RECONSTRUCTING CULINARY CODES IN HUMAN EVOLUTION AND DECONSTRUCTING LEVI-STRAUSS ON COOKING AND CANNIBALISM

In his three volume *Mythologiques* and in other writings Lévi-Strauss (1966, 1969, 1973, 1978) identified and carried out an extensive structuralist analysis of a culinary deep structure underlying and informing social rules pertaining to cooking among new world hunter-gatherer and horticultural societies. These rules are posited as global for the sapiens species. Levi-Strauss also predicts that the structural oppositions in this code are revealed in the practice of cannibalism.

Shankman (1969) gives a well-reasoned critique of Lévi-Strauss' analysis and his prediction pertaining to cannibalism. Shankman summarizes Lévi-Strauss' argument. First, Lévi-Strauss argues that cooking is a language, and like language, has an unconscious structure constituted by binary oppositions. Second, he posits that cooking is structured by a "culinary triangle", namely 'raw versus cooked versus rotten', and that this involves a double opposition between "nature/culture" and "elaborated/unelaborated". Third, this abstract triangle, purely formal, is filled-in in practice with the oppositional contents "roasted/boiled", which correspond respectively to "raw/rotted". Fourth, he argues that, as a general rule, boiling is associated with in-group solidarity (endo-cuisine) and roasting with food served to guests (exo-cuisine). Finally, he predicts, roughly, that boiling will be associated with endocannibalism and roasting with exocannibalism.

Shankman argues that Lévi-Strauss' argument is faulty at each point. First, Shankman regards the analogy of cooking to language, which Lévi-Strauss explains in terms of a phonological triad, as theoretically confusing. Languages concern meaning. The triad is purely physical; phonetic sounds do not carry meaning. The analogy is not elaborated. Second, the oppositions such as elaborated/unelaborated and nature/culture seem arbitrary and methodologically unsound. Third, the explanation of the culinary code by abstract and concrete triangles, and their mapping on to each other is vague and even self-contradictory. Furthermore, major types of cooking, such as baking, smoking, and pulverizing are left out of the triangle. No decision criteria are provided as to which categories are included or excluded from the triangle. Fourth, the universality of the endo/exo-cuisine mapping onto social groups is not convincingly demonstrated.

Fifth, Shankman observes that Lévi-Strauss' definition of cannibalism excludes major types of cannibalism, including starvation cannibalism, antisocial--presumably also pathological--cannibalism, and ritual cannibalism for therapeutic purposes as well as cannibalism within the context of mortuary rites. Shankman then develops tables (*see below*) for endocannibalism and exocannibalism among 60 tribes around the world with respect to method of cooking. These tables, inevitably incomplete [and also questionable in terms of attribution given the context of colonialism and genocide--JH], are enough to suggest that among five tribes practicing both exocannibalism and endocannibalism similar methods, mostly roasting and baking, are applied to both enemies and relatives. Among tribes which practice either exocannibalism or

endocannibalism, exocannibalism is associated with boiling, especially in the Americas, or baking, in the Pacific, while endocannibalism is associated with bone ash, especially in the Americas, or roasting. It could also be argued from the data that exocannibalism and endocannibalism both share roasting. In any event, Lévi-Strauss' prediction doesn't stand up to these patterns. "Lévi-Strauss' general hypothesis--that oppositions in modes of preparing people reflects oppositions in social structure--is not supported by cross-cultural evidence." On the other hand, Shankman observes that this does not require us to abandon the search for parallels between language and cooking or their relations to social structure. I am in full agreement, especially since Lévi-Strauss' *Mythologiques* demonstrates that there is a highly complex culinary code at work in the myth, ritual, and table manners of peoples across the Americas. The problem is that Lévi-Strauss' decoding of deep structure is inadequate to account for his own remarkable findings.

