

# The thermal qualities of substance: a cross-cultural account

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## Abstract

A bewildering array of food items, diseases, individual and group dispositions, colors, eventualities, and spatial arrangements are projected into the *hot/cold* scale. While there are clear examples from routine everyday use (in English and other languages), there are also elaborate expositions of the thermal properties of entities, people and substances laid out within the Ayurvedic tradition in South Asia, within traditional Chinese medicine, as well as in Middle Eastern, Southeast Asian and Native American medical systems. The work reported in this paper represents the first systematic attempt to use modern cognitive theories of concept acquisition and use to analyze this vast array of data. We show how the theory of Idealized Cognitive Models (ICM) and prototypes, and radial category structure extended through metonymy and metaphoric blends can begin to provide an account of the semantic space inhabited by thermal qualities.

**Keywords:** cognitive science, anthropology, cognitive anthropology, concepts, metaphor

## Introduction

Why is an onion *cold* but a piece of garlic *hot*? This assignment of thermal values is popular in the folk classification of the *intrinsic quality* of onion and garlic in many parts of South India. At first glance, the assignment seems arbitrary and most likely based on “myth” and “superstition” perpetrated by local *vaidyas* (doctors) to exercise power over the rest of the population.

If the intrigued observer plunges deeper into the same folk classification system, he will find a bewildering number of food items, medicinal products, diseases, individual and class/caste dispositions (*kunams*), labeled as possessing heating or cooling qualities. He may also find that far from being arbitrary, the assignment of hot and cold qualities taps into a large body of indigenous “knowledge” that pertains to local adaptations of a philosophical world view that integrates materials and power relations (*dharma*) into multiple interacting strands (*gunas*), humors (*dosas*), elements (*bhutas*) and dispositions (*kunams*).

Early western anthropological studies investigating the use and mention of hot and cold concepts have confined themselves to a single culture/language (such as Chinese, Javanese, Tamil) or have attempted cross-cultural generalization from a single data set. For instance, Brenda Beck (Beck, 1969) first attempted to classify South Asian food items as belonging to hot or cold categories. Her generalization from a single data set led to other authors (Daniel, 1989) pointing out various inconsistencies and limitations in explaining the structure and complexity of the conceptual categories themselves (ex. there is a continuum from hot to cold along which substances may be placed, rather than the classical categories used by Beck and others). Looking at other data, researchers

also pointed out the variation and diversity (across geographical regions, class status, group affiliation, caste, as well as individual dispositions) that made any previous attempt at categorization suspect.

We addressed this state of affairs in the following two ways:

- There is now a fair amount of cross-cultural data on entities being classified as hot or cold. We analyze this data to delineate the semantic property space of hot and cold by looking at the similarities and differences across cultures.
- Using tools from cognitive science (Rosch, 1973; Lakoff, 1987) and cognitive semantics we suggest that the concepts hot and cold have an Idealized Cognitive Model (ICM) which forms the core semantics of hot and cold. The core semantics is then extended through various *metonymic* and *metaphoric* mappings.

Our approach leads to the identification of the semantics of *hot* and *cold* from cross-cultural data. The data analyzed comes mainly from Traditional Chinese Medicine (Maciocia, 1989) and from various South Asian (Daniel, 1989; Beck, 1969; Marriott, 1989) and Southeast Asian (Javanese) studies. The theoretical analysis also intersects with work in cognitive linguistics (Lakoff, 1987; Fauconnier & Turner, 2002) especially as it pertains to the structure of conceptual mappings and conventionalized metaphors.

The general approach is divided into three parts. First, the data is presented, followed by the cognitively based model of the semantics of hot and cold. We then present results of applying the model to cross-cultural data. As far as we are aware, this is the first study that has attempted to tackle a broad range of cross-cultural data to uncover the semantics of hot and cold.

## The Data

This research borrows from field work by different anthropologists. The work on Javanese (Samson, 1974) (Geertz, 1960), work on Tamil (Beck, 1969), (Daniel, 1989), work on Punjabi/Sindhi (Kurin, 1988), traditional Chinese medicine (Maciocia, 1989) and on Zimmerman’s interpretation of the Ayurvedic texts (Zimmerman, 1979), are used as data sources for much of the material developed here.

