Refrain from standards? French, Cavemen and Computers

A (short) story of Multidimensional Analysis in French Prehistoric Archaeology*

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In 1981, Françoise Audouze and André Leroi-Gourhan published a critical overview of the evolution and current state of prehistoric and classical archaeology in France. This paper had an explicit message, summed up in its title, "France: A Continental Insularity" [1]. According to the authors, this insularity was mainly due to the weak theoretical developments in French archaeology compared to English-speaking archaeology. The New Archaeology had been flourishing in the US and the UK since the beginning of the 1960s. Pioneered by Lewis Binford [2], the novelty of this archaeology lay in an ambitious scientific strengthening of the discipline. Controlled sampling, statistics and the use of models were considered the best ways to reach this aim, and prehistorians tried to standardize their implementation into the archaeological processes. Françoise Audouze and André Leroi-Gourhan emphasised that, in contrast, French archaeology during these decades was characterized by weakness in theorization and formalization. Insularity is a matter of boundaries, and, therefore, I propose to examine their definitions, starting with attempts at formalization.

Multidimensional analyses (MDA) presents some good characteristics for this study. These methods aroused a renewed interest in the field of statistics during the 1960s and 1970s. In France, Jean-Paul Benzecri's *Analyse des données* [3] provided a whole range of complementary and articulated methods for (di)similarity measurement, classification and the graphical synthesis of datasets [4]. In archaeology, these methods appeared to be the most powerful and modern method to deal with data. In some ways they can be considered as characteristic of the New Archaeology, since the first factorial analysis application was performed by Lewis Binford [5]. I aim to focus on this set of methods, but in a country where the New Archaeology has not been so influential: France.

This raises an important underlying question. In his *Domestication of the Savage Mind* [6], Jack Goody showed how lists and tables were interlaced with the development of the first Middle East writing systems. He considered them as graphical technologies and stressed their cognitive consequences

[1] Audouze and Leroi-Gourhan 1981.
[2] Binford 1962.
[3] Benzécri 1973.
[4] Namely: (Multiple) Correspondence Analysis, Multidimensional Scaling, Principal Component Analysis, etc. Benzecri among others: I.C. Lerman, M. Jambu...
[5] Binford 1966.
[6] Goody 1977.

for human evolution. However, Goody's innovative study only took into account data structures with one and two dimensions: lists and tables respectively. What happens if the number of dimensions increases and becomes theoretically unlimited? In a very early reflection concerning applications of Principal Component Analysis in archaeology, the French archaeologist Jean-Claude Gardin emphasized the specificities of archaeological data compared to linguistic or ethnographic data: a large amount of data which are non-linguistic [7] and partially non-numerical. Examining PCA applications, Gardin stated that "the result is evidently a sharp increase in the combinatorial complexity of the problem, which is likely to exceed the computing power of the human brain" [8]. However, he focused on conceptual issues and did not consider a potential increase in computational power. This increase would happen in the following decades, solving this complexity and providing graphical analysis for n-dimension vector spaces.

The cognitive and social consequences of this new possibility will be our concern here, based on the French prehistoric archaeology case. According to Alberto Cambrosio and Peter Keating, the way a scientific practice acquires an institutionalized form –becomes a discipline– is part of what they call the "disciplinary stake" [9]. They claim that the notion of "discipline" involves a concept of identity and boundary control, in order to preserve them against the danger of heterogeneity of methods and concepts [10]. What happened in France when MDA, both a new standardized metrology of similarity and a graphical synthesis method, were integrated into the prehistorical archaeology discipline?

To address these questions, I shall combine three kinds of materials: interviews conducted with protagonists in the field; a bibliographical review of the *Bulletin de la Société préhistorique française* (BSPF) [11] which published 1,323 papers between 1977 and 2005, including 32 presenting an MDA; and lastly,a citation network surrounding these 32 target-papers.

My aim is to show (1) that MDA were carried out by a new kind of actors in this field, who challenged the previous common language shared by prehistorians. This fundamental change was important, considering that (2) language is a fundamental point for the epistemology of archaeology. However, a comparison of MDA applications over time shall make clear that the differences are mostly a generational matter: the transmission processes between them will be addressed (3).

