CHAPTER 5. COGNITION AS PATTERN PROCESS, AND THE SCIENTIFIC ELUSIVENESS THEREOF.

Possibly the most striking metatheoretic feature of mental attributes, beyond their extraordinary syntax, is their multi-leveled stacking of superveniences. This starts with ordinary language: Psi-verbings with objectual NP-completions are abstractive entailments, given certain reference presumptions, of ones with sentential (fully intentional) completions; many commonsense ψings-that-p entail others with the same propositional content because the mode of one is either constitutive of or disjunctively derivative from the other; and the grounds of '___ ψs that p' being true of s at t is almost certainly s's ψing at t some para-proposition $F(a)$ having causal antecedents and consequences for s-at-t of a kind roughly identified by linguistic expression 'p' but shared by many psychonomically distinct ψable para-propositions among which verbalization 'p' does not distinguish.

Inevitably, any science that takes its inspiration from received mentalistic notions will be forced to cut through this hierarchical snarl of intuitive analyticities by postulating an open array of theoretical properties whose technical specifications are rather like commonsense intentional predicates in having both mode and structured-content components, and which seem to be a plausible abstraction base for explicating ordinary-language Psi-verbings. But no sooner have we regimented these technically re-conceived cognitive properties into variables over some domain D_{μ} of cognizer-stages--and surely something like the $\{[\phi_i F_j(a_k)]\}$ model sketched in Chapter 4 is how any mental science rooted in folk psychology must formalize its primary variables--than pressure returns to continue reductive analysis. We have already noted how contemplation of mentality's domain objects evokes speculation about the t-cores of cognitive variables. But that is just prefatory to the deeper challenge of cognitive composition. For the property, $\phi_1$ing-$F(a)$-with-intensity/vigor-$\langle d,v \rangle$, is surely in some important even if obscure sense a structured complex, with both its elements and how they are put together systematically determining how this property works in the cognitive machinery.

Unhappily, we still know almost nothing about what it is for a property--as distinct from the objects which exemplify it--to be "complexely structured," much less how that matters for its causal behavior. Insight into the nature of attribute-structure is one of molar psychology's most urgent needs. Even so, a large fragment of this matter's analysis lies in the abstractive/translocational analysis of molar variables. The essential a/t-composition of any molar variable $\underset{\wedge}{y}$ over some domain D of macro-objects is exhibited by reduction formalism $\underset{\wedge}{y} = [g[\underset{\wedge}{Z}_1\mu_1, \underset{\wedge}{Z}_2\mu_2, \ldots, \underset{\wedge}{Z}_m\mu_m]\mu_0]$ wherein: (1) $[g[\underset{\wedge}{Z}_1\mu_1, \ldots, \underset{\wedge}{Z}_m\mu_m]]$ is the t-core of $\underset{\wedge}{y}$, i.e., μ_0 maps each o in D into whatever part of o (and/or of o's neighborhood) comprises just the loci of all real micro-events from which macro-event $\ulcorner \underset{\wedge}{y};o \urcorner$ is logically derived; (2) each μ_i (i = 1, ..., m) is a module selector that picks out of each $\mu_0(o)$ a more local part thereof wherein $\underset{\wedge}{Z}_i$-events occur; (3) each $\underset{\wedge}{Z}_i$ is a possibly-singleton and perhaps further a/t-reducible variable whose domain includes $\mu_i\mu_0 D$; and (4) g is an abstracter function over the range of $\langle \underset{\wedge}{Z}_1, \ldots, \underset{\wedge}{Z}_m \rangle$ that may well be compounded out of sub-abstractors in a way that is crucial to the inductive accessibility of laws in which $\underset{\wedge}{y}$ participates. Moreover, translocators μ_0 and $\mu_1, \ldots, \mu_m$ will not in general select parts arbitrarily out of each o in D, but will do so in light of o's assembly structure to insure that micro-loci $\langle \mu_1\mu_0(o), \ldots, \mu_m\mu_0(o) \rangle$ satisfy boundary conditions under which variables $\langle \underset{\wedge}{Z}_1, \ldots, \underset{\wedge}{Z}_m \rangle$ have significant micro-causal consequences. That is, if molar variable $\underset{\wedge}{y}$ is to have any macro-systemic importance, the translocational composants in its a/t-composition must in effect enrich its embedded local variables by whatever more global organization and nonrelational preconditions are required for them to work a certain special way. (From there, $\underset{\wedge}{y}$'s abstractor g more or less skims off just those higher-order properties of the underlying micro-ensemble that have distinguishable effects at whatever levels of molar output are at issue.) I shall illustrate this a/t-composition of structurally complex attributes shortly, but the deeper point is simply this: If the manifest construction of cognitive variables is our basis for generalizing across the transfinitude of laws that variously govern these, e.g., if we can decently infer $[\phi_i F(a)]$'s causal behavior from what we learn separately about ϕ_i, F, and the elements of *a* in other cognitive combinations, and moreover our success in these generalizations lies in some correspondence of our mode/structured-content description of cognitive variables with their a/t-compositions, then we have excellent reason to attempt shifting our level of analysis from the holistic $\{[\phi_i F(a)]\}$ to whatever lower-level variables and assembly structures correspond to the former's generalization features.

Establishing dialog with other contemporary approaches to molar psychology is another reason for a mental science to seek reductive analyses of its cognitive variables. Clearly this is wanted if we are ever to decipher what neuro-physiological events in *s*-circa-*t* have to do with *s*'s $\phi_i$ing-$F(a)$ at *t*, but similar need arises even in the heartland of current work to which the banner of "cognition" is dear. One illustration will suffice. It has become popular in AI circles to model the "information" possessed by *s* at *t* by a digraph of nodes and unidirectional links, each carrying an adjustable, possibly-null verbal label in such fashion that certain connected fragments of the labeled structure can be mapped into stylized English sentences. (E.g., if node #273 is linked to node #526, putting FIDO in the first node, DOG in the second, and labelling the link ISA allows this portion of the digraph to be viewed as containing the sentence 'Fido is a dog'.) The nodes of macro-object *s*-at-*t* are disjoint parts thereof (specifically computer registers or their conjectured organic equivalent), each of which has a particular state (tuple of values) on certain local variables. Part of node #*N*'s local state at time *t* codes the verbal unit carried by #*N*-at-*t*, while other dimensions of this local state have various other functions including "pointer" interpretations of the labeled links emanating from #*N* at *t*. (Translating links as pointer values *within* nodes is needed for real-computer implementation of these models, even though any organic counterpart of AI links would most likely be some aspect of nodal assembly structure.) But regardless of how semantic-network digraphs are to be read as assigning values to a system of variables, what these represent is only a Comp-speak reconstruction of commonsense latent beliefs (i.e., stored "knowledge") which dispose episodic thinking to run off one way rather than another in response to transient antecedents in a process sequence. To establish that these models have anything to do with organic mentality it needs be asked how they describe the episodic process itself, and what abstractions from this are to count as activated $\phi_i$ings-*F*(*a*). Although the literature has remained remarkably taciturn about processes generated by triggering a semantic network, I presume that any current Comp-speak version thereof must envision a set of active-workspace registers, rather like storage nodes in the local variables on which they have values but whose local states--words, pointers, or whatever--are sporadically galvanized by input pulses into a protracted sequence of repeated changes through dynamic interactions among themselves and with the contents of assorted long-term stores. I submit (and am prepared to expound in some detail) that no abstraction from any such series of workspace-register states describable in Comp-speak terms is a plausible approximation to any one $\phi_i$ing-F(a)-to-degree/vigor-<*d*,*v*>, much less to any unbounded conjunction of them. But before the issue can be properly debated, some Comp-speak candidates for the equating must be brought forth.

Molar patterning.

The key to scientific understanding of real mentality (contra the AI kind) is to take seriously that the thoughts activated in *s* at *t* are almost certainly complex pattern properties having t-cores that may well occupy extensive overlapping portions of *s*'s macroscopic CNS circa *t*. In brief, a "pattern" is a property that holds for an object *o* just in case *o* has an array of parts that satisfy certain distinctive relational and nonrelational conditions. (I have tried mightly to identify senses other than this one in which a property might usefully count as "patterned" or "complexely structured," but have reluctantly concluded that this may well be the only attributive structure there is.) Unfortunately, while it is easy to be glib about pattern-valued variables at the level of broad metatheoretic generality--see, e.g., much of Chapter 3, since pattern variables are essentially just a/t-derivative variables with certain nondegeneracy constraints on their abstractors and translocators--careful treatment of substantive pattern instances not of a traditionally statistical sort can easily prove troublesome, starting with their definitions. An illustration will be helpful here, though you needn't study its details closely if you find them tedious.

What is it for something to be "checkered" in its coloration. Or rather, what is the variable, or *a* variable, over compact objects of which surface checkeredness is an ideal value? Begin by taking D to be any domain of objects (things-at-times) or their parts having well-defined continuous outer surfaces, and say that an *alternation grid* on D is any set $\mathbf{f} = \{f_i : i \in I\}$ of translocation functions on D, indexed by the set I of positive integers, with the following properties: (1) For each i in I and o in D, $f_i(o)$ is either null or is a topologically closed region of o's outer surface. (2) For each o in D, the set $\mathbf{f}(o) = \{f_i(o) : i \in I\}$ of o's surface regions is an exhaustive partition of o's outer surface that is disjoint except for common edges. And (3), for any $i \neq j$ in I and any o in D, $f_i(o)$ and $f_j(o)$ have an appreciable common edge only if one of $\{i, j\}$ is odd and the other is even. Let $\mathbf{F}_{ag}$ be the set $\{\mathbf{f}\}$ of all such alternation grids over D (of which there are infinitely many if D is nondegenerate, though without appreciable loss of checkeredness discrimination we can probably restrict $\mathbf{F}_{ag}$ to be finite), and for each $\mathbf{f}$ in $\mathbf{F}_{ag}$, define $\hat{z}_{sq,\mathbf{f}}$ to be a structural variable over D whose value for each o in D measures how well $\mathbf{f}$'s parsing of o's surface approximates a square grid. (Technically, choose some numerical measure $\hat{z}_{sq}$ on bounded two-dimensional but not-necessarily-flat spatial regions $\{a_k\}$ whose value for each a_k is an increasing function of how approximately square a_k is up to a maximum of 1 for perfect solid squares, and then take $\hat{z}_{sq,\mathbf{f}}(o)$ for each o in D to be some average of $\{\hat{z}_{sq}(f_i(o))\}$ over the $i \in I$ for which $f_i(o)$ is non-null.) Next, to consider the color configuration over any o in D relative to any particular $\mathbf{f}$ in $\mathbf{F}_{ag}$, partition $\mathbf{f}$ into its subtuples $\mathbf{f}'$ and $\mathbf{f}''$ such that $\mathbf{f}'$ ($\mathbf{f}''$) comprises just the f_i in $\mathbf{f}$ for which i is odd (even), and define $\hat{c}_m$ and $\hat{c}_v$ to be respectively color-norm and color-variance variables over sets of surface regions such that (1') the value of $\hat{c}_m$ for any surface-region set $A = \{a_k\}$ is the most typical color (averaged however you think best) over the union of regions in A. while (2') c_v is a motley-appraisor whose value for any surface-region set $\underline{A}$ is zero when the union of $\underline{A}$ is monochrome and increases from there with increasing deviation from color norm $\underline{c}_m(\underline{A})$ of local coloration at each point in $\underline{A}$'s union. (That is, $\underline{c}_v(\underline{A})$ measures color variation over the surface partitioned by $\underline{A}$.) And let g_c be a number-valued abstractor on the range of $[{}_{\wedge}c_m\underset{\sim}{f}', {}_{\wedge}c_m\underset{\sim}{f}'', {}_{\wedge}c_v\underset{\sim}{f}', {}_{\wedge}c_v\underset{\sim}{f}'']$ which, for any argument 4-tuple $[\underline{c}_m', \underline{c}_m'', \underline{c}_v', \underline{c}_v'']$, measures the contrast between $\underline{c}_m'$ and $\underline{c}_m''$ degraded by an average of $\underline{c}_v'$ and $\underline{c}_v''$. (That is, $g_c(\underline{c}_m', \underline{c}_m'', \underline{c}_v', \underline{c}_v'']$ is to be symmetrically monotone decreasing in $\underline{c}_v'$ and $\underline{c}_v''$ but symmetrically monotone increasing in how sharply $\underline{c}_m'$ differs from $\underline{c}_m''$ even when $\underline{c}_v' = \underline{c}_v'' = 0$.) Then ${}_{\wedge}z_{c,f} =_{def} [g_c[{}_{\wedge}c_m\underset{\sim}{f}', {}_{\wedge}c_m\underset{\sim}{f}'', {}_{\wedge}c_v\underset{\sim}{f}', {}_{\wedge}c_v\underset{\sim}{f}'']]$ is a patterning variable over $\underline{D}$ whose value for any $\underline{o}$ in $\underline{D}$ appraises the sharpness of color alternations over the parsing of $\underline{o}$'s outer surface imposed by grid $\underset{\sim}{f}$. But regions $\underset{\sim}{f}(\underline{o})$ may not be well-shaped for the purpose at hand; so to measure the quality of $\underline{o}$'s <u>checkeredness</u> relative to $\underset{\sim}{f}$, define ${}_{\wedge}z_{ch,f}(\underline{o})$ for each $\underline{o}$ in $\underline{D}$ to be ${}_{\wedge}z_{c,f}(\underline{o})$ attenuated by the degree ${}_{\wedge}z_{sq,f}(\underline{o})$ to which $\underline{o}$'s surface parts $\{\underline{f}_i(\underline{o})\}$ are imperfectly square, say ${}_{\wedge}z_{ch,f} =_{def} {}_{\wedge}z_{c,f} \times {}_{\wedge}z_{sq,f}$. Finally, for each $\underline{o}$ in $\underline{D}$ put ${}_{\wedge}z^*_{ch}(\underline{o}) =_{def} \underline{sup}[\{{}_{\wedge}z_{ch,f}(\underline{o}): \underset{\sim}{f} \in \underset{\sim}{F}_{ag}\}]$, where <u>sup</u> is the function that yields the supremum (least upper bound) of any set of numbers given to it as argument. Then the value of ${}_{\wedge}z^*_{ch}$ for any $\underline{o}$ in D tells how checkered $\underline{o}$'s surface coloration is, independent of parsing grid, by taking this to be $\underline{o}$'s checkeredness under whatever surface parsing is most favorable to $\underline{o}$ in this assessment.

Although ${}_{\wedge}z^*_{ch}$'s quantification of Checkeredness remains schematic throughout its present definition, it suffices to exhibit several key points about pattern variables. Most evident is the considerable abstractive/translocational intricacy that is here seen to underlie the checkeredness notion.[31] Intricacy as such has no

[31] If you think that my explication of Checkeredness is needlessly complex, <u>you</u> try to do better. Indeed, I have rather oversimplified the account by ignoring local-contrast subtleties.

great significance; but to understand the <u>nature</u> of patterning it is important to appreciate how the pattern property abstracted by ${}_{\wedge}z^*_{ch}(\underline{o})$ is determined as much by a certain structure of $\underline{o}$'s parts (and in this case by a supremum comparison over a great many different parts-parsings of $\underline{o}$) as by local properties of the latter. Moreover, seeking to explicate the categorical ideal of commonsense checkeredness reveals many different facets of gradation both within this ideal (e.g., variation in contrast between $c_m \mathbf{f}'(\underline{o})$ and $c_m \mathbf{f}''(\underline{o})$ even when $c_v \mathbf{f}'(\underline{o}) = c_v \mathbf{f}''(\underline{o}) = 0$ with $z_{sq,f}(\underline{o}) = 1$) and in various approaches to it--e.g., allowing that an $\underline{o}$ whose checkeredness-maximizing $\mathbf{f}(\underline{o})$ may be imperfectly square with appreciable motley within checks can nevertheless be well-checkered by virtue of sufficiently high between-check contrasts, and may even surpass the checkeredness quality of an object $\underline{o}'$ whose best-fitting $\mathbf{f}(\underline{o}')$ is ideally square and monochrome within each of $\mathbf{f}'(\underline{o})$ and $\mathbf{f}''(\underline{o})$ but low in between-check contrast. Further, there is not just one way to make the z^*_{ch}-schema precise, but uncountably many different versions that do equal justice to the commonse category. A science Σ_{ch} that seeks to be comprehensive about checkeredness is in principle obliged to give an account of $\underline{o}$'s status on every one of these z^*_{ch}-precisifications, albeit Σ_{ch} also has the right to identify one or two of them and stipulate that these cover all the checkeredness for which Σ_{ch} accepts responsibility. But note also, at a lower level of abstraction to which Σ_{ch} must also attend if it wants to analyze the nature of z^*_{ch}, each parser-specific variable in $\{z_{ch,f}: \mathbf{f} \in \mathbf{F}_{ag}\}$ is an axis of the infinite-dimensional space of color-alternation features from which z^*_{ch} is a-derivative. Each of the lower-order events $\{\ulcorner z_{ch,f};\underline{o}\urcorner: \mathbf{f} \in \mathbf{F}_{ag}\}$ is at least as real as the higher-level $\ulcorner z^*_{ch};\underline{o}\urcorner$; and this remains true even if $\underline{o}$'s z^*_{ch}-value is very high by courtesy of an alternation grid $\mathbf{f}_*$ under which $\underline{o}$ is ideally checkered but $z_{ch,f}(\underline{o})$ is low because $\mathbf{f}$ is poorly aligned with $\mathbf{f}_*$. Strikingly nonrandom patterns may well have epistemic import for cognizant observers that amorphous patterns lack (cf. Rozeboom, 1972b); but in the explanatory order of events, a pattern is a pattern no matter how undistinguished it may be.

Detection of patterning has been a foreground concern of much recent work on input processing (see, e.g., DeValois & DeValois, 1980, on neurophysiological feature analyzers; McArthur, 1982, on AI scene parsing), and the complexities just illustrated are no strangers there. But despite the undeniable value of this work, its emphasis on detection has been constrictive. For one, it has done little to deepen SLese insight into the nature of patterning, especially patterning other than just that of synchronic energy distributions over a finite geometry of point loci. But far more insidious has been the implicit premise that input patterns *need* detection in order to be behaviorally consequential, and moreover that this should be accomplished by the responding of a single variable, or a small block thereof, dedicated exclusively to this reception and having roughly the same locality/molecularity status as an element of the pattern detected (see, e.g., Walley & Weiden, 1973). That is, we are urged to view pattern detection as a judge's verdict in light of testimony from many consultants. Admittedly, this simplistic metaphor travesties the astutely sophisticated work of Marr (1982) and others on early visual pattern processing. Nevertheless, it reflects a metatheoretical bias that can easily become stultifying.

