How Spoken and Signed Language Structure Space Differently

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0. Overall Introduction

This talk: how objects moving/located relative to each other in space are represented
schematically and structurally in spoken language (Part I) and in signed language (Part II),
how these two are alike or differ, and the cognitive implications of the differences (Part III).

The findings suggest not a Fodor-Chomsky type of discrete whole-language module, but:
a. a more limited core language system for the properties common to spoken and signed language.
b. this core system linking up with different outlying systems for the full functioning
of the 2 different language modalities.

When formal linguistic investigation of signed language began several decades ago, it was important
to establish in the context of that time that signed language was a full genuine language.
The way to do this, it seemed, was to show that it fit the prevailing model of language,
within the Chomskyan-Fodorian language module.
Since then, however, evidence has been steadily accruing that signed language does diverge
in various respects from spoken language.
The modern response to such observations --
far from once again calling into question whether signed language is a genuine language --
should be to rethink what the general nature of language is.

Part I: Spatial Structuring in Spoken Language

1. Introduction

1.1 Distinguishing forms for conceptual structure from forms for conceptual content

1.1.1 A design feature of language - every language has two formally distinct subsystems

open-class (lexical): all morpheme classes large and easy to augment
e.g., (the roots of) nouns, verbs, adjectives
closed-class (grammatical): all morpheme classes small and difficult to augment
e.g., bound: inflections, derivations; free: prepositions, conjunctions, determiners

1.1.2 Semantic difference based on this formal difference

open-class forms: unconstrained; closed-class forms: highly constrained

closed-class forms are semantically constrained at two levels:
a. as to the categories of concepts they can represent
e.g., "number" but not "color"

b. as to the member concepts they can represent even within acceptable categories
e.g., within "number": singular, dual, trial, plural, singulative; some, many, all
but not: even, odd, dozen, numerable

due to these semantic constraints on closed-class forms
language has a universally available inventory
of conceptual categories and member concepts (semantic primitives)
that closed-class forms can ever represent

1.1.3 Functional difference based on this semantic difference
open-class forms represent conceptual content; closed-class forms represent conceptual structure

1.1.4 Topic of this talk: spatial ***structure***
hence, limited just to closed-class forms - specifically, those representing space
and to those conceptual categories in the universally available inventory pertaining to space
hence excludes spatial open-class forms like: spiral, square, zigzag

1.2 Spatial closed-class forms -- "SCCs": the target of analysis
target: cross-linguistically, all closed-class forms that specify spatial structure,
generally whole spatial schemas, including:

1.2.1 SCCs for the spatial structure of paths or locations
a. forms in construction with a nominal
adpositions: *into / above* + adpositional complexes: *in front of*
noun inflections: Finnish "illative" *-:n* `into'
"locative nouns": Japanese *ue* `over-region',
as in *teeburu no ue ni* table GEN top at (= "on the table")
b. forms in construction with a verb
free verb satellites: *(run) back / apart / ahead*
bound verb satellites: Atsugewi *-ic't* 'into liquid'
c. deictic determiners and adverbs : *this / here*
d. indefinites, interrogatives, relatives, etc.:
everywhere / whither / wherever (I'll go wherever you go)
e. qualifiers: *way, right,* as in *It's way / right up there*.
f. adverbials: *home,* as in *She isn't home*.

1.2.2 SCCs for the spatial structure of objects
g. markers for plexity / state of boundedness on nominals
English plural *-s*: *birds*; debounding *-ery*: *shrubbery*
h. classifiers: Korean *chang* 'planar object'
i. instrument markers:
Atsugewi *cu* 'as the result of a linear object, moving axially, impinging on the Figure'

1.3 Provisional finding of the investigation

The schema system of spoken language has 3 parts:
the componential, the compositional, and the augmentive

1.3.1 Basic elements: the componential part of the schema system

a. There is an approximately closed inventory of conceptual elements that are basic -- perhaps primitive -- that recombine in various patterns to constitute the schemas represented by most of the closed-class spatial forms found across languages.
b. There is a relatively closed set of categories that these elements fall into.
c. Each category mostly contains a relatively closed and small number of particular elements -- hence, of spatial distinctions that it can ever mark.
d. The inventory is universally available: each language draws in a different way on the elements and categories of the inventory for its closed-class spatial schemas.

1.3.2 Whole schemas: the compositional part of the schema system

a. These basic elements are combined into the whole spatial schemas that, "pre-packaged", are expressed by SCCs -- perhaps under well-formedness conditions (the least well established aspect of this investigation).
b. Each language has in its lexicon an approximately closed set of SCCs representing an approximately closed set (larger, due to polysemy) of such whole spatial schemas that a speaker must select among in depicting a spatial scene.

1.3.3 Processes on whole schemas: the augmentive part of the schema system

a. There are certain properties and processes that apply generally to the whole spatial schemas expressed by SCCs.
b. The processes extend or deform the basic form of whole schemas perhaps as a system for fitting a language's closed schema set to more spatial situations.

2. Determining basic schema elements and categories

2.1 Method for determining basic schema elements

Systematically change candidate elements of a schema expressed by a SCC.
Those changes preventing the use of that SCC show the elements essential to it.

Consider the locative *across* schema, as in this model sentence:
The board lay across the road. (vs. the alternatives below)

2.1.1 Candidate elements that prove out

a. A Figure object F [the board] is spatially related to a Ground object G [the road].
b. G is ribbonal: a plane with two roughly parallel edges.
These edges (the main axis) are longer than or equal to
the distance between them (the secondary axis).
c. F is linear (and generally bounded at both ends).
-- vs. The wall siding lay over the road.
d. The axes of F and G are roughly perpendicular.
-- vs. The board lay along the road.
e. F is parallel to the plane of G.
-- vs. The board is sticking out of / into the road.
f. F is adjacent to the plane of G.
-- vs. The board lay (buried) in the road. / The board hung suspended above the road.
g. F's length is at least as great as G's width.
-- vs. The baguette lay on the road.
h. F touches both edges of G
-- vs. The board lay over one edge of the road.
i. The axis of F is horizontal. (The plane of G is typically, but not necessarily, horizontal.)
The spear hung across the wall. vs. The spear hung up and down on the wall.