I will now suggest a way to re-analyze and salvage the transformational formula of the deep structure of culinary practice. What's needed is a more rigorous group-theoretic mathematization of the deep structure of the culinary code. This will solve the problems that Shankman identified. Basically, Lévi-Strauss' formulation causes problems because it reduces a sixfold group-theoretic structure to a triangle and thus cannot comprehensively account for the full culinary code, which, as it appears from the evidence presented by Shankman, is indeed sixfold. [Lévi-Strauss (1978:484) is not unaware of the problem. "The existence of these deviant systems poses a problem. It suggests that the semantic field of recipes includes a greater number of dimensions than I indicated at the beginning of the discussion." He then suggests adding smoking as a third term to boiling and roasting. He also added fermenting in 1973 but did not consider it a fourth term.]

Here's how I suggest the culinary code can be better explained. The initial elemental terms in the transformation function should be mathematized thus:

Fx = raw
Fy = rotten
a = watery fire
b = fiery air

As Lévi-Strauss argued, the raw and the rotten are set over against the cooked, which is obtained by the transformation process of cooking. Rather than having to posit abstract categories such as elaborated/unelaborated or nature/culture, this function associates with each term of the opposition 'raw versus rotten' the opposition between two modes of thermal heating, namely something like 'watery fire' and 'fiery air'. (While these terms seem 'out of the blue', I actually back-derived them from the post-transformation functions of boiling versus roasted.)

Fx(a) = raw + watery fire = **raw**, as a kind of cooking via an internal metabolism, which is how plant life feeds itself and grows. (Note: ancient Greek culture viewed 'rawness' (in humans as in food) as a warm-moist, watery-fiery state that was overcome when internal heat (*pepsis*) drove off the water. Compare the Hindu notion of *tapas*.)
Fy(b) = rotten + fiery air = **rotten**, as a kind of cooking via decomposition

The transformation of cooking yields

Fx(b) = raw + fiery air = **roasting**
Fy(a) = rotten + watery fire = **boiling**

Lévi-Strauss' notion that the boiled is to be associated with the rotted and the roasted with the raw is actually a resonance from these two functions.

The inverses might be identified thus:

a-1 (inverse) **=** 1/watery fire = earthy air, i.e., pulverizing to bone ash; or fiery fire, i.e., cremation, holocaust
b-1 (inverse) **=** 1/fiery air = watery air, i.e., baking by steaming; or = earthy fire, baking in earth oven, pit with hot stones
x-1 (inverse) **=** 1/raw = cooking a side-product of that which is otherwise uncooked, either by smoking, inhaling the smoke of the raw substance, rather than the substance itself, as tobacco, or fermenting the substance to distill something out of the raw substance, as honey mead, beer, wine, and so on
y-1 (inverse) **=** 1/rotten = preserving meat from rotting, by fire-smoking or by sun-and-air drying

The inverse functions would be something like:

Fa-1(y) earthy air, i.e., pulverizing to **bone ash** +/versus rotten
Fb-1(x) watery air, i.e., **baking by steaming** +/versus raw
Fb-1(y) earthy fire, **baking in earth oven**, pit with hot stones +/versus rotten
Fa-1(x) fiery fire, i.e., **cremating**, holocausting, nothing remaining +/versus raw

Fx-1(b) smoking (inhaling smoke), a by-product of cooking, that is, smoke rather than the substance, as tobacco +/versus fiery air
Fy-1(a) preserving meat +/versus watery fire, i.e., **smoking** meat
Fy-1(b) preserving meat +/versus fiery air, i.e., **sun-and-air drying** meat
Fx-1(a) fermenting, a by-product of the raw substance +/versus watery fire, i.e. as fermented beverage

With these inverse functions, the full group-theoretic formulation covers the primary forms of cooking mentioned by Lévi-Strauss in the *Mythologique*s, namely, roasting, boiling, smoking, fermenting, and preserving by smoking or sun-and-air drying, as well as additional ones identified by Shankman, such as reduction to bone ash, baking and steaming. This comprehensiveness seems to indicate that we have arrived at an adequate formulation of the deep structure of the culinary code.

