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THE PROBABILITIES OF HYPOTHESIS IN THE WORKS OF CHARLES BONNET (1720-1793)

BY

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ABSTRACT

The probabilities of hypothesis in the works of Charles Bonnet (1720-1793). - This paper studies the language of the hypothesis and probabilities as used by the genevan naturalist and philosopher Charles Bonnet. In his early works (1745-1754), much concerned with experimentalism, he does not almost use these language, whereas he employs it in his works of maturity (1762-1783). The paper relates this emergence of a "doctrine of probability and hypothesis" to the Eighteenth Century shared language of scholars, as well as to the bonnetian project of grounding a logic for experimentation.

The Eighteenth century starts out on a multiple legacy in the field of probability. On the one hand, the works of Pascal and Fermat have prepared the path for the mathematical perspective, exploited by Leibniz, Bernoulli and Moivre (TODHUNTER, 1965) during the first part of the century. On the other hand, the calculation of probabilities develops into decisional models, applied in various fields, spanning from insurance to natural theology and from empiricist philosophy to juridical decisions; and thus begins to focus on the relation between numbers and man, theme on which the physiocratic school and Condorcet are to work on after 1750 (DASTON, 1995). In the 17th century, the "probable" equally referred to a form of knowledge derived from the Latin meaning of the term "probatus": improved. Ideas and sacred authors especially are "probati", i. e. they are credited by the authority of a tradition. The writings of Blaise Pascal testify of this double meaning of the word probability (HACKING, 1978[1]).

Another element of the Seventeenth century's legacy is constituted by a figure of the logical argumentation, to which the idea of probability will be associated during the Eighteenth century: The notion of hypothesis. At the end of the 17th century, although it is used in most scientific texts as Boyle's texts (ROUX, 1996, p. 358), the notion of hypothesis is linked to the language of astronomy, as well as to the literary genre of the

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[1] For a critic of the relation between the old (i.e. "improved") and the modern meaning (i.e. linked to evidence) of probability, see GARBER & ZABELL (1979).

dialogue (ROUX, 1998). In the context of the humanistic and skeptic culture of the late Seventeenth century, good manners should be expressed by the formulation of one's own opinion as a "probable hypothesis". It can be seen in one of the "bons mots" of the French critic Gilles Ménage (1613-1692): «Deux personnes s'entretenant d'une affaire, l'un dit: Prenez, Monsieur, que vous me deviez dix mille écus. L'autre, interrompant aussi-tôt: Prenez, dit-il, je vous prie, une autre hypothèse» (MÉNAGE, 1713, t. 1, p. 83). Hypothesis is also relevant to the context of logic[2]: the lexicographer Antoine Furetière (1620-1688) defined it as a «supposition qu'on fait d'un principe, d'une proposition, pour en tirer des raisonnements et des conséquences» (FURETIERE, 1690, entrée "hypothèse"). He adds: «en bonne logique, il faut prouver le principe qu'on suppose, avant que d'en vouloir faire croire la conséquence».

We will recover most of these linguistic usages in the Eighteenth century, where also specific efforts were made in order to link probability and hypothesis in the main context of the application of the experimental method in life sciences. However, if many naturalists and experimenters of the first part of the century, such as John Desagulier, William Derham or Réaumur use a rhetoric of probability and of hypothesis, these are either not developed or simply dissociated. The works of Charles Bonnet show an important evolution in the methodological language concerning the question of probability, from his period of empirical researches, closed in 1754, and his period of philosophical ripening beginning with the publication of the *Essai analytique sur les facultés de l'âme* (1760). Indeed, as with earlier experimenters, up to 1754 in Bonnet's texts, the occurrences linked to the topic of probability are quite rare, and the term itself "probability" appears only in a limited number of expressions like "dénué de probabilité". The term "probable" is related to other terms like "soupçons". It is a matter of "sentiments", "conjectures" or "d'affirmative jugée probable", but practically not of hypothesis. During this period, the hypothesis is still linked to a general use. For instance the expression "hypothèse probable" appears only once in this *corpus*, in the *Dissertation sur le Taenia*, published in the journal *Savants Etrangers* in the middle of the century: «Recevant donc l'hypothèse de Tison comme probable, on aura dans le taenia une espèce singulière d'animal» (BONNET, t. 3, p. 113)[3]. In other words, for Bonnet, "hypothesis" and "probability" are not strictly and theoretically related to each other until 1754. His philosophical maturation, together with his reflections upon the scientific activity of the natural history of 18th century, will lead him to change his mind on this subject. In the *Considérations sur les corps organisés*, of 1762, and then in the *Contemplation de la nature* (1764), parts of this "doctrine des probabilités" emerge.