Hot and cold are conceptualized with respect to several dimensions. From the data, it appears that these dimensions can be categorized as:

- Edibles
- Diseases

- Characteristics of People
- Emotions
- Colors
- Characteristics of Abstract processes and events

### Edible items

In most cultural systems, food is often cooling, neutral, or hot. Across the data, spicy items (such as chilies, spicy herbs, spicy rubs) are labeled as hot.

In Traditional Chinese Medicine (TCM) (Maciocia, 1989), there is a huge literature of foods that are classified on the hot to cold scale (hot, warm, neutral, cool, cold). Cold foods are linked to *yin* and hot foods to *yang*. Examples of cold foods include some fruits (apples, bananas, citrus fruits, watermelons), soy milk, leafy greens, and some legumes (mung beans), some herbs (cilantro) and some vegetables (zucchini, broccoli, cauliflower). Examples of neutral foods include rice, corn, peas, and lentils. Warm foods include ginger root, sesame, cumin, nuts, oats, eggs and all meat.

From South Asia, the first systematic classification of food items was done by Brenda Beck (Beck, 1969). While the study was careful and While Beck classifies food items as hot or cold (with an occasional note indicate the degree (very hot), subsequent studies (Daniel, 1989; Marriott, 1989) clearly suggest that the quality of hot-cold is mapped onto a *radial category* that indicates a gradient for the classification. The categories are comprised of some central members that are prototypical instances of hot or cold. Other substances are more ambiguous and can be either hot or cold depending on the context.

In all of the data looked at, the notion of context appears to be a key to assigning hot and cold qualities to food items. Across different studies, the following features have been shown to contribute to the context.

- **The geographical region of interest.** The classification varies according to the region of interest. Examples include certain varieties of *vala palam* (banana) which are considered hot in one region of Tamil Nadu (north) while cool in another region (south). Similarly, wheat is considered a *hot* food in China whereas it is a neutral food in much of India. In both Javanese and South Asian data, food items that are *foreign* (originate from outside the region/country) are universally *hot* is character (ice-cream is a hot food in South India!).
- **The individual characteristic/group affiliation of the person consuming the food.** The same food item may be hot for one individual but cold for another. Both in Traditional Chinese Medicine and in the South Asian cultures there are hot and cold individuals. This could be a prior disposition or an abnormal psychological (stressful) or diseased state. The same food item may be more or less hot for specific groups. In South Asia, for instance, goat

meat is considered hot by Nambudri Brahmins of Kerala, whereas in the same village, a Parayan may consider the item as a *cold* item.

- **The changes in seasons.** In certain months (indeed even at different times of a day) the same item may be hot or cold.
- **The state of the food item.** The same item when eaten raw may be cool, but may become hot when cooked. An example is banana when cooked is hot may when eaten raw may be cool.

At first glance, the above list seems bewilderingly arbitrary. In fact, some researchers have suggested that any attempt at delineating a hot-cold semantic property space for food items may be impossible (Daniel, 1989). However, as I will show in the subsequent discussion, using theories in cognitive science such as the idea of graded and radial categories (Lakoff, 1987) combined with notions of systematic metonymic and metaphoric mappings may shed light on the issue.

### Characteristics of People

People can be classified as having hot or cold dispositions. In Traditional Chinese Medicine, hot and cold classification is one aspect of the balance of energies (Qi) and are projected onto the Yin/Yang dispositional matrix. A person diagnosed with being too hot (Yang) (common ailments characterized by /identified as overheating, anxiety, constipation and other binding conditions) may eat too many saturated fats and sugars that are highly caloric. People who are of cold (Yin) disposition may experience weakness, diarrhea, sloth or depression.

In South Asian medical systems (such as Ayurvedic system) individuals are classified as having hot or cold dispositions. The classification is also concerned with the *balance*, *stability*, and *compatibility* of various *humors*. The three basic humors are bile (*pittam*), phlegm (*kapam*) and wind (*vayu* or *vata*). While there is a large amount of literature on the various classificatory schemes and properties of the three humors, I will be concerned mainly with the hot-cold aspect. In general, *pittam* is a hot humor *kapam* is cold, and *vayu* could be either. Individuals are predisposed as having one or more of these humors in excess, and thus inherit the appropriate thermal quality. In addition, individuals also obtain thermal qualities based on their group or caste status.