[7] In the sense that the archaeological findings are materials and not verbals.

[8] Gardin 1965, p. 20.

[9] Cambrosio and Keating 1983.

[10] Keating et al. 1992, p. 399.

[11] Based on interviews, I assume that this journal can be considered as typical of the main trends of French prehistoric archaeology on this period. This field is faintly internationalized, as shown by the dominant majority of French-written papers.

1 How to be radical innovator in the archaeological field

1.1 Innovators' portraits

Due to its complexity, performing an MDA requires technical skills which were initially not available in the archaeological field. Let's start by sketching the scientific career of some of the main introducers of these analyses in prehistoric archaeology. François Djindjian (1950–) was studying engineering when he applied for the first time to a faculty of archaeology. He got his PhD (1981) with a dissertation concerning computer applications in prehistoric archaeology. He conducted a career both as an engineer and firm manager and as a prehistorian, and got a position of associate professor in Paris. His co-author Bruno Bosselin was also an engineer. Georges Sauvet (1941–) is Janus-faced. He carried out a career as a chemistry professor in a Parisian university and, separately, developed his own researches about prehistoric rock art. He published numerous papers and acquired a full legitimacy in this field of studies. attended Benzecri's seminars at Jussieu university in Paris. François Djindjian, notably, completed a *maitrise* degree in statistics under his supervision. Some distance from Paris, in Southern France, both Jean Lesage (1923–2004) and Michel Livache (1944–) undertook pioneering MDA applications in prehistoric archaeology. The former was recruited by the Cnrs [12] in 1965 as a prehistorian specialized in Meso and South America Prehistory. A painter, amateur astronomer and prehistorian, he added statistics to his broad range of interests. Starting in 1971, he decided to undergo his "recycling" in statistics and began to train himself seriously, making contact with specialists in the domain. Michel Livache was one of the key-figures of the *typologie analytique et structurale* group of researchers led by Georges Laplace. This movement had its roots in the method developed by Georges Laplace [13], in which statistics assumed a central role. This group remained in an outside position in the archaeological field. Michel Livache was an elementary school teacher and provided important contributions to this group; he notably learned programming by himself and wrote *typologie analytique* computer implementations. All of these researchers were situated in interstitial institutional and cognitive locations, somewhere between engineering, applied mathematics, applied chemistry and archaeology. Only Jean Lesage held a professional position as a prehistorian.

1.2 An aptitude for mobility

This interstitiality was balanced by a proficiency in mobility, an aptitude for gathering resources from different locations, peoples and instruments. In 1972, Jean Lesage did an internship in the *Centre d'analyse documentaire*

[12] French National Centre for Scientific Research.
[13] Laplace 1966.

pour l'archéologie (CADA) founded in Marseille by Jean-Claude Gardin and then led by Mario Borillo. He benefited from the proximity between the CADA and the *Centre de physique théorique* (CPT), which made it possible for him to perform analysis on his Mexican lithic tools dataset. This laboratory had at its disposal a terminal connected to the Orsay University's (near Paris) UNIVAC 1108, a powerful computer machine. The combinatorial complexity of MDA required this kind of uncommon machine; to get access to them entailed creating the necessary social relations. On his side, François Djindjian treated his datasets on Saturdays for several years at the *Centre Inter-Régional de Calcul Électronique*, (CIRCE) at Orsay; Michel Livache collaborated with a young statistician, recently hired at the new University of Pau, in order to analyze Chinchon site's lithic industry by MDA [14]. Such examples could easily be multiplied. Let's consider the 32 BSPF's papers, related to 43 authors in total. The collaborations between prehistorians and specialists from other fields (statistics and environmental studies) happened mainly during the 1970's and 1980's. Taking only the authors into account would miss an important point concerning the notion of authorship: the person who performed the MDA could sign or not sign the paper, be mentioned in endnote or not. The period doesn't matter concerning this point.

Dealing with the formal expression of archaeological data pushed archaeologists to develop international scientific collaborations. For instance, François Djindjian was for several years one of the few French prehistorians who participated in the Computer Applications in Archaeology Conference, the most important international conference devoted to this topic. Michel Livache belonged to the *typologie analytique* group, which gathered archaeologists from France, Spain and Italy each summer in Arudy (a village in the Pyrenees Moutains) from 1969 to 1988.

