TYPOLOGICAL AND TOPOLOGICAL MEANING IN DIAGNOSTIC DISCOURSE

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Multidimensional Meaning and Video-realism

Viewing a six-minute episode from a 'Problem-based Learning' (PBL) session recorded on videotape (see Introduction and Appendices to this special issue), I seem to see and hear several medical students and their 'coach' talking, gesturing, looking at and pointing to a complex chart, reading aloud from texts and notes, and generally making meaning by acting in and interacting with one another and the materials around them. I want to briefly analyze a few aspects of their talk and action in order to focus on how and why verbal and visual resources are integrated in this activity and how and why various kinds of evaluative meanings are getting made. The analysis is motivated in part by a concern for the materiality of the meaning-making process itself and its implications for the kinds of meanings we make and how we make them. I begin with some reflections on the surprising realism of the video medium, in which the data analyzed here have been recorded, propose an extended semiotic model for multimedia analysis, and present some highlights from my analysis of the PBL episode.

Videotape and sound-film recording of human social activity are, by the conventions of modernist culture at least, the representational technologies which most closely approximate our 'unmediated' social experience. Despite our analytical awareness that camera-angles, lighting, and editing techniques must necessarily create artifacts, and that the *experience* of co-presence or interactive participation (even as a silent observer) is fundamentally different from viewing a video, we nevertheless tend to construct a strong sense of 'reality' for the world on screen. A transcript of the verbal interactions in a scene is quite lifeless by comparison, even

when accompanied by still images that 'storyboard' the action. Why is it that it is the dynamical integration of speech and image, on a realistic time-scale, which affects us so strongly? It is not enough to beg the question by constructing similarities to our pervasive life-experience, for that still does not tell us what there is about the time-unfolding unities of sight and sound that makes such experiences so much more meaningful to us than texts or still and silent images.

I believe that part of the answer to the mystery of video-realism is that we make meaning in social activity in two fundamentally distinct but complementary ways, which I will call the *typological* and *topological* modes (see below). Moreover, there is clearly something about the dynamical coordination in time (on the millisecond scale) of acoustic and visual input which inclines us to integrate them functionally; that is, we make unified meanings from them, treating them as in effect unitary rather than distinct phenomena. This integration is itself achieved through the continuously variable qualities of acoustic-vocal and visual media, and so represents an aspect of their 'topological' meaningfulness.

Typological meaning is the familiar kind described by most theories of linguistics and semiotics: a material form of some sort is assigned to a culturally meaningful category, and the meaning of the category arises from its systematic contrasts with other related categories. In this view of meaning, signs, like words, are assumed to be discrete symbols; as tokens of some type-category they either do or do not possess the various criterial or distinguishing features which define one type as opposed to another. In the neat case of grammatical meaning, a pronoun is either singular or plural, masculine or feminine or neuter, first person or second or third; a verb is assigned to just one of a set of possible tenses, and so on. There are no intermediate cases between present and past, declarative and interrogative, singular and plural -- or if there are (as in some languages) they are again represented as additional discrete categories; there is no continuous variation that is meaningful. The continuous variation in the material world is reduced to categorial difference by interpreting a form as an instance of a sign. Or at least this is how signs work *typologically*.

But the material forms through which we make typological meaning, whether printed word, spoken utterance, or drawn symbol do always also vary from instance to instance in ways that may not be criterial for membership in a sign category, but which exhibit continuous variation that is perceivable and to which our cultures do assign meaning. I will call meanings made on the basis of continuous or quasi-continuous variation in some property of a material form *topological* meanings. Really, of course, these are simply two complementary strategies for making meaning, two fundamental modalities of semiosis. The unique acoustic signature of my voice saying a word, compared to other people saying that same word, identifies me to others in a meaningful way based on linguistically non-criterial differences in pronunciation that in principle vary continuously. The vocal force or emphasis at a point in my speech, and from one phrase to another, my ability to shift the timbre and sound-quality of my voice or prolong particular syllables to create meaningful nuances utilizes the continuous variability of pitch, length, and acoustic harmonics in ways that are counted as 'paralinguistic' precisely to the extent that they are not typological. The linguistic system, of course, does allow for some degree of gradations, a case of typology approximating topology, as in evaluative meanings which are inherently gradable semantically across some range from, say, 'totally impossible' through 'just barely possible' and 'really quite likely' to 'absolutely certain'. For practical purposes it is almost always possible to interpolate an intermediate degree of certainty/uncertainty between any two other degrees expressed in words, but the process quickly becomes awkward.