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[2] ROUX (1996), pp. 355-356: «Dans la deuxième moitié du XVIIe siècle, "hypothèse" est employé dans un contexte plus large que le seul contexte astronomique et même physique. Il s'applique aussi bien à une supposition destinée à expliquer un phénomène particulier qu'aux principes les plus généraux d'une philosophie».

[3] All the quotations of Bonnet are taken from the *Œuvres complètes de Charles Bonnet* in the edition *in 8°* of 1779-1783 (Abreviation *OCB*).

Probability, analogy and hypothesis are then linked in a doctrinal dream: «Si jamais nous avons un bon traité de l'analogie, et combien un pareil traité nous manque-t-il! nous le devrons à un philosophe naturaliste. L'analogie est liée à la doctrine des hypothèses et des probabilités; à mesure que nos connaissances s'étendront et se perfectionneront, les probabilités en chaque genre approcheront de la certitude. Si nous pouvions embrasser la totalité des êtres de notre globe, la méthode analogique serait une méthode démonstrative» (BONNET t. 8, p. 189).

In the *Palingénésie philosophique* of 1769, a great address delivered to rebuilt Christian ideals on the scientific method, and in a small text called "Philalèthe" which is not to be published before the complete edition of 1779-1783 (BONNET, t. 18), appears a concerted theory connected with the "doctrine des probabilités et de l'hypothèse". This emergence of a theoretical frame could be link to important readings made by Bonnet, specially of Leibniz and of some 18th physicians. This theory can be reduced to three main ideas:

1/ There exists a certainty of knowledge, considered as a whole, which cannot be attained. This certainty must therefore be divided: «Si j'envisage la certitude comme un tout et si je divise par la pensée ce tout en parties ou degrés, ces parties ou degrés seront des parties ou degrés de la certitude. Je nomme probabilité ces divisions idéales de la certitude» (BONNET, t. 16, p. 231)[4].

2/ There is a relationship of equivalence between the formal level and that of the experiment. The possible cases can be considered as equal to experiments: «La certitude physique (...) peut être ramenée (...) à des approximations, lorsque tous les cas possibles ne sont pas connus ou que les expériences n'ont pas été assez multipliées» (BONNET, t. 16, p. 266). As in Hume's *Treaty of human nature* (1739), the origin of this idea can be found in the «Lockean tradition that equated probabilities, experience and belief» (DASTON, 1995, p. 201).

3/ Bonnet tries to build a scale of equivalence between the "degree of probability" and the quantity of facts observed: «Une hypothèse est d'autant plus probable qu'elle explique plus heureusement un plus grand nombre de faits ou un plus grand nombre de particularités essentielles d'un même fait» (BONNET, t. 16, p. 329). Simplicity is another criteria to evaluate the probable hypothesis, similar to the first Newtonian rule: «La nature est si simple dans ses voies, qu'une hypothèse perd de la probabilité à proportion qu'elle devient plus compliquée» (BONNET, t. 16, p. 305). Since the 17th, these are recurrent arguments already found in the tradition of astronomy (ROUX, 1998).

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[4] BRUNET (1926), p. 90, quoted the same idea in s'Gravesandes: «On peut considérer la probabilité comme une quantité qui va en croissant depuis le plus petit degré de persuasion jusqu'à la persuasion entière. C'est pour cette raison que nous concevons la certitude comme un tout, divisible en autant de parties qu'on voudra». Brunet showed (*Ibid.*, pp. 89-98) that the relation between probability and hypothesis in s'Gravesandes brings to consider hypothesis as a stage in the process of the discovery. The *Ars Conjectandi* of Jacob BERNOULLI (1713) part. 4, chapter 1, seems the very origin for this idea of a relation between the certainty and the whole to be divided.

