Appearing in:
Proceedings of the 39th Annual Meeting of the Chicago Linguistic Society: The Panels. eds. Jonathon E. Cihlar, David Kaiser, Irene Kimbara, and Amy Franklin. Chicago: Chicago Linguistic Society. 2004.

Recombinance in the Evolution of Language

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1. Introduction

Through comparison with signed language and with other cognitive systems, this paper examines the central role within spoken language that "recombinance" plays in the representation of information, and considers the development of this cognitive mechanism in the evolution of spoken language. Recombinance is the assembling of discrete units into a new higher-level unit with its own identity. It is characterized here in terms of an analytic framework that covers distinctions within the cognitive representation of information. Much in signed language and in nonlinguistic cognitive systems is iconic and gradient -- that is, "analog" in character -- or, when discrete, may not exhibit recombinance. It is the special role of discrete recombinance in spoken language -- that is, the "digital" character of spoken language -- that this paper aims to characterize and to account for.

The present analysis presupposes Talmy (2003). That work examined certain similarities and differences in structure and representation between spoken and signed language, and suggested a neural model to account for them. For one similarity, the open-class and the closed-class subsystems of spoken language are both recombinant in basic character, and they more or less parallel the lexical and "inflectional" subsystems of signed language, which are also largely recombinant.

For a major difference, though, Without any parallel in spoken language, signed language in addition has a "classifier" subsystem that is dedicated to the representation of objects moving or located with respect to each other in space, and that is basically gradient and iconic in character (see e.g., Emmorey (2003) and Liddell (2003)). For the schematic representation of space, Spoken language relies on its recombinant closed-class subsystem, with forms like the English prepositions *across* and *past*. Such forms represent whole spatial schemas. In particular, they represent "pre-packaged" arrangements of basic spatial elements. Each spoken language has a relatively fixed set of such discrete pre-set whole spatial schemas.

By contrast, the classifier subsystem of signed language schematically represents spatial configurations with a large number of concurrently realized parameters that vary independently, that are generally gradient and iconic, and accordingly that correspond in an individualized way to the referent situation without any preset combinations of values. To illustrate, a spatial event that English could express as *The car drove past the tree* could be expressed in American Sign Language (ASL) as follows: The signer's dominant hand, used to represent the Figure object, here has a "3 handshape" (index and middle fingers extended forward, thumb up) to represent a ground vehicle. The non-dominant hand, used to represent the Ground object, here involves an upright "5 handshape" (forearm held upright with the five fingers extended upward and spread apart) to represent a tree. The dominant hand is moved horizontally across the signer's torso and past the non-dominant forearm. Further though, this basic form could be modified or augmented to represent additional particulars of the referent spatial event. Thus, the dominant hand can show additional characteristics of the path. For example, the hand could move along a curved path to indicate that the road being followed was curved, it could slant upward to represent an uphill course, or both could be shown together. The dominant hand can additionally show the manner of the motion. For example, as it moves along, it could oscillate up and down to indicate a bumpy ride, or move quickly to indicate a swift pace, or both could be shown together, as well as with the preceding two path properties. And the dominant hand can show additional relationships of the Figure to the Ground. For example, it could pass nearer or farther from the non-dominant hand to indicate the car's distance from the tree when passing it, it could make the approach toward the non-dominant hand longer (or shorter) than the trailing portion of the path to represent the comparable relationship between the car's path and the tree, or it could show both of these together or, indeed, with all the preceding additional characteristics.

This pattern of structural similarity and difference between spoken and signed language can not be accommodated by the Fodor-Chomsky type of autonomous language module. Accordingly, Talmy (2003) posited a "core" language system in the brain, more limited in scope than the Fodor-Chomsky module, that is responsible for the properties and performs the functions found to be in common across both the spoken and the signed modalities. For certain aspects of representation, this core system would then further connect with two different outside brain systems, presumably already extant ones, respectively responsible for the properties and functions specific to each of the two language modalities. The interaction of the core linguistic system with one of the outside systems would thus underlie the full functioning of each of the two language modalities. As it evolved, the core language system may have introduced what were innovations relative to the extant cognitive systems. Specifically, the appearance or expansion of the cognitive mechanism of recombinance may have taken place in the core language system. This paper examines the basis for such a possibility.

Starting the analysis is a comparison of spoken language with signed language, which opens out later to one with other cognitive systems. As a precursor, note that each of the two language modalities must be characterized in terms of the combination both of a particular form of stimulus production and of the perception of that stimulus type: vocal-auditory for spoken language and manual-visual for signed language (where "manual" is here meant to cover bodily movements more broadly). As noted, each of these two production-perception modalities has certain basic properties of structure and organization, some of which differ across the two. The differences pertinent here fall into three main categories: the extent of parallelness, the extent of iconicity, and the extent of digitalness.

2. Extent of Parallelness

The first category of properties that differ across the two language modalities can be called **extent of parallelness**. Within a modality, this is the number of independently varying parameters with the potential of representing information that can be produced and perceived concurrently -- that is, "in parallel" -- together with the degree of their use. For the vocal-auditory modality of spoken language, the independently variable factors in use would seem to be on the order of some eight to ten in number, as listed in (1). The main parameter of spoken language -- that of phonetic quality -- constitutes a discrete recombinant system, that is, a digital type of system. The other parallel parameters -- which I collectively term **vocal dynamics** -- are gradient in character. This latter analog type of system would seem to be more ancient and to have been carried over as the core digital system of language evolved. Some aspects of vocal dynamics can be, and often are, incorporated into the discrete recombinant system. Thus, the parameter of pitch is tapped for morphemically intrinsic tone or for intonation contours over an expression. The parameter of loudness is used for morphemically intrinsic stress or for stress patterns over an expression. And several of the vocal effects have come to be involved in marking phonological distinctions in various languages.

(1) independently variable parameters in spoken language
- A. the main parameter (a discrete recombinant system)
  1. phonetic quality
- B. parameters constituting "vocal dynamics" (a gradient system)
  2. loudness
  3. pitch
  4. timbre
  5. vocal effects (e.g., nasality, tenseness, breathiness, creakiness)
  6. distinctness (= enunciation, from sharp clarity to loose approximation)
  7. rate
  8. duration (e.g., relative segment length, spacing between words)

By contrast, the number of independently variable parameters in use in the manual

-visual modality of signed language is much greater. The subsystem of classifier expressions, by one analysis, has some thirty distinct parameters, as listed in (2), many of which can be realized concurrently in a single expression. To these can be added further parameters for lexical signs, facial expressions, and body movements -- often concurrently manifested with a classifier expression.