Language of course had to evolve to help us make sense of continuous variation in the world in such fundamental matters as spatial and temporal relationship and quantity of matter. As we developed technologies, and economies, where more and more careful quantitative distinctions were necessary, natural languages became extended semantically by the concepts and symbol systems of mathematics in order to more efficiently represent topological meaning. But from the earliest recorded times, *visual* representations were also in use to supplement the limited ability of language to represent spatial relationships such as the angles of a triangle or quantitative ones such as non-simple or even irrational ratios. Visual media such as geometric

diagrams or pictures sit still for us, like writing, to allow re-inspection and re-tracing of arguments, and their material extension in space allows iconic representation of continuous variation. Body gestures and communicative movement, visual signs for the observer, also help in the representation of topological meaning.

These two complementary meaning-making strategies always occur together. In speech, word choice and grammatical meaning are essentially typological, intonations and prosodies are both typological and topological, and many voice-quality and quantitative emphasis effects are purely topological. In visual representation conventional symbols and shapes often make meaning typologically, while compositional effects of relative size and placement, or meaningful degrees of variation in hue or saturation of colors are mainly topological. A gesture may function as a purely typological sign, or it may be articulated dynamically in time to also convey a topological meaning (e.g. degree of impatience). The manual sign languages of the deaf are very like speech in combining typologically discrete signs (typically hand-shapes) with topologically meaningful modes of articulation of these signs (placement, rates of movement, paths of movement) in the space between the signers.

Each of these basic modes of meaning-making foregrounds particular kinds of potentially meaningful relationships and construes 'entitities' or units of analysis as participants in these relations. Most of our conventional representational media (e.g. written text, photographs) rely far more on one of these two basic semiotic modes than on the other, or juxtapose the two after having already analytically separated them. They can at most offer us their discrete combinatorial possibilities. Video and film media, however, allow us to re-construe endlessly different inter-calibrations of these two kinds of meanings, taking multiple perspectives on how they mutually contextualize one another. While combinatorial presentations, e.g. texts with images, are discrete and static, even if presented sequentially in time, video and film combine audio and visual information, verbal speech and visible action *dynamically* and continuously, so that they can be experienced and made sense of simultaneously or sequentially on an unlimited number of time-scales.

I am not attempting to argue in this way for any superiority of video or film recordings as scientific data; all records have their special uses. I am trying to foreground the special importance and complexity in video-analysis of perspective-taking: critically and reflexively making explicit not only the themes and aims of our analyses, but the role played by each of the two fundamental semiotic modes, how we are inter-calibrating them, and what stance we are taking toward the multiple overlapping time-scales dynamically available to our analysis.

In the comments I wish to offer on a 6-minute video segment of the interactions among several medical students and their 'coach', I will try to focus on the relations between these two fundamental modes of meaning construction, the typological and the topological, and on some dynamical phenomena of social activity as a self-organizing process in time.

Typological and Topological Meaning-making

The participants in this video episode are engaged in a social activity in which they are constructing an approximation of medical diagnostic discourse. One student in particular (Betty) presents a number of hypotheses about the possible causes of a patient's symptoms, and other students react to these. Their tutor/coach intervenes minimally, but attempts to steer the discussion in particular ways.

I want to analyze a tension I perceive in the episode between the norms and strategies of medical diagnostic discourse as practiced by these students, and encouraged by the Coach, and the nature of the social-biological phenomena being construed with language and other semiotic resources.

The diagnostic approach, and the underlying medical terminology for events, conditions, and anatomical objects, is fundamentally, in semantic terms, a *typological* one. That is, it contrasts one diagnostic category with another in 'either-or' terms; it imposes a discrete terminology on continuously varying phenomena and divides even the continuous topography of the brain into bordered territories as seemingly definite as those of nation-states.

Natural phenomena, however, and both natural languages and their technical extensions, also require us to be able to take a more *topological* approach to making meaning with them. We need to be able to speak of quantitative and continuous variation, of multiple simultaneous and mutually non-exclusive descriptive features, of overlaps and in-betweens, of matters of degree and instability.