In its most extremistic conception, a pattern detector is a binary variable whose *on*/*off* values are responses to the presence/absence of some more or less elaborate configuration of properties in the detector's vicinity. But binary detection has no particular SLese merit; so to admit the prospect of detecting a multiplicity of pattern alternatives we can better say

Definition 4. Variable $\underset{\wedge}{y}$ is a *detector* of pattern variable $[g\underset{\wedge}{X}]$ under domain conditions $\underline{D}$ iff, for some possibly-null tuple of supplementary variables $\underset{\wedge}{E}$ causally independent of $\underset{\wedge}{X}$: (*a*) $\underset{\wedge}{y}$ is determined by $\langle \underset{\wedge}{X}, \underset{\wedge}{E} \rangle$ in $\underline{D}$ under a causal law $\underline{y} = \phi(\underline{X}, \underline{E})$ whose transducer has some decomposition $\phi(\_\_,\_\_) = \psi(g(\_\_),\_\_)$ whereby Input Abstraction allows us to regard

$$\text{In } \underline{D},\quad \underline{y} = \psi([g\underline{X}], \underline{E})$$

as a molar causal law under which pattern variable $[g\underset{\wedge}{X}]$ determines $\underset{\wedge}{y}$ in $\underline{D}$; and (*b*) the variance of $\underset{\wedge}{y}$ produced by $\underset{\wedge}{E}$ in $\underline{D}$ unmediated by $\underset{\wedge}{X}$ is sufficiently small, and $\psi(\underset{\wedge}{\tilde{x}},\underline{E})$ is sufficiently monotone in $\underset{\wedge}{\tilde{x}}$, that the one-one correlation between $\underset{\wedge}{y}$ and $\underset{\wedge}{\tilde{x}} =_{def} [g\underset{\wedge}{X}]$ in $\underline{D}$ is high.

(My wording of Clause (b) in Def. 4 tries to acknowledge issues which complicate the technical theory of detector mechanisms, while suppressing details that would be pointlessly distracting here.) To observe the essence of Def. 4, idealize $\underset{\wedge}{E}$ as having negligible effect in $\psi(g(\underset{\wedge}{X}),\underset{\wedge}{E})$ (or encorporate $\underset{\wedge}{E}$ into $\underset{\wedge}{X}$). Then the causal law in Def. 4 simplifies to

(36) $$\text{In } \underline{D},\quad \underline{y} = \psi(g(\underline{X}))\ ,$$

from which, by Input Abstraction, we obtain

(36') $$\text{In } \underline{D},\quad \underline{y} = \psi(\underline{\tilde{x}}) \qquad (\underset{\wedge}{\tilde{x}} =_{def} [g\underset{\wedge}{X}])\ .$$

The monotonicity stipulated in Def. 4 means in this ideal case that transducer ψ is one-one over the range of $\underset{\wedge}{\tilde{x}}$ in $\underline{D}$, and can hence be further simplified into an Identity function by suitable choice of scale for $\underset{\wedge}{y}$ or $\underset{\wedge}{\tilde{x}}$. So equation (36') reinterprets $\underset{\wedge}{y}$'s many-one determination by $\underset{\wedge}{X}$ in (36) as a one-one detection by $\underset{\wedge}{y}$ of the molar variable $\underset{\wedge}{\tilde{x}}$ whose alternative values correspond to $\underset{\wedge}{y}$-wise equivalence classes of $\underset{\wedge}{X}$-values.

It is evident from Def. 4 that any dependent variable is a detector of not just one but many pattern antecedents. For when $\underline{y} = \phi(\underline{X})$ while $\underline{X} = \Psi(\underline{Z})$ in $\underline{D}$, $\underset{\wedge}{y}$ detects not only $[\phi\underset{\wedge}{X}]$ but also $[\phi\Psi\underset{\wedge}{Z}]$. And with $\underset{\wedge}{X}$ partitioned as $\underset{\wedge}{X} = \langle \underset{\wedge}{X_1}, \underset{\wedge}{X_2} \rangle$, there always exist decompositions of ϕ as $\phi(\underset{\wedge}{X_1},\underset{\wedge}{X_2}) = \psi(g(\underset{\wedge}{X_1}),\underset{\wedge}{X_2})$ that satisfy Def. 4 except perhaps for insufficient correlation between $[g\underset{\wedge}{X_1}]$ and $\underset{\wedge}{y}$ to qualify as a "detection" relation. <u>But this holds fully as much for molar dependent variables as it does for molecular ones</u>--which is simply to say that when the behavior of a reactive system includes detection of certain input patterns, this can be achieved just as readily, if not more so, by holistic <u>patterns</u> of reaction by the system's receptors and throughput processors as by the response of a single micro-variable or localized group thereof. To put the point in grandly general terms, if $\underline{Y} = \Phi(\underline{X},\underline{E})$ is an ensemble $\{\underline{Y}_i = \phi_i(\underline{X},\underline{E})\}$ of micro-laws translocated to a common domain $\underline{D}$ of macro-objects, then for any abstractor $\underline{h}$ over the range of $\underset{\wedge}{Y}$, $\underset{\wedge}{\tilde{y}} =_{def} [\underline{h}\underset{\wedge}{Y}]$ is a pattern variable that detects input pattern $[\underline{h}\Phi(\underset{\wedge}{X},\underset{\wedge}{E})]$ as well as, if $\underset{\wedge}{E}$ does not unduly degrade the correlation, any pattern variable $[g\underset{\wedge}{X}]$ for which $\underline{h}\Phi(\underset{\wedge}{X},\underset{\wedge}{E}) = \psi(g(\underset{\wedge}{X}),\underset{\wedge}{E})$ is a decomposition of $\underline{h}\Phi$ wherein all $\underset{\wedge}{X}$-values having the same influence on $\underset{\wedge}{\tilde{y}}$ are assigned the same value by abstractor $\underline{g}$. Conversely, however, if $\underline{h}\Phi$ does decompose as $\underline{h}\Phi(\_\_,\_\_) = \psi(\underline{g}(\_\_),\_\_)$ when $\underline{Y} = \Phi(\underline{X},\underline{E})$ in $\underline{D}$, failure of $[\underline{h}\underset{\wedge}{Y}]$ to correlate tightly enough with $[\underline{g}\underset{\wedge}{X}]$ to count as detection in no way demeans the nomic import of $[\underline{g}\underset{\wedge}{X}]$ for $[\underline{h}\underset{\wedge}{Y}]$. For if $\underset{\wedge}{\tilde{Y}} =_{def} \underline{H}(\underset{\wedge}{Y})$ $(= \{[\underline{h}_i\underset{\wedge}{Y}]\})$ is the tuple of molar abstractions from micro-array $\underset{\wedge}{Y}$ that we have chosen for study, the methodological value of recognizing $\underset{\wedge}{\tilde{x}} =_{def} [\underline{g}\underset{\wedge}{X}]$ as a molar input variable for this system turns on whether $\underset{\wedge}{\tilde{x}}$ together with a relatively small number of other abstractions from $\underset{\wedge}{X}$ mediate via Input Abstraction essentially all the causal force of $\underset{\wedge}{X}$ for $\underset{\wedge}{\tilde{Y}}$. Beyond that, whether any component $\underset{\wedge}{\tilde{y}}$ of $\underset{\wedge}{\tilde{Y}}$ is a high-correlation detector of $\underset{\wedge}{\tilde{x}}$ does not much matter.

I shall say no more about pattern detection here, for my submission is simply that this notion does not belong in the foreground of pattern-processing theory. In particular, to the extent that "pattern detection" is construed to be the judge-interpreting-testimony sort of mechanism prominent in recent neurophysiological research, this is surely the wrong model for molar cognitive processes. When $\underline{s}$'s environmental surround produces configured sensory-surface impingements on $\underline{s}$-at-$\underline{t}_1$ that induce $\underline{s}$-at-$\underline{t}_2$ to perceive that-$\underline{p}_2$, which in turn makes $\underline{s}$-at-$\underline{t}_3$ fearfully recall that-$\underline{p}_3$ while anticipating that-$\underline{q}_3$ and wondering whether-$\underline{r}_3$, thereby activating $\underline{s}$'s trying at $\underline{t}_4$ to accomplish that-$\underline{p}_4$ with resolve to-$\underline{d}_4$-if-$\underline{c}_4$, etc. etc., each of these thoughts is surely not the state of a single neuron or cluster thereof comparable to a computer register. Rather, it is by all odds a grossly holistic abstraction from an ensemble of micro-events whose t-core loci collectively constitute an appreciable part of $\underline{s}$'s macroscopic nervous system throughout some period of significant duration.[32]

32 As demonstrated by compliance of language-proficient subjects with instructions to signal some introspective judgment by a single finger twitch, special programming can apparently establish transient detection dependencies of micro-responders in human motor organs upon at least some cognitive variables. This capacity for micro-focusing has deep significance for the theory of neural organization, but it is feeble grounds for thinking that cognitive variables so detected are similarly localized.

Abstractly, the most plausible model is this: Given that cognitive variables are a/t-derivative from an array Z^* of local micro-variables at some level of neurophysiological analysis that we here regard as fixed albeit unspecified and indeed perhaps not yet recognized by extant neurophysiology, we posit that each cognitive variable $[\phi_i\underline{F}_j(\underline{a}_k)]$ over $\underline{D}_\mu$ has an a/t-analysis of form $[\phi_i\underline{F}_j(\underline{a}_k)] = [g_{ijk}Z_{ijk}]$ wherein $Z_{ijk} = \langle \ldots, z_{hijk}, \ldots \rangle$ is a compound micro-variable whose components decompose as $z_{hijk} = [z^*_{hijk}\mu_{hijk}]$ between a t-core z^*_{hijk} in Z^* and a translocater μ_{hijk} which maps each molar $\underline{s}$-at-$\underline{t}$ in $\underline{D}_\mu$ into a module of $\underline{s}$-circa-$\underline{t}$ where a real micro-event on z^*_{hijk} occurs.[33] A particular change in any one subscript $\underline{h},\underline{i},\underline{j},\underline{k}$ needs not token a difference in each one of g_{ijk}, z^*_{hijk}, and μ_{hijk}. (For example, it is possible even if unlikely that z^*_{hijk} is the same local variable z^* for all translocators $\{\mu_{hijk}\}$. Or perhaps the module-selector tuple $\langle \mu_{1ijk}, \mu_{2ijk}, \ldots \rangle$ which

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33 When we try to spell out what specific neurophysiological properties at what transducer selected body sites might be dimensionalized by array Z_{ijk}, we run head-on into the complication noted earlier (p. 111ff.) that the subjects over which we hope to generalize are a genus spanning great diversity in assembly structure. Present reduction formalism $[\phi_i\underline{F}_j(\underline{a}_k)] = [g_{ijk}Z_{ijk}]$ should be understood to envision one arbitrary fixation of assembly features, such as total number of neurons and their synaptic-abutment layout; from there, we build generic cognitive variables by colligating functional similarities across disjoint neurophysiological assembly details.

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picks out the t-core locus of $\phi_i$ing-$\underline{F}_j(\underline{a}_k)$ events for a particular open mode ϕ_i and content $\underline{F}_j(\underline{a}_k)$ depends on the mode at issue but is indifferent to content and can hence be written more simply as $\langle \mu_{1i}, \mu_{2i}, \ldots \rangle$.) My contention that mental phenomena are in all liklihood "grossly holistic" is the thesis that the reduction bases of different cognitive variables prevailingly have many micro-components in common, especially (let us conjecture) if their modes are similar.

To make clear the psychonomic import of this putative cognitive reduction-base overlap, it is convenient to write Z_μ for the totality of micro-variables over $\underline{D}_\mu$ of which each $\underset{\wedge}{Z}_{ijk}$ is a subtuple, and reformalize the a/t-analysis of each cognitive variable as $[\underset{\sim}{\phi}_i\underline{F}_j(\underline{a}_k)] = [g_{ijk}\underset{\wedge}{Z}_\mu]$ with the understanding that abstractor g_{ijk} may give null weight to many of the components in $\underset{\wedge}{Z}_\mu$. It is then evident both why there should be a plenitude of cognitive variables, and why their joint distribution should be constrained in the way that commonsense calls "attention span." For the number of different abstractors on $\underset{\wedge}{Z}_\mu$ is infinite, or virtually so; and although probably not all of these satisfy whatever conditions may be required for an a-derivative of $\underset{\wedge}{Z}_\mu$ to be cognitive those that do should still vastly outnumber the disjoint registers contained by any real-world Comp-speak mechanism. But on the other hand, for any two cognitive variables $[\underset{\sim}{\phi}_i\underline{F}_j(\underline{a}_k)]$ and $[\underset{\sim}{\phi}_{i'}\underline{F}_{j'}(\underline{a}_{k'})]$ whose abstractors are g_{ijk} and $g_{i'j'k'}$, respectively, the subrange of $\underset{\wedge}{Z}_\mu$-values which g_{ijk} abstracts into high arousal of content $\underline{F}_j(\underline{a}_k)$ in some grade of $\underset{\sim}{\phi}_i$ing may well have little overlap with the $\underset{\wedge}{Z}_\mu$-values abstracted by $g_{i'j'k'}$ into high arousal on $[\underset{\sim}{\phi}_{i'}\underline{F}_{j'}(\underline{a}_{k'})]$. If so, it will be difficult to attain high joint arousal of $\underset{\sim}{\phi}_i$ing-$\underline{F}_j(\underline{a}_k)$-while-$\underset{\sim}{\phi}_{i'}$ing-$\underline{F}_{j'}(\underline{a}_{k'})$.[34]

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[34]By the same argument, cognitive variables with sufficiently similar abstractors should be mutually facilitative. That folk psychology does not recognize such a phenomenon may simply reflect the difficulty in doing so. For if $\underset{\sim}{\phi}_i$ing-$\underline{F}_j(\underline{a}_k)$ is always accompanied by almost the same intensity of $\underset{\sim}{\phi}_{i'}$ing-$\underline{F}_{j'}(\underline{a}_{k'})$ in nearly the same grade of the same mode, there is little to choose between them nor likely incentive to try.

To illustrate by the parallel of color patterns, suppose that multi-ringedness is a molar coloration variable, defined in fashion akin to our previous explication of checkeredness, whose value is high for $\underline{o}$ whenever several circular color bands without common edges are prominant on $\underline{o}$'s outer surface. Evidently, a near-maximum value of checkeredness largely precludes near-maximum values of multi-ringedness, even though cubist art has shown how sub-ideal but still moderately high values of these pattern variables can be conjoined. And if we consider many other holistic pattern variables over surface coloration as well, we should discover that their joint distribution in any population of colored objects shows upper bounds on pattern combinations very like cognitive attention-span.

Why pattern dynamics are prevailingly incomprehensible.

Unhappily, while grossly holistic pattern phenomena are the stuff of humanistic gratifications, they largely resist SLese domestication. The difficulty is not that complex pattern variables somehow manage to evade the lawfulness of micro-variables from which they abstract. Rather, it is that our prospects for identifying conceptually manageable molar laws that integrate into recursive/dynamic systems of practical dimensionality and practical scope become increasingly bleak as the a/t-derivation of their variables increases in holistic intricacy. We have already considered (pp. 121-123) how diversity of micro-assembly structure works against practical molar systemacy. But the problem goes deeper than that.

When an array of micro-laws are assembled by translocation on a domain $\underline{C}$ of macro-objects into a form-(27/28) causal system (p. 107 above), even if the molecular system has a high degree of piecemeal inductive accessibility and much recursive integration (i.e., each component law in (27) has an epistemically easy transducer, and the preponderance of micro-variables on the input side of (28) differ from ones in (28)'s output only by excursive displacements within or between $\underline{C}$-objects), this does not generally remain true of an arbitrary selection (29a) of molar abstractions from (28). Following a generically abstract overview of such supervenience debilities, we shall consider in greater specificity the dynamics of molar patterning in a class of physical systems whose micro-dynamics are not only well-understood but can be adjusted to yield perceptually striking pattern processes.

If you review pp. 98-110 on the definition of a complex system's micro-structure and supervenient molar behavior, you will notice that although system dynamics are not explicit there, this is implicit in that when the kth law in micro-system (27) is instantiated for any $\underline{o}$ in $\underline{C}$ as

$$\underset{\wedge}{y}_k\mu_k(\underline{o}) = \phi_k(\underset{\wedge}{X}_k\mu_k(\underline{o})) ,$$

(where $\mu_k(\underline{o})$, you recall, is paradigmatically some more-or-less restricted though possibly scattered part of macro-object $\underline{o}$), the t-core locus of micro-effect $\ulcorner \underset{\wedge}{y}_k\mu_k;\underline{o}\urcorner$ may well be part of a successor $\underline{f}(\underline{o})$ of $\underline{o}$ in such fashion that for some module selector μ'_k and some micro-variable $\underset{\wedge}{y}{}^*_k$ whose domain includes the μ'_k-parts of the $\underline{f}$-successors of $\underline{C}$-objects, the t-core of $\ulcorner \underset{\wedge}{y}_k \mu_k ; \underline{o} \urcorner$ for any $\underline{o}$ in $\underline{C}$ is $\ulcorner \underset{\wedge}{y}{}^*_k ; \mu'_k \underline{f}(\underline{o}) \urcorner$. If so, this particular micro-law can be rewritten as

$$(27') \qquad \text{In } \underline{C},\ \ \underline{\underset{\wedge}{y}{}'_k f} = \phi_k(\underline{\underset{\wedge}{X}{}'_k}) \qquad (\, \underset{\wedge}{y}{}'_k =_{\text{def}} [\underset{\wedge}{y}{}^*_k \mu'_k],\ \underset{\wedge}{X}{}'_k =_{\text{def}} [\underset{\wedge}{X}_k \mu_k] \,)\ ,$$

where $\underset{\wedge}{y}{}'_k$ is almost certainly a component of $\underset{\wedge}{X}{}'_k$ or at least of $\underset{\wedge}{X}_h \mu_h$ ($\underline{h} \in \underset{\sim}{k}$) for some other micro-law in (27). Then as a special case of fusing selections from law-ensemble (27) into a single system equation (28) by Input Expansion and Output Compounding, we can envision collecting all form-(27') micro-laws for the same $\underline{C}$ and $\underline{f}$ into a single compound law

$$(37) \qquad \text{In } \underline{C},\ \ \underline{\underset{\wedge}{Y} f} \ = \ \Phi(\underline{\underset{\wedge}{Y}}, \underline{\underset{\wedge}{Z}})$$

of total micro-system dynamics for objects of this kind. It will be plain that input compound $[\underset{\wedge}{Y}, \underset{\wedge}{Z}]$ here comprises all components of all $\{\underset{\wedge}{X}{}'_k\}$ in the form-(27') laws combined in (37), partitioned between components that are endogenous (in $\underset{\wedge}{Y}$) and ones that are exogenous (in $\underset{\wedge}{Z}$).[34a]

Technicalities of how (28) subsumes (37) are unimportant here; we simply want to start with a formalism for a complex system's micro-dynamics whose cogency has already been explained and whose import for the system's molar behavior is perspicuous as a special case of (29a)'s supervenience upon (28). If the preceding paragraph seems like sleight-of-hand to you (it does, admittedly, skim briskly over assorted intricacies in the locus structure of micro-laws and the parts-composition of macro-objects), note simply that micro-output compound $\underset{\wedge}{Y}_j$ in (28) might well have been selected to have t-derivative composition $\underset{\wedge}{Y}_j = \underline{\underset{\wedge}{Y} f}$ for some subtuple $\underset{\wedge}{Y}$ of $\underset{\wedge}{X}_j$ under successor-function $\underline{f}$ on $\underline{C}$; whence taking $\underset{\wedge}{Z}$ to be the remainder of $\underset{\wedge}{X}_j$, and algebraically rearranging $\Phi_j(\underline{\underset{\wedge}{X}_j})$ as $\Phi(\underline{\underset{\wedge}{Y}}, \underline{\underset{\wedge}{Z}})$, converts (28) into (37) with a similar conversion entailed for (29/29a).