This shows that at least the following elements figure in SCC-expressed schemas:
a point; a line; a plane
a boundary: a point as boundary to a line, a line as boundary to a plane
parallelness; perpendicularity
horizontality
adjacency (contact)
relative lengths of 2 perpendicular axes

2.1.2 Candidate elements that don't prove out

a. not in *across*, but in other SCCs, hence in the inventory:
F is a plane and coplanar with G
ok: The board lay flat / stood on edge across the road.
So *across* schematizes the Figure only for its linearity, not for any planarity or coplanarity
Hence, this SCC shows no requirement for coplanarity, but other SCCs do:
A tapestry / *A string of beads hung over the wall.

b. not in *across*, perhaps in no SCC, hence not in the inventory:
F is rigid
ok: The pole / cable lay across the road
So *across* shows no element "rigid" or category "state of rigidity";
maybe it is never schema-relevant.

2.2 Establishing the categories

2.2.1 Elements into categories

Having determined many such basic spatial elements, we find certain sets of them such that the elements in a set involve the same spatial property and are mutually incompatible: only one of the set's elements can appear in a given spatial schema.

Such sets are basic spatial categories--also part of language's conceptual structuring of space. Such categories generally have a relatively small number of elements as members.

2.2.2 Principle: get down only to the largest necessary granularity for member elements

Cross-schema analysis yields a category of "angle" between 2 lines, 2 planes, or a line and plane.
This category has at most 3 member elements:
roughly parallel, roughly perpendicular -- both seen earlier for *across* --
and oblique -- seen occasionally -- e.g.,:
English *off* vs. *out*: A secondary pipe branches off/out from the main sewer line.
Atsugewi *ra-* vs. *cu-*: `due to a linear object moving obliquely/perpendicularly against a surface'
e.g., by poling a canoe vs. by prodding an animal

This angle category has much finer distinctions for other cognitive systems
-- e.g., vision / motor control -- but rejects all but these 3 for the closed-class system.

3. Sample of basic schema elements and their categories

The categories are here grouped into 3 classes, ones pertaining to:
scene segmentation / a scene component / the relation between 2 scene components

3.1 Categories pertaining to scene segmentation

3.1.1 Basic scene components: 3 members -- Figure, Ground, Secondary Reference Object

The Figure and Ground components were already seen in the *across* example above.
Secondary Reference Object can be: encompassive / external
encompassive: e.g., the earth-based reference frame -- The lamp is above the TV.
vs. just Figure + Ground -- The lamp is near the TV.
external: e.g., an observer or viewpoint -- He's beyond the border.
vs. just Figure + Ground -- He's past the border.

3.2 Categories pertaining to an individual scene component (e.g., the Figure, Ground, or Secondary Reference Object) -- a selection

3.2.1 Dimensionality: 4 members -- 0 (point), 1 (line), 2 (plane), 3 (volume)

English SCCs requiring just one of these members for the Ground:
0: near a dot; 1: along a trail; 2: (a tapestry) over a wall; 3: (berries) throughout the jello

3.2.2 Number: perhaps 4 members -- 1, 2, several, many

English SCCs requiring one of these members for the Ground:
The basketball lay -- 1: near the boulder; 2: between the boulders;

several: among the boulders; many: amidst the cornstalks.
Not found in this category, e.g.,: `three', `too many', `an even number'

3.2.3 Motive state: 2 members -- moving, stationary
English SCCs requiring one of these members for the Figure and for the Ground:
at vs. *into*: Figure: stationary vs. moving; Ground: stationary
I stayed / *went at the library. vs. I went / *stayed into the library.
up to vs. *after*: Figure: moving; Ground: stationary vs. moving
The lion ran up to the deer. vs. The lion ran after the deer.
Not found in this category, e.g.,:
motion at slow vs. fast rate / location at rest vs. fixedly (staying put)

3.2.4 State of boundedness: 2 main members -- bounded, unbounded
(also: bounded at one end/side)
English SCCs requiring one of these members for the Figure's path relative to the Ground:
unbounded: along -- I walked along the pier for 10 minutes / *in 20 minutes.
vs. bounded: the length of -- I walked the length of the pier in 20 Minutes / *for 10 minutes.
Many English prepositions are polysemous for both member notions:
I walked through the tunnel for 10 minutes. vs. I walked through the tunnel in 20 minutes.
Russian: *Satelit obletel zeml'u za 1 den'* `(the) satellite circum-flew (the) earth in 1 day'
vs. *Satelit letel vokrug zemli 3 dn'a* `(the) satellite flew around (the) earth for 3 days.'
Not found in this category, e.g.,: a gradient boundary, which otherwise does occur in cognition,
e.g., in viewing transition from full forest to full meadowland

3.2.5 Geometric type: 2 members -- rectilinear, radial
and within the radial geometry type, two main kinds:
motion/location along a radius, "coradial" vs. about a center, "circumcentric"
English SCCs requiring one of these members for the Secondary Reference Object:
rectilinear: The boat drifted further and further away from the island.
vs. radial: The boat drifted further and further out from the island. [coradial]
English SCCs requiring one of these members for the Figure's path:
I walked around the maypole. (circumcentric: circuit about a center)
radial geometry applied to a meta-Figure
English SCCs requiring one of these members for a meta-Figure:
I turned the pail around/over. (circumcentric: rotation about a center)
Not found in this category: other geometries or radial types, e.g., spiraling out