1.3 Generic devices and legitimacy

Thus, the innovators are characterized by their abilities in both natural and formal languages. This general competence in communication had its materialization in their close relationship with generic devices. Like multidimensional methods, such devices are not especially designed for a particular problem but are theoretically considered to be applicable to a broad range of questions.

We mentioned the requirement of computation centers for the realization of MDA. At the end of the 1970s, personal calculators became affordable, while personal computers appeared in the 1980s. Jean Lesage, Georges Sauvet, Michel Livache and others wrote their own softwares to perform MDA. Their code, written in BASIC or FORTRAN, passed from hand to hand among the archaeologists.

Once they acquired the skills to practice the *Analyse des données* methods, these researchers multiplied the application fields. For instance, in 1999,

[14] Brochier and Livache 1978.

Bruno Bosselin and François Djindjian performed a multiple correspondence analysis on both sedimentologic, palynologic and palaeontologic data together [15], even though none of them had any specialized skills in these fields. On his side, Georges Sauvet co-published several papers with a linguist. The software tools they developed were adapted for both archaeological and linguistic datasets. Contrary to Gardin's view mentioned in the introduction, the idea here was that the nature of the objects did not particularly matter: MDA could be performed as long as it was a question of distance measurement between a set of objects. This underlying belief was encouraged by Jean-Paul Benzécri himself about his *analyse des données* methodology and denounced as *benzécrisme* [16].

1.4 An emphasis on metrology

This vigorous integration of measurement in the archaeological processes to discriminate artifacts could serve two kinds of strategies. Classifying and defining the most efficient typology were the main concerns of French prehistoric archaeologists from the 1950s to the 1980s. The main typological system was proposed by François Bordes [17], Denise de Sonneville-Bordes and Jean Perrot [18] and then challenged by Georges Laplace, who contested its intuitive basis in typologie analytique [19] .

The use of MDA was, on the one hand, to defend the validity of previous typology. This was the case in the works of Jacques-Élie Brochier and Michel Livache: a correspondence analysis demonstrated that the C stratigraphical level of Chinchon does not belong to the Magdalenian IV chronological phase but to the Tardigravettian [20]. On the other hand, some authors used this analysis to criticize the old typologies and to build a new one in a more explicit and rational way. André Chollet (a pharmacist), Pierre Boutin and Basavanneppa Tallur (a statistician) claimed that "rather than using a predetermined system of analysis, such as that of Georges Laplace, it seemed interesting to use the analyse des données techniques to try to identify partitions in this set." [21]. They finally concluded that the MDA fitted with the Sonneville-Bordes' typology. For their part, François Djindjian and Bruno Bosselin made a revision of the Laugerie-Haute stratigraphy, an important Paleolithic site. The MDA led them to propose a new typology and a new division of the Solutrean phase [22].

[15] Bosselin and Djindjian 1997.
[16] Dreyfus 1975.
[17] Bordes 1950.
[18] de Sonneville-Bordes and Perrot 1953.
[19] Laplace 1966.
[20] Brochier and Livache 1978.
[21] Boutin et al. 1977, p. 363, my translation.
[22] Bosselin and Djindjian 1997.

1.5 A framework for 20th century organization of research

Terry Shinn proposed a framework to characterize an aspect of the 20th century's "radical" innovation in scientific activities that he called "research-technology" [23]. The same features that we previously mentioned are seen as characteristics of this research mode: to be carried out in interstitial areas, to entail generic devices, and to have strong concerns with metrology. Most of the sociological approaches (Merton, Ben-David, Abbott) look at science at the discipline level and stress differentiation processes. The "new" sociology of science has claimed an ethnographic perspective on science and adopted a rather anti-differentiationist perspective on science, between the social and cognitive dimensions. But anti-differentiationism does not imply attention has been paid to integration processes, as Terry Shinn pointed out.

The prehistorians I refer to were involved in two kinds of integration processes. On the one hand, they introduced a new way to present, shape and analyze the archaeological data. They developed a twofold discourse. They proclaimed the power and the necessity of these methods, but they advocated an epistemically careful use of it. In this way, they tacitly included themselves among the few able to use them properly. On the other hand, they were able to cross disciplinary boundaries in order to collaborate, especially with foreign researchers. Considering this twofold advantage and control over languages, we are led to further examine the epistemic role of language in prehistoric archaeology.