(2) independently variable parameters in the classifier subsystem of signed language

A. entity properties
  1. identity of Figure / instrument / manipulator
  2. identity of Ground
  3. magnitude of some major entity dimension
  4. magnitude of a transverse dimension
  5. number of entities

B. orientation properties
  6. an entity's rotatedness about its left-right axis ("pitch")
  7. an entity's rotatedness about its front-back axis ("roll")
  8. a. an entity's rotatedness about its top-bottom axis ("yaw")
     b. an entity's rotatedness relative to its path of forward motion

C. locus properties
  9. locus within sign space

D. Motion properties
  10. motive state (moving / resting / fixed)
  11. internal motion (e.g. expansion/contraction, form change, wriggle, swirling)
  12. confined motion (e.g. straight oscillation, rotary oscillation, rotation, local wander)
  13. translational motion

E. Path properties
  14. state of continuity (unbroken / saltatory)
  15. contour of path
  16. state of boundedness (bounded / unbounded)
  17. length of path
  18. vertical height
  19. horizontal distance from signer
  20. left-right positioning
  21. up-down angle ("elevation")
  22. left-right angle ("direction")
  23. transitions between motion and stationariness (e.g. normal, decelerated, abrupt as from impact)

F. Manner properties
  24. divertive manner
  25. dynamic manner

G. relations of Figure or Path to Ground
  26. path's conformation relative to Ground

27. relative lengths of path before and after encounter with Ground
28. Figure's path relative to the Path of a moving Ground
29. Figure's proximity to Ground
30. Figure's orientation relative to Ground

In the introduction to this section, the "extent" in "extent of parallelness" also included the degree of use of the extant parameters. And this degree differs as well between the two language modalities. On the one hand, it appears that all thirty plus of the parameters indicated above for signed language are in regular active use for conveying concepts in classifi er expressions. In spoken language, on the other hand, the main parameter of phonetic quality would seem to be used for representing information enormously more than all the parameters of vocal dynamics combined. Consider for example, the following difference in the range of parameters used to represent different aspects of a motion event. In a signed classifi er expression, the Figure's type is represented by a handshape; the Figure's path is represented by a linear hand movement; the Figure's Manner is represented by quick hand motions outside this linear path; the Figure's angle relative to the path of motion is represented by the angle at which the hand is held; and the distance between the Figure object and the Ground object is represented by the distance between the dominant and non-dominant hands. By stark contrast, all these different aspects of a motion event are represented in spoken language by the same single parameter, that of phonetic quality (formed in turn into morphemes, collocations, and sentences). If we can posit a category of **parameter range** for the diversity of means for representing information in a modality, it can be observed that signed language employs **parameter spread**, while spoken language employs **parameter concentration**. Put another way, signed language uses a wide range of formats to represent different kinds of information, whereas spoken language channels its representation of virtually all kinds of information into a single format.

The issue of independent parameters was introduced in this section in terms of their *potential* for representing information. The preceding lists include only parameters actually in use. But for the sake of having a full analytic backdrop as a foil for comparison, additional unused parameters can be imagined for each modality. For example, in the vocal-auditory modality, it would seem possible to produce or not produce a whistle concurrently with a range of oral sounds as one further parameter for representing some category of information. Or, as a second additional parameter, perhaps the breath could be either exhaled or inhaled on each syllable or word to signal some component of information. Or, in the manual-visual modality, the angle at which a signer's elbows are held is apparently unused as an independent parameter, but perhaps could be.

The next logical question is why these differences in the use of parameters should be as they are. The explanation for the nonuse of the parameters suggested above

-- whistling, respiratory direction, and elbow angle -- might be found in the character of neuromuscular control as this has evolved in humans (though investigation and corroboration would be needed). But then why the differences in the degree of use of the parameters that do occur? Spoken language has clearly evolved toward reliance on its discrete recombinant subsystem, disproportionately more than on use of its gradient vocal dynamics system. This has perhaps occurred for the reasons proposed in sections 5 and 6 below. However, apart from such potentially compelling reasons for a modality to favor some single parameter for representing information, perhaps the general principle is that a modality will tend to extend its pattern of use to virtually all the parameters available to it. Evidence for this principle may lie in signed language itself, which exhibits just this sort of exploitive extension. This fact gains significance when such extension is considered against the theoretical possibility that signed language could have limited itself to just a few of the available parameters, perhaps ones more similar to those available to spoken language.

To continue filling out the analytic framework, we can next observe that further independent parameters can be available to either a production or a perception system alone, while being excluded from the joint operation of two such systems paired together in a language modality. Consider first the manual-visual modality. Vision alone can discern colors and textures: two additional independently varying parameters. But manually produced shapes and movements have no direct counterparts for representing those categories.[1] And so they are absent from the combined visual-manual modality. In a complementary way, manual movement alone has available the additional parameter of the degree of pressure exerted on a contacted object -- a parameter perhaps genuinely in use in the manual-manual communication system of the deaf-blind. But vision cannot directly discern such degrees of pressure -- at most discerning only accompaniments of such pressures. And this parameter too is absent from the joint modality.

Comparably, we can consider additional parameters that would be available if spoken language were not a joint vocal-auditory modality. For example, audition alone can identify a wide range of sounds that cannot be produced vocally (except perhaps by sound effects specialists) -- for example, rustling leaves, thunder claps, cacophony, and harmony. These accordingly cannot be included as a parameter on the joint vocal-auditory list. More significantly, auditory perception by itself can determine the locations and paths of sound emitters. But vocal production is fixed in place, and so cannot directly represent such phenomena. A speaker cannot genuinely "throw her voice" in the manner often attributed to ventriloquists, for the hearer to perceive it with a specific location or path in space. Accordingly, the parameters involved in such spatial representation are also absent from the joint vocal-auditory inventory. To fill out the complementary side, one could presumably cite movements of the vocal tract that do not produce sounds (as when unaccompanied by breath) and hence cannot be perceived auditorily. These, too, would be off the list.

In sum, as a joint production-perception modality, signed language has available to it more independently variable parameters for representing information than spoken language does, and it puts a greater proportion of its parameters to actual use.

3. Extent of Iconicity

The two language modalities also differ in their **extent of iconicity**. This category is the number of different types of iconicity that are present and the degree of use of each type.

We begin by characterizing iconicity.[2] Given some form that represents some entity, iconicity minimally is a particular additional relationship that the form can bear to the entity. Namely, an aspect of the form that is the same as an aspect of the entity and also represents it is iconic of it.[3] Here, the "sameness" of the two aspects can hold with respect to apparently any conceptual category. For example, in the sentence *It's waaaay over there,* the morpheme *way* represents the concept ‘at a great distance’, and its more-than-average vowel duration represents more-than-average greatness of distance. We can abstract out a certain aspect of the extra vowel duration that is the same as an aspect of the extra quantity of distance that it represents -- namely, more-than-average magnitude along a unidimensional parameter. As can be seen, this commonality is rather abstract. In general, the conceptual category with respect to which two aspects are the same can be more abstract than a commonplace category like that of space or time. Thus, here, the extra vowel duration is realized in the category of time, while the extra distance is in the category of space, yet the iconicity holds across these two categories.

