora and Archives: the Challenge of Interpreting an Author through his Lexicon

The Huygens Database and the AntConc Tool for Concordancing and Text Analysis

My main aim was to find a lexicon able to reconnect the conceptual apparatus underlying the Huygens’ speculative reflections, whose constitutive elements, although not expressed in the canonical forms of philosophy, weave the same theoretical narrative as the greatest philosopher-scientists of his time. I intended to carry out a linguistic analysis finalized not to display the author’s thought based on a preconceived interpretation, but to evaluate Huygens’ conceptual system by providing a linguistic data processing and as objective a description of it as possible. Following the method, as valid in philology as in computer science, based on the assumption of an ideal unity of meaning without internal contradictions in a text, I could evaluate – for the first time in Huygens’ work – whether this consistency of meaning exists and eventually can be understood or not, in order to highlight any contradictions in the system. At the same time, I tested the working process of the computer tool, as it adapted to reach the objectives and create new paths to investigate, in a similar way to the scientific experimentations carried out by Huygens, who built his own “philosophical instruments” (Bertoloni Meli 2006, 5) or “embodied theories” (Koyré 1968, 113).

My text analysis has followed the linguistic “corpus-based” approach (Tognini Bonelli 2001, 65–83) that I adapted to my philosophical problem outlined above. Therefore, since my questions were not, strictly speaking, linguistic, I decided to choose not a generic and enormous “reference corpus” (Chiari 2007, 51) but the specific one of the letters of Huygens and his correspondents.

My database, composed of very heterogeneous texts, is structured in two parts:

1. A primary collection of Huygens’ last writings, which are different in both size and subject. Selected according to the criteria outlined above, I mainly focused on this corpus in comparing between some chosen terms and their contexts in order to examine any variations of meaning so that we can term them as “concept-lemma”.

2. A secondary collection consisting of the Huygens’ complete correspondence (3090 letters). I pulled out the same concept-lemmas of the primary corpus in order to analyse them from a historical point of view.

These key words are significant thematic nuclei around which Huygens gets to the heart of a number of well-known philosophical debates in the second half of seventeenth century.

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14 I followed the methodological approach of philology and translation outlined in Hohenegger 2011, 65–66.
In order to create my database, I took advantage of the material published on the Digitale Bibliotheek voor de Nederlandse Letteren (dbnl)’s website, which makes freely available the Huygens’ complete work edited by the Société Hollandaise des Sciences. After I had collected the texts in digital format, I had to delete prefaces, comments, quotes, footnotes, and all editorial criteria performed by the Œuvres Complètes’ editors with a view to being able to process and interpret preliminary quantitative data relating to the author’s language only. This kind of preparatory work was less demanding for the correspondence’s corpus, directly processed without the critical apparatus thanks to the helpfulness of the Huygens ING researchers, who set it up in light of the ePistolarium tool’s development. In addition, I made a comparison of both corpora with the Codices Hugeniorum manuscripts consisting of a uniformity check and correction of the inevitable errors due to the large amount of data processed during the conversion in OCR character recognition. For this comparison I followed the indications provided by Joella Yoder’s Catalogue (Yoder 2013), in which she describes and orders each manuscript folio by marking it as unpublished or reporting the correspondent pages in the Œuvres Complètes.

Subsequently, I carried out a classical automatic text analysis (e.g. Sinclair 1991) by means of the AntConc tool (Anthony 2014, Version 3.4.3) following a methodological indication by Huygens himself. Having compared physical investigation to the decryption of a letter written in code, he stated that, during the elaboration of an interpretative hypothesis, the existence of a meaning to be discovered must be a given: that is, it must be assumed as an internal rationality in the object being investigated (OC 7, Letter n. 1944, 298–301).

I firstly used the Word Lists search option that allows the extraction of word frequency lists. Having considered the corpus’ multilingualism (Neo-Latin, French, Dutch, English, Italian), I decided to obtain a frequency list for each language in order to have the chance to compare more accurately both the semantic variation of lemmas and the quantitative prevalence of one language over another. Reading these first outputs, there emerged a set of linguistic data previously unknown: that is, the presence of Greek terminology, with scientific and non-scientific meaning, especially in Latin contexts. Therefore, starting from these frequency lists, I chose several of the most significant terms both in Huygens’ last writings and in the history of ideas in the second half of the seventeenth century. I paid special attention to Latin as a substratum of the national European languages’ terminology in scientific and humanistic culture, which has conditioned the elaboration of modern philosophical and scientific thinking (Gregory 2006, 82–83).