Suppose, then, that compound objects of kind $\underline{C}$ have micro-dynamics (37) which, to emphasize what supervenience can lose, we also feel free to idealize in all helpful

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[34a]Supplementary $\underset{\wedge}{Y}$-growth source $\underset{\wedge}{Z}$ in (37) needn't be strictly exogenous throughout, since it may well include some system-state dimensions at prior lags. That is, when $\ulcorner \underset{\wedge}{Y};\underline{o} \urcorner$ and $\ulcorner \underset{\wedge}{Z};\underline{o} \urcorner$ determine $\ulcorner \underset{\wedge}{Y};\underline{f}(\underline{o}) \urcorner$ under (37), any of the micro-system events $\{\ulcorner \underset{\wedge}{Y}_i;\underline{f}^{-r}(\underline{o}) \urcorner\}$ in any $\underline{r}$-step $\underline{f}$-predecessor of $\underline{o}$ ($\underline{r} = 1,2,\ldots$) is in $\ulcorner \underset{\wedge}{Z};\underline{o} \urcorner$ if it would otherwise have effects on $\ulcorner \underset{\wedge}{Y};\underline{f}(\underline{o}) \urcorner$ unmediated by $\ulcorner \underset{\wedge}{Y};\underline{o} \urcorner$ and $\ulcorner \underset{\wedge}{Z};\underline{o} \urcorner$ for a narrower choice of $\underset{\wedge}{Z}$. However, we have nothing to gain here by making such hysteresis possibilities notationally explicit.

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respects save dimensionality. In particular, let us take (37)'s exogenous input $\underset{\wedge}{Z}$ to comprise only identifiable variables (no hard-core indeterminacy) which moveover are controlled wholly by proximal factors outside the system (i.e., are not additionally influenced by $\underset{\wedge}{Y}$ at prior lags) and indeed can either be held constant (i.e., effectively null) by human intervention or have only negligible effect on $\underset{\wedge}{Y}$-growth supplemental to the endogenous effect in $\Phi(\underline{Y},\underline{Z})$ of system-state $\underline{Y}$. We can also presume that each component function ϕ_k in system-growth transducer Φ is epistemically docile in the sense that when we make explicit ϕ_k's input-expansion composition as $\phi_k(\underline{Y},\underline{Z}) =_{def} \phi'_k\sigma_k(\underline{Y},\underline{Z})$, with σ_k the component-selector function that pulls out of total-input array $\langle\underline{Y},\underline{Z}\rangle$ just the components therein that have non-null weight in $\phi_k(\underline{Y},\underline{Z})$, the argument passed on by σ_k to ϕ'_k is only a small fragment of $\langle\underline{Y},\underline{Z}\rangle$ while ϕ'_k itself is a computationally simple function with high inductive accessibility. And to provide for long recursions on (37) in continuant $\underline{C}$-things, we also let (37)'s domain-stability be arbitrarily high, i.e., the $\underline{f}$-successor of almost every $\underline{C}$-object is also in $\underline{C}$.

Despite all these idealities, however, micro-dynamics (37) may still be humanly incomprehensible as a whole. For when this describes the workings of all components individuated by a sufficiently fine-grained parts-parsing of $\underline{C}$-kind objects, the number of dimensions in micro-state array $\underset{\wedge}{Y}$ will be astronomical, vastly greater than any list of variables we could ever in practice itemize one by one, or recognize separately in any written equation whose input variables include all of $\underset{\wedge}{Y}$. Nor could we often compute system-state trajectories under recursions on (37) even when idealizing $\underset{\wedge}{Z}$ as null implies that a continuant $\underline{C}$-thing's succession of $\underset{\wedge}{Y}$-states is perfectly predictable under (37) from that thing's initial $\underset{\wedge}{Y}$-state. (This computational impracticality generally remains true even when we are able to verbalize (37) by the compressive devices sketched in Note 2, below.)

Note 1. The number of endogenous/exogenous dimensions in (37), or in any other law-system, can be made arbitrarily small by formal tricks which, however, compensatorily complexify even the simplest components of Φ beyond all human comprehension. (One simple illustration is the one-one transformation that maps any integer-pair $\langle n_a, n_b \rangle$ whose binary expansion is $n_k = \sum_{i=0}^{\infty} c_{ki} \cdot 2^i$ ($k = a,b$; each c_{ki} either 0 or 1) into the single integer $\sum_{i=0}^{\infty} (c_{ai} \cdot 2^{2i} + c_{bi} \cdot 2^{2i+1})$. Here and elsewhere, I presuppose that any *law with which we are concerned articulates dimensionality in whatever natural fashion largely maximizes its transducer's inductive accessibility. Correlative to this point is acknowledgment of our need for theories of dimensionality optimization--which indeed may already exist in mathematical literature of which I am personally unaware.

Note 2. Given that the dimensionality of $\hat{Y} = [\hat{y}_1, \hat{y}_2, \ldots]$ is enormous, you may well wonder how we can still view (37) as schematizing a verbal statement of C-kind lawfulness. Suppose, for example, that the number of $\hat{Y}$-components is 100,000 (which is still many orders of magnitude less than what we expect of a finely-parsed macro-system), while for simplicity $\hat{Z}$ is null. Clearly we could never in practice make much headway in writing down even one equation $y_i f = \phi_i(y_1, \ldots, y_{100,000})$ in which each input dimension is named individually, much less all 100,000 such equations compounded in $Yf = \Phi(Y)$. Nevertheless, we may be able to work out compressive symbolic devices that allow us to assert what is equivalent to a complete listing of 100,000 determinate equations in 100,001 well-specified variables each. First, although we cannot effectively verbalize a separate definition for each variable $\hat{y}_1$ to $\hat{y}_{100,000}$, it is entirely feasible for us to contrive a linguistic algorithm that converts any integer-name 'i' from '1' to '100,000' into a semantically adequate identification of the particular variable for which '$\hat{y}_i$' is our notational shorthand. (For communicative simplicity, I shall henceforth equivocate between taking numerical indices $i = 1, \ldots, 100,000$ to be on one hand de re integers and on the other the names for these on which we more literally carry out operations.) And an equation in 100,000 input variables can be explicitly verbalized if it is sufficiently simple--e.g., '$\underline{y}_i\underline{f} = \Sigma_{k=1}^{100,000} \underline{y}_k$', albeit this special case is rather too special to illustrate general strategies for practical specification of functions on spaces of enormous dimensionality. Still, given the idealities we are prepared to suppose for Φ, we may well be able to define an algorithm that effectively maps any $\hat{Y}$-component index $\underline{i}$ into (a) a small subtuple $\underline{j}_i$ of these indices and (b) an easily verbalized function ϕ_i', from the range of $\hat{Y}$'s subtuple indexed by $\underline{j}_i$ into the range of $\hat{y}_i$, in such fashion that we can (correctly) describe the ith component function $\underline{y}_i\underline{f} = \phi_i(\underline{Y})$ in this idealized (37) as the one whose value for any $\hat{Y}$-state $\underline{Y} = \langle \underline{y}_1, \ldots, \underline{y}_{100,000} \rangle$ is the value of ϕ_i' for the small subtuple $\underline{Y}_{\underline{j}_i}$ picked out of $\underline{Y}$ by indices $\underline{j}_i$. And if we have a particular $\underline{Y}$ specified by some production device that carries any suitable index $\underline{k}$ into a computationally usable name for the kth component of $\underline{Y}$, we can then effectively compute the value of ϕ_i for this $\underline{Y}$ by first generating verbal identification of $\underline{Y}$'s subtuple $\underline{Y}_{\underline{j}_i}$ and then transforming this by our method of computing ϕ_i' into description of the number equal to $\phi_i'(\underline{Y}_{\underline{j}_i})$, i.e., of $\phi_i(\underline{Y})$.

I'm not sure how clear I have managed to make any of this, but its gist is simple: Even when it is hopelessly impractical to write down every equation in array (37), or even just one of them with each of its component variables named individually, there are nevertheless circumstances of nomic tidiness--hopefully prevalent at levels of fine-grained molecularity in natural systems--under which we can verbalize production rules that in effect express the entirety of (37) by enabling us to name any chosen component $\hat{y}_i$ of total-state compound $\hat{Y}$ and say explicitly how $\hat{y}_i\underline{f}$ is determined in $\underline{C}$ by the fragment of $[\hat{Y}, \hat{Z}]$ that genuinely matters for this. Unhappily, however, what such procedures for verbalizing comprehension-sized pieces of total system (37) do not generally give us is any effective way to compute trajectories (i.e. process sequences) on selected system dimensions $\{\hat{y}_i\}$ under iteration of system dynamics (37). For excepting highly special cases of strong subsystem decoupling, even with $\hat{Z}$ still idealized as null the dependence of $\underset{\wedge}{y}_i\underline{f}^r$ upon $\underset{\wedge}{Y}$ in $\underline{Y}\underline{f}^r = \Phi^r(\underline{Y})$ gives non-null weight to an increasingly large fragment of $\underset{\wedge}{Y}$ as trajectory length $\underline{r}$ increases; whence computating even one component of $\Phi^r(\underline{Y})$ for a specified $\underset{\wedge}{Y}$-state $\underline{Y}$ by any extension of our recipes for computing selected components of $\Phi(\underline{Y})$ becomes unworkable for $\underline{r}$ much greater than 1.

It is difficult to say precisely, much less succinctly, what is required for a system's dynamics to be comprehensible; but that is what we hope to get from molar abstractions on micro-systems too opulent for us to grasp as wholes. Suppose that $\underset{\wedge}{\tilde{Y}}_1 = [\tilde{y}_{11}, \tilde{y}_{12}, \ldots]$ is an array of molar variables over $\underline{C}$-kind objects, all supervenient upon system (37)'s micro-state dimensions $\underset{\wedge}{Y} = [\underset{\wedge}{y}_1, \underset{\wedge}{y}_2, \ldots]$, that is small enough to be humanly manageable. And for motivation say also that array $\underset{\wedge}{\tilde{Y}}_1$ has been selected, either by knowledgeable contrivance (as in choice of sample statistics by mathematically astute data analysts), by our natural holistic perception of $\underline{C}$-kind objects, or by explanatory induction from data on the former, to span some space of molar properties that seem especially salient in our dealings with $\underline{C}$-things.

We need not presume that this particular $\underset{\wedge}{\tilde{Y}}_1$-space contains all molar properties of $\underline{C}$-objects for which we desire to account. Rather, $\underset{\wedge}{\tilde{Y}}_1$ is to bite off only so large a chunk of those as we can cope with in one package; and its subscript signals our readiness, when not preoccupied with $\underset{\wedge}{\tilde{Y}}_1$, alternately to contemplate lawfulness in other subspaces $\underset{\wedge}{\tilde{Y}}_2$, $\underset{\wedge}{\tilde{Y}}_3$, ... of $\underline{C}$-objects' holistic features as well. (E.g., each $\underset{\wedge}{\tilde{Y}}_j$ might be an itemized finite selection from the infinitude of cognitive variables schematized in Chapter 4.) But we may assume without loss of generality that were it feasible for us to work out practical joint dynamics for, say, $[\underset{\wedge}{\tilde{Y}}_1, \underset{\wedge}{\tilde{Y}}_2]$, we would have chosen $\underset{\wedge}{\tilde{Y}}_1$ to include all $\underset{\wedge}{\tilde{Y}}_2$-components in the first place.

Then for each $\underset{\wedge}{\tilde{y}}_{1k}$ in $\underset{\wedge}{\tilde{Y}}_1$, whether we know it or not, there exists an abstractor function g_{1k} on $\underset{\wedge}{Y}$-space such that $\underset{\wedge}{\tilde{y}}_{1k} = [g_{1k}\underset{\wedge}{Y}]$. (Presumably, $g_{1k}(\underline{Y})$ gives null weight to many components of total micro-state $\underline{Y}$; but it serves no point here to make g_{1k}'s particular allocation of indifferences notationally explicit.) Putting $\underline{G}_1 =_{def} \langle g_{11}, g_{12}, \ldots \rangle$ for the string of these abstractors allows us to write simply

$$\tilde{\underset{\wedge}{Y}}_1 =_{def} \underline{G}_1(\underset{\wedge}{Y})$$

and observe that application of $\underline{G}_1$ to both sides of (37) leads by Output Abstraction to

$$\text{(38)} \qquad \text{In } \underline{C},\ \tilde{\underline{Y}}_1\underline{f} \;=\; \underline{G}_1(\Phi(\underline{Y},\underline{Z})) \;=\; \Psi_1'(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y}),\underline{Z}) \;=\; \Psi_1(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y}),\underline{G}_3(\underline{Z}))$$

for some subfunctions Ψ_1', Ψ_1, $\underline{G}_2$, and $\underline{G}_3$. The second line of (38) is an algebraic reorganization of the first that always exists for many different compound abstractors $\underline{G}_2$ on $\underset{\wedge}{Y}$-space supplementary to $\underline{G}_1$, allowing us to opt for a choice thereof that minimizes the importance of $\underline{G}_2(\underset{\wedge}{Y})$ in (38). And (38)'s third line is a reorganization of its second as $\Psi_1'(\_,\_,\_) = \Psi_1(\_,\_,\underline{G}_3(\_))$ from some pleasing choice of $\underline{G}_3$ out of the many abstractor arrays on $\underset{\wedge}{Z}$ that can accomplish this.

⟦To appreciate the scope of possibilities for (38)'s reorganization on $\underset{\wedge}{Y}$, note that any choice of compound function $\underline{G}_1$ has a $\underset{\wedge}{Y}$-complement $\underline{G}_2 = \langle g_{21}, g_{22}, \ldots \rangle$-- indeed infinitely many of them--whose compounding $\underline{G}_{12} =_{def} \langle \underline{G}_1, \underline{G}_2 \rangle$ with $\underline{G}_1$ is a one-one function on $\underset{\wedge}{Y}$-space. That is, $\underline{G}_{12}$ has an inverse $\underline{G}_{12}^{-1}$ whereby, for any $\underset{\wedge}{Y}$-state $\underline{Y}$, $\underline{G}_{12}^{-1}(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y})) = \underline{Y}$. (This holds even if, to avoid triviality, we impose the non-redundancy requirement that no function of $\underline{G}_2(\underset{\wedge}{Y})$ is identical with any function of $\underline{G}_1(\underset{\wedge}{Y})$.) Then $\Phi(\underline{Y},\underline{Z}) = \Phi(\underline{G}_{12}^{-1}(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y})),\underline{Z})$, from which (38)'s second line follows by taking $\underline{G}_2$ to be any $\underset{\wedge}{Y}$-complement of $\underline{G}_1$ and putting $\Psi_1'(\_,\_,\_) =_{def} \underline{G}_1(\Phi(\underline{G}_{12}^{-1}(\_,\_),\_))$. Moreover, with insertion into $\underline{G}_1(\Phi(\ ))$ for guidance, an omniscient mathematician could choose among $\underline{G}_1$'s alternative $\underset{\wedge}{Y}$-complements to more-or-less minimize the weight of $\underline{G}_2(\underline{Y})$ in $\Psi_1'(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y}),\underline{Z})$ relative to that of $\underline{G}_1(\underline{Y})$, albeit precisely what that means must remain obscure here beyond saying that the ideal is for $\underline{G}_2(\underset{\wedge}{\underline{Y}})$ to make no difference whatever therein. Almost certainly $\underline{G}_2$ can be chosen to give at least some components of $\underline{G}_2(\underset{\wedge}{\underline{Y}})$ null weight in $\Psi_1'(\underline{G}_1(\underline{Y}),\underline{G}_2(\underline{Y}),\underline{Z})$. So without loss of generality we can waive presumption that $\underline{G}_2$ is a complete $\underset{\wedge}{\underline{Y}}$-complement of $\underline{G}_1$ and stipulate instead only that it is some meager fragment of one sufficient for the reorganization shown, while Ψ_1' is correspondingly redefined to exclude input on $\underset{\wedge}{\underline{Y}}$-space axes that are irrelevant to $\underline{G}_1(\underline{\Phi}(\underline{Y},\underline{Z}))$ once the values of $\underline{G}_1$ and $\underline{G}_2$ for $\underline{Y}$ are given. Note also, however, that were our omniscient mathematical consultant to pick out the $\underline{G}_2$ that best helps us to understand $\tilde{\underline{Y}}_1$-dynamics in $\underline{C}$, he would consider the conceptual/computational simplicity of the resultant Ψ_1' to be more salient than the bare count of dimensions in $\underline{G}_2(\underset{\wedge}{\underline{Y}})$.

[[For simplicity, I have taken the condensation on $\underset{\wedge}{\underline{Z}}$ in (38) to comprise functions of $\underset{\wedge}{\underline{Z}}$ alone. However, for closer study of molar dynamics acknowledging styles of residuation favored by data-analytic practice, we would need to replace $\underline{G}_3(\underset{\wedge}{\underline{Z}})$ in (38) by a pair $\langle\underline{G}_3(\underset{\wedge}{\underline{Z}}),\underline{G}_4(\underset{\wedge}{\underline{Y}},\underset{\wedge}{\underline{Z}})\rangle$ of compound abstractors in which the second comprises residuals lifted jointly from the system's endogenous and exogenous micro-variables. You don't want to hear about such technicalities; and since they don't really matter here I'm happy to oblige you.]]