Our dominant intellectual culture, however, privileges the position of classical logic with its narrow view of propositions as eternally either true or false, which in turn requires typological semantic approaches to both reasoning and formal terminological systems. Sharp boundaries are required between this and that, and between true and false, contrary to the bulk of human historical experience, which shows that this is an excessively limiting way to view the world.

Natural language has evolved to provide us with resources for talking about quantity, and about degrees of certainty and uncertainty. English and most Indo-European languages, at least, do not basically treat propositions or proposals as either true or false, either good or bad. There are about a half-dozen or so semantic properties of propositions, of which Warrantability or relative probability/certainty is just one among equals (and less frequent and elaborated than, for example, Desirability). All of these are very subtly gradable in matters of degree, with a Polarity option (binary dichotomy) available in some cases through the grammar (*is vs. isn't*) or lexical antonyms like *true, false; good, bad* (though semantically these do not need to be mutually exclusive, except by cultural preference; for this analysis see Lemke 1989, 1992, 1996).

Natural languages have also been extended in those fields (linguistic registers) that have to deal critically with continuous variation and complex quantification. These extensions go, by and large, under the name of 'mathematics' insofar as mathematics is simply an extension of the semantics of natural language. The integration of mathematical and verbal reasoning is possible because of this historical relationship.

Far older still than mathematics, and also intimately involved in its history, is visual semiotics. We humans make meaning with depictional semiotic resources, ranging from our

various conventionalized pictorial resources to more abstract diagrammatic and graphical ones derived from them historically. Writing systems and mathematical symbolisms represent a special case of the general unification of visual and verbal means for making meaningful representations (cf. Harris 1995 and Lemke, in press-a; Cajori 1928). Quantitative reasoning in the sciences represents perhaps the most elaborate case of integrated visual, verbal, and mathematical resources being deployed in meaning-making (see for example, Lemke, in press-b).

Natural language also co-evolved with human gestural and postural systems for communication, and indeed as an integral part of human social activity in all its material, ecological aspects. Ontogenetically, phylogenetically, and historically, speech and gesture share common origins (as do gesture and depiction; see discussion in Lemke 1994). Gesture allows us greater latitude and subtlety in making topological meaning relations than do the mainly typological resources of verbal semantics. Spatialization in gesture is akin to spatial representation in depiction.

In the segment transcribed here (see pp. xxx-xxx of this issue) we see two prime instances of the tension between typological-categorial norms in medical diagnostic discourse and the topological-quantitative nature of the biological phenomena being discusssed and constructed. One is the imposition of typologically discrete terminology on the quasi-continuous tissue manifold of the human cortex (transcript lines 15-85). The other is the imposition of the typological disjunctions of the mutually exclusive categories of medical diagnosis onto the condition of the patient (especially lines 155-192). In both cases, some more topological natural language resources, and the topological power of spatializing gestures, are used by the students to help bridge the contradiction and resolve the tension. This is what I want to examine more closely.

The Setting and the Activity

The medical school students and their coach are interacting in a "Problem-Based Learning" (PBL) session (Koschmann, Myers, Feltovich, & Barrows, 1994). The students are seated around a rectangular table in a small seminar room. From the camera's viewpoint, there is a whiteboard with the patient's case information along the left wall, and a very large free-standing Chart with sectional views of the human brain behind the opposite end of the table. The principal speaker in the episode is Betty, who sits at the near end (head) of the table, Coach to her right. Downtable left are Norman and Jenny, at the opposite end is Lill, and downtable right beyond the Coach are Maria and May (who does not take a full turn at talk in the episode).

The students are attempting to diagnose the case of a (mainly hypothetical) patient whose presenting symptoms and complete test results are available in a 'casebook' which in principle allows fine-grained diagnostic disciminations to be made, but students are expected to access this information only to test specific hypotheses (corresponding to an economical and minimally invasive approach to real patients) -- cf. the semi-humorous remark and responses at lines 307-315.

The transcribed segment begins with Betty's first hypothesis (line 12, 'my theory ...'), which leads to a digression on the exact location of the hippocampus in the human brain. We then get a second hypothesis from Betty (line 86, 'my *other* theory') and a debate of the evidence for or against it, which is focussed by the Coach as an either-or question (lines 155-158). The students find the dichotomy too constraining relative to their interpretation of the case evidence, and this leads them to deploy a number of more topological meaning-making strategies as alternatives to a simple typological diagnosis. No firm conclusion is reached.