Secondly, I conducted a series of preliminary tests and comparison of many terms, such as Deus, ratio / ratiocinium, experientia / experimentum, potentia / potens, intellectus / intellegibilis, sensus / sensibile, gravitas, vortex, atomus, vacuum, infinitum / infinitas, continuum etc. I was looking to verify for each of them not only the number of occurrences but also their co-occurrences by means of three software tools. The Cluster search option shows word groups based on the search term, which are

15 The developer proposes a model for this corpus tool design and development as his answer to the long running debate in the field of corpus linguistics research “concerning the size and annotation of corpora” and the “differences in the outputs of corpus linguistics tools” (Anthony 2013, 144–45). For a features description of this standalone software package for linguistic analysis of texts see: Froehlich 2015.
displayed together with the words immediately on the right and left; the N-Grams search option, by analysing the whole corpus for ‘n’ length clusters, allows you to find common expressions; and the Collocates search option makes it possible to investigate non-sequential patterns in a language.

Eventually, my latter choice of concept-lemmas, on which I mainly focused my interpretative analysis, was based on the Concordance search option, which shows the list of phrases commonly used for each searched term, namely KWIC – Key Word In Context (Fig. 1).

The purpose of this long preliminary analysis was to find, list and compare the most important key word occurrences and their collocations that the research progress has suggested as more significant for a first but consistent study of Huygens’ thought through his own language. In accordance with the well-established recognition of the necessity of both a quantitative and qualitative approach to understand the “system” and the “use” of a language (De Mauro 1995), I especially took into account those computational studies that support an epistemological point of view. A useful guideline was Richard Watson Todd’s attempt, based on the lexical priming theory (Hoey 2005), to distinguish between existing and new knowledge by comparing the relationships between what he defines as “concepts” – namely the key words – and their “associations” (close-span key word linkages) – namely the collocations – and “conceptual associations” (wide-span) – namely the co-occurrences (Watson Todd 2013). Therefore, in an actual comparison of the author with his terminology and that of his different contemporaries, I tried to highlight and to analyse the “intellectual vocabulary” (Russo 2012, 171) of the Dutch scientist as a vehicle of representations and relevant concepts in his intellectual history.
Three Concept-Lemmas Case Studies: “Soul”, “Power” and “Law”

As a result of the preliminary digital texts analysis, I chose three concept-lemmas as case studies, namely “soul”, “power” and “law”. They represent the common thread of my interpretative analysis in which I tried to link, from a strictly theoretical point of view, Huygens’ last and philosophical writings with a historical perspective of the correspondence’s reading. My final decision about these three concept-lemmas was based on their peculiar semantic variation in his last writings’ contexts as well as on the recognition of their relevance in the modern philosophical tradition.

In the course of this analysis, I compared the lemmas with others consisting of their synonyms and collocations, such as regula, usus rationis, finis, miracula, etc. They can be defined as secondary, even if they are often decisive elements of support to interpret Huygens’ speculations. I examined this lexicon through the juxtaposition and concatenation of its contexts related to very different themes. In this way, I tried to retrace Huygens’ continuity of thought, even in its evolution and maturation, and to describe it through a system of internal referrals to his own texts that makes conceptually readable every juxtaposition of each KWIC as a whole to be recreated.

By way of the AntConc ‘advanced search’, I was able to trace the variations of search terms through regular expressions, which are able to take into account the variations of each lemma (singular, plural, and Latin declinations) in the five languages within the corpus.

In the case study of “soul”, I mined the lemmas animus / anima and âme for Latin and French writings and correspondence as well as mind / soul, ziel / geest and animo for English, Dutch and Italian letters. During their occurrences analysis, I was able to trace relevant collocations, such as voluptas animi, immortalitas animi, usus rationis etc., and further co-occurrences from the search term, such as mens / esprit, ratio / raison, sensus / sens, which as synonyms or related and comparative words suggest additional semantic nuances of “soul”.

In the case study of “power”, I looked for potentia / potestas, puissance / pouvoir in Latin and French last writings and correspondence and for power, macht / vermongen and potenza in English, Dutch and Italian letters. In French writings, given the great amount of occurrences of the term pouvoir, I selected only its substantivized forms that refer to a theological and epistemological shade of meaning. This KWIC analysis allowed me to trace very tied collocations, such as potentia dei (or its synonymous conditor and auctor), infinita / immensa potentia, and other co-occurrences more distant from the search term, such as providentia / providence, voluntas / volonté, probabilis / probable, mens / esprit and intellectus, fides / foi and ratio / raison etc.