Equation (38) schematises a compound micro-molar process law that tells how the micro-state and micro-input of any $\underline{C}$-kind object $\underline{o}$ determines certain facets of the micro-state patterning in $\underline{o}$'s $\underline{f}$-successor. And to complete abstraction of a full-blooded molar dynamics for $\underset{\wedge}{\tilde{\underline{Y}}}_1$ in $\underline{C}$, we need only introduce molar variables

$$\underset{\wedge}{\tilde{\underline{Y}}}_2 =_{\text{def}} \underline{G}_2(\underset{\wedge}{\underline{Y}}) \ , \qquad \underset{\wedge}{\tilde{\underline{Z}}} =_{\text{def}} \underline{G}_3(\underset{\wedge}{\underline{Z}}) \ ,$$

as state-pattern/input-pattern supplements to $\underset{\wedge}{\tilde{\underline{Y}}}_1$ to obtain by Input Abstraction that

(39) $$\text{In } \underline{C},\quad \tilde{\underline{Y}}_1\underline{f} \;=\; \Psi_1(\tilde{\underline{Y}}_1,\tilde{\underline{Y}}_2,\tilde{\underline{Z}}) \ .$$

It should be clear that there are enormously many alternatives for $[\underset{\wedge}{\tilde{Y}}_2, \underset{\wedge}{\tilde{Z}}]$ in (39) given a fixed (37) and $\underset{\wedge}{\tilde{Y}}_1$. In practice, we choose these mainly to maximize the conceptual docility of molar system (39). Beyond that, our metatheoretical standards for optimal $[\underset{\wedge}{\tilde{Y}}_2, \underset{\wedge}{\tilde{Z}}]$ should also want the corresponding Ψ_1 in (39) to be, or at least well-approximate, a causal transducer for $\underset{\wedge}{\tilde{Y}}_1$-growth in some molar-causality structure inhabited by $\underset{\wedge}{\tilde{Y}}_1$-events. But that desideratum must perforce go unheeded until we learn more about the nature of molar causality.

The generic derivation of molar dynamics (39) from its micro-underlay (37) tells us nothing about (39)'s details in various specific instances; and of course those are precisely what determine comprehensibility in any particular case. But let us consider the alternatives for what <u>could</u> result, again for simplicity treating exogenous input $\underset{\wedge}{\tilde{Z}}$ in (39) as null or fully under our knowledgeable control. Most ideal, obviously, is for $\underset{\wedge}{\tilde{Y}}_2$ in (39) to be null, while $\underset{\wedge}{\tilde{Y}}_1$ is of small dimensionality on the order, say, of 10^2 or less with each component function in Ψ_1 computationally simple. However, though we can always choose $\underset{\wedge}{\tilde{Y}}_1$ to contain as few dimensions of micro-state patterning as we please, nothing in the logic of (37)'s supervenience upon (37) favors an easy Ψ_1 or negligible $\underset{\wedge}{\tilde{Y}}_2$. So what happens to (39)'s intelligibility if it comes up short on either of these ideals?

For one, even with $\underset{\wedge}{Z}$ null, a little complexity of Φ or $\underline{G}_1$ can easily make any one component transduction $\underline{\tilde{y}}_{1k}\underline{f} = \psi_{1k}(\underline{\tilde{Y}}_1)$ in (39) largely incomprehensible. To begin, observe that even when Φ in (37) is sparcely interconnected, that is, with each ϕ_k therein giving non-null weight to only a small fragment of its argument tuple, most components of $\underset{\wedge}{\tilde{Y}}_1$ are apt to have some effect in each $\psi_{1k}(\underline{\tilde{Y}}_1)$. (This is because any given $\underset{\wedge}{\tilde{y}}_{1j}$ in $\underset{\wedge}{\tilde{Y}}_1$ generally has non-null weight in $\psi_{1k}(\underline{\tilde{Y}}_1)$ if any micro-state dimension in $\tilde{y}_{1j}$'s effective abstraction base contributes to growth of any micro-variable in the effective abstraction base of $\underset{\wedge}{\tilde{y}}_{1k}$.) Yet only modest nonlinearity in functions of more than a few effective input components--and it takes a very special $\underline{G}_1$ to preserve linearity in Ψ_1 even if nature provides it in (37)--may well put such functions beyond human management.

> "Linearity" here is not just $\psi(\tilde{Y}_{11},\tilde{Y}_{12},\ldots) = a_0 + a_1\tilde{Y}_{11} + a_2\tilde{Y}_{12} + \ldots$ for some coefficient tuple $\langle a_0,a_1,a_2,\ldots\rangle$, though that is the paradigm case. Any binary operator having properties of a kind with those that give arithmetic addition its mathematical power generates variously weighted composites of input tuples that also count as "linear." But roughly speaking, for Ψ_1 to be linear in any concatenation operator $\oplus$, both Φ and G_1 must also be linear in $\oplus$.

For example, an rth-degree polynomial in m effective components is the parameter-weighted sum of $(r+m)!/r!m!$ different products of these components taken r or less at a time--which for $m = 50$ is 1,326 just for a quadratic ($r=2$) polynomial, 23,426 for a cubic ($r=3$), and 316,251 for a quartic ($r=4$). Repeated computations on this scale become a practical problem even for modern supercomputers--and low-degree polynomials are among the <u>easiest</u> nonlinear functions. (For contrast, imagine trying to compute your shirt's degree of Checkeredness under some completion of the definition sketched for this measure on p. 162f.) But worse is the <u>epistemic</u> intransigence of such functions: Even if you have large-sample data on $\tilde{Y}_{1k}f$ and $\tilde{Y}_1$, for example, how accurately would you expect to estimate the coefficients in $\tilde{Y}_{1k}f = \psi_{1k}(\tilde{Y}_1)$ if $\tilde{Y}_1$ contains 50 components in which ψ_{1k} is a 3rd or 4th degree polynomial? To be sure, theories of $\tilde{Y}_1$-phenomena can impose enough constraints on the parameters in your nonlinear ψ_{1k} to put these within reach of effective empirical estimation. But we must expect that to be rare, at least for theories of merit. And if some of Ψ_1's components aren't even polynomials or other compositions of classically simple functions, our task of effectively identifying these becomes nearly insurmountable.

To be sure, a component ψ_{1k} of Ψ_1 that is far beyond our means to specify <u>exactly</u> might nevertheless be decently approximated by one within our praxis. But the errors of such approximations are tantamount to (39)'s containing supplementary growth-sources $\tilde{Y}_2$ that are not all null--which is the other comprehension problem for (39).

It is quite beyond reason that we should ever encounter a form-(39) molar dynamics in which $\underset{\wedge}{\tilde{Y}}_2$ is strictly null, even though we have some faint statistical hope (wait for it) that this might be virtually so. But under the circumstances envisioned here in development of (39) from (37), supplementary $\underset{\wedge}{\tilde{Y}}_1$-growth sources $\underset{\wedge}{\tilde{Y}}_2$ are mainly residuals, i.e., factors whose identities are unknown or, more importantly, whose determinate values in particular instances can be ascertained only, if at all, by post-hoc inference from the very effects that these residuation events are invoked to explain. Present discussion stigmatizes $\underset{\wedge}{\tilde{Y}}_2$ as comprising just residuals because we have already stipulated that were some $\underset{\wedge}{\tilde{y}}_*$ to be a $\underset{\wedge}{\tilde{Y}}_2$-component that we are able to identify in one of the ways that give us $\underset{\wedge}{\tilde{Y}}_1$ and can thereafter make effectively explicit in our account of $\underset{\wedge}{\tilde{Y}}_1$-dynamics, $\underset{\wedge}{\tilde{y}}_*$ would already have been included in the $\underset{\wedge}{\tilde{Y}}_1$-array. In real life, of course, study of dynamics for a fixed $\underset{\wedge}{\tilde{Y}}_1$ might well disclose certain additional system-based $\underset{\wedge}{\tilde{Y}}_1$-growth sources with which $\underset{\wedge}{\tilde{Y}}_1$ can then be augmented. But on pain of exceeding our comprehension limits, such cycles of $\underset{\wedge}{\tilde{Y}}_1$-expansion cannot continue indefinitely.

When $\underset{\wedge}{\tilde{Y}}_2$ is epistemically a residual for us in (39), however, it follows that even if we have a computational praxis for each component function in Ψ_1, we cannot infer $\underset{\wedge}{\tilde{Y}}_1\underline{f}(\underline{o})$ from $\underset{\wedge}{\tilde{Y}}_1(\underline{o})$ and $\underset{\wedge}{\tilde{Z}}(\underline{o})$ under Ψ_1 but can only derive a credibility distribution for $\underset{\wedge}{\tilde{Y}}_1\underline{f}(\underline{o})$ corresponding to the various credence-weighted possibilities for how the blank in $\Psi_1(\underset{\wedge}{\tilde{Y}}_1(\underline{o}),\_\_,\underset{\wedge}{\tilde{Z}}(\underline{o}))$ might be filled by $\underline{o}$'s $\underset{\wedge}{\tilde{Y}}_2$-standing. Under suppositions of the sort by which statisticians wring residuals out of molar data patterns in statistical samples (see p. 95a ff., above), we can try to persuade ourselves that $\underset{\wedge}{\tilde{Y}}_2(\underline{o})$ should differ only negligibly from some constant or, more generally, from $\underline{o}$'s value on some well-behaved function θ of $[\underset{\wedge}{\tilde{Y}}_1,\underset{\wedge}{\tilde{Z}}]$ specified by a small number of identifiable parameters. From there, we could conclude that $\Psi_1(\underline{\tilde{Y}}_1,\underline{\tilde{Y}}_2,\underline{\tilde{Z}})$ is well-approximated by $\Psi_1''(\underline{\tilde{Y}}_1,\underline{\tilde{Z}}) =_{def} \Psi_1(\underline{\tilde{Y}}_1,\theta(\underline{\tilde{Y}}_1,\underline{\tilde{Z}}),\underline{\tilde{Z}})$--which is in effect a case of (39) wherein $\underset{\wedge}{\tilde{Y}}_2$ is null. Unhappily for molar tidiness in real macro-things, however, (39)'s supplementary sources $\underset{\wedge}{\tilde{Y}}_2$ are not at all random in any ontological sense, but have a dynamics of their own in $\underline{C}$ entailed by (37) and abstractor array $\underline{G}_2$. And it seems implausible that $\tilde{\underline{Y}}_2\underline{f} = \underline{G}_2(\Phi(\tilde{\underline{Y}},\tilde{\underline{Z}}))$ would often let any function of $[\underset{\wedge}{\tilde{Y}}_1,\underset{\wedge}{\tilde{Z}}]$ well-approximate $\underset{\wedge}{\tilde{Y}}_2$ in $\underline{C}$, even though, to be sure, it is certainly possible that the complexity of this system induces $\underset{\wedge}{\tilde{Y}}_2$ to behave as statisticians find comely in residuals. (To my knowledge, we have no systems theory as yet on conditions that might promote this happy outcome.) We must expect, then, that we will seldom have reason to concentrate our guesses at residual $\underset{\wedge}{\tilde{Y}}_2(\underline{o})$ for any $\underline{C}$-object $\underline{o}$ in a small sector of $\tilde{Y}_2$'s range; whence if the weight of $\underset{\wedge}{\tilde{Y}}_2$ in $\underset{\wedge}{\tilde{Y}}_1\underline{f}(\underline{o}) = \Psi_1(\underset{\wedge}{\tilde{Y}}_1(\underline{o}),\underset{\wedge}{\tilde{Y}}_2(\underline{o}),\underset{\wedge}{\tilde{Z}}(\underline{o}))$ is as large as we must fear prevails in molar systems, the reduction in our uncertainty about $\underset{\wedge}{\tilde{Y}}_1\underline{f}^r(\underline{o})$ ($\underline{r} = 1,2,\ldots$) afforded even by an effectively computable (39) from knowledge of $\underset{\wedge}{\tilde{Y}}_1(\underline{o})$ and our control of $\underset{\wedge}{\tilde{Z}}\underline{f}^{r-1}(\underline{o})$ ($\underline{r} = 1,2,\ldots$) becomes negligible beyond a trajectory length $\underline{r}$ so brief as scarcely to matter for our dealings with $\underline{C}$-things.

Yet not all is lost for manageable $\underset{\wedge}{\tilde{Y}}_1$-dynamics when $\underset{\wedge}{\tilde{Y}}_2$'s role in (39) is appreciable. There may well be certain values $\tilde{\underline{Y}}_{2c}$ of $\underset{\wedge}{\tilde{Y}}_2$ such that if $\underline{C}_{\tilde{Y}_{2c}}$ is the largest subdomain of $\underline{C}$ such that $\underset{\wedge}{\tilde{Y}}_2$ is quasi-constant at $\tilde{\underline{Y}}_{2c}$ in the domain-constriction of (39) to $\underline{C}_{\tilde{Y}_{2c}}$ (see p. 82a, above), not merely is this domain-constricted molar dynamics intelligible but its domain-stability lets trajectories on $\underset{\wedge}{\tilde{Y}}_1$ often continue in $\underline{C}_{\tilde{Y}_{2c}}$ long enough to allow diagnosis that the special $\underset{\wedge}{\tilde{Y}}_1$-dynamics instated by $\underset{\wedge}{\tilde{Y}}_2(\_) = \tilde{\underline{Y}}_{2c}$ are locally in force. We can best leave this point's clarification and SLese significance to the more specific example taken up next. But the general idea, that specially patterned micro-conditions can set up orderly molar processes that fall apart when their ephemeral supports decay, has already been nicely illustrated by our Law of Shadows, p. 45ff.

If mental attributes are indeed grossly holistic abstractions from the micro-states of neural complexes, as I have urged with scant originality, present reflections on (37/39) forbode meager returns from the scientific study of mind--at least if domain-stable process laws are what we seek. The success of folk psychology in conducting human affairs is evidence enough that cognitive variables enjoy some appreciable degree of causal regularity.[35] But we have little assurance that this

[35]Contrary to modern philosophy-of-mind mythology (see, e.g., Churchland, 198 , p.), folk psychology gives us virtually nothing worth honoring as a lay theory of mental functioning. Rather, it equips us with an extraordinarily rich repertoire of introspectably applicable concepts adjoined by well-trained intuitions for their usage on particular occasions. A theory of sorts--with enormous residuals and of dubious coherence--undoubtedly lurks somewhere within these usage propensities. But folk-psychology suggests no *laws of thought/action whose *ceteris paribus* disclaimers don't largely trivialize them; and if you are honest with yourself you must confess that you can't verbalize any decent conjectures about mental regularity either. Even so, your commonsense expectations about other people, based on your intuitions about what you would think/do were you to be in what you surmise is the other guy's (partial) state of mind, generally come off reasonably well.

can be refined by sufficient effort and SLese sophistication into recursive/dynamic mental systems having much more predictability than commonsense mentalistic intuitions already enjoy. Arguably, most mental regularities now in our ken manage to give cognitive abstractions significant purchase only by presuming **strong** domain restrictions scarcely less fleeting than those under which demonstrations of lighting principles find applications for molar descriptors like 'shadow length' and 'light-source position'.

The challenge of physical picturing principles: Two heuristics.

Bemoaning the scientific recalcitrance of molar-pattern dynamics in the abstract conveys little sense of this problem's SLese reality. That can best be acquired through efforts to formulate molar regularities with appreciable domain-stability for particular physical systems whose micro-mechanisms are well understood. Although Chapter 2's Law of Shadows is a clear case in point, its extreme simplicity lacks evident parallel to molar psychology. Much closer in that respect, or apparently so, are certain commonsense picture phenomena that seem entirely open to our understanding, yet are instructively elusive to subsumption under domain-stable molar laws. Although these may at first seem digressive, I shall try to convince you that cognitive psychology has much to learn from them.

Heuristic 1a. Figure/ground patterning in cartoon processes.

Within recent years, computer-animated graphics have become an increasingly popular instrument of education and entertainment. Let us call a sequence of display-screen images so produced a cartoon process, with the understanding that this is to be a discrete (i.e. integer-indexable) series of displays, each a synchronic configuration of colors/brightnesses over a bounded two-dimensional surface, such that (a) each display in the sequence seems largely identifiable by commonsense descriptions of shapes, colors, sizes, positions, etc., and (b) progression from one display to the next is controlled by a well-behaved underlying system dynamics which may or may not include running input disturbances controlled by a human operator. Examples might be the progression of pictures in a video game, or rotation of an industrial drawing through a series of perspectives and scale adjustments, or the view during a flight simulation, or a line figure evolving through a programmed iteration of transformations. For specificity, let us further declare the display screen to be an n_1-by-n_2 matrix of evenly spaced pixel elements $\{p_{jk}: j = 1,\ldots,n_1;\ k = 1,\ldots,n_2\}$, each of which at each stage t of the process emits light at an independently adjustable intensity on each of three fixed wavebands. The spatial relations among pixels $\{p_{jk}\}$, which are an important part of the micro-system's assembly structure, are also stipulated to remain invariant across stages of our display process. Now: To what extent under what boundary conditions can we actually put into words the dynamics of molar cartoon processes? If we prove unable to formulate well-SLesed molar regularities even under such ideally controlled and epistemically transparent circumstances, confidence that we know how to get on with a science of mind can only be dismissed as a fatuous fantasy. Alternatively, we may find that working through the far-from-trivial details of these comparatively simple processes--which are about as tidy as real-world pattern phenomena ever get--will educate us in the general SLese discipline and special pattern-theoretic understandings we need to make real progress in molar psychology. I am still hopeful for the latter.

To begin, observe that any one cartoon process should be straightforwardly subsumable under system-dynamics schema (37)-(39), though we shall also want briefly to partition the micro-system totality of state dimensions as $\underset{\wedge}{Y} = [\underset{\wedge}{Y}_1, \underset{\wedge}{Y}_2]$, with $\underset{\wedge}{Y}_1$ comprising just the components of $\underset{\wedge}{Y}$ that are in $\underset{\wedge}{\tilde{Y}}_1$'s effective abstraction base. Each member of domain $\underline{C}$ in this application is a compound device-stage $\underline{o}$ = $\underline{s}$-at-$\underline{t}$ of a specially prepared kind $\underline{C}$ whose parts include pixel-stages $\{\underline{o}_{jk} = \underline{p}_{jk}$-at-$\underline{t}\}$ together with stages of assorted microchips, wiring connectors, etc., which we need not itemize. The subarray $\underset{\wedge}{Y}_1$ of $\underset{\wedge}{Y}$ in (37) whose states constitute the actual displays in a cartoon process is $\underset{\wedge}{Y}_1 = [\underset{\wedge}{y}^*_h \mu_{jk}$: $\underline{h} = 1,2,3$; $\underline{j} = 1,\ldots,\underline{n}_1$; $\underline{k} = 1,\ldots,\underline{n}_2]$, where $\underset{\wedge}{y}^*_h$: Luminance-at-the-hth waveband is a local variable over pixel-stages, and module selector μ_{jk} maps each $\underline{C}$-kind device-stage $\underline{s}$-at-$\underline{t}$ into its $\underline{jk}$th pixel at $\underline{t}$. The remainder, $\underset{\wedge}{Y}_2$, of $\underset{\wedge}{Y} = [\underset{\wedge}{Y}_1, \underset{\wedge}{Y}_2]$ comprises whatever variables are needed to complement $\underset{\wedge}{Y}_1$ into dimensionalization of the micro-system's total state-space, especially transmission thresholds at various junction gates in the system's micro-circuitry. $\underset{\wedge}{Z}$ dimensionalizes input from the system's user, together with residuals that in this case should be negligible. And the total micro-state $\underset{\wedge}{Y}(\underline{o})$ (= $\langle \underset{\wedge}{Y}_1(\underline{o}), \underset{\wedge}{Y}_2(\underline{o})\rangle$) of each $\underline{C}$-kind device-stage $\underline{o}$ = $\underline{s}$-at-$\underline{t}$ conjoined with $\underline{s}$'s input $\underset{\wedge}{Z}(\underline{o})$ at $\underline{t}$ is carried into the micro-state $\underset{\wedge}{Y}\underline{f}(\underline{o})$ of $\underline{o}$'s immediate successor $\underline{f}(\underline{o})$ = $\underline{s}$-at-$\underline{t}$+1 by some transducer Φ that has been engineered to impart certain desired molar behaviors to kind-$\underline{C}$ systems even though we would find it insufferably tedious to write down all the specifics of compound equation $\underline{Yf} = \Phi(\underline{Y},\underline{Z})$.