2 Multidimensional patterns and the problem of intentionality

Taking into account formalized languages, in addition to the natural ones, is of particular relevance because of the particular status of linguistic facts' in archaeology. Archaeologists deal with remains of phenomena which imply a language ability, but the content of this language is definitely lacking in an archaeological site.

This lack can be conceptualized as an incompleteness of the empirical data, compared with those available for the historian or the sociologist. Such an incompleteness can be compensated, depending on the author, by the use of analogy, interpretation, or identification of statistical trends. In this perspective, archaeology is mostly a way to get an understanding of the meaning of material remains and to draw a restitution of the past. Let's call this a semantic-oriented archaeology.

In another way, this lack can be seen as an epistemic feature of the archaeological arguments' construction. In this perspective, interpretation is severely criticized and a strict control on archaeological enunciation is re-

[23] Shinn 2005, p. 735.

quested. The aim of archaeology is, here, the study of the transformations of a set of artifacts over time. Let's call this a syntactic-oriented archaeology.

Donald Kelley pointed out the importance of language for the history of science by suggesting that a discipline could be considered as a speech community [24]. In this section, I aim to show the various epistemic roles assigned to the MDA, and the ways the consecutive generations of researchers considered these roles. An MDA is a pattern-finder method. The controversial point concerns what can be said about an identified pattern. Thus, we could distinguish the epistemic roles according to whether one aims to deal with the syntactic aspect or the semantic aspect of an archaeological dataset [25].

2.1 Multidimensional patterns and syntactic interest

Most of the oldest papers showing a MDA expressed a very careful attitude regarding the meaning of the results. A pattern identification was considered, so to say, as a result in itself, and the limitations of the methods were underlined, as here, for instance:

> In the present state of research, they [the MDA] do not provide an "automated sorting machine"; their primary role concerning typology is rather to highlight the structure of a dataset and to allow comparison of related sets later. [26]

In a later paper, Bruno Bosselin and François Djindjian [27] expressed their doubts about any interpretations of their *Analyse des correspondances* in social or psychological terms. The distance measurements and the factorial structure were supposed to be related primarily to an archaeological data structure, and not directly to a psychological or social past reality. This concern was also of central importance for the archaeologists who took part in the *typologie analytique* group, such as Jacques-Élie Brochier and Michel Livache. The emphasis was on issues of methods, and psychological or social interpretations were either considered as a secondary concern or not treated at all.

2.2 Multidimensional patterns and semantic interest

A second kind of papers showed an increasing interest in the semantic aspects rather than in the syntactic aspects of the patterns produced by a MDA. In this perspective, a factorial structure was considered, somehow, as a remaining consequence of a past intentionality. This intentionality was

[24] Kelley 1997, p. 13–28.

[25] I shall introduce a difference between the syntactic/semantic orientation of the question raised, and the syntactic/semantic orientation of the method that is used for this purpose.

[26] Boutin et al. 1977, p. 375, my translation.

[27] Bosselin and Djindjian 1988, p. 304–331.

interpreted as proceeding either from a collective intentionality or from a personal intentionality.

Georges Sauvet and Suzanne Sauvet [28] performed a multiple correspondence analysis on a prehistoric rock art dataset in order to explain the spatial distributions of the motifs. They claimed that the factorial structures revealed an underlying semiotic system, which is a way to combine both collective and individual levels of action without referring to psychological concepts.

A 1982 study by André Decormeille and Jacques Hinout is of interest here, in that they combined explicitly collective and personal intentionality. Their aim was to discriminate among the various Mesolithic lithic artifacts from the Parisian region.

> A correspondence analysis, eventually followed by a cluster analysis, helps to show the population unity or its multiplicity for a given site and to precise the features of the standard tool, [...] a virtual armature whose features equal the mean of those of a given population. It represents the ideal image of the tool that the Mesolithic men suggested themselves to produce. [29]

> It is indisputable that the first factor indicates a significant gap between the north and the south of the Paris basin and the nature of this gap is cultural. [...] In conclusion, it is clear that the results obtained demonstrate the power of the method used. [30]

MDA has been used here to fill the gap between the material remains (their proper individual features), an aggregation of individual stone knappers and a holistic entity (here a culture).