In the case study of “law”, I searched for the lemmas lex, gis / loy, loix in Latin and French last writings and correspondence, whereas in English, Dutch and Italian letters I tried with the lemmas law(s), wet / recht and law. During this automatic textual analysis, two main collocations emerged, namely lex motus / loy du mouvement and lex naturae / loy de la nature as well as a number of very significant Latin synonyms, such as praescriptum, jussu and regula, and co-occurrences, such as providentia / providence, finis / fins, miraculum / mirabilia / miracle.

In all these three case studies, the co-occurrences repeated significantly in their respective word clusters turned out to be an essential way to connect the three major key words to each other. Then,
I ordered the “soul”, “power” and “law” concordances into lists dividing those in the writings from those in correspondence. This second list is further divided into sub-lists according to both the language of the Key Word In Context (KWIC) and of its co-text (Context). Moreover, in addition to their frequency (F), the letters – sorted chronologically – are provided by the sender and recipient names in the “Metadata” (Fig. 2).

For each case study, I searched for the three key words, their synonyms and collocations in a number of databases, archives and thesauri referring to the same or previous period being considered. This further research was based on both random hypothesis and previous knowledge of most of the main thinkers in the history of ideas.

Figure 2: file sheet of the KWIC “power”.

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16 Among others, I especially refer to: The Works of John Locke in Nine Volumes (Online Library of Liberty), Early Modern Letter Online (EMLO), Banca dati di testi filosofici dell’età moderna – Lessico Intellettuale Europeo e Storia delle Idee (ILIESI-CNR), Daphnet Modern Philosophy (ILIESI-CNR), Lessici filosofici di età moderna (ILIESI-CNR), Centre National de Ressources Textuelles et Lexicales, Trésor de la Langue Française informatisé, Analyse et Traitement Informatique de la Langue Française.
Results Obtained with Two Complementary Approaches of Computational Lexicography

A Quantitative Analysis

The first step was to analyse the quantitative outputs, namely each concept-lemma. Below I try to summarize for each case study the most relevant ones in their lists of word frequency and collocations.

In the case study of “soul”, firstly it is remarkable the prevalence of Latin occurrences in both Huygens’ writings and correspondence is remarkable: data of further importance because of the great diversity – for size and style – of the two corpora. In French writings, there are only 13 occurrences within three writings out of 15 processed by the AntConc tool; instead, in Latin, animus,-i and anima,-ae number 41 items in seven writings out of 15. Moreover, in the correspondence the trend seems to be the same. Only in 29 of 1947 French letters, we count 32 occurrences of âme(s). On the contrary, in the 787 Latin letters there are 126 occurrences of anima and animus, to which we have to add the other 10 Latin occurrences within the 25 mixed Latin-French letters, consisting of mostly French text with a significant presence of Latin sentences or entire paragraphs.

Secondly, another relevant result is the predominance of Latin occurrences in their declension of the male lemma animus,-i, which seems often to have the same meaning as mens,-tis, a term rather less frequent also in philosophical contexts, in which Huygens seems to prefer ratio,-nis.

Thirdly, it is interesting to note the use of this lemma in sentences consisting of figures of speech or letter endings. These kinds of occurrences are the prevalent ones in Dutch, English and Italian letters. In the 215 Dutch letters, there occurs only once the lemma ziel, literally soul, and six times geest, translatable as both mind and spirit. In the 52 English letters, soul never appears in favor of seven occurrences of mind, with a similar meaning to the 13 items of animo in the 42 Italians ones.

From a chronological point of view, this concept-lemma in the correspondence reveals the evolution of Huygens’ attitude relating to the post-Cartesian issue on the immortality of soul and on whether or not animals possess it. It seems that from the 1770s, his interest began to emerge as a careful exchange with his inner circle until it became a clear stance in the early 1790s, argued openly in the last philosophical writings.

In the case study of “power”, the most significant outcome is the very different meaning of the term as ‘divine power’ in the last writings and as ‘arithmetic power’ in all the correspondence. From a semantic point of view, the two corpora are opposed to each other.

In addition, if in the writings primacy is assigned to theological meaning with the clear collocation of potentia Dei / puissance de Dieu, another contrast emerges systematically: the lemma potentia / puissance is always opposed to the human potestas / pouvoir, which can be transposed as men’s intellectual ability and, at the same time, as their right to do something.