[Note 1. For many choices of excursion step $\underline{f}$'s temporal span, pixel-state dimensions $\underset{\wedge}{Y}_1$ may seem to qualify only as outputs to which Φ gives null weight in the system dynamics. That is, one may question whether the state of $\underline{p}_{jk}$ at $\underline{t}$ is strictly a causal contributor to $\underline{p}_{jk}$'s state at $\underline{t}$+1. (For example, the distinctive luminance of each pixel may usually persist as a decay function of its last excitation from its off-screen control, but be overridden every few micro-moments by another control pulse. What we want to say about the auto-regressive causal-force of one pixel stage for its successors one or more control-pulses later is problematic.) But in any case, $\hat{Y}_1$ correlates so highly in $\underline{C}$ with certain micro-state dimensions Y_1^* which are unquestionably sources of $\hat{Y}_1\underline{f}$ (e.g., $\hat{Y}_1^*$ might be central-processing variables that set control pulses for the pixel array) that for study of the system's behavior it is most convenient to treat $\hat{Y}_1$ as a surrogate for $\hat{Y}_1^*$.

[Note 2. As envisioned here, the micro-state of $\underline{C}$-kind system $\underline{s}$ at discrete time (stage) $\underline{t}$ is itself a molar abstraction from even finer levels of molecularity. For example, pixel $\underline{p}_{jk}$-at-$\underline{t}$ occupies a spatial region, each smaller part of which has its own spectrum of light emissions. And if the temporal displacement (excursion step) between $\underline{s}$-at-$\underline{t}$ and $\underline{s}$-at-$\underline{t}$+1 is taken large enough to allow each pixel component of $\underline{s}$ to receive a new control pulse between $\underline{t}$ and $\underline{t}$+1, transducer Φ derives by Mediated Composition from a c-series (cf. p. 69) of serial-processing steps explicitly designed by the system's engineering. But just how the value of each component of $[\underline{Y},\underline{Z}]$ for $\underline{s}$-at-$\underline{t}$ supervenes on the micro-micro-state/input of $\underline{s}$-circa-$\underline{t}$ has no relevance here.]

As we all know, a main reason why a cartoon process runs off one way rather than another is the programming which has been put into the system's memory store prior to activating the display sequence. Programmed memory can be viewed either as the state of a subtuple of system variables that are responsive just to a special subtuple of input dimensions which remain constant throughout each run, or as domain preconditions that differentiate cartoon generators of one specific kind $\underline{C}$ from another. We adopt the latter treatment for now, which is to say that when interpreting (37) in the fashion just sketched as the micro-law of cartoon animation for device-stages of kind $\underline{C}$, we envision that (37) derives by Strong Domain Constriction (cf. p. 82) from a broader cartoon-generation law

(40) $$\text{In } \underline{C}^*, \quad \underline{Y}\underline{f} = \Phi^*(\underline{Y},\underline{Z},\underline{W})$$

for which ($\underline{a}$) $\underline{C}$ is a subdomain of $\underline{C}^*$ defined by a particular fixed state $\underline{W}_c$ on certain additional variables $\underset{\wedge}{W}$ that specify programming and mode of operation, i.e. $\Phi(\_\_\_)$ $=_{def}$ $\Phi^*(\_\_\_,\underline{W}_c)$, and ($\underline{b}$) for all $\underline{o}$ in $\underline{C}^*$ and all excursive successors $\underline{f}^r(\underline{o})$ ($\underline{r} = 1,2,\ldots$) of $\underline{o}$, event $\ulcorner \underset{\wedge}{W};\underline{f}^r(\underline{o})\urcorner$ is causally independent of event $\ulcorner[\underset{\wedge}{Y}_1,\underset{\wedge}{Y}_2,\underset{\wedge}{Z}];\underline{o}\urcorner$.[36] Condition ($\underline{b}$)

[36]Formalism (40) does not strictly capture the design of modern programmable computers, at least not if each component of $[\underset{\wedge}{Y}_2,\underset{\wedge}{Z},\underset{\wedge}{W}]$ is taken to describe condition alternatives at one particular location in the micro-circuitry. For extant computers don't reserve a fixed subset of registers exclusively for program storage. A more technically accurate version of (40) would envision a total array $\underset{\wedge}{Y}_2^*$ of micro-state variables additional to display array $\underset{\wedge}{Y}_1$, and say that a "program," roughly speaking, is a particular setting $\underline{W}$ on some subtuple $\underset{\wedge}{W}_h$ of $\underset{\wedge}{Y}_2^*$ such that if $\underset{\wedge}{W}_h(\underline{o}) = \underline{W}$ for any $\underline{o}$ in $\underline{C}^*$, $\underset{\wedge}{W}_h\underline{f}(\underline{o}) \neq \underline{W}$ only if a special reprogramming input is received by $\underline{o}$. But once $\underset{\wedge}{W}_h\underline{f}(\underline{o})$ is made to differ from $\underline{W}$, $\underset{\wedge}{W}_h\underline{f}^2(\underline{o})$ can be affected by components of $\underset{\wedge}{Y}_2^*\underline{f}(\underline{o})$ additional to $\underset{\wedge}{W}_h\underline{f}(\underline{o})$ while some other setting $\underline{W}'$ on some (generally) other subtuple $\underset{\wedge}{W}_{h'}$ of $\underset{\wedge}{Y}_2^*$ takes over the role of $\underline{f}(\underline{o})$'s "program." Complicating formalism (40) to acknowledge this technicality would for present purposes be utterly pointless.

allows us to presume--as true of computers in fact--that if device-stage $\underline{o} = \underline{s}$-at-$\underline{t}$ is of specific cartoon-generator kind $\underline{C}$, the programming $\underset{\wedge}{W}\underline{f}(\underline{o})$ in $\underline{o}$'s immediate successor seldom differs from $\underset{\wedge}{W}(\underline{o})$ and hence that $\underline{f}(\underline{o}) = \underline{s}$-at-$\underline{t}$+1 is almost always also of kind $\underline{C}$. That is, in its fixed-program-cartoon-generation interpretation, micro-dynamics (37) has high domain-stability: Its recursive application to the successors $\{\underline{f}^r(\underline{o})\}$ of any particular $\underline{o}$ in $\underline{C}$ can usually be continued through a long sequence of stages before reaching an $\underline{f}^r(\underline{o})$ that has been shifted by program changes, power loss, or other exogenous disturbances either into some subdomain of $\underline{C}^*$ other than $\underline{C}$ or outside of $\underline{C}^*$ altogether.

Now that we have made so good a start on detailing how the micro-behavior of real-world cartoon generators can be effectively described by SLese formalisms, our most natural next step might seem to be articulating the t-derivational character of central-processing variables $\underset{\wedge}{Y}_2$ and input controls $[\underset{\wedge}{Z},\underset{\wedge}{W}]$ to at least the level here sketched for pixel array $\underset{\wedge}{Y}_1$, followed by some specifics of the assembly/micro-causal structure from which (40) is put together. Indeed, you will find that instructive to try on your own, either by exploiting your technical knowledge of computer hardware to spell out what the architecture of a typical cartoon generator is really like, or, lacking such expertise, speculating what these details might be. But present concern is only for what may be sayable about the dynamics of a cartoon process in everyday molar terms, without attention to the behavior of individual pixels much less to that of their controlling micro-circuitry.

More specifically, our main task in Heuristic 1a is simply to conceive of an assortment of molar display variables, a-derived from the ensemble $\underset{\wedge}{Y}_1$ of pixel micro-state dimensions, whose respective values for any device-stage o demark pattern abstractions from $\underset{\wedge}{Y}_1(o)$ of the sorts picked out by commonsense visual perception.

Note that although each value Y_1 of micro-variable array $\underset{\wedge}{Y}_1 = [\ldots,\underset{\wedge}{y}^*_1\mu_{jk},\ldots]$ is only a $(3,n_1,n_2)$-tuple of numbers, the complete property Having-value-Y_1-of-$\underset{\wedge}{Y}_1$ on domain C^* encorporates not just pixel luminosities but also their spatial distribution by virtue of the fixed pixel geometry built into the translocation functions $\{\mu_{jk}\}$ that pick particulzr pixel-stages out of particular C^*-objects. For this reason, any holistic feature we perceive in the display of any o in C^* should abstract from o's having value $\underset{\wedge}{Y}_1(o)$ of $\underset{\wedge}{Y}_1$. Were pixels in C^*-things to dart around like fireflies, however, with the module selectors constituting $\underset{\wedge}{Y}_1$ perforce redefined to pick them out through some other part/whole relational constancy in C^*, we could still get perceptible molar patterning out of $\underset{\wedge}{Y}_1$ if this is expanded to include, along with the local (t-core) luminosity dimensions $\underset{\wedge}{y}^*_1,\underset{\wedge}{y}^*_2,\underset{\wedge}{y}^*_3$, a fourth local variable $\underset{\wedge}{y}^*_4$ whose value for each pixel-stage is the spatial position thereof. (This momentary micro-structure can also be captured in other ways

Heuristic 1b will then consider, for one or two small subtuples $\underset{\wedge}{\tilde{Y}}_1$ of such display-pattern variables, what it would be like for some C-kind cartoon process on whose display Y_1 supervenes to have a form-(39) dynamics in which $\underset{\wedge}{\tilde{Y}}_1 f$ is decently predictable from $\underset{\wedge}{\tilde{Y}}_1$. But the first part is hardest.

If we think just of cartoon processes such as exhibited by the early video games, it might seem that the Gestalt thesis, that perception always sees figures upon a ground, points to the optimal format for describing molar patterning. And this may indeed prove to be the best we can do. But let us examine with some care how this works out. Begin by envisioning a pixel display that is a homogeneous color field, say grey, except for one distinctively colored figure, say a solid red circle. (Ignore that a discrete pixel array cannot display perfect circles.) How might we predicate such a configuration of cartoon-generator stage s-at-t and treat this as one in a range of disjoint alternatives comprising the values of a molar pattern variable on which s changes from stage to stage in orderly fashion? The easy first approximation is

(41) $P_1(\_\_, x_1, x_2)$: ___'s display screen contains a solid red circle, 3 cm. in diameter, whose center is positioned x_1 cm. above and x_2 cm. to the right of the display screen's center,

wherein 'x_1' and 'x_2' are placeholders for names of numbers on the real continuum. So long as cartoon-generator stages of kind C display just one figure of the right sort, specifically a 3 cm. solid red circle on a uniform contrasting background, (41) defines a two-component numerically scaled Figure-position variable whose domain includes C--i.e., for each c in C there is exactly one number pair $\langle x_1, x_2 \rangle$ such that $P_1(c, x_1, x_2)$. Moreover, if C-kind programming is of early video-game vintage, this variable's series of values for the successors of any given c in C will manifest a simple dynamics that we see as predictable movement.

But now introduce a modest increment in display complexity: Suppose that our C-kind game-like programming allows simultaneous display of several colored figures, each of which may undergo process changes not only in screen position but also in size, color, and perhaps even shape. Background color, too, might vary. Now how do we characterize the perceptually salient features of C-kind displays as the values of variables undergoing orderly change?

Even before inserting more than one figure into C-kind displays, allowing the figure to vary in size, color, or shape destroys (41)'s identification of a variable over C, insomuch as for many o in C there will be no numbers $\langle x_1, x_2 \rangle$ such that $P_1(o, x_1, x_2)$. We can, of course, augment the class of predicates schematized by (41) with the anomalous alternative, '___ does not contain a 3 cm. solid red circle'; but you can easily see that attempting to write molar dynamics in C for this anomaly-expanded variable would be an exercise in futility. Alternatively (though at bottom this is almost the same as admitting the anomaly), were we to write dynamics just for the subclass C' of C-kind device stages whose screens do contain a 3 cm. solid red circle, restricted domain C' will be so unstable--i.e., when sizes, or colors, or shapes generally vary during C-kind cartoon processes, seldom will o and f(o) both be in C'--that dynamics in C', too, would be worthless.

The most natural modification of (41) to accomodate variation in size/color/shape is a predicate schema something like

(42) $P_2(\_\_, w, x, y, z)$: ___'s display contains a figure of shape w, color x, size y, and position z,

wherein 'w', 'x', 'y', and 'z' are placeholders for adjustable descriptions of the indicated sorts whose specifics we ignore here even though detailing their alternatives is technically rather demanding. However, with C-objects allowed to exhibit multiple display figures, (42) no longer schematizes a variable over C. For now $P_2(\_\_, w, x, y, z)$ can be simultaneously true of o for a great many specific choices of $\langle w, x, y, z \rangle$. Thus, o might contain a 3 cm. solid red circle in its 1st (upper-right) screen quadrant and a 2 cm. solid green star in its 3rd quadrant, both surrounded by a large hollow black square, etc. etc. In fact, whenever $\underline{o}$'s screen contains a 3 cm. solid red circle, it also contains many smaller solid red circles, squares, stars, etc. nested inside the first. To be sure, we can banish the latter by legislating that to count as a "figure," a display region must be set off by appreciable color contrast across all its boundary points; but that, as we shall soon note, is draconian.

Defining molar display variables in terms of figures that are not by fiat singletons apparently requires us to use some variant of format

(43) $\underline{P}_\alpha(\_\_,\underline{x}_{\alpha 1},\underline{x}_{\alpha 2},\ldots)$: The α-thing $\left\{\begin{matrix}\text{in \_\_'s display} \\ \text{displayed by \_\_}\end{matrix}\right\}$ has features $\underline{x}_{\alpha 1},\underline{x}_{\alpha 2},\ldots$,

wherein ($\underline{a}$) each '$\underline{x}_{\alpha j}$' is placeholder for reference to exactly one alternative on some feature dimension $\underline{x}_{\alpha j}$, and ($\underline{b}$) 'The α-thing displayed by $\underline{o}$' is a descriptor that, for most cartoon-generator stages $\underline{o}$ of kind $\underline{C}$, picks out exactly one figure in $\underline{o}$'s display which, moreover, is in the domain of all feature dimensions $\underline{x}_{\alpha 1}$, $\underline{x}_{\alpha 2},\ldots$. Examples might be

(43.1) The square displayed by __ has side length $\underline{x}_1$, color $\underline{x}_2$, and position $\langle\underline{x}_3,\underline{x}_4\rangle$.

(43.2) The blue figure displayed in __'s 3rd quadrant has shape $\underline{y}_1$ and size $\underline{y}_2$.

(43.3) The 2nd-largest hollow triangle displayed by __ has size features $\langle\underline{x}_1,\underline{x}_2,\underline{x}_3\rangle$ [specified in terms of side lengths and angles], and position $\langle\underline{z}_4,\underline{z}_5,\underline{z}_6\rangle$ [specified by the figure's screen coordinates and angle of rotation].

(43.4) The dashed line displayed by __ has dash length $\underline{w}_1$, gap width $\underline{w}_2$, end points $\langle\underline{w}_3,\underline{w}_4\rangle$ and $\langle\underline{w}_5,\underline{w}_6\rangle$, and curvature parameters $\langle\underline{w}_7,\ldots\rangle$.

It is relatively straightforward, even if not often easy, to specify the alternatives ranged by each feature placeholder in (43) as exhaustively disjoint over α-things--which is to say that if $\underline{C}_\alpha$ comprises just those $\underline{o}$ in $\underline{C}$ such that $\underline{o}$ displays exactly one α-thing, we can define an $\underline{m}$-dimensional compound variable $\underset{\wedge}{X}_\alpha = [\underset{\wedge}{x}_{\alpha 1},\ldots,\underset{\wedge}{x}_{\alpha m}]$ over $\underline{C}_\alpha$ by

(44) The value of $\underset{\wedge}{X}_\alpha$ for __ is $\langle\underline{x}_{\alpha 1},\ldots,\underline{x}_{\alpha m}\rangle =_{def} \underline{P}_\alpha(\_\_,\underline{x}_{\alpha 1},\ldots,\underline{x}_{\alpha m})$.

(Similarly, we can define compound relational variables $\underset{\wedge}{X}_{\alpha\beta}$, $\underset{\wedge}{X}_{\alpha\beta\gamma}$, etc., each component of which is a dimension of relationship between the α-thing and β-thing, or among the α-thing, β-thing, and γ-thing, etc.) From there, augmenting the range of $\underset{\wedge}{X}_{\alpha}$ defined by (44) with the anomalous value predicated by '___ contains either more than one α-thing or none at all' makes $\underset{\wedge}{X}_{\alpha}$ a variable over all of domain $\underline{C}$. But only $\underline{C}$'s subset $\underline{C}_{\alpha}$ is in $\underset{\wedge}{X}_{\alpha}$'s regular domain--which is to say that the domain of any effective molar dynamics for kind-$\underline{C}$ cartoon processes whose state variables include one or more arrays $\langle X_{\alpha}, X_{\beta}, \ldots \rangle$ defined in fashion (44) is not $\underline{C}$ but at most the intersection of $\langle \underline{C}_{\alpha}, \underline{C}_{\beta}, \ldots \rangle$.[37] Even when $\underline{C}$ itself has high domain-stability,

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[37] Technically, this is not altogether true. For to some extent, dynamics that allow their variables to pass through anomalous values can be contrived by tricks of the sort overviewed on p. 113ff. But as also discussed there, how effectively that can be brought off in practice depends greatly on the particularities of the application at issue.

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that of $\underline{C}_{\alpha} \cap \underline{C}_{\beta} \cap \ldots$ may well be ephemeral.