Socially, there are at least the following agendas at work:

= the construction, maintenance, and negotiation of group interpersonal relations

= the negotiated construction of thematic views of medical phenomena

= the enactment of cultural and subcultural norms and formations

These agendas are intimately interwoven and interdependent as close analysis can show. They include matters of personal dominance and authority, cultural gender roles, the discourse formations of medical theory, and institutional role relationships.

Most of the action in these episodes is talk, and therefore a linguistic-semantic analysis is most revealing for what meanings are being made through this talk and how. But there is also significant use of gesture, and in the first episode use of the visual semiotic resources of the Chart is essential. Gestures enable the creation of intermediate alternatives not available in the lexicon of available diagnoses. The Chart provides representations of three-dimensional spatial relationships within the brain that are not readily described in words. An integrated analysis of at least these three semiotic modalities must be attempted (for prior work on such integration see Lemke 1987; 1995a,b; in press-b).

Locating the Hippocampus

Let's consider very briefly the first part of the episode, in which, after Betty's suggestion that the lesion causing the symptoms may be near the hippocampus, the Coach asks the students (line 28) "Where is the hippocampus?" What is worth noting here is first of all that Betty's immediate reaction is not to begin a verbal answer, but to orient to the need for "a picture" (line 29). Verbal language by itself is pretty well powerless to answer the question because its predominantly typological resources may be very good at saying what things are, but are rather limited in establishing spatial relationships, especially in three dimensions and for spatial regions of irregular shape and not readily visible location.

Norman first points to the Chart from his seat, then gets up and walks a considerable way to be able to point less ambiguously, and finally puts his finger on or almost on the chart (thus minimizing the visual ambiguity due to parallax) and *traces* the spatial region corresponding to the hippocampus. The information he thus conveys with the help of the Chart could not be conveyed verbally in natural language alone.

This procedure is then basically repeated by Lill for a different sectional view of the three-dimensional cortex. Semantic typology is used during the co-construction of Lill's gestural identification by other participants (*go to the crevice, that's white matter, that little loop*), but these expressions only work *indexically* (exophoric spatial deixis) together with the visual-kinesic-spatial resources being deployed here by the group to make meaning topologically. Without the Chart's being visible to all, these locutions would be functionally useless. At one point the Coach says: (lines 58-61), "That's it. That's the hippocampus, then you go over one more gyrus and you're in the *temporal* lobe." His contrastive stress on *temporal* presses the typological approach of medical scientific terminologies. In fact, no sharp boundaries can be drawn for a 'gyrus' or a 'lobe'. The cortex is a quasi-continuous tissue manifold. Even at the microanatomical level there would not be such boundaries, but rather different cell types intermixing and overlapping in space. I am not even sure if it is absolutely possible to say for any given cell whether it belongs to the hippocampus or not in absolute terms. Nor would it necessarily be medically useful to do so.

We see in these portions of the PBL episode examples of the close functional integration of topological and typological strategies and resources for making meaning. They are clearly complementary, but there is also a tension between them produced by the typological bias of medical diagnostic discourse. We also sense here, from the videotape, the dynamics of this functional integration in time (see Rogers Hall's account of locating the hippocampus in his contribution to this volume). An even clearer example of dynamic integration occurs in the section of the episode I discuss next; there the gestural topology helps break down typological diagnostic dichotomies, while language is mobilized to express complex degrees of warrantability for various hypoptheses.

Between True and False

We turn now to a more central concern of the episode and of medical diagnostic reasoning. It is not just spatial continua that are not well represented by typological semantic

strategies, it is also conditions and events. When typological categories are imposed to represent phenomena, propositions made about these phenomena in terms of such categories become problematic. It is not usually possible in life to simply say this is true and that is false, and natural language recognizes this state of affairs semantically by offering us a number of interpolations between polar truth and polar falsity. These have been analyzed in a number of ways in linguistics, most usefully in my opinion by Halliday (e.g. 1985), whose analysis has been extended in various ways by Martin (1992) and myself (Lemke 1996). My argument here, however, could easily be recast in the terms of other semantic theories.