While this categorical sameness of aspects may be definitional for iconicity, a form and the entity it represents can exhibit further commonalities beyond this minimum. One such commonality is that the category with respect to which two aspects are the same can include a set of values, with the form and its referent exhibiting correspondences over this set. This additional iconic property can be called **covariation**. A still further commonality would be present if the form and the entity it represents covary proportionally along some dimension (or over some n-dimensional space). Then a further commonality yet would be present if such proportionality is direct -- presumably the default -- rather than inverse. Illustrations of these three additional forms of commonality appear in (3). The degree of extra vowel duration of the word *way* in (3a) and the number of repetitions of the word *up* in (3b) covary with and are directly proportional to the additional quantity of distance that both of these features represent.

(3) a. It’s waay / waaaay / waaaaaay over there.
b. The bird flew up up / up up up / up up up up and away.

An additional difference between these two examples points to one further form of commonality that can occur in iconicity. The duration of the vowel of the word *way*, in (3a) is a gradient and matches the gradience of our conception of the quantity of distance it represents. That is, together they exhibit **cogradience**. By contrast, The number of repetitions of *up* in (3b) comes in discrete chunks. This form still covaries in direct proportion to the quantity of distance it represents, but it is not cogradient with it. (Perhaps instances also occur in which both the form and its referent exhibit "codiscreteness"). To the extent that a form bears such additional resemblances to the entity it represents beyond the definitional minimum -- ones like covariation, proportionality, proportional directness, and cogradience -- it can be considered to be "strongly iconic".

The notion of "extent" in the preceding "extent of parallelness" category, discussed in section 2, parallels that in the present category. The extent of iconicity involves the number of the distinct forms of iconicity that are available in a modality, and the degree of their use. For the present category, we can propose in addition a reason why one might expect a particular form of iconicity to be in greater use: its **relevance to communication**. A form of iconicity is more relevant if it involves referential areas that occur in communication more frequently, more pervasively, or more ramifiedly -- for reasons that themselves can be separately examined. For example, the motion or location of objects relative to each other in space can be taken to be generally more relevant in communication than, say, the temperature of those objects. Thus, the notion of the "extent" of iconicity here can be spelled out as: the number of available forms of iconicity in their degree of relevance and use -- or, more succinctly: available relevant iconicity in use.

Of the thirty independent parameters listed in (2) for the classifier subsystem of signed language, all but the first two are systematically iconic with the conceptual content they represent.[4] For example, an entity’s rotatedness about its left-right axis (parameter 6 in (2) above), its locus in space (parameter 9), motive state (parameter 10) , path contour (parameter 15), path length (parameter 17), vertical height (parameter 18), manner of motion (parameter 24), rate of motion (parameter 25), and the Figure’s proximity to the Ground object (parameter 29) are separately represented by corresponding behaviors of the hand or hands. Most of these parameters, moreover, manifest strong iconicity: they exhibit directly proportional cogradient covariation with their referents. Further, they share not just a highly abstracted factor with them but a repletely structured domain, that of space. Thus, in a classifier expression, greater motion of the dominant hand upward represents greater motion of the represented Figure object upward -- not motion that is more downward or more circular -- nor, for that matter, say, greater importance of the object. Comparably, the faster the dominant hand moves, the faster the motion of the Figure it represents -- not, say, the slower its rate, or the larger its size, or the brighter its color.

In terms of "extent" of iconicity, it can be seen that the 28 systematically iconic parameters of the classifier subsystem of signed language are certainly all available, seemingly equally in use, and apparently all relevant relative to the kinds of information that language users frequently want to include in their communication.

As noted in section 2, vision and manual production taken singly, apart from their joint signing role, encompass additional parameters of information. These -- including aspects of color, of texture, and of pressure -- are mostly iconic[5] and seemingly fairly relevant. But, of course, they are not available to the signed language modality as a whole.

Turning now to spoken language, all the parameters in the category of vocal dynamics are indeed available as forms of iconic representation, some even with strong iconicity. But the issue of communicative relevance enters and, in fact, little of the available iconicity is used. For example, timbre and vocal effects (parameters 5 and 6 in (1) above) do at times get used with covarying directly proportional cogradient iconicity, as when a speaker uses his own vocal quality to represent that of another speaker or to represent other ambient sounds. But this is typically only an occasional practice, not of pervasive relevance to communication, and this form of iconicity has in fact not become part of spoken language’s systematic organization.

Consider now the temporal parameters of spoken language, the last two listed in (1) above: rate and duration. These parameters are certainly available to the joint production-perception system of this language modality; they can be strongly iconic (covarying in direct cogradient proportion) with conceptual content pertaining to rate and duration; and they would seem to be relevant to communicative needs. Curiously, though, such iconic use of them has not entered into linguistic structure. If they had been so used, it might have been obligatory, for example, to utter each of the three successive phrases in sentence (4a) progressively faster in iconic correspondence with the speed of the three events depicted. Or a speaker might have had to introduce pauses between the three phrases in sentence (4b) -- in fact, pauses longer than the utterance time of each phrase by itself -- to iconically represent the duration of the intervals between the depicted subevents in the situation. It is not clear why this form of available and seemingly relevant iconicity was not structurally adopted into the spoken language modality. One possible explanation, though, is the commitment that spoken language took as it evolved to the single format of the phonetic quality parameter (and the morphemes etc. that it forms into) for the representation of conceptual content, as discussed in section 2.

(4) a. The pen lay on the table, rolled to the edge, and fell off.
b. I entered, sat down, and fell asleep.

Again, as noted in section 2, audition and vocal production considered singly, decoupled from their joint role in speech, include additional parameters. Of these, our auditory capacity to discern the locations and paths of sound-emitting entities is iconic and would be the most relevant to communication. If it had been possible to "throw one’s voice", spoken language might well have formed a subsystem for the iconic representation of objects following particular paths through space or occupying particular sites within space -- much as signed language has. But such iconic representation of space is not available in the joint modality of spoken language as a whole.

Summing up, the manual-visual modality of signed language has one highly relevant system of iconic representation available to it -- space, with its numerous separately distinguishable structural parameters -- which is not available to the vocal-auditory modality of spoken language. The latter has a few minor forms of iconicity available to it -- as well as one unused form of potential relevance -- but nothing more. As with the category of extent of parallelness, one can posit as a general principle that a modality will tend to expand maximally to embrace use of the forms of iconicity available to it -- barring other significant reasons for any lack of such uptake. Basically both language modalities have followed this principle, with the outcome that signed language simply has a much greater extent of iconicity than spoken language does.

4. Extent of Digitalness

The third set of property differences across the two language modalities can be termed **extent of digitalness**. This category can be analyzed as cumulatively comprising four factors: **degree of discreteness, degree of categoricality, degree of recombination**, and **degree of emergentness**. The last two factors together are here considered to constitute **degree of recombinance**. A high-end value for the first factor enables the second factor to play a role, and so on progressively to the circumstance in which digitalness is manifested to its greatest extent with a high-end value for the fourth factor.