Let us call any compound variable defined as $\underset{\wedge}{X}_{\alpha}$ in (44) a <u>thing-specifier</u> whose <u>(thing)-delimiter</u> is description-schema 'the α-thing displayed by ___'. How effectively we can write dynamics for a tuple of thing-specifiers over $\underline{C}$ depends greatly on how cleverly their delimiters have been chosen in light of the $\underline{C}$-kind micro-regularities. The complications that arise here can best be appreciated from an example or two:

<u>Item</u>. Suppose that $\underline{C}$-kind cartoon processes are progressions of molar changes that commonsensically appear as two solid red figures, a square and a circle, moving on a grey background in orderly trajectories that occasionally intersect. We would like to treat these pattern changes as the dynamics of two thing-specifiers, $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$, such that the α-thing is the solid red square, the β-thing is the solid red circle, and the values of X_{α} and X_{β} give sizes and display coordinates for the square and circle, respectively. <u>But what do delimiters</u> 'the solid red square displayed by $\underline{o}$' <u>and</u> 'the solid red circle ...'

designate when the two figures run together, assuming that the area of overlap retains the color common to their noncoincident parts? If we allow 'the solid red square ...' and 'the solid red circle ...' to pick out only display regions that are set off by sharp color contrasts at all their boundary points, these delimiters lose reference--i.e., the values of X_{α} and X_{β} become anomalous--whenever the display passes into what we see as an intersection configuration. Yet relaxing the distinct-boundary requirement on display figures reactivates the problem that the solid red square (and similarly for other figures) displayed by *o* has many smaller solid red squares nested within it, some having visible boundary fragments coincident with part of the enveloping square's boundary, while the boundaries of others are wholly indistinct--whence 'the solid red square ...' again fails at unique reference.

Item. When 'the α-thing displayed by *o*' referentially misfires because *o*'s display shows more than one α-thing (to keep intuitions clear, say ones whose boundaries are all distinct), we need to add a clause to the delimiter that picks out just one of the α-things displayed by *o*. (More precisely, we want a tuple of delimiters differently elaborated to individuate all of the α-things displayed by *o*.) Examples of such enrichment when 'α-thing' is 'red square' might be 'the 3 cm. red square ...', or 'the red square in quadrant 2 ...', or 'the largest red square ...'. But unless the α-thing displayed by *o* and its close successors are constant with respect to this enrichment clause's applicability, the delimiters so expanded are still likely to have intermittent or discontinuous reference that defeats their effective participation in domain-stable molar dynamics. The three enrichment examples just given suffice to make the point: Suppose that the cartoon process at issue appears to us to include several red squares undergoing Keplerian motions in separate orbits around the screen's center, while these squares also cycle through expansions/contractions of size. It is evident why delimiters 'the 3 cm. red square ...' and 'the red square in quadrant 2 ...' cannot yield domain-stable dynamics in this case. But the third's debility is more subtle. Ignoring the occasional configuration wherein two or more red squares are tied for largest, 'the largest red square ...' picks out exactly one figure in each display of the process. But that does not always preserve continuity of motion, insomuch as when square size is increasing in one orbit while decreasing in another, largest-ness may suddenly jump from one to the other. Similarly, even if 'the red square in quadrant 2 of ___'s display' manages to designate exactly one figure in each stage of succession o, $f(o)$, $f^2(o)$,...,$f^r(o)$, it may well fail to select a red-square sequence within which the evolution of position and size is orderly.

The upshot of considerations such as these is that excepting only the simplest of cartoon processes, dynamics for a thing-specifier $\underset{\wedge}{X}_{\alpha}$ whose delimiter's referent for process stage o is identified just by the display configuration $\underset{\wedge}{Y}_1(o)$ at a single stage o = s-at-t of cartoon generator s are unlikely to have appreciable domain-stability. But here is where commonsense notions of thing-identity through time become important. What we really need are delimiters that abstract their referents from *series* of display-process stages in a fashion roughly illustrated by recursive definition schema

(45*a*) The *John-thing displayed by s-at-stage-t_0 $=_{def}$ the α-thing displayed by s-at-t_0 with distinguishing features Q,

(45*b*) The *John-thing displayed by s-at-stage-t+1 ($t \geq t_0$) $=_{def}$ the α-thing displayed by s-at-t+1 that most lawfully continues the *John-thing displayed by s-at-t,

(45*c*) The *John-thing displayed by s-at-stage-t-1 ($t \leq t_0$) $=_{def}$ the α-thing displayed at s-at-t-1 of which the *John-thing displayed by s-at-t is the most lawful continuation,

(45*d*) *John $=_{def}$ the totality (mereological sum) of all *John-things displayed by some stage of s.

"Most lawful continuation" is to be explicated in terms of whatever molar regularities can be developed for cartoon generators of the kind to which (45) is applied.

Usually, this should be interchangeable with some reading of "closest resemblance."

It is far from clear how often descriptor-schema (45) can in fact be fleshed out to designate, when successful, something that is literally an abstractive aspect of $\underline{s}$'s display sequence rather than a theoretical entity whose properties conjecturably underlie $\underline{s}$'s displays without being constituted from them (cf. p. 194 below). But if (45) can be made to work as intended, it enables delimiter 'the *John-thing displayed by ___' (and similarly for 'the *Mary-thing', 'the *Fido-thing', etc.) to ground definition of a thing-specifier $\underset{\wedge}{X}_{*John}$ in the fashion shown by substituting '*John' for 'α' in (43/44)--except that now the values of some or all components of $\underset{\wedge}{X}_{*John}$ for $\underline{s}$-at-$\underline{t}$ can abstract from $\underline{s}$'s display configuration not just at $\underline{t}$ but from thicker subsequences of display precession $\{\underset{\wedge}{Y}_1(\underline{s}\text{-at-}\underline{t}\text{-}\underline{r}): \underline{r} = 0,1,2,\ldots\}$, as required e.g. to define velocity and acceleration for *John at $\underline{t}$.[38] In particular, this may allow us to make sense out of such otherwise mystefying claims as that at certain times in the display process *John's size decreases to zero, or that *John's color becomes the same as the background even while *John continues when so invisible to have a determinate position that changes in accord with the same regularity that fits *John's more conspicuous motions. Similarly, we can now try to distinguish between "apparent" and "real" color in order to say, e.g., that the particular cartoon process from which $\underset{\wedge}{X}_{*John}$ abstracts gives *John the same real color at all stages, say solid yellow, even though *John's apparent color at $\underline{t}$ is partly green by virtue of *John's passing behind an opaque green *Mary. (Note the fascinating complexities of relational patterning looming here, all of which would demand great care and

[38] To keep this thickened conception of molar patterning from violating our ground rule that $\tilde{\underset{\wedge}{Y}}_1(\underline{o})$ is to abstract from $\underset{\wedge}{Y}_1(\underline{o})$, we can expand our original definition $\underset{\wedge}{Y}_1 = [\underset{\wedge}{y}^{*}_{h}\mu_{jk}: \underline{h} = 1,2,3;\ \underline{j} = 1,\ldots,\underline{n}_1;\ \underline{k} = 1,\ldots,\underline{n}_2]$ of the micro-variable array whose value-configuration for any $\underline{C}$*-kind device stage $\underline{s}$-at-t is its "display" into $\underset{\wedge}{Y}_1 = [\underset{\wedge}{y}^{*}_{h}\mu_{jk}\underline{r}^{-r}: \underline{h} = 1,2,3;\ \underline{j} = 1,\ldots,\underline{n}_1;\ \underline{k} = 1,\ldots,\underline{n}_2;\ \underline{r} = 0,1,\ldots,\underline{q}]$ for some lag depth $\underline{q}$. Then the display $\underset{\wedge}{Y}_1(\underline{s}\text{-at-}\underline{t})$ comprises not just the synchronically instantaneous luminances of $\underline{s}$'s pixels at $\underline{t}$ but their more or less short-term luminance history as well.

inflict much frustration were we to attempt actual verbalization of molar cartoon dynamics in which they matter.) Let us call descriptors defined in fashion (45), and the compound variables based upon them, continuant thing-delimiters and continuant thing-specifiers, respectively. It will be evident that format (45) for building continuant thing concepts is not at all restricted just to cartoon processes, but applies to any dynamic system containing a micro-variable array construable as a "display."

Of continuant thing-specifiers' own special obscurities and SLese limitations, not least is the strongly restricted localization of their delimiters. Specifically, '*John' as defined by (45) is elliptic for 'the *John based on $\underline{s}$-at-$\underline{t}_0$', or '*John-von-($\underline{s}$,$\underline{t}_0$)' in the idiom of surnames; and for a shift of base from ($\underline{s}$,$\underline{t}_0$) to ($\underline{s}'$,$\underline{t}_1$), *John-von-($\underline{s}'$,$\underline{t}_1$) may well be disjoint from *John-von-($\underline{s}$,$\underline{t}_0$) even when $\underline{s}' = \underline{s}$. (Thus, the red square displayed by $\underline{s}$-at-$\underline{t}$ that has evolved continuantly from the smallest square in $\underline{s}$'s 2nd screen quadrant at $\underline{t}_0$ may or may not be identical with the red square displayed by $\underline{s}$-at-$\underline{t}$ whose continuant identity is based on the smallest square displayed in $\underline{s}$'s 2nd screen quadrant at $\underline{t}_1$.) Consequently, any law governing a continuant thing-specifier whose delimiter is '*John-von-($\underline{s}$,$\underline{t}_0$)' can have as its domain only an $\underline{f}$-connected sequence of system stages that passes through this one particular $\underline{s}$-at-$\underline{t}_0$--scarcely the scope one expects of a useful scientific regularity. How to liberate continuant thing-specifiers from this shackle, however, is for advanced SLese to contrive. (It can be done, but not easily.) Here it suffices to venture that any cartoon process whose display sequence we find perceptually interpretable will almost certainly be describable in terms of continuant thing-specifier dynamics if it has any effective molar SLese formulation at all.

Although we have scarcely begun to explore the intricacies of verbalizing cartoon processes in terms of figure/ground abstractions, much less that of non-thingy display pattern dimensions such as Checkeredness and Multi-ringedness, we have gone far enough to move on, in Heuristic 1b, to the fundamental elusiveness of well-behaved molar dynamics. So let us conclude Heuristic 1a with some answers to a question that has undoubtedly been nagging at you for the past several pages: Just what may be the point of all this thingish nit-picking, especially considering that cartoon displays are arbitrary human contrivances that can be programmed to run off however our whims may fancy?

There are, in fact, several excellent reasons for this concern. First of all, virtually all commonsense views on how the world works lump nature's infraperceptual micro-events into the behaviors of segregated, spatially mobile macro-things that prevailingly endure and often interact throughout sequences of causal progression. Our conceptions of such entities and the variables which dimensionalize their attributes arguably develop under the very same format as sketched here for continuant thing-delimiters/specifiers even if, to be sure, the properties of real-world things are far more richly variagated than are perceptible features of things in cartoon displays. Working out details of whatever well-SLesed lawfulness of molar thing-specifiers, continuant or otherwise, can be discerned in suitably programmed cartoon sequences should be invaluable as pilot study for deeper research into the logic of natural thing processes. It may not have occurred to you that the latter's perspicuity is at all wanting. Yet philosophers have found ordinary notions of continuant identity and the "sortal" concepts that ground them (e.g. the "α-thing" restrictor in (45)) to be surprisingly obscure. (See e.g. Wiggins, 1980.) And need for an advanced technical methodology of thing-delimitation/specification will become increasingly urgent as the generic theory of structurally complex macro-systems--which is still in its infancy, and for which pp. 98-123 in Chapter 3 is but a prefatory sketch--seeks applications beyond the range of extant engineering models of the simpler physical systems. For whenever the behavior of a macro-system is to be analyzed as derivative from the assembly structure and micro-behaviors of its parts, each "part" thereof will inevitably require identification by a thing-delimiter, in all likelihood a continuant one.

Secondly, of more direct relevance to molar psychology, any SLese account of how cogitation is responsive to environment must perforce characterize much of this input as a configuration of values on an array of stimulus variables. We have already noted in Chapter II, and will re-examine shortly, that what can pass muster as a technically workable dimensionalization of stimulation remains an outstanding psychonomic conundrum that indeed may have no comfortable solution. But if we ever do achieve an effective SLesing of organisms' distal surrounds that corresponds even roughly to how ordinary human perception parses this, continuant thing-delimiters/specifiers will figure prominently in the account. Not merely should detailing the particularities of thing-specifiers in molar cartoon processes ease us into the knottier technicalities of this matter, study of how thing-specified features of cartoon-display sequences drive perceptual reactions in their human viewers may also highlight, less cryptically than in most perceptual research, the special problems that stand between us and an honest causal theory of world/percept relations.

Thirdly, thing-specifier process in cartoon displays are a paradigm *par excellence* of what it is for events we perceive in holistic molar terms to be in fact supervenient upon certain constituting ensembles of micro-events even when we are not aware of how one relates to the other. The unmitigated reductionism of my psychophysical thesis, that whatever aspects of reality are signified by commonsense mental predicates must surely be a-derivative from translocationally integrated complexes of the brain's micro-attributes and assembly structure, is notoriously controversial. Indeed, there are competent thinkers even today who view such proposals as patently absurd. Yet what could be more plain (with one reservation noted on p. 194) than that the thing phenomena we see on screen in a cartoon process are *nothing but* abstractions from the sequence of pixel luminances and pixel geometry in the device that contains these events. When we observe that the solid red circle in *s*'s display at *t* is high-to-the-right and rather small, we certainly do not concommitantly perceive any pixel p_{ij} in *s* at *t* as having some particular luminance.

Yet were we to know the luminance conditions of all these $\underline{p}_{ij}$, together with their inter-pixel distances, the only impediment to our deducing with logical certainty whether the solid red circle in $\underline{s}$'s display at $\underline{t}$ has features such-and-so is our failure to have clarified what it takes for the screen really to contain a unique solid red circle with such-and-so properties, as distinct from a display's merely appearing this way to us. This is just like my remaining uncertain whether your son is still a boy, after learning of his 19th birthday celebration yesterday, only because I am vague about where to put the boy/man cut on the Age continuum. If chronological age in human males isn't the entire story of boyness, the latter is surely supervenient upon species, sex, and maturational factors of which Age is our official measure; and so do a display screen's red-circle specifications supervene upon its pixel properties.

It is a considerable challenge to detail specific instances of a thing-delimiter α and then work out computable abstractor functions $\{g_{\alpha i}\}$ on micro-array $\hat{Y}_1$ such that $\{\hat{x}_i =_{def} [g_{i\alpha}\hat{Y}_1]\}$ are dimensions of a thing-specifier $\hat{X}_\alpha$ whose respective values derived from any particular display configuration $\underline{Y}_1$ correspond closely to what we perceive as properties of a unique α-thing in $\underline{Y}_1$. (E.g., pick one of (45.1)-(45.4) and contemplate programming an algorithm g_i on a two-dimensional, evenly spaced array $\hat{Y}_1$ of variably colored dots that maps each display configuration $\underline{Y}_1$ into either (a) the value given by $\underline{Y}_1$ to the $\underline{i}$th specification dimension in $\hat{X}_\alpha$ for the square, or the blue figure, or whatever other α-thing is presupposed by this specification, or (b) when $\underline{Y}_1$ does not satisfy this presupposition, into an anomaly marker.) I urge that this challenge be taken seriously. For when it becomes clear how, despite large difficulties in explicating the connection, an array of abstractors over micro-variable array $\hat{Y}_1$ can conjoin the t-cores-cum-translocators composition of $\hat{Y}_1$ to constitute the molar features we see in $\hat{Y}_1$-displays, i.e., how an object's having some holistically conceived attribute $\underline{Q}$ can be ontologically identical with this object's having a display configuration in a certain distinctive region of $Y_{\lambda 1}$-space, it should no longer seem so counterintuitive that your introspected ψing-that-p might be just your mega-dimensional brain state's being patterned in a rather special way, even though that pattern's physiological constitution lies far beyond your ken.

Finally, computer-programmed cartoon processes are an especially perspicuous microcosm within which to study why scientifically tractable molar dynamics are so hard to come by. Thing-specifiers are just one of many kinds of pattern variables that can be abstracted from pixel displays, perhaps not exemplifying all molarity issues that emerge in micro-systems of the greatest structural complexities but certainly ranging broadly over these within a physical reality whose behavior we can perceive and exhibit publically even while programming this to be as ideal as we find useful for suppression of unwanted complications. In particular, we can chart the boundaries of molar docility through attempts to program display sequences that manifest simple pre-selected dynamics for chosen dimensions of display patterning, not just for thing-specifiers but for other seemingly worthy types of molar abstraction as well. Unhappily, although thinking through these technicalities is exceedingly important for understanding the nature of pattern phenomena in complex systems, I have found no way to discuss them that is not protractedly tedious. So with reluctance, I shall here settle for just one simple figure/ground illustration of the complications for molar lawfulness inherent in pattern competetion, and await some other occasion to explore this situation in the depth it deserves. Some fragments of that deeper study are offered in Appendix A.

Heuristic 1b. Competition and domain-instability in cartoon dynamics.

Suppose that with exceedingly modest initial aspirations, we seek to program a cartoon sequence wherein a red disk (boundary-distinct solid red circle), on a uniformly grey background in the absence of any other figures, moves about the screen and changes size as a function just of the disk's immediately preceding specifications. (That is, we aspire only to the simplest nontrivial dynamics possible here: lag-1 auto-regressive with no exogenous disturbances.) The only relevant thing-specifier in this case is

$\underset{\wedge}{X}_{\alpha}(\_\_) = \langle \underline{x}_1, \underline{x}_2, \underline{x}_3 \rangle$: The red disk in __'s display is centered $\underline{x}_1$ cm. to the right of and $\underline{x}_2$ cm. above the screen's center (more briefly, has position $\langle \underline{x}_1, \underline{x}_2 \rangle$), and is $\underline{x}_3$ cm. in radius.