3.2.6 State of consolidation: 2 members--Compact, diffuse
indicate that a region is of relatively smaller vs. larger ambit; further associated with:
the region is bounded vs. unbounded
the measurement of the region was relatively precisional vs. approximative
an object's location within the region is relatively certain vs. uncertain
English SCCs requiring one of these members for the Ground region:
compact *at* vs. diffuse *around* (*somewhere* can only go with *around*):

The other hiker will be waiting for you at vs. around the landmark.
neutral *there* vs. diffuse *thereabouts*:
Go to the market; you'll find her there vs. thereabouts.
Malagasy locative adverbs -- 2 forms and typically accompanying gestures:
eto `here/there within this/that bounded region'; a pointing finger
vs. *ety* `here/there spread over this/that unbounded region'; a sweep of the hand
Not found in this category: intermediate or extreme degrees of consolidation

3.2.7 Phase of matter: 3 main members -- solid, liquid, empty space -- perhaps plus: fire
Some Atsugewi directional suffixes require one of these members for the Ground:
-ik's `horizontally into solid substance' as in chopping an ax into a treetrunk
vs. *-ic't* `into liquid'
vs. *-ipsnu* `into a volumetric enclosure' (e.g., a house, an oven)
vs. *-caw* `into a fire'
English SCCs neutral to or requiring one of these members for the Ground:
neutral: *in*; only empty space: *inside*
The rock is in the box / water / ground / fire.
vs. The rock is inside the box / *water / *ground / *fire.
Not found in this category, e.g.,: powder, mushy/mucky material

3.2.8 Intrinsic parts: ? members
English SCCs requiring the front, side, back, top, bottom, or interior of the Ground:
The cat lay before / beside / behind / atop / beneath / inside the TV.
English SCCs requiring the upper vertical, lower vertical, horizontal part
of the earth-based reference frame as a Secondary Reference Object:
The bird is up in the tree. / down in the well. / over on the ledge.

3.2.9 Object identity: ? members
One French preposition requires the Ground's identity to be a home:
chez, `at the home of'
Not found in this category: vehicle, shade

3.3 Categories pertaining to the relation of one scene component to another -- a selection

3.3.1 Angle: 3 members -- parallel, oblique, perpendicular
= the angle between 2 lines, 2 planes, or a line and a plane
English SCCs requiring one of these members for the angle--
A. without the earth grid involved
a. --between The Figure's (fictive) linear path and a linear Ground
parallel vs. perpendicular: The caterpillar crawled along / across the crack in the sidewalk.
perpendicular vs. oblique: A secondary pipe branches out / off from the main sewer line.
B. with a component of the earth-based spatial grid involved
perpendicular: 2 components -- the vertical axis, the horizontal plane
b. --between the Figure's linear path and the vertical axis as Secondary Reference Object

parallel: The bat flew up to the ceiling of the cavern. / down to the floor of the cavern.
vs. perpendicular: The bat flew over to a ledge in the cavern.
c. -- between the Figure-Ground line and the vertical axis as Secondary Reference Object
parallel vs. perpendicular: The lamp is above / beside the TV.
d. --between a meta-Figure's axis of rotation and the vertical axis as Ground
parallel: The top spun around. / I turned the pail around.
vs. perpendicular: The top toppled over. / I turned the pail over.
Not found in this category: any angle up to 90 degrees finer than just "oblique"
obtuse angle; 180 degree "angle"; angle greater than 180 degrees

3.3.2 Degree of remove: 5 members -- (with contact) coincident, adjacent, (without contact) proximal, medial, distal

English SCCs requiring one of these members for the Figure's remove from the Ground
coincident vs. proximal: The carousel is in the front of / in front of the fairground.
The latter form is shown to be proximal, not distal, thus:
The carousel is 50 yards / *50 miles in front of the fairground.
A form can be neutral to the proximal/distal distinction:
The hawk is 1 foot / 1 mile above the table.
adjacent vs. proximal: The fly is on / over the table.
medial distinguished from proximal and distal:
in languages with a here / there / yonder type of spatial distinction
Not found in this category e.g.,: within bodily reach, throwing distance, a day's trek

3.3.3 Density of distribution: 2 members -- sparse, dense

The distribution is of Figure objects with respect to a Ground object.
dimensionality of objects in examples below: peas: 0; knife: 1; table: 2; aspic: 3
English SCCs neutral to or requiring one of these members
for the density of Figure objects distributed over the Ground.
neutral: There are peas on the knife / on the table / in the aspic.
sparse:
There are peas here and there on / along the knife.
There are peas here and there on / over the table.
There are peas here and there in the aspic.
dense: There are peas all along the knife. / all over the table. / throughout the aspic.
Not found in this category, e.g.,: dense vs. total filling of the Ground,
Figure objects evenly or unevenly spaced; with or without clumping

3.3.4 Relation to Directedness: 2 members -- codirectional, antidirectional

= whether the path of a moving object / the successive locations of fixed objects
are in the same/opposite direction as the directedness of a further entity
directedness is based on: motion (e.g., flowing stream); internal structure (a gradient, a queue)
English SCCs requiring one of these members for--
a. a moving Figure relative to a stationary directed Ground
The axon grew along / against the chemical gradient.

b. a stationary Figure and Ground relative to a directed stationary Secondary Reference Object
Mary is ahead of / behind John in line.
c. a moving Figure relative to a directed moving Ground
The bear swam with / against the current.
d. a moving Figure relative to the vertical axis as a directed stationary Ground
The feather floated down / up.
Not found in this category: any non-linear directedness

3.3.5 Contour: 4 members -- straight, arced, circular, meandering
English SCCs neutral to or requiring one of these members for a Figure relative to a Ground.
neutral: I made a bee-line / zig-zagged / circled through the woods.
straight: I drove across the plateau / *hill.
arced: I drove over the hill / *plateau.
circular: I walked around the maypole.
meander: I walked about the town.
Not found in this category, e.g.,: square, spiral, wavy, zigzag

3.4 Nongeometric categories
Certain nongeometric categories are recurrently found in association with
geometric ones in spatial schemas. What it is about our cognitive structure
that favors these and not other associations remains to be investigated.