### Events and Abstract Processes

Most events that involve some kind of substance transformation also involve heat. Events could be cooking, rituals, pilgrimages, ceremonies, etc. Sexual intercourse is generally heat producing across cultures. Several researchers have observed that cross-culturally menstruation is viewed as a heat generating process. Other heat generating events include the ceremony of *Grahapravesham* (house *warming*) or specific forms of group prayer, or ritual/ceremonial fires. Rituals of cooling are often used in these ceremonies to counteract the extreme heat generated by the event. Example include the use

of cooling *ghee* (clarified butter) and *manjal thanni* (tumeric and water).

### Diseases

In traditional Chinese medicine, common ailments characterized as hot ailments include anxiety, constipation and other binding conditions. Cool illnesses include the experience of fatigue or weakness, diarrhea, sloth or depression.

In Ayurvedic systems hot (pittam generated) ailments include boils and eruptions, gum disease, hemorrhoids, rashes, bad stomach, measles, anemia, headache and earache. Most external eruptions (especially those with puss) are hot.

Cold ailments (kapam generates) include common cold (with a runny nose), coughing, general body aches, stiffness. In the absence of other symptoms, conditions like general body aches are presumed to be created by an excess of cold.

In general, the treatment for an ailment depends on an iconic relationship between the drug and the patient's body, the humor of the drug substance and the generative factor (heat or cold related) of the illness, or the combination of other heat and cold creating factors (for instance the type of place/region, the patient's *kunam*, and the type of the pathogen). Note that this is in sharp contrast to the western tradition that relies exclusively on cause-effect representations (homeopathic versus allopathic) (Zimmerman, 1979).

### Emotions

Intense emotions are characterized as hot in many cultures. Anger, rage, lust, passion are prototypical hot emotions. Sadness, depression, apathy, are usually classified as cold emotions. There are some interesting blends (Fauconnier & Turner, 2002) such as *cold rage*.

### Hot and Cold Colors

Red and black are classified as hot colors, while green and white are cold colors. Often orange is classified as hot (in TCM and in the Javanese data). Other colors are usually neutral.

Rituals (such as the flower ritual (Beck, 1969)) often use indexical and iconic relationship between the color red and a hot body state, the color white and a cold body state to illustrate ailments, remedies and general concepts of health and sickness.

### Making sense of the data: The semantics of hot and cold

The following two propositions guided our approach to modeling the data.

- **Proposition 1.** The concepts hot and cold code for concepts that occur frequently in our experience of applying heat to substances. Our experience generates an Idealized Cognitive Model (ICM) (Lakoff, 1987) that captures the *process, effects, and entailments* of heating substances.<sup>1</sup>

<sup>1</sup>It is possible that there is a separate ICM for the process of cooling entities, but the specifics of cooling were not necessary to model

- **Proposition 2.** The ICM for hot and cold is extended via systematic conventional metaphor mappings and metonymic clusters to apply to abstract concepts. Many of these mappings and clusters are cross-cultural, some are culture specific.

We first describe the ICM for heating entities that generates the set of basic dimensions forming the semantic space of hot and cold across cultures. We then outline the central mappings that project features along these dimensions to abstract categories such as dispositions, ailments, rituals, etc.

### An Idealized Cognitive Model

We hypothesize that the commonsense experience of applying heat to substances consists of (at least) the following schematic process.

1. You need to have an energy source with sufficient energy to heat a substance.
2. You heat a substance by applying a heat energy source to the substance to be heated. The prototypical case is through contact of a hot source with the target to be heated. The process starts when heat is applied.
3. As the energy source continues to provide heat to the target, the target absorbs this heat and increases in temperature (becomes hot).
  - (a) The increase is scalar where there are key points on the scale (very cold, cold, cool, hot, very hot).
  - (b) Fluids are a prototypical heated substance where the ongoing heating process generate greater activity, movement, and eruptions (bubbles).
4. After the target is at a desired (higher) temperature, the heat source is removed and the heating process finishes.
5. The heated entity will remain hot based on the ambient temperature of the environment and the capacity of the heated substance to *hold* the heat.

This common experience sanctions a number of associated inferences that are relevant to the assignment of hot and cold to entities.