Thus, an interest in the semantics of the dataset appeared in some early works. It became predominant in later papers. For instance, Bruno Bosselin aimed to distinguish between "primary intention productions" and "derived intention productions" [31] based on the results of a multiple correspondence analysis. The pattern identified was supposed to show the distinction between the tools (what the knapper wanted) and the refuse (what he did not want). Papers published in the 1990s and later presented less frequently the previous methodological concerns: the presentation of the analysis (which algorithm was used, by who?) became less detailed if not lacking, as if this method had become transparent. This phenomenon was described as the black-boxing of an instrument [32]. But how to explain the strengthening of interest in the identification of personal intentionality and the relative dismissal of the methodological concerns? Let's take into consideration the reasons why some researchers moved away from MDA.

[28] G. Sauvet and S. Sauvet 1979.

[29] Decormeille and Hinout 1982, p. 83, my translation.

[30] Decormeille and Hinout 1982, p. 88.

[31] Respectively, "produits de première intention" and "produits d'intention dérivée". My translation. Bosselin 2001, p. 624.

[32] A notion popularized by Latour in Latour 1987.

2.3 MDA under prehistorians' criticisms

François Djindjian had a close relationship with Jean-Paul Benzécri, whose seminar he followed, and he graduated in statistics under his direction. However, he finally opposed his master on the epistemic role and objectivity of the method. Contrary to Jean-Paul Benzécri, François Djindjian argued for the necessity of a data structuration prior to the performance of a correspondence analysis. In the following years, he developed such a method, dedicated to archaeological applications.

Catherine Perlès also followed Benzécri's seminar and attempted some *Analyse des données* applications on lithic remains. However, she moved away this method, but for a different reason than Djindjan's. According to her, the inferential and non-hierarchical perspective was more of a disadvantage than a benefit. She considered the capacity to hierarchize as a natural competence. However, because of its non-hierarchical basis, the MDA would miss the prehistoric intentional facts. Thus, she turned to the technological study of lithic tools.

In her research on Neolithic stone artifacts, Vanessa Léa scrutinized the concept of "tool". According to her, the shape cannot be deemed as a sufficient criterion to identify a tool, considering the morphological variability of the artifacts that she analyzed. To solve this difficulty, she turned also to other methods, namely the technology analysis, related to the production of the tool, and the use-wear analysis, related to the use and function of the tool. Doing so, she preserved her research question –the tool– but at the cost of a change of method and a redefinition of the relevant features to analyze.

2.4 Results

In archaeology, the identification of intentionality raises a more salient and fundamental problem than in other sciences devoted to anthropic phenomena, in which it is assumed that intentionality could be considered as a non-ambiguous fact. As Arkadiusz Marciniak [33] pointed out, each theoretical view in archaeology is located somewhere between an assumption of reachability and the assumption of unreachability of past intentions based on the study of material remains.

I suggest that MDA appeared as a hope to overcome the gap between prehistoric intentional facts and material remains observed in the archaeological field. By the combination of a huge quantity of data and the quick and automatic extraction of its very structure, it was as if it was possible to reach the inner syntax of a set of archaeological artifacts. This method gave hope of reaching the unreachable: as if the syntax resulting from a formal language would have been an approximation of the structure of a collective or personal past intention.

However, this belief was not broadly accepted. Even if during each decade

[33] Marciniak 1998, p. 416.

Object / method	Natural language	Artificial language
syntactic	Empirical typology	*Typologie analytique*
semantic	Technology	Synthetic lineage

Table 1: Trends of research in French prehistoric archaeology.

some exceptions appear, I propose to summarize this historical evolution. I have introduced a distinction between syntactic and semantic orientations concerning the archaeologist's query. I suggest the application of the same distinction concerning the methods used to reach this aim, according to whether they used a natural or an artificial language [34]. Table 1 organizes the trends of research in French prehistoric archaeology from the 1950s to the 2000s.