3.4.1 Force dynamics: 2 members -- present, absent
English SCCs requireing one of these members for the Figure relative to the Ground:
Both *on* and *against* represent a Figure in adjacent contact with a Ground,
but differ in whether that contact supports the Figure against the pull of gravity.
This = the presence vs. absence of force dynamics.
contact + support: The poster is on / *against the wall.
vs. contact, no support: The helium balloon is against / *on the wall.
(vs. no contact, no support: The helium balloon is near / next to / *on / *against the wall.)
Not found in this category, e.g.,: degrees of force dynamics

3.4.2 Relative priority: 2 members -- coequal, ancillary/main
English SCCs requiring one of these members for the Figure relative to the Ground:
I jog together with him. -- we are coequal
vs. I jog along with him. -- he is the main entity, I am ancillary
otherwise, both satellites represent joint participation
and indicate that the Figure's path is coextensive with and parallel to the Ground's path
Not found in this category, e.g.,: alternating/conditional priority, degrees of priority difference

4. The issue of constraints on the inventory of elements making up spatial schemas

4.1 Hierarchy without lower boundary
Surmise: the inventory is hierarchical. Elements, categories, and member elements within categories

perhaps range from common to rare in spatial schemas across languages.
Hence, perhaps the inventory is not sealed with an absolute lower boundary
but permits sporadic novel elements.
Example: in English, the concepts ‘walkway’ and ‘transportation’ are elements in one *on* schema:
on: in a (partially) enclosed vehicle with a walkway currently in use as transport
the walkway requirement:
in a car vs. on a bus
in a helicopter vs. on an airplane
in a grain car, in a caboose vs. on a train
in a rowboat vs. on a ship
the transport requirement: The kids played in/*on the abandoned bus. (< Fillmore)

4.2 Non-coalescing categories
Some categories may not settle down to some small number of member concepts
e.g., category 2.8 "intrinsic parts" of an individual scene component
common: front, side, back, top, bottom, interior
but Makah has many verb suffixes with meanings like ‘at the neck’, ‘at the groin’

4.3 Response to Bowerman challenge
The thesis here: apart from sporadic novel elements and non-coalescing categories,
the spoken-language closed-class schema system seems largely to include a universally available approximately closed inventory of basic schema elements and their categories.
Bowerman has led the challenge to this view.
E.g., at the same time that kids learn English *in* vs. *on*,
Korean kids learn *kkita* ‘put [Figure] in a snug fit with [Ground]’
vs. *nehta* ‘put [Figure] in a loose fit with [Ground]’
The factors ‘snug/loose fit’ are presumably rare among world’s spatial schemas
so they don’t come from any preset inventory; are learned from variable adult language semantics.
Reply -- I surmise: Korean closed-class schemas are still largely built from a preset inventory.
The cited forms are open-class verbs, perhaps learned at same time as English *hug* or *squeeze*.
Open-class semantics is a different cognitive subsystem,
drawing from broader and finer perceptual/conceptual discriminations.
Thus, kids perhaps know early that *squeeze* involves:
centripetal pressure from encircling or bi-/multi-laterally placed Antagonists
-- typically arm(s)/hand(s);
an Agonist that resists pressure but yields down to some smaller compass
where it blocks further pressure;
and hence that one can squeeze: a teddy bear, a tube of toothpaste, or a rubber ball,
but not: a piece of string / sheet of paper; juice, cooked cereal, sugar;
a table / the corner of a building

5. The basic elements assembled into whole schemas
So far: an analytic procedure to map out the componential part of the spatial schema system
-- starting with whole schemas represented by closed-class forms and abstracting from them

an inventory of basic spatial elements.
Now: a procedure of synthesis to characterize the compositional part of the spatial schema system
-- showing how a selection of individual spatial elements are assembled
in a specific arrangement into a particular whole schema.

5.1 Example: the elements arranged to make up the schema for English *past*
as in: The ball sailed past my head at exactly 3 PM.

5.1.1 Features of this arrangement of basic elements
(the category of an element is named in brackets)
a. There are a Figure object and a Ground object (here, the ball and my head, respectively)
[members of the "major scene components" category].
b. The Figure is schematizable as a 0-dimensional point
[a member of the "dimension" category].
c. This Figure point is moving
[a member of the "motive state" category].
d. Hence it forms a one-dimensional line, its path
[a member of the "dimension" category"].
e. The Ground is also schematizable as a 0-dimensional point
[a member of the "dimension" category].
f. There is a certain point P at a proximal remove
[a member of the "degree of remove" category] from the Ground point.
g. Point P forms a 1-dimensional line
[a member of the "dimension" category] with the Ground point.
h. This line is parallel
[a member of the "angle" category] to the horizontal plane.
i. In turn, the horizontal plane is a part
[a member of the "intrinsic parts" category] of the earth-based grid.
j. And the earth-based grid is a Secondary Reference Object
[a member of the "major scene components" category].
k. The Figure's path is perpendicular
[a member of the "angle" category] to the line between point P and the Ground.
l. The Figure's path is also parallel to the horizontal plane of the earth-based grid.
[same as h/i/j above].
m. If the Ground object has a front, side, and back
[members of the "intrinsic parts" category],
then it is the side part to which point P is proximal.
n. There is a certain point Q of the Figure's path that is not one of its boundary points
[a member of the "state of boundedness" category].
o. Point Q becomes coincident
[a member of the "degree of remove" category] with point P at a certain point of time.

