New Cognitive Data for Paleolithic Men: When Psychology Meets Archaeology

I. Saillot
Institut de Paléontologie Humaine, Muséum National d’Histoire Naturelle de Paris

We studied the functional chain of mammal process isolated on layer 5 Scladina cave, Sclayn, Belgium, which corresponds to a halt of chamois hunters during middle paleolithic (M.-H. Moncel, M. Patou-Mathis, M. Otte, 1998). Behavioural data is processed with a method from experimental cognitive psychology and especially the field of goal oriented actions: the elements of the analysis are the artefacts handled by prehistoric men on the site and the properties ascribed to the objects by these men. Objects and properties are linked through binary relationships, then processed by SIMBOL, a software developed at the IPH, after an initial publication of the Laboratoire de Psychologie Expérimentale of University Paris 8.

SIMBOL returns a graph of the task representation in memory leading to a rigorous description of the cognitive activities that occurred on the site. For the prehistorian, this method relies on the use of conceptual and methodological tools from goal oriented actions psychology and its main advantage is that these tools have been validated independently in their domain. We assume that it can allow prehistorians to clarify the current debates about ancient cognition, which so far lack common basis, authors usually using cognitive terms and theories without any reference to their scientific acceptions among psychologists.

The graph produced for layer 5 gives an instant view of the categorization process related to the subsistence behaviour of the men who occupied the site. A general view of human cognition will nevertheless be possible when enough data about various sites and periods is collected.

Certain steps of middle paleolithic behaviour are typical goal oriented actions
Goal oriented actions are the actions performed by a subject in order to achieve a goal, usually set by the experimentalist. Certain steps of the subsistence behaviour are typical goal oriented actions in so far as they lead to task performance (acquisition, processing), they are oriented by goals (to eat, to design tools), they’re based on the use of perception data (identification of animals, places, contexts, ethological, climatic or social meanings). To split some phases of the subsistence behaviour hence allows an interpretation of this behaviour in terms of categories and categorization.

On which methodological grounds is it possible? In fact, we assume that it is possible to investigate neanderthal man categorization process the same way ours is studied too, and this position is supported both by prehistorians and psychologists.
First, many authors have proved that neanderthal population had a cognitive level similar to ours. For M. Otte, M. Patou-Mathis (1992), the subsistence behaviour of neanderthal man would present such a complexity that it would already be possible to talk about modern type societies. Similar conclusions arise from studies about fishing at the same period (Maingeot, 1999). J. Pelegrin (1993) studies lithic artefacts and concludes that in lower paleolithic, a kind of operational knowledge is similar to that of modern man as far as technical skills are concerned. P.G. Chase & H. Dibble (1987), state that neanderthal man is not really different from us regarding his symbolic capacities.

Second, it is important to emphasize that what is dealt with here is not cognition from a general point of view, but the process of categorization. According to psychologists (J.-F. Richard, 1990), knowledge about objects is expressed by categories and categorization. To categorize is to create classes of objects and define the links between classes. The process of categorization is therefore shared by all vertebrates (Vauclair, 2002) and the attempt to modelize it is legitimate what species may be considered.

Building the action associative network of paleo-ethnological data

How-to-do knowledges can be seen as properties of objects as well as surface properties (Poitrenaud, 2001): procedural knowledge is a property of objects as well as shape, colour or size. For instance a pen is not only a long object with a mine but also something to write with. Knowledges about actions are structured in memory like knowledges about objects and can therefore be presented as associative networks. This point of view is particularly interesting for paleoethnologists: what treatment prehistoric artefacts underwent is often well known, especially in the case of middle paleolithic subsistence behaviour (Patou-Mathis, 1996).

So what has the paleopsychologist to do? His task becomes to split prehistoric behaviour into the objects found on the site and the properties they have been ascribed to by prehistoric men: this is a new definition of what paleoethnology already partially consists in, associated with a cognitive purpose.

When relevant paleoethnological data is selected, objects and their properties are put in a double entry table. When an object (usually some raw material) has a property, the intersection cell is checked. These tables are then computer processed to obtain a graph of the logical structure enclosed in the initial table. The graph is the associative network related to the cognitive task performed for subsistence purposes on the site. With this graph, the description of ancient cognition can start, according to cognitive psychology standards.

Computer processing is based on an algorithm that returns the simplified Hasse diagram of the Galois network generated by the object – properties combinations present on the site. Preliminary studies were achieved thanks to STONE software developed by S. Poitrenaud of University Paris 8, and the results obtained proved this new method to be valid.

For Sclayn, the study has been made with a new software designed at the Institut de Paléontologie Humaine: SIMBOL (Système Informatique de Modélisation par Buts et Objets Liés). Developed under Excel VBA, it uses the Galois network.
algorythm and traces the hierarchy of the double entry table, like STONE did.