1. Entities when heated acquire greater energy.
2. Entities when heated are likely to increase activity.
  - (a) Entities mix more readily when heated and less so when cold.
  - (b) Inherently *hot* substances are likely to fuse together whereas cold substances tend to be separate.
3. Entities when heated are likely to expand.

the data. It appears that much of the concept of cold is derivative from the heating ICM.

- (a) Hot entities are likely to boil, erupt, or result in inflammations.
  - (b) Hot entities are likely to be bigger in volume
4. Substances transform when they are heated
- (a) Heated substances often change color (such as turn red).
  - (b) Heating transforms substances from solid to liquid and from liquid to gas.

**Metonymic features of hot and cold** Various aspects of the ICM and commonsense inferences generated are incorporated metonymically into the concepts of hot and cold. So entities, properties, resources, processes and effects that participate in the heating process (such as expanding substances) can be identified as being hot. Conversely, properties, processes, entities, and effects that obtain in the reversal of heating process are often mapped to the cold end of the scale. So energy sources (heating resource), red colors (heating effect) are conceptualized as hot and contraction (effect) as cold.

**Metaphoric extensions of the basic dimensions** The basic dimensions outlined above are systematically extended through metaphor to other domains. The following list of relevant metaphors is taken from the Berkeley Master Metaphor List (Lakoff, Espenson, & Schwartz, 1991).

- *Anger is a Hot Fluid in a Container.* (Lakoff, 1987) discusses the linguistic realizations of this metaphor (such as She is fuming).
- *Intense Emotions are Heat.* By default, this sanctions the inference that the lack of emotions is cold.
- *Lust is Heat.* This sanctions the inference that the lack of lust is cold (frigid).
- *Detachment is cool.* This comes from the ICM where hot substances tend to move, make contact and attach to each other.
- *Affection is Warmth.* This is a *primary metaphor* in that it appears fairly early developmentally and appears to be a compositional primitive structuring larger mappings (Grady, 1997).

There are additional common mappings that may extend the basic features in culturally specific ways. For instance, in many Western cultures there is a common mapping *Rational is Detached* which often entails the complimentary mapping *Emotional is Attached*. This when combined with the *Detachment is Cold* mapping, yields compositionally the mapping *Rational is Cold*.<sup>2</sup>

<sup>2</sup>Ongoing work is attempting to identify all such relevant compositional mappings in different cultures.

## The Semantic Feature Space of Hot and Cold

From the ICM and its extensions, we constructed the following semantic features as providing contributions to the concept of hot or cold. Along with the feature is listing the source where the feature is derived from (The ICM of the apply heat process, associated inferences, or metaphoric mapping).

HOT QUALITY	COLD QUALITY	Derived From
Temperature = hot	Temperature = cold	ICM
Rises	Sinks	ICM
Expands	Contracts	ICM
Fast	Slow	ICM
High Intensity	Low Intensity	Metaphor
Adds (Builds)	Reduces	ICM + Metaphor
Stimulates	Sedates	ICM
Mixing	Inert	ICM
Active	Inactive	ICM
High Energy	Low energy	ICM
Movement	Stillness	ICM + Metaphor
Attached	Detached	ICM + Metaphor
Processed	Natural	ICM + Inference
Cooked	Raw	ICM + Inference
Impure	Pure	ICM + Inference

Table 1: Thermal qualities of entities. A set of consistent effects of heating and cooling that cluster metonymically to refer to hot and cold. This is not meant to be exhaustive since the list can be extended inferentially through various culturally specific mappings, as in (Marriott, 1989).

## Results

We first describe the results of using the features derived from the ICM and associated mappings to build an automatic classifier to assign hot and cold to different food items. We used gold-standard data from multiple cultures (based on Javanese (Samson, 1974) (Geertz, 1960), work on Tamil (Beck, 1969), (Daniel, 1989), work on Hindi and Punjabi (Kurin, 1988), work on traditional Chinese medicine (Maciocia, 1989)). We then show how the scalar concept of hot and cold can be used in context specific ways to construct alternative hypotheses concerning individuals and groups in terms of relevant dispositional attributes. Here the data used is from (Kurin, 1988) on alternative interpretations of concepts of *Jangli* and *Babu* as applied to groups and individuals in Northern Pakistan.