5.1.2 Reasons for some of the preceding features
A ball moving horizontally through a point P--

re (f): distal from my head would: sail along over there.
adjacent to my head would: sail into my head.
re (m): in front of my head would: sail by in front of my head/face.
re (h): above my head would: sail over my head.
A ball moving downward vertically through the point P--
re (l): proximal to the side of my head would: sail down alongside me.

5.2 Constraints on the selection and arrangement of elements into schemas
(the least well understood aspect of this investigation)
A. Not clear what well-formedness conditions may govern the combination of elements into schemas.
No obvious principles based, say, on geometric simplicity, symmetry, consistency.
On the one hand, some Byzantine combinations, like the schemas for *across / past*,
occur with some regularity across languages.
On the other hand, various simpler combinations are never found.
E.g., an invented schema combination represented by an invented preposition:
"apit": ‘down into a surround that is radially proximal to a center point’
as if in: "*I poured water apit my house." referring to--
I poured water down into a nearby hole dug in the field around my house
But such forms are not found.

B. An account of extant schemas based on often encountered spatial situations fails.
If the presence of linguistic schemas depended only on the frequency of spatial occurrence, then:
individual spoken languages should not have such different sets of schemas in their lexicons
and signed languages should not have such different sets of schemas from those
in spoken languages (see below).

6. Properties and processes applying to whole spatial schemas
Whole spatial schemas were just seen to be assembled from basic elements.
Each language can directly represent a specific set of such whole spatial schemas
with the spatial closed-class forms in its lexicon (more schemas than forms, due to polysemy).
These are its "pre-packaged" schemas, applicable only to a specific set
of spatial configurations in physical space.

Compensating for this limitation-- given a need to refer to a wider range of such configurations--
language has a system for generalizing each extant schema to a family of schemas.
This is the augmentive part of its overall schema system.

6.1 Properties that extend spatial schemas
Under each such property, a SCC’s schema exhibits atopological or topology-like neutrality
to some feature of Euclidean geometry, thus applying to a range of spatial configurations.

6.1.1 Magnitude neutrality
In *across*: The ant crawled across my palm. / The bus drove across the country.
In *this that*: This speck is smaller than that speck. / This planet is smaller than that planet.

6.1.2 Shape neutrality
In *through*: I made a bee-line / zig-zagged / circled through the woods.
In *across*: I swam in a zigzag path across the irregularly shaped lake.

6.1.3 Bulk neutrality
= neutrality to any radial extension out from a point or line
In *past*, with the Figure and Ground objects reduced to 0 dimensional points:
The ball sailed past my head. / The asteroid sailed past the earth.
In *along*, with the Ground object reduced to a 1 dimensional line:
The caterpillar crawled up along the filament / the tree trunk.

6.2 Processes that extend spatial schemas
Each such process extends a basic schema to yield a certain family of non-basic schemas.

6.2.1 Extendability in ungoverned dimensions
A scene component of dimensionality N in a basic schema can be raised in dimensionality to form a line / plane / volume oriented and contoured not to conflict with the schema's other requirements.
Thus, the basic radial *out* schema applies to a point Figure moving along a radius away from a center point through a continuum of concentric circles, as in:
The boat sailed further and further out from the island.
This point can be extended along a radius:
The caravan of boats sailed further and further out from the island.
Or the point can be extended along a concentric circle:
A circular ripple spread out from where the pebble fell into the watr.
This circle can be extended to fill in the interior plane:
The oil spread out over the water from where it spilled.
Or the circle can be extended in the vertical dimension to form a cylinder:
A ring of fire spread out as an advancing wall of flames.
Or the circle can be extended to form a spherical shell:
The balloon I was blowing into slowly puffed out.
This spherical shell can be extended to fill in the interior volume:
The leavened dough slowly puffed out.

6.2.2 Extendability across motive states
The motive state and Figure geometry of a basic schema can be extended to other values.
Thus, a basic schema with a point Figure moving to form a 1-dimensional path can generally be extended to a schema with a 1-dimensional Figure stationary along that path.
E.g., the basic *across* schema may be for a moving point Figure: The gopher ran across the road. which extends to the static linear *across* schema first seen: The board lay across the road.
All the constraints first seen on the linear Figure of static *across* are inherited from the same constraints on the point Figure's path in the basic dynamic *across*.

6.3 Processes that deform spatial schemas
Each such process deforms a basic schema's requirements to yield certain non-basic schemas.

6.3.1 Deformation by stretching (up to a certain degree)

A usual *across* schema requirement: the crosswise axis is less than or equal to the main axis.

fine: a. I swam across the canal. <from one long side of the canal to the other>

b. I swam across the pool. <from one side of a square pool to its opposite>

c. *I swam across the canal. <from one narrow end of the canal to the other>

but: d. ?I swam across the pool. <from one narrower side of a somewhat oblong pool to the other>

In (d), the longer axis can be conceptualized as stretched from an equal-axis square shape.

The *across* schema still applies to the stretched axis when moderate--then progressively less.

The fact that the schema applies at all to the stretched axis and is not abruptly inapplicable is evidence for the existence of a cognitive process of schema deformation.

6.3.2 Deformation by cancellation of one or more schema requirements

Two usual *across* schema requirements: a moving point Figure

a) begins at one side and b) terminates on the other side of the ribbonal Ground.

(b) is canceled in: The shopping cart rolled across the boulevard and was hit by an oncoming car.