On the other hand, in his correspondence Huygens has never used the collocation “power of God” in any languages of this corpus, nor even in those letters dating from the same period as the last writings here considered. This lack seems to be a strong position by Huygens in face of its use by
some of his contemporaries in theological and epistemological debates in which they sought un unsuccessfully to engage him. In the other languages, especially in English and Dutch, only “Almighty God” is used in figures of speech or letter endings. Conversely, the massive presence of arithmetical power in the correspondence testifies that Huygens was one of the most important points of reference in the major scientific debates of the second half of the seventeenth century, especially in solving mathematical problems. In fact, according to the Dutch scientist, the only truly reliable thing was reasoning, unlike the weak arguments in theological controversies.

In the case study of “law”, unlike in the previous one, the most remarkable result is the recognition of a quantitative and semantic equivalence (both in singular and plural forms) of French and Latin occurrences in the last writings. The same trend can be found in these two languages even throughout the correspondence.

Moreover, there is another similarity in the two corpora consisting of the presence of three main collocations as synonyms in both French and Latin, namely “law of motion”, “law of mechanics” and “law of nature”. However, in the writings this last collocation plays the role of implicit reference to law as a part of divine design: it is confirmed by the use of its synonym collocation praescriptum naturae. In this case, the identification of relevant synonyms and collocations was crucial to highlight some underlying argumentations in the last writings, such as the interchangeability of the terms “Nature” and “God”.

From this terminological consistency, it is possible to infer Huygens’ strong continuity of interest in the issues addressed in both the correspondence and last writings. The latter do not abandon research in the fields of physics and astronomy, which actually are the foundations of Huygens’ cosmogonic and anthropological speculations.

A Qualitative Analysis

After the quantitative analysis as presented above, the second step was to interpret the concordances of the three concept-lemmas in their different contexts. This type of approach, which allowed me to establish which of Huygens’ works contain the most interesting meanings of the chosen key words, also enabled the detection of the theoretical elements of continuity between the correspondence – mainly bound to scientific themes – and the philosophical sources re-elaborated by Huygens in his last writings. The elements of continuity can be summed up in three main themes.

The first consists of Huygens’ probabilistic epistemology. He adapted his early mathematical studies on random probability to his methodological concern to accept a “degré de vraisemblance” during his physical investigations in absence of mathematical certainty. In his last writings, this research methodology appears also in his epistemological considerations on natural philosophy. By means of the analytical interpretation, possible only thanks to the computer tool, I have been able to recognize an interesting similarity to the ideas expressed by Locke in An Essay Concerning Human

\[17\] OC 19, Traité de la lumière, 454; see also OC 21, De probatione ex verisimili, 541.
Understanding, which may add philosophical value to the probabilistic arguments on the nature of other planets and of their inhabitants in the Cosmotheoros.

The second is related to his thinking on animals. They are machines with a soul that differs from ours only on the rational side. These reflections are able to open a window on Huygens’ religiousness and show his interest in and standpoint on a still open post-Cartesian debate. The “miracle”18 of the animals’ generation would fit in the mechanical laws of nature, since there was not a unique creation, but many of them.19 Therefore, I may include Huygens in the circle of “English empiricists”, following the distinction made by Robert M. Burns. In fact, in seeking an explanation of miracles in the context of mechanical philosophy, the empiricists do not try, as the “continental rationalists” Descartes, Spinoza, Malebranche and Leibniz, to fill a gap in the scientific explanation but to use them as practical evidence of the Christian truth and as a posteriori proof of God’s existence (Burns 1981).

The third is present in Huygens’ conception of the legality of nature. Starting from the comparison of his concept of “providence” with that of Spinoza and Boyle, it turned out that the greater similarity of thought would be with Boyle. Huygens seems to endorse the re-elaboration of the Christian notion of providence made by the English scientist from the Roman stoicism of Cicero and Seneca (Harwood 1991). Furthermore, he seems to share Boyle’s mature thought regarding the relationship between natural philosophy and theology in which an “epistemology of the limit” is sketched out (Pacchi 1973, 244). In Huygens, the insistence on the limits of human reason and on the need to renounce a rational foundation of metaphysics can be found in many of his last writings and it has Descartes as its first critical goal.20 Moreover, human beings’ awareness of their “imbecillitas”21 (namely mental and physical weakness), combined with the desire to preserve their lives, would be the incentive to join others in a society governed by laws of nature. In my view, these considerations show a component of rational cosmopolitanism based on stoic philosophy that, following the idea of a common human nature, may include the Dutch scientist among those thinkers of the doctrine of natural law.22 Therefore, these results might be able to reduce the importance of the moral libertarianism and scepticism that would influence Huygens in his Paris years, as some scholars have sustained (Gori 1976, Vilain 1996).