"Empirical typology" includes works by both François Bordes and André Leroi-Gourhan. Leroi-Gourhan has clearly expressed a syntactic interest, for instance:

> Techniques are at the same time gestures and tools, organized in sequences by a true syntax which gives to the operational series both their stability and their flexibility. [35]

"*Typologie analytique*" and "Synthetic lineage" were most related to the integration of MDA into the prehistoric field. A syntactic-oriented method, such as MDA, does not imply an aim of knowledge oriented toward the syntactic aspect of the data. Finally, the latest orientation, namely technology studies, turned again toward a method relying on natural language. Let's assume that this periodization is relevant and that we have such "generational paradigms", following Andrew Abbott's words [36]. How can we explain the genetic differences between each generation? What kinds of transmission processes bound or divided them?

3 Intergenerational boundaries and the transmission of methods

Citation analysis [37] is a way to study transmission processes at a larger scale of analysis. A citation network which surrounds the 32 papers published

[34] In practice, this distinction is quite ambiguous; Gilles-Gaston Granger pointed out a "formalist illusion", according to which the syntax could function without any relations with the semantic level: Granger 1967, p. 59.

[35] Leroi-Gourhan 1993, p. 114.

[36] Abbott 2001, p. 59.

[37] This is a long-standing used method and its limits are well known. For an overview that dates back to the 1970s, see Chubin 1976.

in the BSPF [38] from 1977 to 2005 has been obtained from Google Scholar [39]. It counts 2589 edges (citations) and 2112 vertices (papers). Assuming that to cite a paper reveals a cognitive interest for it, where are the MDA-based papers located in the archaeological bibliographic field? What kinds of relationships did they developed over time?

To start with, a basic observation can be made regarding the relationships among the 32 target papers. Without consideration for the chronology, 15 papers among the 32 have a tie with at least one other. From a bibliography standpoint, around half of the multidimensional applications were done without referring to papers which had a similar interest. Among the connected papers, three groups can be distinguished: a cluster of pioneering applications (including works by François Djindjian and Georges Sauvet), a cluster of papers concerning the Mesolithic period (including works by André Decormeille and Jacques Hinout, who we mentioned) and a cluster constituted only by the self-citations between papers co-authored by Bruno Bosselin and François Djindjian. This network is faintly connected. We shall conclude that the BSPF in itself was not an especially favorable publication space for the development of MDA. There was a need for editorial spaces devoted to computer applications in archaeology: small journals were created for this concern, but remained confidential (for example *Archéologues et ordinateurs*). More generally, this lack of editorial space helps to explain the low diffusion of MDA in French archaeology.

If the target papers themselves are not especially bound together, what about the references related to the MDA bibliography? Considering that the pioneering archaeological applications of such analysis cited publications which specialized in statistics, what can be said about the transmission of this indexation? To answer this, I built for each year a network including: 1) the ties created during the year considered and directed toward a target paper, 2) the methodology references cited by the target and, if it is the case, also by the level 1 papers. Did the papers that cited a target paper also cite its methodology references? Formally, this can be answered by a measurement of the network transitivity for each year. Figure 1 shows clearly a dual phenomenon of disconnection of the archaeological literature from the methodology references.

Starting from around 1995, the number of methodology references decreased and the transitivity score fell and stayed at zero. This result strengthens our previous observation concerning how the authors of the MDA receive less, or no, mention over time. This can be seen as evidence of integration of the method into the archaeological field. However, this integration has to be nuanced: the transitivity score, even before 1995, has never been very high: either the prehistorians have become so qualified with regard to

[38] My sample is built from just one journal; however, I assume that this journal is central enough in this field to give access to a significant part of the literature.

[39] Google Scholar's indexation appears as the best approximation, especially for this kind of French-written literature characterized by a low citation and diffusion rate.