As before, we arrange for the sequence of displays in the device $\underline{s}$ we are programming to be paced by a successor function $\underline{f}$ such that when $\underline{o}$ is an $\underline{s}$-stage that exhibits a synchronically complete display $\underset{\wedge}{Y}_1(\underline{o})$, $\underset{\wedge}{Y}_1\underline{f}(\underline{o})$ is the next complete display in this sequence. To bring it about that $\underline{s}$'s stages have regular values on $\underset{\wedge}{X}_{\alpha}$ against a uniform grey background, we create a 3-tuple $\underset{\wedge}{V} = [\underset{\wedge}{v}_1, \underset{\wedge}{v}_2, \underset{\wedge}{v}_3]$ of numerical variables in computer memory to act as surrogates for the respective components $\underset{\wedge}{x}_1, \underset{\wedge}{x}_2, \underset{\wedge}{x}_3$ of disk-specifier $\underset{\wedge}{X}_{\alpha}$, and put into our program a display-production subroutine that, for any configuration $\underline{V} = \langle \underline{v}_1, \underline{v}_2, \underline{v}_3 \rangle$ received as the state of $\underset{\wedge}{V}$ for $\underline{s}$-stage $\underline{o}$, makes the color of each pixel $\underline{p}_{ij}$ in $\underline{o}$ red or grey according to whether $\underline{p}_{ij}$ is within $\underline{v}_3$ cm. of screen position $\langle \underline{v}_1, \underline{v}_2 \rangle$. This subroutine achieves $\underset{\wedge}{X}_{\alpha}(\underline{o}) = \underline{V}$ whenever it is possible for any $\underset{\wedge}{Y}_1$-display to so-position a red disk this large. And to generate sequences of disk changes governed by whatever transducer $\Psi = \langle \psi_1, \psi_2, \psi_3 \rangle$ we like, we also program a dynamics subroutine that follows production of each $\underline{o}$'s display from $\underset{\wedge}{V}$-state $\underline{V} = \underset{\wedge}{V}(\underline{o})$ by rewriting $\underline{V}$ as $\underline{V}' = \Psi(\underline{V})$, i.e. $\underline{v}_i' = \psi_i(\underline{v}_1, \underline{v}_2, \underline{v}_3)$ for $\underline{i} = 1,2,3$, with $\underline{V}'$ then retained to be the value of $\underset{\wedge}{V}$ for $\underline{f}(\underline{o})$. Finally, upon start-up our program first assigns an initial state to $\underset{\wedge}{V}$ by some method of selection from an allowed start-up subrange of $\underset{\wedge}{V}$, and thereafter alternates between the display-production and dynamics subroutines until interrupted. For each nonterminal device-stage $\underline{o}$ in the run, the recursive transformation we have imposed on memory register $\underset{\wedge}{V}$ yields $\underset{\wedge}{V}\underline{f}(\underline{o}) = \Psi(\underset{\wedge}{V}(\underline{o}))$, which our display-production subroutine mirrors by $\underset{\wedge}{X}_{\alpha}\underline{f}(\underline{o}) = \Psi(\underset{\wedge}{X}_{\alpha}(\underline{o}))$ <u>so long as</u> $\underset{\wedge}{V}(\underline{o})$ <u>and</u> $\Psi(\underset{\wedge}{V}(\underline{o}))$ <u>are both in the range of</u> $\underset{\wedge}{X}_{\alpha}$.

The programming just sketched puts a unique red disk on $\underline{s}$'s display screen with whatever dynamics we elect by our choice of Ψ--but does so only within limits of realizability. To appreciate the latter's nature, start by getting clear that components $\{\underline{x}_i\underline{f} = \psi_i(\underline{x}_1, \underline{x}_2, \underline{x}_3) : \underline{i} = 1,2,3\}$ of compound equation $\underline{X}_{\alpha}\underline{f} = \Psi(\underline{X}_{\alpha})$ describe how we want the red disk's screen position $\langle \underline{x}_1,\underline{x}_2\rangle$ and size $\underline{x}_3$ in any frame of the display sequence to determine its position and size in the next frame. For example, if $\underline{a}_1$, $\underline{a}_2$, and $\underline{c}$ are numerical constants with $\underline{c}>0$, dynamics

$$
\begin{aligned}
(46)\qquad \underline{x}_1\underline{f} &= \underline{x}_1 + 0\cdot\underline{x}_2 + 0\cdot\underline{x}_3 + \underline{a}_1 \quad (= \underline{x}_1 + \underline{a}_1\ )\\
\underline{x}_2\underline{f} &= 0\cdot\underline{x}_1 + \underline{x}_2 + 0\cdot\underline{x}_3 + \underline{a}_2 \quad (= \underline{x}_2 + \underline{a}_2\ )\\
\underline{x}_3\underline{f} &= 0\cdot\underline{x}_1 + 0\cdot\underline{x}_2 + \underline{c}\cdot\underline{x}_3 \quad (= \underline{c}\cdot\underline{x}_3\ )
\end{aligned}
$$

moves the disk across the screen at constant velocity $(\underline{a}_1^2 + \underline{a}_2^2)^{1/2}$ cm. per frame in a straight path at angle $\arctan(\underline{a}_2/\underline{a}_1)$ to horizontal, while the disk's size increases explosively if $\underline{c}>1$, remains constant if $\underline{c} = 1$, or shrinks asymptotically to zero if $\underline{c}<1$. In this special case all dimensions of $\hat{X}_\alpha$ are completely <u>decoupled</u> from one another in that for each $\underline{i} = 1,2,3$, change in $\hat{x}_i$ is affected only by $\hat{x}_i$ itself: Although all $\hat{X}_\alpha$-dimensions occur formally as local inputs in each component of $\underline{X}_\alpha\underline{f} = \Psi(\underline{X}_\alpha)$, the allocation of null-weightings in the latter minimizes the interconnectedness of these pattern variables. Another choice of Ψ with less decoupling and correspondingly fancier action is

$$
\begin{aligned}
(47)\qquad \underline{x}_1\underline{f} &= (\underline{x}_1^2 + \underline{x}_2^2)^{1/2}\cdot\cos(\underline{a} + \mathrm{arc}(\underline{x}_2,\underline{x}_1))\\
\underline{x}_2\underline{f} &= (\underline{x}_1^2 + \underline{x}_2^2)^{1/2}\cdot\sin(\underline{a} + \mathrm{arc}(\underline{x}_2,\underline{x}_1))\\
\underline{x}_3\underline{f} &= |\underline{x}_1\cdot\underline{x}_2|^{1/2} + \underline{b} \quad (\ \underline{b}>0\ ) \qquad ,
\end{aligned}
$$

wherein $\mathrm{arc}(\underline{x}_2,\underline{x}_1)$ is the angle in the unit-circle whose sine and cosine are respectively $\underline{x}_2/(\underline{x}_1^2+\underline{x}_2^2)^{1/2}$ and $\underline{x}_1/(\underline{x}_1^2+\underline{x}_2^2)^{1/2}$. This moves the disk at constant angular velocity in a circular orbit selected by the start-up $\langle \underline{x}_1,\underline{x}_2\rangle$, while the disk's radius waxes or wanes as it approaches or recedes from the diagonal of its current screen quadrant. In (47), $\hat{x}_1$ and $\hat{x}_2$ are decoupled from $\hat{x}_3$ but not from each other, while $\hat{x}_3$ is driven by $[\hat{x}_1,\hat{x}_2]$ with no auto-regressive force. To enliven these dynamics even further by full reciprocal coupling, we might replace the constants in (47) by functions of $\hat{x}_3$, say $\underline{b}$ by $\underline{b}\cdot\underline{x}_3$ and $\underline{a}$ by $\underline{a}/\underline{x}_3$.

We shall have more to say about decoupling shortly. But the key point here is that not all number 3-tuples which may be input to our display-production subroutine can be realized in any $\underset{\wedge}{Y}_1$-display as a state of $\underset{\wedge}{X}_\alpha$. Obvious examples are violations of limits on the individual pattern dimensions: In our present case, the finite physical expanse of pixels constituting $\underset{\wedge}{Y}_1$ places upper and lower bounds on $\underset{\wedge}{x}_1$ and $\underset{\wedge}{x}_2$ beyond which there is no display screen and hence no possibility of positioning a disk there; while disk radius $\underset{\wedge}{x}_3$ has a lower bound of zero enforced by real geometry and an upper bound again set by the screen limits. But deeper than mere constraints on the separate pattern-component ranges, many combinations of separately realizable values of $\underset{\wedge}{X}_\alpha$'s dimensions are incapable of simultaneous display. Thus for almost every off-center screen position $\langle\underline{x}_1,\underline{x}_2\rangle$, a disk can be centered at $\langle\underline{x}_1,\underline{x}_2\rangle$ by taking $\underline{x}_3$ sufficiently small even while there are also radius values $\underline{x}_3$ for which the screen has insufficient room in a disk centered at $\langle\underline{x}_1,\underline{x}_2\rangle$ although it can accomodate disks that large elsewhere. Let us say that a prospective value $\underline{X} = \langle\underline{x}_1,\underline{x}_2,\underline{x}_3\rangle$ of thing-specifier $\underset{\wedge}{X}_\alpha$ (and similarly for any other array of pattern variables) is <u>competetively unrealizable</u> (as a value of $\underset{\wedge}{X}_\alpha$) iff $\underline{X}$ is not in the range of $\underset{\wedge}{X}_\alpha$ even though each component $\underline{x}_i$ thereof is in the range of $\underset{\wedge}{x}_i$. Or, with slightly different wording, a state of one subtuple of pattern variables over $\underset{\wedge}{Y}_1$ "competes" or "interferes" with some state of another if these two subpatterns cannot be realized jointly in some $\underset{\wedge}{Y}_1$-display. More loosely, two or more pattern variables are competetive to the extent that some states of one interfere with certain states of the others.

Meanwhile, our $\underset{\wedge}{X}_\alpha$-surrogate V undergoing dynamic transformations in computer memory suffers no such constraints on what states it can occupy. For within practical limits too mild for present concern, any 3-tuple $\underline{V} = \langle\underline{v}_1,\underline{v}_2,\underline{v}_3\rangle$ of real numbers can be coded in the register reserved for $\underset{\wedge}{V}$. And even when $\underset{\wedge}{V}$-state $\underline{V}$ is unrealizable as a value of $\underset{\wedge}{X}_\alpha$, our display-production subroutine still generates from $\underline{V}$ some display-configuration $\underline{Y}_1$ albeit not one that abstracts into a regular value of $\underset{\wedge}{X}_\alpha$. Sometimes this $\underset{\wedge}{X}_\alpha$-anomalous display $\underline{Y}_1$ is blank (e.g. if $\underline{x}_3$ is negative), while for other unrealizable $\underline{V}$ it will contain a solid red semicircle abutting the screen's edge.

But either way, the display produced from a $\underline{V}$ that is unrealizable as a state of X_{α} provides no referent for thing-delimiter 'the red disk contained in __'s display' and hence abstracts into an anomalous value for every dimension of X_{α}.

Moreover, unless our chosen dynamic transducer Ψ is degenerately simple, there will usually be X_{α}-surrogate values $\underline{V}$ that are realizable as a state of X_{α} when $\Psi(\underline{V})$ is not. Consequently, when we run our program for red-disk dynamics from a realizable start-up $\underline{V} = X_{\alpha}(\underline{o})$, iteration $\{\Psi^{r}(\underline{V}): \underline{r} = 0,1,2,\ldots\}$ proceeds indefinitely but generates a Ψ-governed display sequence $\{X_{\alpha}\underline{f}^{r+1}(\underline{o}) = \Psi(X_{\alpha}\underline{f}(\underline{o})): \underline{r} = 0,1,2,\ldots\}$ only so far as $\Psi^{r+1}(\underline{V})$ remains realizable. In particular, dynamics (46) or (47) breaks off whenever the disk edges off the screen. Under (46), loss of the disk is inevitable from any start-up $\underline{V}$ unless $\underline{a}_1 = \underline{a}_2 = 0$ and $\underline{c} \leq 1$; whereas under (47), the disk remains intact on screen for an arbitrarily long run if and only if start-up selects a sufficiently small orbit of rotation. Let $\underline{C}_{\alpha}$ comprise just the stages $\{\underline{o}\}$ of our device's runs under this program for which both $V(\underline{o})$ and $\Psi(V(\underline{o}))$ are realizable X_{α}-states. Then $\underline{C}_{\alpha}$ is the domain within which we have engineered dynamics $X_{\alpha}\underline{f}(\underline{o}) = \Psi(X_{\alpha}(\underline{o}))$ to obtain. Once a run's succession $\{\underline{f}^{r}(\underline{o}): \underline{r} = 0,1,2,\ldots\}$ leaves $\underline{C}_{\alpha}$, it may or may not return. (Under (47) it does; under (46) it does not.) But even when the sequence repeatedly re-enters $\underline{C}_{\alpha}$, the salient point is that its tendency to leave at all makes domain $\underline{C}_{\alpha}$ unstable, just how ephemerally so depending on how persistently the successors of an arbitrarily selected device-stage in $\underline{C}_{\alpha}$ tend to linger in $\underline{C}_{\alpha}$.

The unrealizabilities that create domain-instability in our single-figure example may well seem largely trivial, since apart from negative radii, which never arise under (46/47) from allowed start-ups, they result merely from our display screen's fixed finite size. (There are also some realizability complications due to the pixel array's grain which I choose to ignore.) But now let us add a second moving figure to our display process, say a green chip (boundary-distinct solid green square) whose size and orientation we shall for simplicity hold constant. That is, along with regular values of X_{α} we now want the display also to abstract into regular values of the thing-specifier $\underset{\wedge}{X}_\beta$ whose delimiter is 'the green chip in __'s display' and whose values are screen-position 2-tuples. With one computationally mild but conceptually crucial complication we prepare our device just as before, with its controlled display-pattern dimensions expanded to $[\underset{\wedge}{X}_\alpha, \underset{\wedge}{X}_\beta] = [\underset{\wedge}{x}_i : \underline{i} = 1,\ldots,5]$ $(\underset{\wedge}{X}_\alpha = [\underset{\wedge}{x}_1, \underset{\wedge}{x}_2, \underset{\wedge}{x}_3]$, $\underset{\wedge}{X}_\beta = [\underset{\wedge}{x}_4, \underset{\wedge}{x}_5])$, its central-state surrogate for these similarly expanded to $\underset{\wedge}{V} \doteq [\underset{\wedge}{V}_\alpha, \underset{\wedge}{V}_\beta] = [\underset{\wedge}{v}_i : \underline{i} = 1,\ldots,5]$, and its programmed dynamics $\underline{Vf} = \Psi(\underline{V})$ partitioning into two subsystem dynamics $\underline{V}_\alpha \underline{f} = \Psi_1(\underline{V}_\alpha, \underline{V}_\beta)$ and $\underline{V}_\beta \underline{f} = \Psi_2(\underline{V}_\alpha, \underline{V}_\beta)$ which we seek to mirror on-screen by $\underline{X}_\alpha \underline{f} = \Psi_1(\underline{X}_\alpha, \underline{X}_\beta)$ and $\underline{X}_\beta \underline{f} = \Psi_2(\underline{X}_\alpha, \underline{X}_\beta)$. The complication lies in our display-production subroutine. We program this to control each screen pixel $\underline{p}_{ij}$-in-$\underline{o}$ in such fashion that when $\langle \underline{V}_\alpha, \underline{V}_\beta \rangle$ is the $\underset{\wedge}{V}$-state of device-stage $\underline{o}$, $\underline{p}_{ij}$-in-$\underline{o}$ is made red if $\underline{V}_\alpha$ and $\underline{V}_\beta$ respectively call for this screen position to be disk-foreground and chip-background, green if these call for it to be disk-background and chip-foreground, and grey if both call it background. (You can easily fill in the technicalities of these foreground/background "calls.") But we cannot honor these calls simultaneously if $\underline{V}_\alpha$ and $\underline{V}_\beta$ both want $\underline{p}_{ij}$-in-$\underline{o}$ to be foreground for their respective figures. We can give one figure precedence over the other, or let their colors summate, or adopt some other rule of color combination in overlapping foregrounds. Yet however we program this, we will have the following situation: So long as $\underline{V}_\alpha$ and $\underline{V}_\beta$ are both individually realizable and do not call for overlapping figures, our display-production subroutine will construct from $\underset{\wedge}{V}(\underline{o}) = \langle \underline{V}_\alpha, \underline{V}_\beta \rangle$ a screen display $\underline{\underset{\wedge}{Y}}_{\underline{i}}(\underline{o})$ that abstracts into both a unique red disk with specifications $\underline{V}_\alpha$ and a unique green chip with specifications $\underline{V}_\beta$. But no display produced under a foreground-overlap call provides referents for both delimiters 'the red disk ...' and 'the green chip ...' when we require each of these to pick out a unique boundary-distinct figure of fixed shape and color as stipulated.

[Of course, we can try redefining the thing-delimiters in $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$ to designate a unique circle and square, respectively, even in displays where these overlap. Indeed, such was the motivation for our earlier musings on continuant things. But that is only a distraction here. In the first place, defining continuant thing-delimiters having the referential prowess we want of them is far more difficult than (45)'s introductory sketch suggests. In fact, when a cartoon process appears to us as though diverse continuant things are changing their positions, sizes, shapes, colors, etc. in ways that defeat their individuation by descriptors less sequence-specific than ones of the '*John-von-($\underline{s}$,$\underline{t}_0$)' sort, it can be argued that our percepts are not literally of molar display events but are more like theoretical constructs which account for ephemeral surface phenomena by appeal to inferred continuant sources thereof. That is, perhaps perceiving the green chip as passing behind the red disk is a hypothesis whose truth is not determined solely by the display sequence but also resides to some extent in the orderly progression of central $\underset{\wedge}{V}$-states.

[Be that as it may, even were we to coax our present example's thing-specifiers into abstracting regular values from overlapping-figures displays, this would only replace $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$ by a somewhat different array of pattern variables that would still show in some more complicated way the problem at issue here. This is simply that however the delimiters in $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$ are defined (or indeed, with one distinctive class of exceptions described in Appendix $\underline{A}$, when these are almost any compound pattern variables a-derived from $\underset{\wedge}{Y}_1$), there will generally be $\underset{\wedge}{V}$-values $\langle \underline{V}_{\alpha}, \underline{V}_{\beta} \rangle$ for which $\underline{V}_{\alpha}$ is realizable as a state of $\underset{\wedge}{X}_{\alpha}$, and $\underline{V}_{\beta}$ as a state of $\underset{\wedge}{X}_{\beta}$, but $\langle \underline{V}_{\alpha}, \underline{V}_{\beta} \rangle$ is competetively unrealizable as a state of $[\underset{\wedge}{X}_{\alpha}, \underset{\wedge}{X}_{\beta}]$-- not as an artifact of screen size but inhering in the nature of patternings $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$. Figure overlap for the distinct-boundary solid-color reading of our thing-delimiters illustrates this nicely.]

And why is competitive unrealizability important? Simply because this is the final barrier to well-behaved molar dynamics even when all else is obliging. Basically, it engenders domain-instability for the reason we have already noted for red-disk movement under (46) or (47). But the problem is more subtle than yet brought out. One prospective dynamics for $\underset{\wedge}{X}_{\alpha}$ does not have to be domain-unstable just because another is. Even as it stands (47) will iterate indefinitely from some start-up states; and you can easily think of ways to revise equations (46) or (47) to make the red disk rebound into the display field whenever it reaches screen edge. The so-modified Ψ will be considerably more complicated to write out than are the present versions (I chose these particular formulas primarily for their algebraic convenience), but it will still be a perfectly good domain-stable dynamics for display patterning $\underset{\wedge}{X}_{\alpha}$. Similarly, although an arbitrary choice of dynamic transducer Ψ for display-patterning surrogate $[\underset{\wedge}{V}_{\alpha},\underset{\wedge}{V}_{\beta}]$ will almost certainly have its reflection in $[\underline{X}_{\alpha},\underline{X}_{\beta}]\underline{f} = \Psi(\underline{X}_{\alpha},\underline{X}_{\beta})$ frequently interrupted by competetive unrealizability of the pattern combination called for by $[\underline{V}_{\alpha},\underline{V}_{\beta}](\underline{o})$, it is in principle routine to design a Ψ that not merely keeps both the disk and the chip always fully on screen but also deflects them from any impending collision. But the cost of domain stability so salvaged is high: It largely precludes that $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$ can be dynamically decoupled from one another except by restricting their effective ranges to regions wherein they are noncompetetive. For unless at least one of $\underset{\wedge}{X}_{\alpha}\underline{f}$ or $\underset{\wedge}{X}_{\beta}\underline{f}$ heeds both $\underset{\wedge}{X}_{\alpha}$ and $\underset{\wedge}{X}_{\beta}$, their independent trajectories will almost surely cross in conflict if their effective ranges permit.