Many aspects of this definition of the probable hypothesis can be found in the Eighteenth century literature, for the philosophers (Leibniz, Hume) as well as for the scholars. The Dutch physicist Jacob s'Gravesandes (1688-1742), (Gori, 1972, pp. 266-274), and the *Encyclopedie* (DIDEROT & D'ALEMBERT, 1777, t. 28, p. 470) use this definition in relation with precise requirements also found in Bonnet's thinking since his first works. One of these relates to the question of the system. MC NIVEN HINE (1979) has shown the importance of the idea of system in the middle of the century. As it is known, one of the highlights of this idea is linked to the resistance, in the context of the *Académie Royale des Sciences*, to the introduction of Newton's ideas in France during the first part of the century. This is analyzed in Condillac's *Traité des systèmes*, showing the positive and negative aspects of the system. The spirit of system has its supporters and its detractors. Nevertheless, once of the elements of the system is precisely hypothesis, and for many authors, the system is directly linked to hypothesis. For example, in Louis-Bertrand Castel's (1688-1757) *Traité de physique*, published in 1724, the hypothesis is synonymous to the system. This strong relationship between hypothesis and system is derived, among other things, from Seventeenth century astronomy: Claude Gadrois (1642-1678) in his *Système du monde selon les trois hypothèses* (1675), where the notion of hypothesis is partially used in the classical meaning found in logic[5], employs it equally to designate competing astronomical systems - Ptolemaic, Copernican, Keplerian – concerning the movement of heavenly bodies (GADROIS, 1675, pp. 61, 121)[6]. In the first part of the century, the different meanings attributed to the words system and hypothesis are disturbed by political dissension, further enhanced by the quarrel opposing the British to the French science, with the result of the disappearance of the Cartesian theory (BRUNET, 1931). This quarrel implies numerous scholars, including Dortous de Mairan, d'Alembert and Condillac (MC NIVEN HINE, 1995). In the *Académie*, yet another astronomer – the Abbé de Gamaches (1672-1756) – is one of the most faithful defenders of system ideology. His *Astronomie physique* (1740, p.i) argues in favor of the spirit of system, synonymous for him of French spirit: «C'est avec sagesse que l'Académie Royale des Sciences essaie de réveiller en nous le goût du système, qui semblait se perdre insensiblement». Generally speaking, the meaning taken by hypothesis – also conditioned by the *hypothesis non fingo* – is captured in the system network, and carries all its negative connotations. A naturalist and experimenter as was William Derham, heir of the *Boyle's Lecture* tradition, will argue for the sake of experience and against «des hypothèses incertaines et chimériques» (DERHAM, 1726, p. 43).

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[5] See GADROIS (1675), p. 286: If the comets are «hors de la portée des sens, [..en] prenant pour règle de nos raisonnements tout ce que nous aurons pu observer, les hypothèses seront du moins vraisemblables, si elles ne sont véritables».

[6] GADROIS (1675), p. 61: «Des diverses hypothèses pour expliquer le mouvement des astres»; p. 121 «composer un troisième système». For LALANDE, in the article "hypothesis" of the *Encyclopédie*, (DIDEROT & D'ALEMBERT, 1777), t. XVII, p. 983, "hypothesis" is used for the Kepler theory.