The graph shows a tree structure with nodes and oriented arcs. Nodes display objects (letter o) and their properties (letter p), while arcs show the relationships between nodes. As each node is a set of objects - properties, it is a cognitive category, according to action psychology. The network not only displays categories used by prehistoric men on the site, but also the relationships between them: we attend the categorization process as it occurred during middle paleolithic.

**Spliting behaviour: objects - properties binary relationships**

Faunal remains are abundant at Sclayn and relatively well preserved (M. Patou-Mathis, 1998a). The chamois is the main species exhibiting anthropic marks, but other species have also been processed on the site, partially dealt with here (M. Patou-Mathis, 1998b). Rich zooarchaeological data led to rich paleo-ethnological results: man induced marks on the site yielded knowledge about the gestures they came from (M. Otte, M. Patou-Mathis, M.-H. Moncel, D. Bonjean, 1998) and even goals that commanded them. These goals and the objects with marks are the starting point of our analysis (M. Patou-Mathis, H. Bocherens, 1998).

The objects, i.e. bones, are identified here by their taxonomic origin, namely wolf, stag, deer, horse, rhinoceros, reindeer, chamois and a few other bones or fragments not precisely ascribable to a species. Selected goals are: extract fur and tendons (grouped together), meat and marrow (grouped together), prepare for tool, store, burn and use as symbol.

To discover the goals and intentions of Sclayn people cannot always be done with certainty and a large amount of zooarchaeological available data has nevertheless to be neglected. For instance on layer 5 many anthropic marks are striations, but it’s not possible to state firmly about the goal pursued. On the contrary it is easy to define the step of the processing chain where the marks occurred, but as each of these steps doesn’t consist in a goal in itself, the bones must be kept away from the data.

Table I presents the behavioral results suitable for our analysis. The selection criteria is the following: the object found on the site must be able to be replaced into the sequence of acts that led to the marks. In other words, the prehistorian must know how the object has been processed, either at the level of the elementary gesture, or at the level of the goal intended.

Table 2 presents the former data made compatible for computer processing with SIMBOL. The entry line includes the objects and the entry column the goals. When an object has a property, the intersection cell is checked. These tables are initially an Excel sheet directly processed by SIMBOL. See Table 2.

**Graphs by SIMBOL**

The following graph has been generated by SIMBOL. It returns the logical structure enclosed in the initial double entry table. Blue rectangles, the graph nodes, are sets of objects and properties, namely cognitive categories. The categories organisation is shown on the hierarchy, from the most specific ones (hierarchy source) to the most general ones (top of the lines), as indicated by the arrows on the arcs. Such a graph is an action associative network,
analogous to a semantic network for verbal data. Therefore it can be studied as any other cognitive networks with cognitive psychology methods.

Figure 1 is described and interpreted. The description is a standard psychological one and allows fruitfull debate between prehistorians and psychologists but also among prehistorians themselves, which is one of its main utility. Evolutionnist interpretations of the graphs are partially out of the field of cognitive psychology, though Piaget emitted many hypothesis regarding hominization processes. Hence the view that’s proposed here is left open to new investigations and as a matter of fact also to any suggestion. See Figure 1.

Graph description and interpretation

The graph superordonned category concerns meat extraction, its displays the greater number of objects and is the more general category of the associative network. Subsistence behaviour obviously aims at feeding and from this point of view, the former statement could resemble a tautology. This would be neglecting the fact that very early in prehistory, animals must have been considered as raw material sources, food being only part of it. As we have already emphasized, subsistence behaviour is far more extended than alimentary behaviour. In fact preparing bone tools or extracting furr are subsistence actions but not alimentary ones.

The graph underordonned categories concern symbolic behaviour and food storage. Very specific ones, they have a little number of objects. The hierarchy source is concerned with the most abstract categories, their abstraction level decreasing along with procedures specificity. In fact, intermediate categories dealing with preparation of tools, furr extraction or burning are very well documented for periods as anciant as lower paleolithic. Their abstraction level itself seems intermediate between the one of the categories before and after on the line. It is interesting on this graph to address the fact that the hierarchy could reflect the cognitive increase in complexity during hominization. Cognitive psychology is here a bit far from its basis, but the data here seem to display a structure compatible with an evolutionnist interpretation.

Some categories have less than two neighboors on the graph: the possibility of cognitive processes like meaning slides from a concept to another is low. According to D. Hofstadter (1995), these cognitive processes would allow mecanisms like analogy creation themselves permitting complex strategies like problem solving or group hunting. Layer 5 Scladina action associative network doesn’t allow to infer the existence of such cognitives processes, but no conclusion regarding Neanderthal men as a group could of course be drawn. Enhanced data volume is needed to start general studies in time and space, which could give insights into hominization as a whole.