In short, the group-theoretic transformation for the culinary code is as follows.

active	**:**	**passive**	→	**reflective** reflexive	**:**	**double reflection** inverse	
Fx(a)	**:**	**Fy(b)**	→	**Fx(b)**	**:**	**Fa-1(y)**	normalized
			→	**Fy(a)**	**:**	**Fb-1(x)**	alternative path
Fx(b)	:	Fy(a)	→	Fx(a)	:	**Fb-1(y)**	first derivative
			→	Fy(b)	:	**Fa-1(x)**	second derivative
Fa(x)	:	Fb(y)	→	Fa(y)	:	**Fx-1(b)**	third derivative
			→	Fb(x)	:	**Fy-1(a)**	fourth derivative
Fa(y)	:	Fb(x)	→	Fa(x)	:	**Fy-1(b)**	fifth derivative
			→	Fb(y)	:	**Fx-1(a)**	sixth derivative

raw	**:**	**rotten**	→	**roasting**	**:**	**reduction to bone ash**
			→	**boiling**	**:**	**baking by steaming**
			→		**:**	**baking in earth oven**
			→		**:**	**cremating**
			→		**:**	**smoking (inhaling)**
			→		**:**	**preserving by smoking**
			→		**:**	**sun-and-air drying**
			→		**:**	**fermenting**

Rather than a 'culinary triangle' we see that there exists a group-theoretic 'culinary dodecagon'. This accounts for virtually all the basic forms of cooking (although each might have its internal differentiations). It also predicts, as Lévi-Strauss demonstrated in the *Mythologiques*, that roasting and boiling are the two forms of cooking with the greatest universality. Roasting is the normalized route of the transformation, boiling the secondary or alternative route. This is precisely reflected in the many myths about the origins of cooking, in which roasting is 'prior' to boiling. (Lévi-Strauss imports the distinction between unmediated/mediated between roasting and boiling, but this is not necessary. The mathematical function establishes them as opposites analogous to the opposites raw and rotten).

Note that this formula allows us to dispense with Lévi-Strauss' problematic form/content explanation and his various hesitations about whether roasting is allied to raw and boiling to rotten or vice versa.

Lévi-Strauss' view (1973) that fermenting is a 'reversal' of cooking would then need to be qualified; fermenting is an inverse transformation. Inverses typically bear the transcendental dimension. This we clearly see among those South American tribes in which honey mead belongs to the most sacred ceremonial of the year.

Finally, if we want to continue to use the distinction, nature/culture, we will have to say that 'nature', whether raw or rotten, is prior to the transformations of cooking; all the ten forms of cooking are 'culture'. Two of these, roasting and boiling, partake of 'reflexive' action, while the other eight are 'inverse' actions. A full articulation of the culinary formula also makes clear that

raw and rotten nature are, strictly speaking, also operations of fire, the former watery fire, the latter fiery air.

Derrida has criticized Lévi-Strauss' notion of the opposition between nature and culture. Derrida (1976) argues that Lévi-Strauss privileges nature over culture and romanticizes the 'primitive'. Rather there is no nature prior to culture and nature is already cultural. Our reanalysis of the transformation underlying culinary rites appears to be in full accord with Derrida's critique. Rather than having to posit abstract categories such as elaborated/unelaborated (marked/unmarked, motivated/unmotivated, etc.) or nature/culture, our reanalysis suggests that the equation transforms the opposition 'raw versus rotten' together with the opposition 'watery fire' and 'fiery air' into the 'cooked'. The raw defines itself as a kind of watery fire just as the rotten defines itself as a kind of fiery air. They already contain an innate cooking fire. Otherwise they would be totally dead, inanimate, with no capacity for sustenance, for good or for ill. In other words, 'nature', i.e., the raw and the rotten, is already 'culture' and culture, i.e., the roasted and boiled, is implicitly raw or rotten, that is, 'nature'. Our reanalysis thus seems to be a fully deconstructed analysis.