The degree of discreteness -- or "granularity" -- of a parameter pertains to the size of the components occupying that parameter (perhaps relative to the size of the whole parameter). With sufficiently fine granularity, the parameter can be considered gradient. At the other end of this continuum, it can be considered to consist of discrete chunked elements. Although this factor could be treated as dichotomous, with the two member values "gradient" and "discrete", the term "degree of" has been introduced to allow for some possibly intermediate cases.[6]

The second factor of "degree of categoricality" applies only to the case where a parameter has the discrete chunked form of granularity under the first factor. At issue here is whether a coarse-grained chunked element in the parameter is considered to be simply a discrete step along the parameter or a qualitatively distinct category with a separate identity in its own right. This factor might again be best treated as dichotomous, with the two member values of "noncategorical" and "categorical". But the term "degree of" has been added because the strength with which a cognizable identity is associated with what is otherwise a qualitatively distinct category may vary across parameters.

The third factor of "degree of recombination" applies only to the case where the chunked elements of a parameter are considered under the second factor to be distinct categories in their own right. At issue here, then, is whether the categories in the parameter occur there solely with their own identities and at sites relevant to that identity or can also combine in different arrangements with respect to each other in a systematic way, as characterized more precisely in (5a). The occurrence of such a system of arrangements is the only requirement for emergentness described next. But this factor of recombination is referred to in terms of "degree" because a system of arrangements can range from the simple to the complex in type and constraint, as illustrated below.

Finally, the factor of "degree of emergentness" applies only to the case where discrete categorical units with particular identities participate, under the third factor, in a system of alternative arrangements. At issue here is whether such arrangements are simply patterns resulting from the process of arranging or, rather, constitute new higher-level entities with their own identities, as characterized more precisely in (5b).[7] As another perspective, one could regard this additional step that emergentness takes over recombination as another application of the second factor of categoricality, now again assigning individual category status and a separate identity, but at a higher level. The term "degree" has been added to the present factor because, as discussed below, examples of emergentness seem to differ as to how fully the higher-level form functions as a wholly distinct new cognitive entity with its own identity.

(5) recombinance: recombination together with emergentness
a. Recombination: a system of combinations of discrete categorical units that (to some degree) have distinct identities, drawn in various numbers and with various selections from an available inventory, in alternative arrangements of a certain type in accordance with a system of constraints on possible arrangements
b. Emergentness: the cognitive pattern in which the combinations of (a) represent new higher-level entities with their own separate novel identities, where these identities bear no systematic relation to each other or to the identities of the component units, hence, are not predictable from them (or, are "arbitrary")

Starting with signed language, we can consider its classifier subsystem first with respect to the factor of granularity. We find different aspects of this subsystem at one or the other poles of the factor, exhibiting the properties of being continuous or discrete. Thus, many of the independently variable parameters of the classifier subsystem have a fine degree of granularity, in effect behaving as gradient continua for both motoric production and visual perception. For example, it seems that over a roughly continuous range, a signer can vary the locus of a hand within sign space, the contour, length, and speed of a path of motion, and the distance between Figure and Ground.

By contrast, the handshapes that represent the Figure (or Manipulator, Instrument, or Ground) are for the most part organized into discrete categories -- hence, the term "classifiers". For example, as already seen above for ASL, the handshape with the palm vertical, thumb up, first and second fingers held apart and pointing forward, and the last two fingers tucked in represents the category ‘ground vehicle’. Distinct from this, the handshape with the palm facing down, the thumb, forefinger, and pinky held apart and pointing forward, and the remaining two fingers tucked in represents the category ‘aircraft’. As an additional and separate case, some of these classifiers permit an indication of the size of the categorized object they represent, but only in terms of three discrete values, not as a gradient. For example, with the thumb and forefinger of each hand extended and curved to form a semicircle, the two hands can be held touching, slightly separated, or much separated to represent a planar circular Figure object that is small, medium, or large.[8]

These last two cases of discretely chunked representation can next be considered with respect to the factor of categoricality. They again demonstrate both member properties of the factor. Thus, the discrete indication of object size as small, medium, and large simply exhibit chunked steps along the parameter of size, hence, are noncategorical. But the classifier handshapes that represent different classes of objects are wholly distinct categories, each with its own individual identity. They do not behave as steps along a qualitatively single parameter. For example, the handshape representing a ground vehicle cannot be morphed -- either continuously or by steps -- into the handshape representing an aircraft to represent a series of hybrid machines that progress in design from ground vehicles to aircraft.

Signed language also exhibits both poles of the factor of recombination. It appears that classifier expressions for the most part do not manifest recombination. generally, values from within parameters 3 through 30 of the list in (2) are manifested independently of each other, included if relevant and omitted if not, each occupying its own designated portion or aspect of the whole classifier expression, without entering into rearrangements relative to each other. Only the first two parameters -- in which typically the Figure and the Ground objects are represented by the dominant and nondominant hands, respectively -- participate in a regular system of rearrangements, albeit a very simple one. For example, in two classifier expressions respectively representing a car moving past a plane and a plane moving past a car, the two classifier handshapes will be interchanged. By contrast, the lexical and inflection subsystems of signed language do exhibit recombination. The discrete categorical signs within those subsystems combine in a complex system of constrained arrangements, the counterpart of syntax as understood in spoken language.

Finally, both poles of the factor of emergentness are also realized in signed language. As discussed in greater detail below for syntax in spoken language, the recombination of signs in the lexical and inflectional subsystems of signed language do not constitute new higher-level categorical entities with unpredictable novel identities. Rather, the meanings of the expressions are systematically related to the meanings of the component signs in their particular arrangements. Emergentness does appear, however, in the combining of individual positions and movements of the fingers and hands -- themselves presumably drawn from some relatively limited inventory -- into categorically distinct signs comprised of particular handshapes undergoing particular movements.

Turning to spoken language, this modality, like that of signed language, exhibits both the continuous and the discrete forms of granularity. Thus, all the parameters of vocal dynamics appear to be gradient in character. This is the case both for vocal production and for auditory perception. But the core parameter of phonetic quality is perceived in terms of discrete chunks (and production tends to cluster within approximate chunks as well).

With respect to the factor of categoricality, these discrete phonetic chunks are not perceived merely as coarse steps along an otherwise qualitatively singular parameter. In fact, unlike signed language, spoken language may lack any aspects behaving as steps along a parameter. Rather, they are famously perceived categorically as distinct types of entities. Thus, an English speaker hearing a finely graduated series of sounds from an exaggerated [b] through to an exaggerated [p] will regularly perceive only two distinct sounds, a "b" and a "p", with the switch from one to the other occurring at some point along the continuum.

Next, spoken language exhibits both poles of the factor of recombination. The parameters of vocal dynamics -- parameters 2 through 8 in (1) -- generally do not manifest recombination. As with parameters 3 through 30 of the classifier subsystem of signed language in (2), values from within the vocal dynamics parameters are generally realized independently of each other, and do not enter into rearrangements relative to one another. By contrast, recombination is exhibited by four successive levels of organization within spoken language. The first three levels also exhibit emergentness, and so are discussed next, together with characterizations of their forms of recombination. The fourth level is syntax, the system of recombination par excellence, also discussed further below for its lack of emergentness.