### Automatic classification of hot and cold foods

We attempted to use the features in Table 1 along with their values for the various items to automatically classify food items from different cultures into hot and cold foods. We attempted this by training a classifier on a subset of the labeled dataset (for each culture separately) and then testing the classifier on unseen data (from that culture). The dataset for the experiments below

are at <http://www.icsi.berkeley.edu/~snarayan/hot-cold/hot-cold-data>.

For the classifier, we used a Support Vector Machine <sup>3</sup> with a Radial Basis Kernel (RBF kernel). The feature set used for the experiments included the following:

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High calorie/low calorie (from ICM)
Hot/cold (from ICM)
Pungent/Non-Pungent (from Intensity in ICM)
Spicy/Bland (from Intensity in ICM)
Mixed(say with oil or combination of spices)/Non-mixed (from ICM)
Wet/Dry (from Metaphor and ICM)
Color = red, orange, brown white, green. (from ICM)
Leafy/Non-leafy (from ICM and metaphor)
Root/Non-root (from ICM)
Raw/cooked (from ICM)
Meat product/Non-meat product (from ICM (Active -> Animate))
Local/Non-local(Foreign) (from ICM and metaphor)
When available in the data:
Time of Year: Hot Season/Cold Season (from ICM)
//Additional features (we only had values in the Tamil and Hindi data):
Disposition of individual consuming = hot/cold
Caste of person consuming = Upper/Lower.
```

The features were assigned on a per data item basis manually. For each culture, the dataset contained around 400 food items, each with hot and cold labels. There were also a small number of neutral items in the data. For this experiment we threw away that data and did a binary classification of foods into hot or cold. The different cultures included Tamil, Javanese, Chinese, and Hindi. We used 10-fold cross validation (total data size was 1649 tokens). Table 2 below shows the accuracy of our classifier on the different cultural datasets. We did a separate counting of the number of hot instances that were correctly labeled and the number of cold instances that were correctly labeled by the classifier. The training and testing were done on the same culture (such as train and test in Chinese).

Attribute	Dataset	% correct	Notes
Score(Hot)	Chinese	85	$F_1$
Score (Cold)	Chinese	76	$F_1$
Score(Hot)	Tamil	81	$F_2$
Score (Cold)	Tamil	85	$F_2$
Score(Hot)	Hindi	81	$F_2$
Score (Cold)	Hindi	78	$F_2$
Score(Hot)	Javanese	76	$F_1$
Score (Cold)	Javanese	85	$F_1$
Score (Overall)	All data	81	(1336/1649)

Table 2: Preliminary classification results using the feature set on the various food items in multiple datasets. Results are shown for the gold standard annotated test set.  $F_1$  is the feature set without additional features (see feature set above).  $F_2$  is the total feature set with all the features.

The results obtained were well above chance (50) in all cases across cultures. Clearly it is also above a simple baseline (such as assign the most frequent category to all tokens (both categories (hot and cold) are classified correctly above

<sup>3</sup>Our experiments used the LibSVM package which is a free SVM package available from <http://www.csie.ntu.edu.tw/~cjlin/libsvm/>

chance). It appears that the semantic space for hot and cold at least as it applies to food items is largely captured by the features from the ICM and associated projections. We tried training and testing on different datasets (train on Chinese and test on Hindi). Our results in all such cases were at chance levels suggesting that the relevance of the different features varied widely across the datasets. Ablation studies could reveal further the relevance of various features in terms of the different data sets.

### Context specific interpretations: sophisticated urbanites or weakling *babus*?

A second application of the model revealed the context sensitivity and the flexible use of hot and cold concepts in cultural and ethnic categorization.

Kurin (Kurin, 1988) analyzes the differences in culture and ethnicity in Pakistan. In his essay, he discusses the Arabic, Persian, and Hebrew terms *ruh* (spirit), *aql*(rationality and intellect) and *nafs* (life spirit and passion) (related to blood *kuhn* and life *jan*). *Aql* is metaphorically and metonymically related to reason, humanity, civility and judgment. In his essay, Kurin analyzes how the three terms and their meaning can be used to systematically analyze differing images of class and ethnicity.

The crucial observation is that various combinations of these terms can denote hot and cold qualities. The variation in culture and ethnicity of people can then be mapped onto the along this scale and thereby used for social and political action. Our model of hot and cold suggests that rational intellect (*Aql*) is mapped to the cold end of the scale and life spirit and passion (*Nafs*) is mapped to the hot end of the scale.