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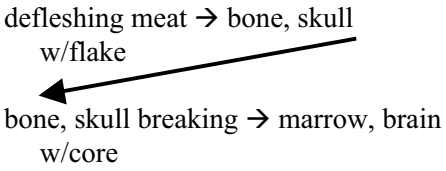
In the light of the culinary code reflected in historic and ethnographic records of *Homo sapiens sapiens*, what might have been the culinary codes during the preceding stages of hominid evolution? I suggest the following reconstructions that correspond to hypothetical Piagetian stages in cognitive evolution.

First, we can ascribe 'culinary' practice to chimpanzees. [Hence, contra Lévi-Strauss cooking does not correspond to 'becoming human'.] When eating meat, chimpanzees tear off chunks of meet with their teeth and hands. Large bones are cracked open and marrow extracted; small bones chewed and swallowed. In case of small prey, first the face is bitten into and the skull is bitten open, blood sucked and the brain consumed. Large prey skulls are bitten open or opened by enlarging the foramen magnum. Then viscera are eaten. Almost always a morsel of meat is chewed together with a wadge of leaves, and usually discarded along with unwanted pieces of bone or skin. Sometimes the brain is scraped out of the skull with a leaf wadge (Goodall 1986). The leaf wadge practice is an example of chimpanzee culture (Whiten 1999). (At the other end of the alimentary process, chimpanzees use leaves to wipe themselves after defecating, a practice also considered a cultural tradition.) Rather than spitting out gristle or bone chimpanzees may be avoiding crudity in the eyes of other chimpanzees or they may be showing respect for the source of their food, another living being. Either way the etiquette of the leaf wadge belongs to a chimpanzee culinary code.

During the Oldowan we may hypothesize a simple sequential ordering of culinary activities beginning with using a stone flake to deflesh meat from bones, yielding meat, and then moving on to using a hammerstone and anvil or a chopper core to split and break open bones, yielding marrow, or skulls, yielding brain, both of which are greasy, fatty substances of high nutritional value.

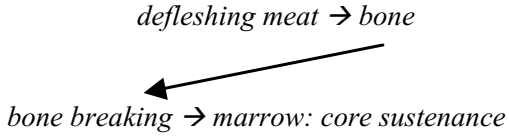


The two sequential culinary activities involve complementary pairs of tools, a cutting flake and core (chopper core, hammerstone), as well as the pairings of bone and meat and bone and marrow. Meat, which is on the surface of bone, is analogous to flakes and also obtained by using sharp-edged flakes, which themselves come from the surface of stone blanks. On the other hand, as inside the skin or hide, meat is analogous to a core. Marrow is inside bone which is inside flesh, which is inside the skin or hide; it is within the within. Marrow is analogous to chopper cores, which are 'inside' cutting flakes, and is also obtained by using chopper cores to break open bones (or hammer and anvil technique, such that the bone is like a stone blank that releases a core). The activities adhere to an analogical schema:

flake (outside of stone) : inside hide : meat
:: chopper core (inside of stone) : inside bone, skull : marrow, brain

As manifesting proximity, separation, pair, alternation, and sequential order these culinary schemas exemplify the cognitive stage of preoperations A, which Wynn (1989) suggests is the minimal cognitive competence manifest in Oldowan tool technology.

The analogical schema associates two levels or layers of sustenance, meat and marrow, one deeper inside than the other.

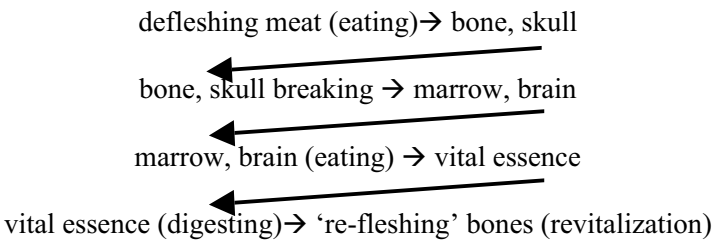


There is a doubling intensification of the nutritional value of the 'raw', from meat to marrow and brain, which are also inside the inside, as a second doubling. This intensification is placed in analogy, in turn, to the 'core' of the chopper core, which would be also an inside of an inside. To obtain marrow or brain is to obtain the 'core sustenance'. This lends a symbol of life, or life-concept, as 'obtaining the core that sustains us'. This matches the ontogenetic first stage of the life-concept as an activity that benefits us.