«Les philosophes sont partagés sur l'usage des hypothèses»[7], wrote Condillac in the *Traité des systèmes*. In many respects, hypothesis is an idea which has not crossed the field of experience, to sum up, in those time of empirical studies, it is an incomplete idea. And this incompleteness probably leads the naturalists of the Geneva school (TREMBLEY, 1987; BUSCAGLIA, 1994) to refuse the use of this term: Abraham Trembley does not use it in his *Mémoires pour servir à l'histoire d'un genre de polypes d'eau douce à bras en forme de cornes* (1744), and neither does Bonnet in his early works, on parthenogenesis of aphids (1745), and on the functions of the leaves (1754). This inadequacy could therefore be read as linked to a specific kind of temporal feature. In fact, being incomplete, the hypothesis must still be perfected, and it probably is for that reason that it can be found in different shapes of time, among which is hastiness. As Bonnet later writes, in 1764: «Les conclusions précipitées sont l'écueil le plus dangereux de la physique» (BONNET, t. 8, p. 287). Ten years earlier, he had denounced in the same way the system of Hartsoeker and Vallisneri, in the *Dissertation sur le taenia*: «Cette hypothèse est le refuge d'un naturaliste pressé par les difficultés qui accompagnent les autres systèmes, mais ce n'est pas un refuge assuré» (BONNET, t. 3, p. 139). The only way to resist to this recklessness in the elaboration of the idea of hypothesis, is to refer to a topos of methodological caution, which is the suspension of judgement: «J'ai discuté, says Bonnet, avec toute l'impartialité dont je suis capable les différentes hypothèses qui ont été imaginées pour rendre raison de l'origine des vers du corps humain. Il s'agirait présentément de décider entre ces hypothèses; mais je suspends mon jugement jusqu'à ce que je sois mieux instruit» (BONNET, t. 3, p. 142). This topic will become a pedagogical program of *reform of the logic*, in the *Considérations*: «L'histoire naturelle est la meilleure logique parce qu'elle est celle qui nous apprend le mieux à suspendre notre jugement» (BONNET, t. 6, p. 249)[8]. This amendment clearly appears in his later works more especially as the term "logic" is not used by him before this time, when logic becomes an important part of his thinking. Indeed, most scholars considered Bonnet as an authority for experimental logic, as Bonaventura Corti (MANZINI, 1988, p. 9) or Spallanzani (MANZINI, 1982, p. 51). The forward of the *Contemplation* is presented as an «essay de logique à l'usage du contemplateur de la nature» (BONNET, t. 7, p. XVI); and in the *Abrégé de l'essai analytique*, published in the complete works, Bonnet calls for a revolution of logic: «Il nous manque un livre qui seroit le plus utile de tous ceux qui peuvent sortir de l'esprit humain: ce seroit une histoire de l'attention. Si ce livre était bien fait et bien pensé, il ferait tomber toutes les logiques; c'est qu'il serait une logique réduite en action» (BONNET, t. 15, p. 53).

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[7] CONDILLAC (1822), t. 2, p. 254.

[8] We could also interpret the reception of the newtonian *hypothesis non fingo* as: «Je ne me précipite pas», close to the sense of «my ideas do not preceed my experience». *Hypothesis fingo*, is usually translated in the Eighteenth century scientific prose as «*avoir recours aux hypothèses*».

In Bonnet's texts the notion of hypothesis oscillates constantly between two meanings: first, that of a metonymy of a system, a basis for it, where hypothesis is considered as an element to be rejected: Bonnet pretends to «s'être élevé tant de fois contre l'abus des conjectures et des hypothèses» (BONNET, t. 15, p. 66). But in front of this negative judgment concerning hypothesis, there is also the idea that it constitutes a source able to fertilize scientific research: «Tournons-nous de tous les côtés, formons de nouvelles conjectures, enfantons de nouvelles hypothèses, mais souvenons nous toujours que ce ne sont que des conjectures et des hypothèses, et ne les mettons jamais à la place des faits» (BONNET, t. 5, p. 99). From this standpoint, hypothesis, if it can be useful, is not sufficient to create scientific activities.

A common point to these two ways of imagining hypothesis still is a temporal shape, which can be characterized by the fact of "coming before": It is anticipation, like prejudice, when negative, and imaginary creativity when positive. This could be a central notion located between the imaginary of the discovery and that of theory. And, in the methodological score, this temporal figure crosses precipitation, sharing its negative and positive aspects. As we have seen, to be in a hurry, is to remain in error, in the system, and outside the experience. A further testimony is this quotation by Bonnet that belongs to the Eighteenth century methodological speech, and could have been written by other naturalists: «Je voudrais qu'on soit moins pressé à chercher des objections contre une hypothèse, qu'à étudier cette hypothèse et à juger de l'enchaînement des principes sur lesquels elle est fondée» (BONNET, t. 16, p. 144).

Whether it is known that Bonnet supported hardly the preformationist system, in his metaphysical writings such as the *Palingénesie philosophique*, the *Recherches sur le christianisme*, or the *Philalèthe*, equally he defends a scientific shaping up of the Christian doctrine by probabilities and hypotheses. In this framework the rhetoric of the hypothesis is associated with that of probability, carrying out in this way a kind of metamorphosis of its temporal figure. Therefore, the anticipation will turn either to the future, or will be unified in a formal intuition, which tends to eliminate time. How does all these works? Thanks to the characteristics already emphasized: a) division of certainty considered as a formal whole, b) equivalence between the possible and the experience, c) building of a quantitative scale regulating the passage from facts to their formalization. Consequently, faced with these two manners, the positive and the negative, to consider hypothesis as an anticipation, probability appears as the ideal concept to forge a new logic of hypothesis, approaching its modern definition, i.e. a heuristic step in a normative-deductive system.