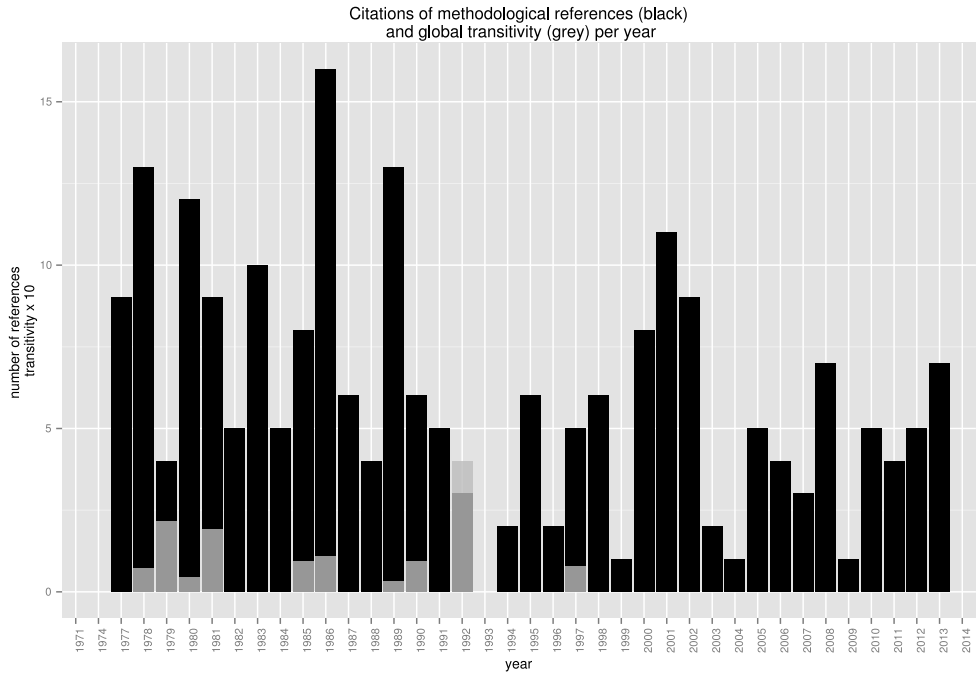

Figure 1: Citations of methodological references (black) and global transitivity (grey).

MDA that they were able to disregard the relative literature, or they simply neglected its methodology.

This is mostly a matter of education, which is the other main vector of transmission in scientific activities [40]; however, it cannot be reached by the sole citation analysis. There were two principal ways to gain the competency to perform a MDA: a quite informal teaching from one person to one, let us call it dyadic transmission; and the institutionalized frame of transmission, for example lectures or summer schools.

Dyadic forms of transmission mainly appear for contingent reasons due to the personal network of a researcher. For instance, in the 1990s, Jean Lesage welcomed into his own home and personally helped a young prehistorian throughout his thesis. The second form appeared often in quite marginal academic spaces: the *séminaire de typologie analytique*, previously mentioned; the "European Summer School" organized by François Djindjian in Valbonne and Montpellier (1981 and 1983) or the seminar he led at the *École Normale Supérieure*, starting in 1985.

[40]For a dynamic modelization of the development of a scientific specialty, where education and publications have a key-function, see: Mullins 1972.

4 Conclusion

In this paper I have explored three lines of evidences to shed light upon the integration and reception of MDA in French Prehistoric archaeology. I reintegrated the history of this set of methods into the main trends of development in this field. The role of a particular type of protagonist, the combination of these analyses with the fundamental issue of archaeology –through the case of intentionality– and, lastly, the bibliographic structure of their reception were considered. The promotion of MDA was part of a broader call for a rationalization, a standardization and an explication of the reasoning of French archaeology. What changes did this integration induce into this field?

Since Kuhn's Structure of Scientific Revolutions, a classical explanation of scientific change is a paradigm shift which occurs when too many anomalies are raised in the normal science: consequently a differentiation process takes place. This explanation may be appropriate when it comes to physics but it might not be relevant for prehistoric archaeology. An "anomaly" set, which would have been inconsistent with the morpho-typological framework, never emerged. I suggest here that the integration of the Analyse des données and then the lack of interest about it should be explained by some more contingent reasons, related both to the structural and the biographic dimensions of scientific activities. Terry Shinn's "research-technology" framework for 20th century science seems to be relevant to explain the intervention of the innovators who introduced multidimensional analysis, thanks to their abilities to move between several interstitial areas and to reach the prehistoric archaeology field. Rather than anomalies, we should speak here of a cumulative replacement of questions, what Andrew Abbott called "object inflation" in the field of sociology [41]. He proposed a dynamic model in which discipline development is moved by a fractal process of lineage differentiation at each generation. In these cycles, steps of division and conflict among lineages can be followed by an ingestion process: the victorious lineage integrates the questions and methods of the defeated lineage. Such a model can now be proposed, based on what we have learned from the MDA applications case in prehistoric archaeology (Figure 2).