The Oldowan culinary activities clearly precede the use of fire and hence the Oldowan culinary code precedes a code that contrasts the raw and the cooked. Nevertheless it is still a cultural code.

A more complex pre-fire culinary code involves an extended sequence of culinary activities and ends with a reversal, from defleshing to re-fleshing. This is a mirror reversal, which is a cognitive procedure at the stage of preoperations B. (If it were a concrete

operation's reversal, then it would return to defleshing.) The code involves a sequence of four transformations or conversions.

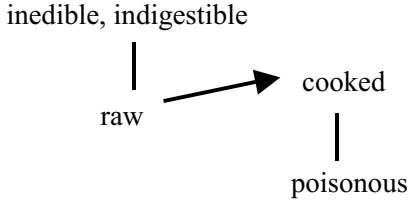


This culinary code contrasts concepts of 'flesh' and 'bone' and involves two abstract, although very concrete, concepts, (a) vital essence, the 'soul' or 'spirit' that is obtained from the nutritionally rich fatty tissue of marrow and brain, and (b) health, vitalization, life-energy as capacity for movement. That which causes the re-fleshing and revitalization is the 'vital essence'. This is a second stage symbol of life, or life-concept, in which life is conceived as an ego-independent capacity for movement (*kinesis*), a vital essence that can be incorporated into a person, by ingesting food, so that that individual moves, is alive, vigorous, 'fat' and healthy.

This culinary model and its corresponding cognitive stage, preoperations B, would correspond to the Early Acheulian stage of tool technology. Like the Oldowan culinary code, this Early Acheulian code also precedes the use of fire and hence precedes a code that contrasts the raw and the cooked. Nevertheless it is still a cultural code like its Oldowan predecessor and one that involves sophisticated ideas of soul-spirit and life-energy.

Holly Smith (1999) argues that the lessened degree of dental wear on the erectus KNM-WT 15000 versus habilis OH7 suggests increased dependence on meat eating, but not cooking in ashes, which would introduce greater grit into the diet. If so, this accords with a hypothetical Early Acheulian culinary code focused on uncooked meat eating.

We can propose the hypothesis that prior to the advent of the controlled use of fire in cooking modes of cooking without fire were invented. McGrew (1999) suggests cooking methods such as marinades to denature protein and soaking in water to dilute toxins. Milton (1999) adds pulverizing. Such cooking would be especially useful in preparing underground roots and tubers and other potentially toxic or indigestible vegetal foods. If so, this might be the first appearance of the culinary code of the raw and the cooked.



The oppositions are organized into a quaternion of cross-complementarities that contains a state change, in this case from the raw to the cooked by the transformative power of one or another liquid (marinade, water) or air (sun-and-air drying, pulverizing) or the paradoxical supplement, fermenting, which has the quality of liquid and of air, that is, bubbling.

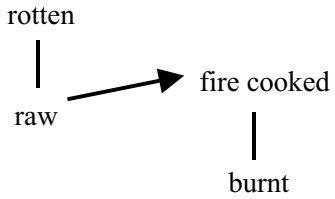
> The quaternion is analogous to Piaget's notion of a quaternary group—a cornerstone of concrete operations—but different. A quaternary group is a four-cell matrix containing the position and negation of two things, events, actions or states of affairs, which permits the testing and falsification of causal or other logical relations between them. It is implicitly dependent upon set-theoretic logics. A quaternion is a four-cell matrix containing positive and negative values applied to four possible states of a cultural-symbolic transformation. It is implicitly dependent upon group-theoretic logics. The two kinds of logics are as different as sign and symbol, and perhaps, left-brain neural substrates and right-brain substrates.