The recovery of Huygens’ philosophical sources has been possible only thanks to a textual comparison between fragments of his different texts and then with that of other philosopher-scientists. Firstly, I interpreted the meaning variations of each concept-lemma and, secondly, I followed the research paths suggested by critical literature. I took into account some studies that have proposed comparison between the thought of Huygens and that of some “real” contemporaries. Above all, I tried to support Alfred R. Hall’s thesis according to which Huygens should not be compared only with Leibniz and Newton, since they belong to a further generation less tied to Descartes’ authority (Hall 1980, 303). I indeed considered and tried to reply to those studies that have indicated possible influences and

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18 OC 21, Cosmotheoros I, 759; Cosmotheoros II, 787 and 789; Verisimilia de planetis, 543 and 554.
19 OC 21, Préface del Discours de la cause de la pensanteur, 436.
21 OC 21, Cosmotheoros I, 743; OC 21, De probatione ex verisimili, 541.
22 OC 21, Cosmotheoros I, 749; OC 21, Quod animalium productio, § 8; OC 21, Verisimilia de Planetis, §§ 12, 15, 23.

Final Remarks and Perspective on Digital Humanities

My research methodology consisting of a preliminary digital text analysis enabled an objective exploration and lexicographical comparison, never before done, of two corpora: Huygens’ late writings and correspondence. During the first step of the data quantitative analysis, I was able to use the AntConc tool to process a large number of texts without any previous knowledge of their content and to obtain information related to the word frequencies and key words in the five languages. Based on this quantitative data, I was able to select the terms that seemed the most interesting by looking through their concordance lists and interpreting their co-texts. Therefore, the second step of qualitative analysis allowed me to find other relevant and related terms, which each time I checked for their frequency and collocations count. This entailed going back to the first phase and so on until the terms were able to fulfil my analytical needs. From this point of view, it means that the two quantitative and qualitative approaches, even though separated into two different phases, are extremely connected and complementary in the extraction of new knowledge from texts. The final choice of each concept-lemma to be interpreted was a wager, a hypothesis that might be evaluated only at the end of the juxtaposition and analysis process of the text fragments whose common thread consisted of each Key Word in Context. Nevertheless, we can recognize that this computational “corpus-based” approach allowed a wide scope of exploration that led to the achievement of some relevant insights into the history of ideas of the seventeenth century, which were – as I hoped – not predictable in advance.

Many research perspectives based on this preliminary digital analysis might be pursued. Firstly, several other conceptual words could be analysed, paying particular attention to those co-occurrences that are common to a number of word clusters. In this regard, it would be useful to use a data visualization tool able to display any repetition of collocations and co-occurrences in the word clusters so that one can see more effectively when a repeated term may be considered as the same “conceptual association” between key words. Subsequently, it would be possible and extremely useful to build a terminological database or electronic thesaurus, based on conceptual-semantic and lexical associations (on the example of WordNet) also from a diachronic perspective, for each author computationally analysed. This could eventually lead to a mapping of conceptual associations not only between an author’s works in different years but also between different authors who were involved in the same theoretical debate.
Bibliography

Primary sources


Secondary sources


Digital Resources

L. Anthony, AntConc (Version 3.4.3) [Computer Software]. Tokyo: Waseda University, 2014. www.laurenceanthony.net/software/antconc

Digitale bibliotheek voor de Nederlandse letteren, Uitgaven van Christiaan Huygens www.dbnl.org auteurs auteur.php?id=huyg003

ePistolarium, Huygens ING, Developed by Walter Ravenek http://ckcc.huygens.knaw.nl/epistolarium


Early Modern Letter Online (EMLO) http://emlo.bodleian.ox.ac.uk/home
Banca dati di testi filosofici dell’età moderna, Lessico Intellettuale Europeo e Storia delle Idee (ILIESI-CNR) [http://lie11.let.uniroma1.it:8777/iliesi/home.htm](http://lie11.let.uniroma1.it:8777/iliesi/home.htm)

Daphnet Modern Phylosophy, ILIESI-CNR
[www.daphnet.org](http://www.daphnet.org)

Lessici filosofici di età moderna, ILIESI-CNR
[www.iliesi.cnr.it/Lessici](http://www.iliesi.cnr.it/Lessici)

Centre National de Ressources Textuelles et Lexicales
[www.cnrtl.fr/portail](http://www.cnrtl.fr/portail)

Trésor de la Langue Française informatisé, Analyse et Traitement Informatique de la Langue Française
[www.atilf.fr/tlf](http://www.atilf.fr/tlf)

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1 Last consultation: 22/08/2017.