Both (a) and (b) are canceled in: The tumbleweed rolled across the prairie for an hour.

Part II: Spatial Structuring in Signed Language

Aviso: Signed language is outside my area of expertise (spoken language).

For their help with my questions on American Sign Language, ASL (and other SdL's), my thanks to --

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7. Introduction

7.1 What to compare between spoken and sign language

How to compare schematic spatial representation across spoken and signed language, which lack a one-to-one structural correspondence?

7.1.1 First main difference between the two language modalities: their associated subsystems

candidate division into subsystems for spoken language:

open-class (lexical) forms -- overall representing conceptual content

closed-class (grammatical and syntactic) forms -- overall representing conceptual structure

"vocal dynamics" (e.g., pitch, loudness, rate, timbre, distinctness, unit separation)

associated "somatic subsystem" (e.g., facial expressions, "body language", gestures)

candidate division into subsystems for signed language:

lexical forms (noun, verb, adjective signs)

modulations of ("inflections" on) lexical forms (e.g., for person, aspect)

size and shape specifiers (SASS's)

classifier constructions

gesture (along a gradient of incorporation into all the above)

face-head-torso representations

"bodily dynamics" (e.g., amplitude, rate, distinctness, unit separation)

associated (overlaid) "somatic subsystem" (e.g., further facial expression, "body language")

7.1.2 The classifier subsystem of sign language -- "ClS"

Apparently all signed languages have a subsystem of "classifier constructions/expressions"
dedicated solely to the schematic and structural representation of:
objects moving / located with respect to each other in space.

Commonly, the dominant hand represents the Figure and the non-dominant hand represents the Ground.

E.g, an expression can represent independently and to a large extent concurrently:
1) The Figure as a surface vehicle 2) the Ground as a tree 3) the Figure as passing the Ground
4) this passing as part of a fuller path continuous over some distance
5) the lateral separation between car and tree 6) viewpoint from which the path is observed
7) incline of the path (e.g., uphill) 8) contour of the path (e.g., curving around the tree)
9) the manner of the motion (e.g., bumpy/fast)

7.1.3 Optimal initial comparison for the representation of spatial structure is between:
that part of the spoken-language closed-class subsystem pertaining to space, SCCs,
and the signed-language classifier subsystem, ClS.

These two domains are analogous in that:

a. Each structurally schematizes objects moving / located with respect to each other in space.

b. Each is distinct from a lexical subsystem in a structure/content contrast.
e.g., English closed-class *into* vs. open-class *enter*
ASL classifier representations for `into' vs. lexical sign for `enter'

c. In each, a schematic representation can optionally be elaborated by an added lexical form.
e.g., English: It drove past. vs. The motorcycle drove past the boulder.
ASL: bulk vehicle-move-past-bulk
vs. BOULDER bulk MOTORCYCLE vehicle-move-past-bulk

7.2 The basic finding

More than SCCs in spoken language, the ClS in sign language parallels
the apparent structural characteristics of scene parsing in visual perception.

It does so in 2 venues: 1) in the inventory of basic elements and categories; 2) in an expression.

• First Venue: in the inventory of ClS hand shapes/movements

8. Larger inventory of basic elements and categories

The ClS inventory: the relevant components of hand shapes and movements.
It has more elements, more categories, and generally more elements per category
than the SCC inventory -- closer to the granularity of visual scene parsing.

8.1 Comparable category membership in signed as in spoken language

a. basic scene components: 3 members -- Figure, Ground, Secondary Reference Object

b. dimensionality: 4 members -- 0 (point), 1 (line), 2 (plane), 3 (volume)

c. state of boundedness: 2 main members -- bounded, unbounded (also: bounded at one end/side)

8.2 Moderately greater category membership in signed than in spoken language
NB: the membership of these categories is probably gradient,
but without the capacity to represent many fine distinctions clearly
a. path length: apparently more than spoken language's 2 members (short, long)
b. angle: apparently more than spoken language's 3 (parallel, oblique, perpendicular)

8.3 Much greater category membership in signed than in spoken language
a. path contour: indefinitely many more than spoken language's 4 (straight, arc, circle, meander)
b. locus within space: apparently many more than spoken language's 3 (here, there, yonder)

8.4 Categories present in signed, absent in spoken language -- some listed in 11.2
e.g., a. an entity's rotatedness relative to its path of forward motion
b. pattern of distribution: e.g., parallel vs. crossed pencils arrayed along a ledge

8.5 Closer look: more elements / categories in the semantic domain of rotation
English SCCs: 1 category: orientation of spin axis: 2 members -- horizontal, vertical
horizontal: *over* (fall/topple over); vertical: *around* (turn/spin around)
ASL ClS: also distinguishes these categories and their members:
a. amount of rotation
turning less than vs. exactly vs. more than vs. several times one full circuit
b/c. Figure's geometry and the relation of the spin axis to it
spin axis at Figure's center, e.g.: propellor vs. pencil spinning on point
spin axis at Figure's periphery, e.g.: swung cape vs. swinging gate

• Second Venue: in an expression of the ClS

9. More iconic representation in the expression
Spatial representation in signed classifier expressions -- unlike in spoken SCCs --
is iconic with scene parsing in visual perception in several ways:

9.1 Iconic clustering of categories
In one's perception of a motion scene, e.g., a car driving bumpily along a curve past a tree,
a. it is the same single Figure entity that:
1) has object properties as a Figure 2) moves 3) has a manner of motion
4) describes a path of a particular contour
5) relates to an outside object (Ground) in its path of motion
b. perceived as separate: 1) the Ground object 2) any Agent