Three categories are found close to each other, at the same hierarchical level. We suggest that they can be seen as a larger one enclosing them and regarding tools: similarity in their configuration suggests similarity in the cognitive processes underlying them. From this point of view, preparing tools, burning and extracting furr can be seen as various modes of one more general category consisting in preparing raw materials displayed by animals, especially large mammals.
On the graph, the category linked to a potential symbolic behaviour is isolated. It’s called an orphan category. Unfortunately, such a configuration is not very informative because what would be interesting to address is the relationship between a symbolic behaviour and the other parts of man activities. Of course, the fact that a category is present at least shows on the graph that the corresponding activity existed on the site, but strictly no new data is given compared to the initial double entry table, in this case.

The category linked to food storage for further use seem to underline important cognitive resources, according to its topographic position on the graph. It is hence possible to suggest that such activities were relatively new ones at the time of Sclayn people, and from an evolutionnist point of view. The place of the category dealing with burning bones could suggest that mastering fire could not be more complex than designing bone tools. For a broader view, what will be needed is a comparison between sites of different places and time.

**Conclusion**

This categorization study is going to allow to draw cognitive maps of any digging site rich enough in paleoethnological data. The associative network regarding prehistoric men behaviour should become a basic site information like other systematically investigated data (stratigraphy, datation, polens and so on). Recording action associative networks allows to draw comparisons between places and periods and even with ethnological data or of course modern experimental prehistorical techniques.

The method presented here has many limits. One of the most important ones is that its own data are already interpretations (of the digging results), coming from paleo-ethnology. So the quality of the primary step, namely digging is of crucial importance here and the paleo-psychologist must collect their data as accurately as any other specialist on the site.

**Author Notes**

I. Saillot can be reached at Institut de Paléontologie Humaine, Muséum National d’Histoire Naturelle de Paris, 1 rue René Panhard, F-75013 Paris. E-mail: saillot@mnhn.fr

**References**


**Table 1**

*Paleo-ethnological Data Selected for Cognitive Analysis*

<table>
<thead>
<tr>
<th>OBJECTS</th>
<th>GESTURES</th>
<th>GOALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>wolf phalanx</td>
<td>striations</td>
<td>furr</td>
</tr>
<tr>
<td>stag rib</td>
<td>striations</td>
<td>feeding</td>
</tr>
<tr>
<td>deer scapula</td>
<td>striations</td>
<td>feeding</td>
</tr>
<tr>
<td>deer calcaneum</td>
<td>striations</td>
<td>feeding</td>
</tr>
<tr>
<td>horse métapodiale</td>
<td>fracturation</td>
<td>feeding</td>
</tr>
<tr>
<td>horse long bone</td>
<td>striations</td>
<td>feeding</td>
</tr>
<tr>
<td>horse rib</td>
<td>striations</td>
<td>feeding</td>
</tr>
<tr>
<td>horse long bone</td>
<td>tool</td>
<td></td>
</tr>
<tr>
<td>rhino femur</td>
<td>striations</td>
<td>trophy</td>
</tr>
<tr>
<td>other chamois long bones</td>
<td>fracturation</td>
<td>marrow</td>
</tr>
<tr>
<td>chamois skull fragment</td>
<td>skinning</td>
<td>skin</td>
</tr>
<tr>
<td>chamois bone</td>
<td>skinning</td>
<td>skin</td>
</tr>
<tr>
<td>other bones</td>
<td>tendons</td>
<td></td>
</tr>
<tr>
<td>meat</td>
<td>meat drying / smoking</td>
<td>exportation</td>
</tr>
<tr>
<td>reindeer tibia</td>
<td>calcination</td>
<td></td>
</tr>
<tr>
<td>10 unidentified bones</td>
<td>calcination</td>
<td></td>
</tr>
<tr>
<td>skin</td>
<td>racloir processing</td>
<td>tool</td>
</tr>
<tr>
<td>long bone ongulae</td>
<td>tool</td>
<td></td>
</tr>
</tbody>
</table>
Table 2
Reconstruction of Binary Relationships Between Objects and Properties

<table>
<thead>
<tr>
<th></th>
<th>wolf</th>
<th>deer</th>
<th>horse</th>
<th>rhino</th>
<th>reindeer</th>
<th>chamois</th>
<th>other bones</th>
</tr>
</thead>
<tbody>
<tr>
<td>extract furr, tendons</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>extract meat, marrow</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>prepare for tool</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>symbol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>store</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>burn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 1.
Graph Related to Layer 5 Scladina Cave

Number of nodes or categories : 7
Number of relationships between categories : 5
Number of abstraction levels : 3
Number of close neighbors : maximum of 2
Most general category : extract meat
Most specific categories: symbol, store.