1. *Aql* (intellect) is MAPPED onto the cold end of the hot-cold scale.
2. *Nafs* (life spirit, passion) is MAPPED onto the hot end of the scale.

I will briefly reproduce Kurin’s data to demonstrate how this mapping can be used characterize different views of the villages versus the urbanite. The first set of data pertain to the *Jangli/Babu* difference. *Jangli*’s are referred to as having their *nafs* dominate their *aql*, and *Babus* as having their *aql* dominate their *nafs*. *Babus* in this reading as the urbanities and *Janglis* are the villagers.

Let us consider the main features of the *Jangli* and *Babu* using our mapping.

- The *Janglis nafs* dominates his *aql*. He lives close to nature (literally in the jungle), and has a hot disposition.
- The *Babu’s aql* dominates his *nafs*. He is a city dweller. He may work as a Government official, or may be a noble. He has a cool disposition.

Now let us look at the boundary conditions of the hot-cold case with two points each on the hot-cold scale. There are four possible combinations (two points on the hot (warm and

hot) scale for the Jungli and two on the cold scale (cool and cold).

1. Jangli is mapped to *hot* and Babu to *cold*.
2. Jangli is mapped to *hot* and Babu to *cool*.
3. Jangli is mapped to *warm* and Babu to *cold*.
4. Jangli is mapped to *warm and Babu to cool*.

While all possible boundary conditions can theoretically exist, two (condition 2 and 3) serve to outline the differences. These serve to generate the two *views* in Kurin's data. These views are described below.

- **The Babu-centric View.** This view corresponds to condition 2. The view is pejorative toward the Jangli and meliorative toward the Babu. The characteristics of the Babu and the Jangli are as follows:
  1. The *hot* Jangli is viewed as illiterate, violent ill-mannered, criminal, uncooperative, stupid, and sex-crazed.
  2. The *cool* Babu is viewed as literate, controlled, well-mannered, peaceful, civil, temperate, humanistic.
- **The Jangli-centric view.** This view corresponds to condition 3. The view is meliorative toward the Jangli and pejorative toward the Babu. The characteristics of the Babu and the Jangli are as follows:
  1. The *warm* Jangli is viewed as healthy, strong, brave, direct, well-adjusted, realistic, frank and open.
  2. The *cold* Babu is viewed as sickly, weak, mal-adjusted, cowardly, afraid, deluded.

The main thing to notice about these views is their close correspondence to earlier conceptions of hot and cold as being clustered along the same dimensions. This gives us further evidence that the concepts are clustered in a radial category that occupies a cross-cultural semantic space.

Once we have established the features of the semantic space, we can look at combinations of the features at the target level and try to see if the mapping holds. Let us change the definitions of the urbanite and the villager to observe if the mappings hold.

Supposing we change our definition of the city dweller and look at a person who has both *aql* and *nas*, though *aql* still dominates. Here is a person who has intellect and reason (coolness) and also possess strong desires. This can make him crafty and a schemer. Such a person is referred to as a *chalak*. In fact, the data Kurin presents demonstrates that the *chalak* person is referred to as having a **heated coolness** exactly what we would expect from the individual mapping and their combination in the source domain (hot-cold).

Similarly we can change our definition of the villager, and ask what would happen if the villager lost his *nas*. Here is

a person who is neither desirous nor needy. He has no intellect nor any need for acquiring possessions. He is basically accepting, and naive. He is likely to be unassuming, and uninteresting. In other words he is a simpleton and is referred to as a *seedha saadha*. Performing the same trick of source domain inference as before, we would say that such a person had a *cooled heat* disposition. Guess what Kurin's data suggests.

## Conclusion

Using recent research in metaphor and conceptual categorization theory we can begin to develop a semantic property space for hot-cold categorizations in different cultural settings. Clearly, there is no single algorithm that can unambiguously assign hot and cold across cultures. However, the assignment is not arbitrary and relies on a constellation of features based on our shared experience in the world which is extended in culturally specific ways leaving ample room for flexible interpretations. The data analyzed so far covers concepts and practices from English, Tamil, Javanese, Chinese, Hindi, and Persian. Preliminary investigations of data from South American cultures shows good promise and data from other languages and cultures is being culled.

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