A ClS expression matches this perceptual pattern of clustering.
The dominant hand shows all 5 of the above Figure-related factors:
Figure type, motion, manner, path contour, relation to Ground object
The nondominant hand shows the Ground object type.
All spoken languages diverge from this visual fidelity to a greater or lesser degree.
E.g., one English counterpart: The car bumped along past the tree.; its clusters:

a. subject: NP (*the car*): Figure
b. verb complex: verb (*bumped*): motion + manner
satellite (*along*): translational path
c. prep phrase: preposition (*past*): path in relation to Ground
NP (*the tree*): Ground

9.2 Iconic representation of object vs. action

In signed languages, virtually always?:
the Figure is represented by a hand shape; the Path by a hand movement.
But one can imagine an alternative setup, apparently never realized:
Path: represented by hand shape -- e.g.,
a fist = stationary; fingers flat together = a straight path;
fingers together in curved plane=curved path; fingers alternately forward/back=zigzag path
Figure: represented by hand movement, -- e.g.,
hand moves straight =straight Figure; hand moves in circle = round Figure.
The mapping in sign language is visually iconic: it assigns the representation of
the material object in a scene to the material object in a classifier complex, the hand,
and the movements of that object in the scene to the movements of the hand.
No such iconic correspondence is found in spoken language, e.g.:
material objects are prototypically represented by English nouns, but by Atsugewi verbs;
paths are prototypically represented by English satellites/prepositions, but by Spanish verbs.

9.3 Iconic representation of further particular categories

Many categories in 11.1 are iconic with visual parsing, e.g., in the representation of an object's:
form by the form of the hand(s); size by the compass of the hand(s);
number by the number of digits / hands shown;
motive state / path contour / path length / manner of motion / rate of motion
by analogs in the hand(s).
By contrast, spatial iconicity is minimal in spoken language; two of the few examples:
path length by vowel length: It's waay / waaaay up there.
path length by quantity of iteration: The bird flew up / up up / up up up and away.

9.4 Iconic representation of the temporal progression of a trajectory

E.g., for the Figure's path in signing "The car drove past the tree":
the Figure hand progresses from nearer side of the Ground hand, to beside it, to its farther side.
By contrast, the preposition *past* in the corresponding English sentence exhibits no progression.

10. A narrow time-space aperture represented in the expression

Tentative principle: a classifier complex readily represents what appears within a narrow scope
of space and time if one were to zoom in with one's scope of perception around a Figure object.
hence, readily represented are: the Figure and its type/shape;
an immediately adjacent manipulator or instrument;
the current state of motion; a current manner; a path contour / direction.
thus, the ASL classifier subsystem and English can both represent within a single clause:

I pinched moss up off the rock. / I pulled the pitcher along the counter (adjacent manipulator)
I scooped jelly beans up into the bag. (adjacent instrument)
The cork bobbed past the seaweed. (concurrent manner)

But temporally nonlocal factors are little represented in the ClS, though still fine in English:
I kicked the football over the goalpost. (prior causation: first I kick, then ball sails off)

And spatially nonlocal factors are little represented in ASL, though still fine in English:
I walked/ran/drove/flew the memo to the home office. (concurrent causation by external Agent)

Signed language here is closer to visual perception in its temporal narrowness.

Problems, though, with the spatial narrowness proposal:
a. Vision includes not only focused perception but also wide-scoped perception.
b. The ClS does permit the representation of a non-adjacent Ground within the same expression.

11. More distinctions independently representable in the expression

11.1 Distinct substitution classes compared across the SCC and classifier systems

a spoken language's SCC morphemes fall into certain "substitution classes", as based on:
1) which syntactic slot within an expression they appear in;
2) only one member of a class can occur in a given syntactic slot within an expression.

Such classes largely express non-overlapping sets of spatial properties.

English has some 6 such classes pertaining to a Figure's path relative to a Ground.
From 0 to at most 5 of them can appear together in a single motion-event expression.

E.g. 1 member from each of 4 classes in: The bat flew way back up into its niche in the cavern.
Satellite slot 1, 'distance': *right/way*; satellite slot 2, 'return': *back*;
satellite slot 3, 'earth-grid direction': *up/down/over*; preposition slot, 'configuration'.

Such classes vary independently, apart from some cooccurrence/obligatoriness constraints; one can:
select a category for inclusion in an expression independently of other selected classes;
select a member element of a class independently of other member selections.

But any spoken language has relatively few such classes, perhaps around a maximum of 8,
and can include only some smaller number together at the same time in a single expression.

ClS elements also fall into certain substitution classes, as based on:
1) which portion/aspect of the expression they occur in;
2) only 1 member of a class can be executed by a signer's hand there in an expression at a time.

These classes also vary independently of each other, apart from certain constraints; one can:
select a category for inclusion in an expression independently of other selected classes;
select a member element of a class independently of other member selections.

But the ClS in ASL has some 30 such classes -- almost as many as the categories in its inventory --
and seemingly more of them can appear together in a single ClS expression than in a spoken one

E.g., a classifier expression can selectively include and independently vary a path's
contour, length, vertical angle, horizontal angle, speed, manner, relation to Ground object.

The ClS can thus represent some 30 distinct aspects of spatial structure independently;
though not all at once, the selection presented is wider and not pre-packaged.

The classifier system may be closer than the SCC system to visual parsing by largely lacking:
a fixed set of discrete pre-packaged full schemas subject to extentions and deformations.

11.2 Provisional list of distinct substitution classes in the ASL classifier system

These classes are proposed in accord with the 2 bases cited above. Hence, e.g.:
Class 1 joins together 4 inventory categories--type of Figure/instrument/manipulator/pointer--
since they apparently cannot be separately represented in a single expression;
and classes 11-12-13 are kept distinct since the categories they express--
internal/confined/translational motion--CAN be separately represented in a single expression.