Finally then, spoken language exhibits three successively higher levels of emergentness. Each level has a different type of arrangement of its discrete units and a different set of constraints on the arrangements. At the lowest level -- for those phonological theories that frame the matter this way -- phonetic features in a particular number and with certain identities, drawn from an inventory of phonetic features available in the language at hand (itself in turn drawn from a universally available inventory), combine to constitute a higher-level entity, a phoneme, with a particular new identity. Different combinations of phonetic features constitute different phonemes. The type of arrangement that the combination exhibits is one of the simplest: mere cooccurrence. And the constraint on them is also one of the simplest: mere compatibility.

At the second level of emergentness in spoken language -- well known since de Saussure -- phonemes in a particular number and with certain identities, drawn from the inventory of the phonemes available in a particular language, combine to constitute a higher-level entity, a morpheme, with a particular new identity, one that includes a particular associated concept. Different combinations of phonemes constitute different morphemes. As to its type, the arrangement that the phoneme units combine in is generally sequential and contiguous. But some types of phonemes, -- for example, tones -- are concurrent with parts of a sequence that is otherwise present. And the phonemes of some morphemes -- for example, the triconsonantal roots of Semitic languages -- allow the insertion of other phonemes between them while they retain their sequence. Thus, the three English phonemes /k/, /t/, and /æ/ can be arranged in three different contiguous sequences to constitute three different morphemes: /kæt/ *cat*, /tæk/ *tack*, and /ækt/ *act*. The system of constraints that such arrangements of phonemes are under -- generally known as "phonotactics" -- can be quite complex.

A range of tests that vary the phonemic composition or the conceptual referent of a morpheme provide the main demonstration that any systematic correlation between a morpheme's phonemes and its meaning is largely absent. Thus, the resequencing of the phonemes in the *cat / tack / act* triplet correlate with nothing comparable in the meanings of the three morphemes. Or, the set of morphemes that share the phoneme /k/ in initial position -- which includes *cat / cut / can / clean* -- have no apparent component of meaning in common. Demonstrations like these against any general phonemic-semantic correlation obviate the need for any finer test that would depend on such a correlation, such as a phonemic-semantic covariation along some parameter, but one is offered here anyway for its relevance below. Thus, starting with the English morpheme *red*, referring to a particular color concept, one finds certain successive colors along the parameter of the spectrum represented by phonemically unrelated morphemes, *orange* and *yellow*. We do not find, say, that the color concept 'orange' is represented by a morpheme *redge* (/rej/), and that of 'yellow' by a morpheme *reg* -- two forms that, together with *red*, would have their final phoneme vary along a feature parameter of place of articulation. In a complementary way, we could begin, say, with the morpheme *rib* referring to a type of bone in the chest, and vary the final phoneme along the feature parameter of place of articulation. What results is a series of semantically unrelated morphemes: *rid* 'free (from something unwanted)', *ridge* 'linear mound of earth', *rig* 'equipment'. There does not result a series of morphemes whose meanings proceed along some semantic parameter, say, that of neighboring bone types: 'vertebra', 'sternum', 'clavicle'.[9]

At a third level of emergentness, morphemes in a particular number and with certain identities, drawn from the inventory of the morphemes available in a specific language, can combine to constitute a higher-level entity, an idiom, with a particular new identity. This new identity includes an associated concept. Thus, like a morpheme, an idiom associates a particular form with a particular concept. But this overall concept is not systematically related to those of the component morphemes. Different combinations of morphemes can constitute different idioms. The type of arrangement is mostly sequential: morphemes at successive, though not necessarily contiguous, locations in a word or phrase. The constraints that apply to the arrangements of the morphemes making up an idiom are largely those of morphology[10] and syntax. That is, the individual morphemes of an idiom largely follow the requirements on certain affixal or lexical categories to occur in certain structural locations that apply in general to the compositional (nonidiomatic) combination of morphemes.

In addition to the range of idioms that seemingly occur over virtually any part of morphology or syntactic structure, a language often has a principal structural mechanism for the formation of idioms. In English, it is combinations of a verb with a satellite and/or preposition, as illustrated in (6).

(6) English idioms with a particular verb plus a satellite and/or preposition

A. with *turn* as verb
turn up 'become found' *My cufflink turned up at the bottom of the clothes-hamper.*.
turn down 'reject' *I turned the offer down*.
turn in 'go to sleep' *I turned in for the night.*
turn out 'eventually be realized'
It turned out that he had been telling the truth all along.
turn X on to Y 'rouse X's interest in Y' *She turned him on to Rilke*.
turn on X 'suddenly attack X after being allied with X'
When he objected, his friends turned on him.
turn X over (to Y) '(reluctantly) give X to the authorities Y'
They turned the stolen property over to the police.

B. with *come* as verb
come up 'occur as a topic' *Corporate media control came up in the discussion.*
come up with X 'originate the concept of X' *She came up with the idea of a head-band computer.*
come down off X 'return to an everyday state of consciousness from the exhilarated one of X' *She finally came down off her intellectual high*.
come down with X 'contract the disease of X' *I came down with the flu*.
come on to X 'act so as to seduce X' *He came on to her at the bar, but she just turned away.*
come off 'become realized successfully' *Our planned march didn't come off.*
come out 'be revealed' *it came out in the investigation that he had been on the company's pay.*
come across as X 'give the impression of being X' *She comes across as self-important.*
come through 'perform promised actions, showing trustworthiness (despite doubts)' *We needed her help, and she did come through in the end*
come about 'happen' *Her expected promotion never came about*.

Inspection of such forms and their meanings shows that by and large there is no obvious semantic component common to those glosses associated with the same verb or with the same satellite/preposition. The meanings of the morphemic combinations are largely independent of each other and of their components. They are not subject to any apparent principles governing systematic semantic regularity.[11] As already noted with the phoneme-morpheme association, this general noncorrelation naturally precludes any more specific correlation, such as covariation along a parameter. But to provide one as an illustration in any case, let us assume that the literal spatial senses of the satellites *up, across* and *down* form a succession along a parameter of orientation. But then no comparable semantic succession can be discerned in the meanings of the three idioms with *come* that include those satellites: *come up* ‘occur as a topic’, *come across* ‘give the impression of’, and *come down* ‘contract (a disease)’.

Apart from any idioms contained within them, compositional morphology and syntax themselves do not constitute a further level of emergentness. This is because the meaning of a whole complex word or phrase is systematically related to the meanings of the component morphemes and the morphological relations or constructions these are in (and, from some theoretical perspectives, the morphological relations and constructions available in a language are themselves morphemes of a kind). Thus, the sentences in (7) all share certain morphemes as components -- e.g., *dog, cat, like,* present tense, and habitual aspect. And, indeed, the overall meanings of the sentences are related to the meanings of these morphemes and to each other.