To cook is to convert something not yet edible—at least culturally speaking—to edible sustenance. Cooking in this model involves a state change, a transmutation or metamorphosis that requires the application of a curious and paradoxical element, that we can only call 'liquid air'. It is a work, an alchemical *opus* without fire.

Such a culinary code, which involves a quaternion with its state transformation, could have arisen during the early Middle Acheulian period, which, as Wynn argues, has a tool technology for which the minimal cognitive competence is early concrete operations.

We may also hypothesize that the third stage symbol of life arose during this period. This is the life-concept in which life is conceived as the capacity for spontaneous self-initiated movement. It moves itself (*autokinesis*). It is like seed, root, tuber, or menses that through spell or song (*logos spermatikos*) is turned into vigorous growth, birth, the breath of life, or what the Irian Jaya Dani call the 'singing-seed' of life, i.e., the soul-spirit. This spontaneous movement would be seen in the early Middle Acheulian as a kind of fermentation, a paradoxical liquid air, liquid sunlight or liquid dryness, a bubbling that yields sustenance, and like fermented honey, intoxicating joy.

With the innovation of the controlled use of fire and its use in cooking, perhaps—as current archaeology suggests—during the latter part of the Middle Acheulian period, the culinary code of the raw and the cooked, or more precisely, the raw and 'the cooked with fire', would have made its appearance. It is not necessary to hypothesize that the full culinary code formulated by Lévi-Strauss, which as he articulates it requires some notion of formal operations, appeared at this time. Rather we can hypothesize a code that would correspond to 'full' concrete cognitive operations. At first thought it might have been something like this:



The oppositions are organized into a quaternion of cross-complementarities that contains a state change, in this case from the raw to the cooked by the transformative power of fire. The activity of cooking is structured by an analogy: *rotten : burnt :: raw : cooked*. By implication the raw involves an aspect of inner fire or inner cooking which keeps it from rotting, which like rigor mortis has the quality of coldness, or too cold. Conversely, the burnt is overcooked, too hot.

Logically, the cooked should retain a bit of rawness, as when meat is cooked rare or vegetables lightly steamed and still crisp.

> Here again, as in the case of cooking without fire, we have a quaternion, a four-cell matrix containing positive and negative values applied to four possible states of a cultural-symbolic transformation.

Cooking in this model involves a state change, a transmutation or metamorphosis that requires the application of fire. It is a work, an alchemical *opus*. To cook with fire is to convert something 'raw' into something 'fire cooked'. The conversion is by means of fire. In a sense, fire is something added to the cooked, its supplement. Fire, which at this cognitive stage would have been viewed as a kind of spontaneous self-initiated movement, that is, as something alive, is added to the raw. By a kind of mystical arithmetic the result is a sustenance that contains or is infused with 'life' (soul, spirit). The application of fire in the act of cooking is itself a self-initiated movement. Without such self-initiated movement nothing gets cooked. Fire transforms 'raw' inner fire into 'cooked' inner fire. In cooking with fire there is a triple fire: the 'fire' of the cook brings fire to bear upon a food material to turn it into a sustenance that sustains by its innate, inner fire, which in turn the eater incorporates into this own inner fire. As in the Middle Acheulian case of the 'life' in fermentation, the Later Acheulian art of cooking with fire also would evoke a third stage symbol of life as spontaneous self-initiated movement. It moves itself (*autokinesis*) as it makes itself (*autopoiesis*). It is like a transmutation from coal to spark (the alchemical *scintilla*) to fire. This transmutation is effected by the 'spark of life', the breath of life, or soul-spirit as a kind of fire that is added to the 'body', which would otherwise be 'raw', 'mere matter' subject to rot and decay. Or, conversely, a frail body subject to being blasted by too much fire, too much spirit. The alchemical work is to find just the balance of spirit and matter, soul and body, so as to make the balanced . . . heart, knowing the strength and frailty of the human condition.

Such concrete operations models for cooking, first by 'liquid air' (fermenting, marinating, drying), and then by fire, or more precisely by either 'fiery air' (roasting) or 'watery fire' (boiling), seems likely to have preceded the more complex model proposed by Lévi-Strauss, and to be phylogenetically 'deeper' than the formal operations model, which I articulated in the first section of this study.