One interpolation between true and false is that of probability. The Warrantability of a proposition, as a semantic attribute of propositions, is a matter both of degree (how likely) and of polarity (likely to be, likely not to be). We can assert or warrant a proposition both as more or less certain and as more or less uncertain. Another interpolation is that of frequency. The Usuality of a proposition is a semantic attribute we can construct for it and which tells the speaker's view of how frequent, normal, usual, expected (or rare, abnormal, unusual, surprising) it is. A not very well understood, but fairly common, extension of the semantics of Usuality (or perhaps its intersection with the semantics of Temporality), is that of Stability or Temporariness. What is not usual may also be something newly arisen, or something changed from what it has been. It may not be usual because it is only temporarily or recently the case. Finally, it is perhaps worth mentioning that there is a third systematic option in the semantics of evaluating propositions. We may do so with explicit 'subjectivity', saying for instance: 'I am sure that ...' or 'I suspect that ...' or we may 'objectify' and say instead: 'It is certain that ...' or 'It is possible that ...' and in the extreme polar case, simply: 'It is so' or 'It is not so.'

In lines 170-176, Jenny says that the condition called RIND is "somewhere in between a completed stroke and TIA [another condition]" and she makes a complex gesture co-ordinating right hand with "completed stroke" and left hand with "TIA", creating a gestural space which stands here metaphorically for the topological space of possible meanings in between the typological categories of the diagnosis. Betty then quips "like ... unstable angina of the mind!"

(lines 178-181), making a semantic connection between the issue of Stability or Temporariness and the continuum of possible conditions under discussion.

These conditions differ from each other, so far as is said here, in part by a *quantitative* difference in how long symptoms persist. That quantitative difference can be represented spatially in contrast with the discreteness of the typological diagnostic categories, and the instability of the symptoms or condition contrasts with the implicit stability of the notion that a patient 'has a condition'. The students laugh here over the tension between a norm of clear-cut right-or-wrong diagnosis with its scientific definitiveness, and the fuzzy nature of the phenomena they must deal with.

When Jenny co-articulates her gestures and speech (including the vocal gesture of the pitch pattern for 'in be-tween', line 175) there is again a dynamic integration in time which has special force in the video that is lost in the transcript, even if supplemented by a still photo, or photo sequence, of her gesture. What linguistics and kinesics separate for analytical purposes, the physiology and functionality of human communication fuse as a unitary perceptual phenomenon and meaning-reality. No doubt they are fused as well for Jenny in the process of producing co-ordinated voicing-and-moving, and insofar as we as viewers, or Jenny's co-participants face-to-face, are entrained by the 'interactional synchronies' (Condon & Ogsten 1967, Kendon 1973) of the dynamic situation, they are fused for us as well. A focus on topological strategies and resources for making meaning cannot be separated from a concern for the general materiality, including bodily involvement, of sense-making. This applies both to the primary participants in the video and ourselves as secondary participants interacting with the video.

Returning to the analysis proper, we find The Coach a moment later (line 186) again pressing a typological view: "So which one did he have?" and the responses begin with Maria's "he's progressing to a stroke", which emphasizes Instability through the aspectual semantics of verbs (the ways we express incipience, progression, habituality, completion, etc. of processes). Norman comments: "A little bit of both", thus implicitly challenging the either/or semantics of

typological categories, and the Coach's "which one?". Betty then begins (line 193) another long discussion that turns on the Stability of the patient's condition and symptoms.

In the course of this (see lines 242-245), Norman rather forcefully frames the Instability with a contrast between "we're seeing an acute leg deficit" but "now we're seeing five-over-five strength", and he makes hand gesture movements to accentuate this instability and temporariness. (Note that the issue of temporariness and change had been introduced initially by the Coach in lines 131-132: "so why do the leg findings go away?"). Typological categories stand synoptically outside of time, in an eternal Platonic present of abstract relations. Even continuous change in properties can be assimilated to this paradigm (one of the triumphs of modern mathematics and science), but what about intermittent, discontinuous, unreliable, unstable, and merely 'temporary' phenomena or symptoms? Part of video-realism, as of life, is the meaningfulness of such phenomena. In language, they are not readily represented in individual clauses, but can be approximated over the course of longer texts or narratives. In visual semiotics again, we require a dimension of time (in production, presentation, or interpretation) to represent them.