(7) a. The dog likes the cat, but the cat doesn’t like the dog.
b. The dog likes the cat a lot, and the cat likes the dog a little.
c. The dog and the cat like each other equally.
d. The cat likes the dog a lot, and the dog likes the cat a little.
e. The cat likes the dog, but the dog doesn’t like the cat.

Thus, the compositions of morphology and syntax do not yield a higher-level entity with a novel identity. Of course, short of this, they do exhibit recombination. They involve discrete units combined in arrangements under a system of constraints, ones that govern the slotting of the discrete units in to discrete positions within a structured framework. The character of these arrangements excludes covariation along a parameter. To illustrate, the meanings of the sentences in their succession in (7) vary in a progression as to the ratio of affection between the dog and the cat. But nothing in the composition of the sentences progresses along some structural parameter in a corresponding way. Rather, we find such discrete devices as the order of two clauses, the use of *but* vs. *and* as a conjunction, the presence or absence of a negative, the use of a reciprocal or nonreciprocal construction, the appearance of adverbials of quantity like *equally, a lot, a little*, and the assignment of the nouns to subject or object position.

In summary, by comparing these observations across signed and spoken language, it must be concluded that spoken language exhibits a much greater extent of digitalness. While signed language has an important subsystem, the classifier subsystem, that is mostly gradient, spoken language relies centrally on its main parameter of phonetic quality, which is almost entirely discrete. While signed language employs some of its existing discrete forms as mere steps along a parameter, spoken language appears to treat them all as distinct categories. While in signed language the important classifier subsystem mostly shows non-recombination, only the relatively peripheral vocal dynamics system in spoken language lacks recombination. While signed language has two major forms of recombination, that in its handshapes and that in its lexical-inflectional expressions, spoken language has four major forms of recombination, each feeding successively into the next. And while signed language has one major form of emergentness, that in its handshapes, spoken language has three successive levels of emergentness.

5. Extent of Digitalness across Cognitive Systems

Talmy (2000a and b) proposed and began research within a perspective -- termed the "overlapping systems model of cognitive organization" -- in which different cognitive systems can be compared with each other as to similarities and differences in their organizational properties. Major cognitive systems that can be approximately distinguished in animals with more complex nervous systems (with some to be found in much simpler animals as well) include the following: perception (in its various modalities), motor control, affect, and reasoning/inferencing, -- together with such cognitive faculties as memory and attention that interact with the preceding substantive systems. In addition, with the emergence of humans, the last two of the major substantive cognitive systems to have evolved are those of language and of culture.[12] Digitalness is the type of representation that spoken language clearly most relies on and that may have found its greatest elaboration in that modality. Accordingly, an examination of digitalness across cognition is in order, and might give clues to any elaboration it may have had in the evolution of the language system. It is considered next in terms of the four successive factors that comprise it, with special attention to the highest two factors, recombination and emergentness -- that is, to recombinance.

Looking first at the factor of gradience that distinguishes the continuous from the discrete, many cognitive parameters can be seen to be continuous in character. In visual perception, examples are an object’s locus in space, path of motion, speed, size, and brightness. In motor control, examples are a body part’s locus of placement, path of movement, speed of motion, and pressure exerted. In the affect system, an example is the intensity of an emotional value. And in spoken language, of course, the various parameters within the system of vocal dynamics are all gradients.

We can next look for cognitive parameters that are discrete with respect to the gradience factor. Some of these will further appear to constitute individual entities with their own distinct identities with respect to the factor of categoricality. In visual perception, one case would seem to be the discrete classificatory identity of objects. An example is seeing a certain long thin pointed object and identifying it as a knife -- that is, perceiving it as a discrete entity and, further, one having a membership in a category with its own identity. Perhaps the vertices, edges, and planes of a perceived solid object are each processed as discrete elements in qualitatively distinct categories. The perception of hue may have partially discrete categorical character in a way that, say, the perception of brightness or saturation does not. Perhaps the organization of the cognitive system for motor control structurally incorporates provision for distinct units of movement -- motons? -- such as the movement of one leg forward in walking. In the affect system, emotions might tend to be processed in terms of approximate categories, each with its own qualitatively distinct character, rather than simply shading off continuously into one another. And in the cognitive system underlying music, a scale or a melody consists of discrete notes, rather than of some pitch continuum.

Combining consideration of recombination and emergentness together, we can next see which of these or other seemingly discrete categorical units can combine in arrangements that themselves constitute qualitatively new entities with their own distinct identities. That is, this examination has arrived at the question of where recombinance might occur. With regard to visual perception, the first aspect of it considered above, the classificatory identity of objects, would seem not to systematically yield higher level entities. Thus, one could view a knife, a plate, a glass, and a napkin located near each other or even in motion relative to each other, but one would continue to see or track them in terms of their separate identities located at specific sites or traversing certain paths.[13] AT most, one could perceive them as together constituting a place setting, which is perhaps a certain kind of higher-level entity, but perception of their individual identities would not fade away, and further, there is no organized system by which different arrangements of those objects would come to be perceived as a series of different higher-level entities. By contrast, perhaps a likelier candidate for recombinance is the perception of different distinct object shapes from the different arrangements of vertices, edges, and planes perceived in the exteriors of the objects. If visual perception proves to include "geons" -- basic elements of shape that combine in different arrangements to constitute the overall shape of an object, as proposed by Biederman (e.g., 1987) -- then they too would constitute a discrete recombinant system. Further examples of such a system might be found in certain processes proposed for the visual processing stream -- for example, "contour integration" by which the minute oriented line segments perceived from tiny receptive fields on the retina can combine in the perception of a particular larger-scale contour. With regard to motor control, perhaps the motor units posited above can recombine in higher-level patterns. For example, maybe a forward bend at the waist, which might otherwise be used in leaning over, and a bend at the knee, which might otherwise be used in lifting a leg, combine together with further motor units in what can be processed and experienced as a larger-scale movement pattern with its own separate identity, that of sitting down.

We can turn to the processes of the cognitive system that underlies music for a last nonlinguistic example of possible recombinance. It would seem that a melody is experienced as having a kind of identity of its own that is distinct from the identities of the notes that make it up. In fact, it is possible to narrow in on the factors that a melody's individual identity rests on by considering a range of changes to an existing melody and seeing which ones leave its identity intact and which alter it, as outlined in (8).