A. Entity properties
1. type of Figure / instrument / manipulator (handling classifier)/pointer (index classifier)
2. type of Ground
3. magnitude of some major entity dimension
e.g., a ‘pizzalike shape’ can be shown as ‘small’ / ‘medium’ / ‘large’
by the amount of separation between the 2 hands
4. magnitude of a transverse dimension
e.g., any of the preceding pizzalike shapes, made only with thumb and index finger,
can show depth by adding a second finger or the remaining 3 fingers (as for a bowl)
5. number of entities
e.g., 1, 2, 3, etc. raised fingers can be used to represent 1, 2, 3, etc. people arriving

B. Orientation properties: the angle at which an entity is rotated relative to a canonical position
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
e.g., vehicle classifier moved forward with its "front" leading / trailing / to one side
to represent, say, a car moving forwards / backwards / sideways

C. Locus properties
9. locus within sign space

D. Motion properties
10. motive state: moving / stationary
11. internal motion
Components of a Figure/instrument/manipulator are shown moving relative to each other, as in:
dilation (expansion / contraction), change of form, twisting, wriggling, swirling
12. confined motion
Figure/ instrument/manipulator moves as intact whole within confined region
without overall change of location, as with:
straight oscillation, rotary oscillation, rotation, local wander
13. translational motion
Figure/instrument/manipulator moves as intact whole through space with overall change of location

E. Path properties
14. state of path’s continuity: continuous / saltatory

15. contour of path
16. state of boundedness: unbounded / bounded at start / bounded at stop / bounded at both ends
17. path length and whether a path's beginning/end is in/out of view
18. vertical height
19. horizontal distance in front of signer
20. left-right positioning
21. up-down angle ("elevation")
22. left-right angle ("direction")
23. transitions between motion and stationariness

These distinctions can apparently be made: a Figure's--
stopping normally / slowing to a stop / stopping abruptly, as from impact
being placed at a point of support / being given into someone's grasp

F. Viewpoint properties

An observer's perspective on the depicted scene is largely indicated by E. Path properties
e.g., a path directed forward vs. right-to-left suggests a view from behind vs. from the side.

G. Manner properties

24. divertive manner
a movement the Figure makes during and in addition to a forward path motion, e.g., bouncing
25. dynamic manner: speed

H. Relations of Figure or Path to Ground

26. path's conformation relative to Ground -- e.g., past it, above it, into it
27. relative lengths of path before and after encounter with Ground
28. Figure's path relative to the path of a moving Ground

Usually Ground object is stationary; but can also show Ground moving along a path
e.g., for Figure pursuing / catching up with / passing it

29. Figure's proximity to Ground
30. Figure's orientation relative to Ground

Part III: Cognitive implications of spoken / signed language commonalities/differences

12. Comparison of spatial structuring in the two language modalities

12.1 where spoken and signed language are alike

Both the spoken closed-class spatial system and the signed classifier system:

a. represent multifarious subtly distinct complexes of objects
moving/located with respect to each other in space.
b. represent such spatial complexes schematically and structurally.
c. rest on an inventory of basic elements that -- when selected and combined --
make up these structural schematizations.
d. group mutually exclusive elements into categories that
themselves represent categories of spatial structure.
e. observe cooccurrence/obligatoriness conditions on the combinations

of elements and categories into full structural schematizations.
f. permit semantic amplification of structural elements of a schema by open-class/lexical forms.
g. allow alternative conceptualizations of a spatial scene for alternative schematizations.

12.2 where spoken and signed language differ

Relative to the spoken closed-class spatial system, the signed classifier system:
a. is not a proper counterpart to it. More generally:
there is no one-to-one match of subsystems across the two language modalities.
b. has more basic elements, categories, and elements per category.
c. has more gradient representation in addition to discrete representation.
d. has an iconic representation of object vs. action and of other categories in the expression.
e. represents only a narrow time-space aperture in the expression.
f. can select categories and category elements independently for representation in an expression.
g. can represent more categories and category elements together within an expression.
h. avoids pre-packaged element combinations and processes for their extension / deformation.

12.3 Alternative to a distinct whole-language module

Proposed: both spoken and signed language are based on some more limited core linguistic system
that then connects with different further subsystems
for the full functioning of the 2 language modalities.
This core linguistic system has certain basic properties, e.g., it:
associates individual concepts with overt physical representations, whether vocal or manual.
maintains a conceptual structure/content distinction.
And it includes the spoken-signed commonalities of section 12.1 in more general form, e.g., it:
maintains inventories of relatively basic concepts as member elements.
groups these concepts into categories.
selects and combines these concepts into conceptual complexes represented in an expression.
follows cooccurrence/sequencing/obligatoriness constraints
both for the concepts and their physical representations in this process.

In representing at least spatial structure, this linguistic core might then further connect with
2 different cognitive systems to yield the signed-spoken language differences of section 12.2.
a. for signed language: with aspects of the visual system that govern scene-structure parsing
b. for spoken language: with a putative "package-and-modulate" system that:
assembles disparate elements into stable schema-like complexes,
and affords processes for extending or deforming such complexes.
Speculatively, such a system may have previously evolved for the governance of motor patterns,
e.g., certain knee-bend / waist-bend components combined into a general "sitting down" schema,
in turn modulated for sitting on a bench, on a railing, or on the ground.

This proposal seems consonant with neuroscientific findings: relatively smaller neural assemblies
linking up in larger combinations in the subservance of any particular cognitive function.
In turn, the proposed core language system might itself be found to consist of
an association and interaction of still smaller units of neural organization,

many of which might in turn participate in subserving more than just language functions.

References Note: the works by me cited below are all directly available on my website: http://linguistics.buffalo.edu/people/faculty/talmy/talmy.html

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