The PBL discussion next moves on to the other main symptom, a problem with verbal language. In lines 255-260, Norman argues that the patient's speech is "screwed up", and Betty challenges this in a polar and typological way: "Is it screwed up?" Norman asserts again with a qualification "somehow" (which is a shade less definitive than the pure polar choice), and Betty concedes only in topological terms: "a little bit" and makes a gesture with her fingers held extremely close together. *It is* vs. *It isn't* has been converted again to a matter of in-between, of degree, of manner, of how much. And this is not the end of the discussion, for in her follow-up (lines 269-277) Betty invokes a whole host of Usuality resources (*occasionally, rarely, often*) and a construction of Instability (one part of the mental status exam vs. "the rest" of it).

By the time she gets to her conclusion (lines 279-286), the resources of Warrant-by-degree are in full sway: "I don't know" (i.e. no polar assertion, no high degree of warrantability), "I think", "would probably lean more towards" (lower degrees of probability and warrant),

together with the associated Instability, "something transient that comes and goes", "at a fairly good moment".

Her final argument again turns on Instability (line 293-301), that things must have been worse at one time than they are "right now". Again her hands seem to move to show the temporal dynamics she's trying to construct, as opposed to a more static or synoptic view of a patient's definitive condition.

Conclusions

My point here is not that medical diagnostic discourse is inappropriate to the real complexity of biological and social phenomena, but that a formal emphasis on typological meaning constructions, on definitive categorizations and sharp boundaries, is necessarily in tension with the topological aspects of the phenomena. Natural language gives us some topological resources for making the kinds of meaning that are needed in such situations, and together with gestural and visual semiotic resources, as extended by mathematics and quantitative reasoning, we are reasonably well positioned to deal with them. In this episode, when the tension is strongest, the students bring these resources to bear. Both topological and typological meaning-making strategies are necessary; purely classificatory reasoning, pure classical *reductio* and *excluded-middle* reasoning is not sufficient.

The Coach here has mainly been pressing for a typological approach, and perhaps that is at times a valuable heuristic, forcing the sort of appeal to counter-evidence that also occurs in the episode. His summary comment (lines 316-320): "Some patients are vague ... don't give you the answers you wanna hear," can however be taken as marginalizing this particular case rather than emphasizing how typical it is that instances do not quite fit general categories, putting the blame on the patient, and/or ratifying that the students should "wanna hear" more definitive answers. I am not blaming the Coach, and I may not be interpreting him generously enough. Perhaps in other episodes with this group there is more emphasis on quantitative metrics and on the impossibility of making exact mappings between continuously varying phenomena and

discrete diagnostic categories. The resources the students bring to play, both semantic and gestural, seem to stand outside the official norms of the discourse, and yet they are clearly critical to making the meanings that need to be made here.

There is a great need in scientific education, especially when dealing with complex and individualized systems (e.g. local and planetary meteorology, organisms, ecosystems, etc.) to understand better the role of topological meaning in verbal semantics and reasoning, in gestural-kinesic and visual semiotics, and in the integration of mathematics with both verbal and visual reasoning. I believe that a semiotic analysis of the kind I have tried to sketch here offers some useful tools for doing this.

Regarding the video-recording medium itself, I think the points made here should be sufficient to suggest that the dynamic integration of gestural and visual communication with speech is often essential to characterizations of the kinds of meanings participants make in an interaction. It is not simply that the significance of a gesture becomes more focal when we see it co-produced with, say, speech that is constructing degrees of warrant or usuality, but that the foregrounding of such gradable meanings in the event is itself co-produced, for the participants as well as for us, by such phenomena. Meanings of many different kinds inevitably get produced in most interactions, but some kinds become more salient than others for participants, and that salience in turn sets the stage for what is more likely to emerge next in an interaction. While we may segment activity into this or that unit of action according to a particular focus of interest, and criteria based on the occurence of verbal, gestural, or other signs relevant to that interest, video-analysis still shows us that activity is continuous and that every action or sign may be construed as belonging to on-going processes on multiple time-scales, and so subserving multiple social functions. We cannot account for the dynamical, self-organizing, and emergent character of spontaneous social interaction and activity if our data, or our focus on the data, artificially dismembers the unity of meaningful action into what our various semiotic analyses (linguistic, kinesic, graphical, etc.) have evolved to describe separately. If we separate, it should only be in order to more richly reconnect.

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