(8) factors that do and that do not determine the identity of a melody

A. main factors determining the identity of a melody--
changes in them would yield a different melody

1. a sequence of notes within a relative scale (ignoring grace notes)
2. the relative duration of these notes and of the intervals between them
3. the relative loudness of the notes (in part determining rhythm and phrasing)

B. operations on a sequence of notes that would yield a different melody[14]

1. reversing the sequence
2. inverting the relative height and relative depth of the notes about some chosen pitch
3. multiplying the relative pitch differences between the notes by some chosen factor
4. treating the succession of notes as mere rises and drops in pitch and altering the size of these steps

C. factors generally not determining the identity of a melody--
changes in them would largely not yield a different melody

1. the absolute key in which the scale-relative notes of the melody are realized
2. the overall speed/tempo of the melody (within certain extremes)
3. the overall loudness of the melody
4. the timbre of the notes
5. ornamentation (grace notes, slides on the main notes)
6. additional notes produced concurrently with those of the main sequence (as for harmony, counterpoint)

These various possible or clearcut cases of recombinance across cognition seem to differ in their degree of emergentness -- that is, in the degree to which the higher-level form emerges as a wholly distinct new cognitive entity with its own identity. Several factors can be proposed as responsible for such differences. First, the separate identity of the higher-level entity seems to be promoted to the degree that awareness of or attention on the lower-level components is reduced relative to that on the higher-level entity itself. Thus, attention on the phonemes that make up a morpheme would seem to usually be low compared to that on the morpheme itself. Perhaps the motor components that make up a categorical movement pattern is also attentionally low relative to the whole pattern itself (if such an analysis proves viable). Such wide attentional ratios would seem to advance the independent status of the morpheme and the motor pattern, respectively. By contrast, it would seem that awareness of the morphemes that make up an idiom do not greatly fade away relative to awareness of the whole idiom. And perhaps attention on the notes making up a melody is not slight compared to attention on the melody as a whole.

As a second factor, a higher-level entity seems to be more autonomous and more decoupled from its lower-level components to the degree that it is different in kind from them. Metrics for rating such qualitative similarity or difference still need to be proposed. But perhaps it will be judged that one case of a major difference in kind between a lower- and a higher-level entity is that between a phoneme -- solely a unit of sound -- and a morpheme which, beyond its sonic characteristics, has an associated concept. By contrast, the morphemes that make up an idiom are similar in character to it: the entities at both levels have both a sonic and a conceptual aspect. Perhaps comparable similarity in kind will be judged to be present between phonetic features and phonemes, between notes and a melody, between motor units and a movement pattern, or between the visual elements that make up a shape and that shape.

A third factor favoring the seeming cognitive autonomy of a higher-level construct is arbitrariness in the selection of its lower-level components and their arrangement. If basic visual elements recombine in the perception of existing solids, and basic motor units recombine in the production of motor patterns designed to achieve certain goals amongst physical givens, such recombinance could not be systematically arbitrary, but rather would largely need to follow from characteristics both of the basic elements and of the higher-level entity. By contrast, the selection and arrangement of phonemes in a morpheme exhibit the greatest degree of arbitrariness. They can only be remembered, not inferred.

On the basis of the three preceding factors together, the phoneme-morpheme relationship at the heart of spoken language may prove to be the most extreme form of recombinance to be found across cognitive systems.

6. Evolution of the Digital Character of Spoken Language

Evidence has just been presented that recombinance is perhaps more central and elaborated in language than in any other cognitive system, if indeed it does occur elsewhere. One question that arises is whether, as it evolved, the language system could have adopted this recombinant form of organization from other cognitive systems already extant. If recombinance is in fact not found in other cognitive systems, or is relatively minor there, then the evolving language system must have developed recombinance newly or ramified it into playing a major role. If that is the case, there is the question of why it might have been advantageous or necessary for that to happen. Part of the answer may lie in the following considerations.

For whatever reasons -- themselves needing separate examination -- language evolved relying on the vocal-auditory channel. If for now we take the perspective of the receiver of that channel, we can contrast the perception of speech with visual and general auditory perception. This contrast can be made with respect to the following four features that, together, suggest an information transfer bottleneck in the originally nascent perception of speech.

First, as discussed in section 2, visual and general auditory perception involve a (much) greater number of independently variable parameters that can carry information than the roughly eight to ten parameters of the vocal-auditory channel. That is, they have more extensive means for the transmission of information.

Second, there is a difference in similarity and directness of relationship between the stimulus and the percept. A perceiver of patterns of light or sound needs to cognitively reconstruct the entities that themselves produced such patterns of light or of sound. But a perceiver of vocal speech does not reconstruct the entity producing that speech pattern. Rather, she needs to reconstruct the pattern of concepts that it represents. Thus, the trigger of cognitive processing and the cognitive representation produced by that processing are more alike and directly related in the case of visual and general auditory perception than in the case of speech perception.

Third, the stimulus producing entities that are the target of a perceiver's reconstructions in the case of vision and general audition apparently involve much that is intrinsically gradient in character. And such gradience can be iconically delivered to the perceiver by the gradient stimulus parameters. Thus, as discussed in section 5, continuous in character are the location or path in space of an entity that emits light or sound, the speed, size, or brightness of a light-emitting entity, and the loudness, pitch, or timbre of a sound-emitting entity. By contrast, in the conceptions typically relevant to communication, relatively little is of gradient character and therefore suitable for direct iconic representation by gradient parameters.

Fourth, consider the spatial region and the temporal interval occupied by an entity producing light or sound. The light or sound will occur in some pattern over this region and interval. Because entities are constrained by the properties of natural objects, it is possible that the patterns they produce exhibit a kind of regularity and occur with greater frequency -- hence, are more predictable. By contrast, the patterns of concepts represented by speech can be relatively more unpredictable, both in overall content and in details. This is because the principles governing their character are the complex cognitive processes that underlie someone's individual thought.[15]

Given these observations, it may be concluded that the kind and number of parameters available for the perception of light or sound are adequate for the needs of the perceiver to process the stimulus information being received with respect to three key criteria: its character, quantity, and rate. But this might not have been the case for the perception of communicative speech. Even if the vocal-auditory parameters had all been gradient in kind, and even with their relatively smaller number, they might have been adequate if the three key criteria were different. For example, they might have been adequate if the concepts needing transmission were more gradient and predictable in character. Or they might have been adequate if the number of distinct concepts available and the amount of them needing to cooccur in an ensemble were lower. This, after all, is exactly the situation with the repertoire of calls in some animal species, for example, vervet monkeys. And they might have been adequate if the rate at which concepts were communicated or the rate at which such concepts needed processing in the receiver were slower. However, at the possibly high level of cognitive complexity and speed already present even in our pre-speech human predecessors, any communication of concepts from one organism to another may have required more than was afforded by the kind and number of vocal-auditory parameters then available.

In the evolving human, an advantage would presumably have existed in any increase in the complexity, quantity, or speed in the communication of concepts. Such an advantage would have placed selective pressure on the transmissional parameters to change in a way that accommodated such an increase. The result may have been an increasing development of recombinance -- whether by adoption from elsewhere in cognition or by innovation -- to the point of reaching its central organizing role in fully human language. Through its digital character, the mechanism of the recombinance of discrete units would have enabled the transmission of more information about largely nongradient phenomena over a narrower bandwidth with greater speed and fidelity.