In the decades following the Second World War, the morphological approach was the main trend for lithic artifacts studies. From the end of the 1960s on, proponents of an analytical typology opposed the natural language-based and intuitive methods of the previous generation. However, the first lineage resisted and became hegemonic. Some aspects of the analytical branch were remapped and integrated: formal methods were considered as a potential way to capture collective intentional facts. This dominance was then challenged by a flourishing lineage, which promoted a technological analysis from the mid-1970s on. The newcomers criticized the morphological approach for being limited to aggregated phenomena (culture, society) and

[41] Abbott 2001.

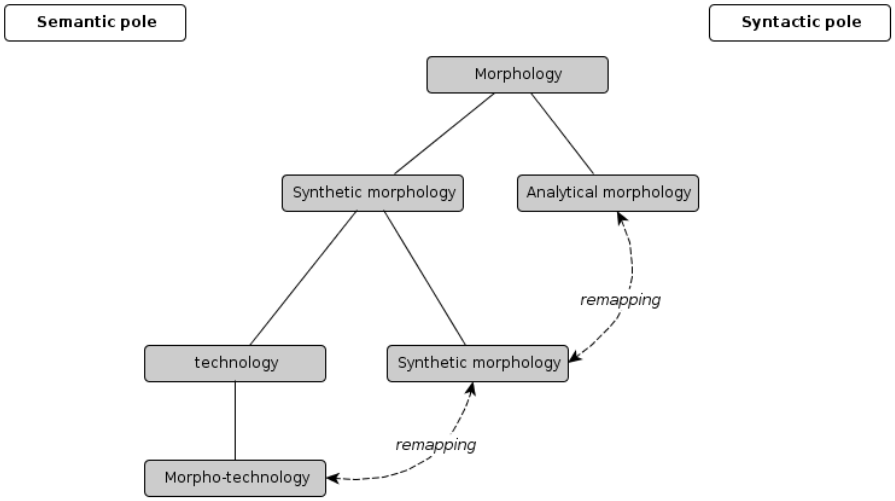

Figure 2: A model for the development of prehistoric archaeology

for missing the personal dimension of prehistoric life. Rooted in Leroi-Gourhan's palethnology, the technological approach aimed to reach the culture and, above all, the "man behind the tool". It became in turn the dominant trend in the mid-1980s, and after a while integrated some features of morphological analysis. A proper lithic study was then supposed to combine both of these analyses. In this paper, little space was given to another important lineage, since it was not as related to the formal methods, namely the functional (use-wear) analysis and the recently flourishing archaeometry [42].

Does it mean that nothing changed following the integration of MDA? Writing the history in which he took part, François Djindjian did not hesitate to label the 1970s as a "Golden Age" [43]; for his part, British archaeologist and statistician Mike Baxter claimed that most of what has been done since this decade has never been of such radical novelty [44]; Jacques-Élie Brochier, a former *typologie analytique* promoter, criticized his colleagues' lack of rigor in their data analysis treatments [45]. Obviously, summing up the consequences and the legacy of an intervention into a scientific field is also a matter of self and generational legitimation. Indeed, Abbott's view on scientific evolution challenged the very notion of cumulativity regarding social science knowledge; a genuine scientific breakthrough is likely to be found elsewhere, not in the claims for innovation that occur in each generation. As shown by Wiktor Stoczkowski, anthropogenesis narratives dating from the 16th to the 20th centuries can be reduced to a combination of a few elements [46]. Fac-

[42] Contrary to the English-speaking custom, archaeometry in France includes mainly physical and chemical analysis of archaeological remains and far less the data computation.
[43] Djindjian 2009.
[44] Baxter 2008.
[45] Brochier 2008
[46] Stoczkowski 2002.

ing this long-standing persistence, it is doubtful that any standardization attempt could ever radically change the deep (social) motives of prehistoric studies.

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