When Bonnet writes, for example, that a «hypothèse est d'autant plus probable qu'elle explique plus heureusement un plus grand nombre de phénomènes» (BONNET, t. 16, p. 329), hypothesis has left the temporal figure carried along, tied to the system. Almost synonymous to "theory", it is thus in relation to the phenomenons, by means of an illusion of quantification. So the probability of hypothesis constitutes a still empirical endeavor to create a system of equivalence more or less strict between a fictive quantification of the phenomenons and the validation of the theory. As a consequence,

the temporal figure of the hypothesis is no longer that which is found "before" the phenomenons, anticipating them by prejudices linked to the system, but it is the figure of the *a posteriori*, showing the labor of experience on the matter of hypothesis. During this journey, hypothesis has crossed the present, situated rather *before it* in the beginning of the century, and *after it* at the end. Bonnet seems to have felt reflected common conceptions, having applied "hypothesis and probabilities", as he writes in his correspondence with Albrecht von Haller, in order to convert the atheist (SONNTAG 1983, p. 828)[9]. For a system, in order to be credible, might change the shape of its presentation, going from an *a priori* dogma to the flexibility of the *a posteriori*. This transformation of the temporality of hypothesis is not typical of Bonnet. One could find it, in almost similar words, in the writings of scholars or philosophers from the 17th, where the use of hypothesis permitted to shift from the context of discovery to that of justification (LAUDAN, 1981, p. 24; for a critic, see ROUX, 1996, p. 333sq.). Some philosopher of the Enlightenment, like Hume or Boullier, used probabilities against the theory of the animal-machine: «les phénomènes de cette espèce (..) après avoir passé par toutes les épreuves que j'ai marquées, seront si rares qu'ils ne formeront en faveur de l'hypothèse des brutes qu'une probabilité très légère» (BOULLIER, 1729, p. 400). This conception belongs to the linguistic and conceptual culture of the century shared by scholars, as shown by DASTON (1995). It is therefore difficult to find in probability the only unifying basis for the Eighteenth century rationality. Actually, the probabilities do not justify the procedural technologies implied in the practice of experiment, they do not explain the construction and the complexity of the methodological lexicon, which reflect the share of scientific disciplines in continuous evolution. In Bonnet's case, the methodological lexicon of the 18th century portrays a relatively hazy semantically and disciplinary outline (RATCLIFF, 1996). Let us consider the meaning of the term "physicist" up to the French Revolution: it means "experimenter" but will change progressively, related to various transformations, such as the development of Lavoisier chemistry, the institutional changes dependent of the French Revolution, the evolution of naturalist thinking, and the separation of biology from physics. These social and scientific factors lead to the modern meaning of the term "physicist". The notion of hypothesis does not escape this evolution, which is much more general and complex. By changing partly the temporal figure of its meaning, it follows also a general tendency by which the expressions of the lexicon become more abstracts, more decontextualized: for instance, the French term "fonctionnement" is used not quite in French Eighteenth century (GOHIN, 1903), but will be abundantly employed from the beginning of the following century.

The «doctrine des probabilités et de l'hypothèse» will most likely have taken a part in this evolution, typical of the second half of the 18th century, when strong

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[9] Letter from Bonnet to Haller, 25 July 1769.

tensions slowly brought the concrete language of the experimentalism to a level ever more abstract. The meaning of "hypothesis" in the context of probability is not far from that of "theory". Possibly for that reason, the notion of hypothesis will be forsaken with the Positivism giving, like the Restoration, its patents of nobility to determinism and scientific certainty.

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RÉSUMÉ

LES PROBABILITÉS DE L'HYPOTHESE DANS L'ŒUVRE DE CHARLES BONNET (1720-1793)

Cet article étudie le langage de l'hypothèse et des probabilités dans l'œuvre du naturaliste et philosophe genevois Charles Bonnet. Dans ses travaux de jeunesse (1745-1754), largement dédiés à l'expérimentalisme, il n'utilise pratiquement pas ce langage, alors qu'il l'emploiera dans ses œuvres de maturité (1762-1783). L'article rapporte l'émergence de la "doctrine des hypothèses et des probabilités" tant au langage des savants du XVIIIᵉ siècle qu'au projet bonnetien de fonder une logique pour l'expérience.

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