Of the vocal-auditory parameters available, the mechanism of recombinance developed only with respect to the parameter of phonetic quality. Based on that parameter, phonetic features recombined into phonemes, with the extension of the latter to morphemes, to idioms, and -- with recombination but without emergentness -- to morphology and syntax. The more ancient system of vocal dynamics carried over through this evolution of the recombinant language system. It continues today in its original function of representing mostly affective information. It does this in the vague, approximative, continuous fashion of these originally gradient parameters. And this is in contrast with the crisp representation of discrete concepts of the new recombinant system.

If the new language system had originally evolved as a manual-visual modality, the greater extent of parallelness and perhaps finer granularity available in that modality might well have permitted a continuation of the more analog representational type. However, language did evolve using the vocal-auditory channel, with that channel necessitating a basically discrete recombinant type of representation. The core language system, as this was characterized in the introduction, accordingly evolved to function on the basis of the recombinant type of representation. For this reason, the secondary formation of a manual-visual linguistic system is now largely of the discrete recombinant type -- as manifested in it's lexical and inflectional subsystems. Only certain of its subsystems -- notably the classifier subsystem and the size-and-shape-specifier (SASS) subsystem -- dedicated to representing the spatial properties of objects, have returned to a more analog type of representation. As proposed in the introduction, this might result from the core system's interaction with an outlying brain system with more analog properties-- in fact, presumably with the visual processing system itself. But digitalness in general, and recombination and recombinance in particular, have become the hallmarks of human language.

Endnotes

1. The classifier subsystem *is* able to represent textures indirectly. Though not well examined, it seems to lack a uniform format for this kind of representation, but does include a range of methods. In one of these, for example, a rough or

stippled surface can be represented by many little pokes with the fingers (Karen Emmorey, personal communication). Gestures of this sort represent a static pattern by means of motion (an example of fictive motion in signed language -- see Talmy 2000a, chapter 2). (This form of representation is perhaps minimally iconic.) What does not occur, though, is a direct representation of static textures with static configurations of the hands.

2. Haiman (e.g., 1985) does not appear to give a single definitive characterization of iconicity -- hence, the attempt at one here.

3. The condition that one aspect must *represent* the other is needed because mere identity of the two aspects is not enough. For example, one aspect of the linguistic form *horse* and one aspect of a physical horse is existence in our universe. These two aspects are the same. But the former aspect does not function to represent the latter aspect. They are both present independently. So the word's existence is not iconic of the horse's existence.

4. Individual classifier handshapes are often weakly iconic in that they share some aspect of form with the category of objects they represent. This shared aspect can be quite salient, as with a flat hand representing a planar object. Or it can be suggestive, as with the forearm, hand, and fingers held vertically upright, fingers spread, to represent a tree. Or it can be quite obscure or imaginative, as with the forefinger and middle finger held up but bent into a kind of hooked shape to represent an animal. The point here, though, is that unlike the other parameters, these two classifier parameters for the Figure and Ground objects are not systematically or strongly iconic with their represented objects. For example, they do not shift and stretch in a graduated way to represent objects whose shapes exhibit comparable variations.

5. Aspects of the notion of iconicity should apply as well, it seems, to the relation between stimuli and perceptions of the stimuli. Thus, brightness and the perception of brightness are largely covariant, proportional, proportionally direct, and cogradient. By contrast, hue and its perception are not strongly iconic in this way. As the wavelength of light increases as a gradient, one's percepts of it do not simply shift continuously but also exhibit a categorical character.

6. For example, in an ASL classifier expression, the distance between the dominant and nondominant hands -- e.g., representing the Figure and Ground at the moment when a car is passing a tree -- might in principle be gradient. But fine distinctions might in practice not be readily produced or perceived -- or be meaningful, especially with the relativistic character of magnitude indications. Accordingly, Such distance indications might be realized in relatively discrete jumps, though ones without "official" categorical standing.

7. The concept of an "emergent" phenomenon in physics does imply the ultimate inferrability of the phenomenon from lower-level factors, even if the calculations that would yield the result are currently intractable. Thus, the liquidity of water may be understood as an emergent relative to the properties of water molecules, but it is assumed that the former follows from the latter in accordance with standard physical regularities, and does not occur in nature as a random surprise. On the other hand, the meaning of a morpheme does not follow from the phonemes that make up its shape. Hence this pattern, and its like in cognition, are genuine cases of arbitrariness needing recording in memory. The term "emergent" as used in physics is thus not wholly appropriate for them, but has been adapted for this modified use.

8. As with the discrete chunking in the *up up / up up up / up up up up* example of (3b), this classifier indication of size is iconic with the size of the objects it represents with respect to covariation, proportionality, and proportional directness, but it is not cogradient with it.

9. Exceptional to the general phonemic-semantic decoupling, there do occur some sound-meaning correlations, generally of a vague, approximative, or suggestive character, known as "onomatopoeia" or "sound symbolism". An English example might be *tick*, felt by some to mimic the sound, say, of a clock. Or, again, a certain number of morphemes beginning with the phonemes sl/ have the common semantic component of being a messy / distasteful semi-liquid mass. Examples are *slop / slush / sludge / slime*.

10. The morphemes making up a multi-morphemic word can also combine either compositionally or idiomatically. A compositional example in English might be *unresettable* (This kind of trap is unresettable). An idiomatic, example is *practically* in its sense of 'virtually' rather than 'in a practical manner'. Further, the multi-affixal verbs of polysynthetic languages like Navajo and Atsugewi include many idiomatic combinations of particular affixes (which need not be contiguous). Thus, in Atsugewi the combination of the directional suffixes *-tip* 'out of liquid', *-uu* 'extendedly , and *-im* 'thither' means 'down into a large hole in the ground'.

11. However, as with onomatopoeia between phonemes and morphemes, some departures from total decoupling exist between the level of morphemes and that of idioms. Such departures include certain semantic tendencies, occasional minor patterns, and metaphoric motivations. For example, certain senses of both *turn in* and *turn over* -- *They turned the fugitive in to the police. / They turned the stolen property over to the police* -- refer to transfer of something one controls to the authorities. And perhaps the *up* common to both *turn up* 'become found' and *come up* 'occur as a topic' contributes to both glosses a semantic component of 'become available to attention'.

12. Talmy (2000a) proposes the presence of a "cognitive culture system" in the human brain, responsible for an individual’s acquisition and manifestation of cultural patterns.

13. It is open to question whether the patterns of positions and paths that distinct objects can manifest with respect to each other -- or our perception of such patterns -- should be considered a full case of recombination. The more or less continuous relations that objects can bear to each other in space is different enough in character from the type of recombination found in, say, syntax -- which could be better characterized as a framework with slots and fillers for the slots -- that it might be better thought to manifest a lack of recombination.

14. Although some composers have used B1 and B2 -- reversal and inversion -- to produce variations on a theme, it seems unlikely that our spontaneous musical cognition would class these as the same original melody.

15. To be sure, natural entities occur in a great variety of identities and arrangements, a fact that lessens their predictability. And much of the ideational and affective content that is communicated follows familiar trajectories, a fact that increases its predictability. Still, the overall tendency may be as stated.

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