Table 1. Evolution of the Culinary Code		
	Hypothetical Culinary Code	**Hypothetical Piagetian Cognitive and Life-Symbol Stages** (after Wynn 1989; Case 1985, Piaget 1967)
Chimpanzee	Tearing off chunks of meat, breaking skull for brain and bones for marrow; using leaf wadge for discard of inedibles	*Sensorimotor*: action schemas, transferred across situations and/or *Preoperations A*.
Oldowan	*defleshing meat → bone* *bone breaking → marrow: core that sustains us*	*Preoperations A*: action rehearsal 'in thought'; spatial concepts of proximity, separation, pair, sequential order. Life-concept 1: being-alive is activity, especially that benefits (or harms) ego
Early Acheulian	*defleshing meat (eating)→ bone, skull;* *bone, skull breaking → marrow, brain;* *marrow, brain (eating) → vital essence;* *vital essence (digesting)→ 're-fleshing' bones (vitality)*	*Preoperations B*: actors independent of ego, ego de-centering, artifact independent of action and thought of ego; preceding spatial concepts plus constant interval, mirror reversal of shape, artifact as whole overall 2-D shape; bipolar, binary opposites of shape qualities. Life-concept 2: being-alive is to be capable of, or in the act of, movement
Middle Acheulian	*inedible* *indigestible* *raw* → *cooked* *poisonous*	*Early Concrete Operations**: object as whole with parts; coordination of multiple points of view (plan, profile, cross-section); 3-D Euclidean space, inner volume; measured space and conservation of shape under motion; straight edge, quantity displacement; regular cross-section; congruence symmetry of reversed shapes; bilateral symmetry across all three planes; quaternary group** Life-concept 3: being-alive is to be capable of spontaneous self-initiated movement
Later Acheulian	*rotten* *raw* → *fire cooked**** *burnt*	*Full Concrete Operations:* refinement of preceding
Middle Paleolithic	*ditto*	*Full Concrete Operations:* Levallois reflexive cross-application of volume shaping and flake retouching
Upper Paleolithic	*raw : rotten → boiled : ash → roasted : steamed* (after C. Lévi-Strauss)	*Formal Operations* (Case's '*Vectorial*'): preceding now generalized to all possible situations of things; abstract systems of thought, proportional reasoning, solving verbal analogy problems, inference of psychological traits in others; coordination of inversion and reciprocity. Life-concept 4: being-alive is a quality that belongs to animals and plants

Historic *H. sapiens sapiens*	*ditto*	*Advanced Formal Operations*: hypothetical-deductive reasoning and propositional logic; group-theoretic logic

* 'Operations' = conservation and reversibility, the latter including inversion, reversing operation to return to starting point, and reciprocity; they provide for pre-correction of errors (Wynn 1989).
** Wynn 1989 does not differentiate Middle and Later Acheulian intelligence, and attributes to the latter 'early concrete operations', although Middle Acheulian tools also reflect concrete operations. It would make more sense to ascribe early concrete operations to the Middle Acheulian and 'full' concrete operations to the Later Acheulian.
*** Early evidence for controlled use of fire is debatable. Arguments and counterarguments have been made for sites such as FxJj20 Main and FxJj20 East, Koobi For a, Kenya (1.64 MYA); Chesowanja, Kenya (1.42 MYA); Gadeb, Ethiopia (700,000-1.4 MYA); Swartkrans MIII (1.0 MYA); L'Escale Cave, France (400-700,000 BP); Olorgesailie (400,000 BP); Menez-Dregan I, France (465,000±65K BP); and St. Estève-Janson (250-300,000 BP). Diverse opinions in Wrangham *et al* (1999) suggest that while Early and Middle Acheulian provides evidence for controlled use of fire strong evidence for cooking (hearths, dental wear), does not occur until the Later Acheulian L'Escale and Menez-Dregan. If it were shown that cooking with fire occurred in the Middle Acheulian period or earlier, my proposed cooking stages could be shifted back in time. Indeed, since writing the preceding, there is now strong evidence for hearths with burnt flint, seeds and wood at Gesher Benot Ya'aqov, Israel (Goren-Inbar *et al* 2004) at a location dating c. 750,000 BP (Goren-Inbar *et al* 2000), that is, in the middle of the Middle Acheulian prior to the onset of the Later Acheulian around 600,000 years ago.

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What is the relation, if any, between Lévi-Strauss' formal operations formulation of the culinary code and cannibalism? Of course, there is no immediate relation; in the realm of mythology there are only cross-mappings of one structure upon another. Thus, to perform a comparison or cross-mapping between the culinary code and cannibalism one must develop a group-theoretic analysis of cannibalism. Clearly, as Shankman notes, cannibalism is far more categorically complex than the distinction exocannibalism versus endocannibalism. But even without comprehensively developing a group-theoretic structure for cannibalism that covers warfare cannibalism, nutritional cannibalism, mortuary cannibalism and virtue or therapeutic cannibalism--which I have done elsewhere--it is possible to see some cross-mappings in Shankman's tables.

1. Exocannibalism is differentially associated with boiling, especially in the Americas, or baking, in the Pacific.
2. Endocannibalism is associated with bone ash, especially in the Americas, or roasting.
3. Roasting is also frequent to both exocannibalism and endocannibalism.

This highly tentative set of findings might be viewed as reflecting, and confirming, the culinary code transformation formula, as I have reformulated it. For roasting and reduction to bone ash belong to the normalized path of the transformation, with bone ash being its inverse, while boiling and baking belong to the alternate path, with baking its inverse.

Table 1. Cannibalism and Cooking Methods [after Shankman 1969: Tables 1, 2, 3]

Exocannibalism (only N=29+*5 practicing both)						**Endocannibalism** (only N=26+*5 practicing both)					
Cases	**Roasted**	**Boiled**	**Baked**	**Bone Ash**	**Other**	**Cases**	**Roasted**	**Boiled**	**Baked**	**Bone Ash**	**Other**
Pacific						**Australia**					
Lau			+			**& Pacific**					
Lesu			+			Dieri					r
Tanga			+			Marula					r
Malekula			+			Tangara					r
Maori			+		pr	Boucat Bay					
Kurtatachi			+			Murgin			+		
Kwaio			+			Mara			+		
Keraki			+			Mukjarawaint	+				
Battas	+				r	Turrbal	+				
Jale	+		+			Djibaru	+				
*Daribi			+			*Daribi			+		
*Duau	+					*Duau	+				
*North Fore			+		c	*North Fore			+		c
*Usurufa			+			*Usurufa			?		
Americas						**Americas**					
Apíacá	+					Tarairiu	+			+	
Carib	+				s	Uraba	+				
Araucanians	+				r	Cashibo				+	
Tupinamba	+	+			s	Nuevo de Leon	+				
Cubeo	+	+			s	Mayoruna	+	+			s, de
Amani	+	+			po, pr	Guaipunabi		+			
Quimbaya	+	+				Tariana				+	
Aztec		+			dr	Tucano				+	
Shipaya	+	+				Amahuaca				+	
Piritu					po	Yanomamö				+	
Umotina		+				Remo				+	
Gae		+				Waica				+	
Witoto		+				Poinauas				+	
*Kwakiutl					r	Moré				+	
Africa						Guayape				+	
Boloki		+			s	Sáliva				+	
Mambila		+			r	Sae	+			+	
Sura		+			r	Mujaranguana	+			+	
Ganawuri		+			r	*Kwakiutl					de
Rukuba		+									
Azande		+									

po = powdered, pr = preserved, dr = dried, s = smoked, c = cooked on a fire in bamboo tube, r = raw, de = decomposed

Sources: for each tribe cited in Shankman 1969. Accuracy of these accounts given colonial oppression and active genocide remains an open question.

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