Since the issue at which we have now arrived--the linkage among competetion, decoupling, and domain-ephemerality in pattern dynamics--is massively technical, please bear with me while I try through our cartoon-process example to intimate its essence and importance as briskly as I can.[41] Our first concern is what it takes

[41] I wish I could share with you the dozens of pages I have generated in repeated efforts to lay out this matter in some of the abstract generality it deserves. Great stuff--but you'd never read it.

to run a domain-stable dynamics in $\underline{C}$ simultaneously for red-disk specifier $\underset{\wedge}{X}_{\alpha}$ and green-chip specifier $\underset{\wedge}{X}_{\beta}$ when neither is dynamically affected by the other. More precisely, using the programming procedure already described, we are to give the red disk and green chip a lag-1 errorlessly endogenous dynamics $[\underline{X}_\alpha,\underline{X}_\beta]\underline{f} = \Psi(\underline{X}_\alpha,\underline{X}_\beta)$ of decoupled form

(48-1) In $\underline{C}_{\alpha\beta}$, $\underline{X}_\alpha\underline{f} = \Psi_1(\underline{X}_\alpha) + 0\cdot\underline{X}_\beta \quad (= \Psi_1(\underline{X}_\alpha))$

(48-2) In $\underline{C}_{\alpha\beta}$, $\underline{X}_\beta\underline{f} = 0\cdot\underline{X}_\alpha + \Psi_2(\underline{X}_\beta) \quad (= \Psi_2(\underline{X}_\beta))$,

wherein Ψ_1 is under the constraint that $\Psi_1(\underline{X}_\alpha)$ be a realizable state of $\underset{\wedge}{X}_\alpha$ whenever $\underline{X}_\alpha$ is, with Ψ_2 constrained similarly, in a not-necessarily-proper subdomain $\underline{C}_{\alpha\beta}$ of $\underline{C}$ which if possible is to have the same long-term stability as $\underline{C}$. That is, although $\underline{C}$-runs must inevitably terminate through power failure, operator interrupt, etc., we want the successors of any $\underline{c}$ in $\underline{C}_{\alpha\beta}$ to remain in $\underline{C}_{\alpha\beta}$ as long as they are in $\underline{C}$. Or more simply, we do not want $\underline{C}_{\alpha\beta}$ to be ephemeral through runs in $\underline{C}_{\alpha\beta}$ being broken by calls for figure overlap.

Why are we imposing on thought-problem (48) the requirement that $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$ be dynamically decoupled from one another? Because in cases less idealized than this one, decoupling may well be required for the dynamics in question to lie within the reach of human understanding. For our present $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$, a fully coupled dynamics $\underline{X}_\alpha\underline{f} = \Psi_1(\underline{X}_\alpha,\underline{X}_\beta)$ and $\underline{X}_\beta\underline{f} = \Psi_2(\underline{X}_\alpha,\underline{X}_\beta$ wherein each transducer ignores none of its argument-components would still be a 2-tuple of functions in just five dimensions--child's play for modern multivariate thinking unless Ψ_1 or Ψ_2 is especially quirky. But suppose instead that our display process exhibits a large array $\alpha, \beta, \gamma, \ldots$ of figures whose respective specifiers $\underset{\wedge}{X}_\alpha, \underset{\wedge}{X}_\beta, \underset{\wedge}{X}_\gamma, \ldots$ are themselves richly multi-dimensional (as needed e.g. to describe figures less boring than solid circles and squares). You can then easily see how a dynamics for any one of these thing-specifiers, say $\underline{X}_\alpha\underline{f} = \Psi_1(\underline{X}_\alpha, \underline{X}_\beta, \underline{X}_\gamma, \ldots)$, that gives $\underline{n}_\alpha$ dimensions in $[\underset{\wedge}{X}_\alpha, \underset{\wedge}{X}_\beta, \underset{\wedge}{X}_\gamma, \ldots]$ appreciable weight would with increasing $\underline{n}_\alpha$ soon reach levels of complexity far beyond our detailed comprehension, especially if Ψ_1 is more interactively curvilinear than a low-order polynomial. Unless a molar dynamics of realistic dimensionality is extensively decoupled, we are forced in practice to write off much, perhaps nearly all, of its to-be-accounted-for pattern sequencing as the work of unidentified residuals.

There is really only one credible way to bring off domain-stability under decoupling as in (48), albeit a <u>deus-ex-machina</u> alternative must also be acknowledged. The main solution is for every $\underset{\wedge}{X}_{\alpha}$-state that can be reached by iteration of (48-1) from any allowed start-up display to be noncompetetive with every $\underset{\wedge}{X}_{\beta}$-state attainable by iteration of (48-2). For example, split-screen programming under which transducer Ψ_1 and the start-up constraints on $\underset{\wedge}{X}_{\alpha}$ confine the disk to one screen sector, while Ψ_2 and start-up for $\underset{\wedge}{X}_{\beta}$ confine the chip to another, assures that the disk and chip never collide. In particular, taking (48-1) to rotate the disk by a suitable parameterization of (47), while (48-2) is the invariance $\underline{X}_{\alpha}\underline{f} = \underline{X}_{\alpha}$ iterated from a start-up chip always tucked into a screen corner over which the disk never passes, illustrates how constancy of some patterning components can work to avoid competetion. An especially important even if intuitively degenerate version of noncompetetive subpattern constancy is for $\underset{\wedge}{X}_{\beta}$ (or similarly $\underset{\wedge}{X}_{\alpha}$) to take only anomalous values in $\underline{C}_{\alpha\beta}$, i.e. for no start-up display to contain a green chip and for none to appear thereafter. Thus, programming our device's display sequence to show just the red disk moving on a uniform grey background can be viewed as an instance of (48-1,2) wherein the green-chip subpatterning is vacuously constant at anomaly.

(Even when some $\underset{\wedge}{X}_{\alpha}$-states and $\underset{\wedge}{X}_{\beta}$-states attainable in $\underline{C}_{\alpha\beta}$ separately are unrealizable jointly, it may still be possible for runs of (48) to continue indefinitely without a competetion call if start-up is tightly constrained. For example, let (48-1) again be (47) while (48-2) likewise rotates its figure in a circular orbit. If the disk and the chip are given the same angular velocity, with chip size taken suitably small, confining start-up chip location to a certain window of angular displacement from the start-up disk allows (48) to iterate indefinitely without figure overlap. But it requires a heavy hand in parameter selection and start-up engineering to contrive this even in a man-made cartoon process, suggestive of no deep-origins control mechanism at all plausible for a natural system.)

Now consider the appearance of display sequences in $\underline{C}$ when we have programmed (48) <u>without</u> evading $\underset{\wedge}{X}_{\alpha}/\underset{\wedge}{X}_{\beta}$ competetion. That is, our dynamics subroutine for patterning-surrogate array $\underset{\wedge}{V} = [\underset{\wedge}{V}_\alpha, \underset{\wedge}{V}_\beta]$ computes $\underset{\wedge}{V}_\alpha \underline{f}(\underline{\rho}) = \Psi_1(V_\alpha(\underline{\rho}))$ and $\underset{\wedge}{V}_\beta \underline{f}(\underline{\rho}) = \Psi_2(V_\beta(\underline{\rho}))$ for all $\underline{\rho}$ in $\underline{C}$ after start-up, with $\underline{\rho}$'s pixel display $\underset{\wedge}{Y}_1(\underline{\rho})$ produced from $[\underset{\wedge}{V}_\alpha, \underset{\wedge}{V}_\beta](\underline{\rho})$ as before; but we now permit the program's iteration often to pass through $\underset{\wedge}{V}$-states that call for disk/chip overlap. (Decoupling of $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$ from each other is not really relevant to the present point, but we'll stick with the formulas already in hand.) By design, some $\underline{f}$-connected subsequences of $\underline{C}$-runs are in $\underline{C}_{\alpha\beta}$ and have ephemeral dynamics (48); but what is the display patterning like in $\underline{C}$-run segments that are __not__ in $\underline{C}_{\alpha\beta}$? When $\underset{\wedge}{V}(\underline{\rho})$ calls for disk/chip overlap, what we get in $\underset{\wedge}{Y}_1(\underline{\rho})$ is anomalous values on one or both of $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$, depending on how we have programmed coloration for pixels that are foreground under both $\underset{\wedge}{V}_\alpha(\underline{\rho})$ and $\underset{\wedge}{V}_\beta(\underline{\rho})$. Rather than containing one red disk and one green chip, $\underset{\wedge}{Y}_1(\underline{\rho})$ presents instead some new array of boundary-distinct solid figures whose specifiers enjoy a brief regular dynamics of their own until they vanish into anomaly as the disk and chip reappear to resume dynamics (48). Such $\underline{C}$-runs can be viewed as flitting among different ephemeral "modes of action," each characterized by a distinctive set of salient thing-specifiers with its own local dynamics.

To be sure, we can also try to integrate these local action-mode dynamics into a broader dynamics whose domain is the entirety of $\underline{C}$. But to do so we must include in the set of relevant pattern variables not merely $\underset{\wedge}{X}_\alpha$ and $\underset{\wedge}{X}_\beta$ but also specifiers $\underset{\wedge}{X}_\gamma, \ldots$ for whatever additional figures emerge when display production calls for disk/chip overlap; and each of $\underset{\wedge}{X}_\alpha, \underset{\wedge}{X}_\beta, \underset{\wedge}{X}_\gamma, \ldots$ will in general be decoupled in this broad, domain-stable pattern dynamics from few if any of $\underset{\wedge}{X}_\alpha, \underset{\wedge}{X}_\beta, \underset{\wedge}{X}_\gamma, \ldots$.

__Pattern vacuities and modes of molar action.__

From these elementary illustrations, I now boldly extrapolate. For the totality of state dimensions $\underset{\wedge}{Y}$ of a complex micro-system having a well-behaved dynamics in a stable domain $\underline{C}$, let $\underset{\wedge}{\tilde{Y}} = [\underset{\wedge}{\tilde{y}}_k : \underline{k} \in \underset{\sim}{k}]$ be some suitably indexed array of nonredundant pattern variables a-derived from $\underset{\wedge}{Y}$ in sufficient abundance to capture all that is relevant for $\underset{\wedge}{\tilde{Y}}\underline{f}$ in $\underset{\wedge}{Y}$. That is, each $\underset{\wedge}{\tilde{y}}_k =_{def} [g_k \underset{\wedge}{Y}]$ for some abstractor function g_k even though the range of $\underset{\wedge}{\tilde{y}}_k$ so defined may include an anomaly, notably when $\underset{\wedge}{\tilde{y}}_k$ is a thing-specifier. (We allow that $\underset{\wedge}{\tilde{y}}_k$ may itself be multi-dimensional, especially if it is a compound with some special integrity such as holds for a thing-specifier array with a common delimiter.) By saying that $\underset{\wedge}{\tilde{Y}}$ is "nonredundant," we mean that no subarray of $\underset{\wedge}{\tilde{Y}}$ is perfectly predictable in C from $\underset{\wedge}{\tilde{Y}}$'s remainder. Since that permits $\underset{\wedge}{\tilde{Y}}$ to be only a minor subset of all the pattern dimensions a-derivable from $\underset{\wedge}{\tilde{Y}}$, to maintain our present focus we add that we have chosen for $\underset{\wedge}{\tilde{Y}}$ components that are extensively competetive. Despite this nonredundancy limitation, stipulating sufficient abundance for $\underset{\wedge}{\tilde{Y}}$ implies that the dimensionality of $\underset{\wedge}{Y}$-space should be enormous, presumably many orders of magnitude beyond what we can understand as an undivided whole.

In rough initial approximation to a distinction whose more technical explication would be highly relativized and finely graded, let us view the full range of each pattern dimension $\underset{\wedge}{\tilde{y}}_k$ in $\underset{\wedge}{\tilde{Y}}$ as partitioned between values that are salient and ones that are vacuous. (We allow that a particular $\underset{\wedge}{\tilde{y}}_k$'s values may be all one or all the other, though all-vacuous would be degenerate.) Heuristically, salient $\underset{\wedge}{\tilde{y}}_k$-values are (scalings of) pattern alternatives on $\underset{\wedge}{\tilde{y}}_k$ that impress us as worthy of recognition, in contrast to vacuous values which, were they the only grades of $\underset{\wedge}{\tilde{y}}_k$ realized in this system, would leave the $\underset{\wedge}{\tilde{y}}_k$-concept bereft of motivation here. The clearest examples of vacuous patterns are the anomalous values taken by thing-specifiers when their delimiters lack referents, but near-zero values of Checkeredness (if that is abstractable from $\underset{\wedge}{\tilde{Y}}$) illustrate that regular values of a quantitatively continuous variable can also be vacuous. (Intuition seems insistent that zero Checkeredness has essentially the same ontological emptiness as do thing-specifier anomalies demarking reference failure, albeit the SLese significance of that intuition is not immediately plain.) Even so, our subjective appraisals of salient/vacuous are but impressionistic diagnoses of a distinction that is eventually to be cashed out by contrasts in how alternatives on a pattern dimension participate in molar regularities, especially by intradimensional differences in competetiveness.

⟦Intuitive appraisal of anomalous thing-specifier states as "vacuous" presupposes that when the delimiter at issue, say 'the α-thing associated with ___' or more briefly '$\underline{f}_\alpha$(__)', fails at reference for some $\underline{o}$ in $\underline{C}$, this is because there exists no α-thing suitably associated with $\underline{o}$. But anomalous α-specification can also result from $\underline{o}$'s being associated with a surfeit of α-things; and the competetion force of having several α-associates is very different from the vacuity of having none at all. When '$\underline{f}_\alpha(\underline{o})$' is far more likely to fail at reference for the $\underline{o}$ in $\underline{C}$ from α-deficiency than from α-surplus, as usual in thing-specificational practice, we can ignore the latter as a rare residual disturbance. Better, however, is to distinguish two anomalous states of any thing-specifier based on '$\underline{f}_\alpha$(__)', one for each version of reference failure, and regard only the α-absence anomaly as vacuous. Either way, we may continue to take anomalous thing specifications as paradigmatic of "vacuous" patterning.⟧

In general, with many qualifications and exceptions to be largely ignored here, for any two components $\underset{\wedge}{\tilde{y}}_h$ and $\underset{\wedge}{\tilde{y}}_k$ of $\underset{\wedge}{\check{\tilde{Y}}}$, salient values of $\underset{\wedge}{\tilde{y}}_h$ compete with a good proportion of the salient values of $\underset{\wedge}{\tilde{y}}_k$ but not with $\underset{\wedge}{\tilde{y}}_k$'s vacuous values. (This salience-competetiveness is often conditional on other variables in the sense that jointly realizable $\underset{\wedge}{\tilde{y}}_h$-value $\underline{\tilde{y}}_h$ and $\underset{\wedge}{\tilde{y}}_k$-value $\underline{\tilde{y}}_k$ are shown to be competetive by a state $\underline{\tilde{Y}}_a$ of some additional subarray $\underset{\wedge}{\check{\tilde{Y}}}_a$ of $\underset{\wedge}{\check{\tilde{Y}}}$ such that $\langle\underline{\tilde{y}}_h,\underline{\tilde{y}}_k,\underline{\check{\tilde{Y}}}_a\rangle$ is competetively unrealizable even though $\langle\underline{\tilde{y}}_h,\underline{\check{\tilde{Y}}}_a\rangle$ and $\langle\underline{\tilde{y}}_k,\underline{\check{\tilde{Y}}}_a\rangle$ are each realizable separately.) And the competetiveness of saliences is cumulative in that for any subarray $\underset{\wedge}{\check{\tilde{Y}}}_a$ of $\underset{\wedge}{\check{\tilde{Y}}}$, the larger the number of dimensions in $\underset{\wedge}{\check{\tilde{Y}}}_a$ the smaller is the proportion of states in $\underset{\wedge}{\check{\tilde{Y}}}_a$'s range that are fully salient (i.e. contain no vacuous components) and the less likely it is that a fully salient $\underset{\wedge}{\check{\tilde{Y}}}_a$-state $\underline{\check{\tilde{Y}}}_a$ is compatible with any salient value of any given dimension in the remainder of $\underset{\wedge}{\check{\tilde{Y}}}$. (Imagine attempting to pack one pixel display with regular thing-specifier states for increasingly many different delimiters.) That is, it is generally not possible for more than a small fraction of all $\underset{\wedge}{\check{\tilde{Y}}}$-component patterns $\{\tilde{y}_k = g_k\underline{Y}: \underline{k} \in \underset{\sim}{k}\}$ abstracted from any one state $\underline{Y}$ of micro-array $\underset{\wedge}{Y}$ to be salient; on pain of competetive unrealizability their vast preponderance must be vacuous. Consequently, the trajectory $\{\underset{\wedge}{\tilde{y}}_k\underline{f}^r(\underline{o}): \underline{r} = 0,.,2,...\}$ on any $\underset{\wedge}{\tilde{Y}}$-component $\underset{\wedge}{\tilde{y}}_k$ over a very long succession $\underline{o},\underline{f}(\underline{o}),\underline{f}^2(\underline{o}),...$ of $\underline{C}$-objects will typically show occasional short bursts of salient $\underset{\wedge}{\tilde{y}}_k$-values scattered among long stretches of $\underset{\wedge}{\tilde{y}}_k$-vacuity during which other $\underset{\wedge}{\tilde{Y}}$-dimensions especially competetive with $\underset{\wedge}{\tilde{y}}_k$ take their turns at short-run salience.

[Although I have already winced at the gross simplification in taking patterns categorized as vacuous to be generally noncompetetive with ones categorized as salient, certain especially flagrant exceptions to this rule had best be acknowledged in order for us to ignore them wittingly: For any molar variable $\underset{\wedge}{\tilde{y}}_k =_{def} [g_k\underset{\wedge}{Y}]$ abstracted from micro-array $\underset{\wedge}{Y}$, no matter how strongly $\underset{\wedge}{\tilde{y}}_k$'s salient values compete with <u>most</u> other salient patternings abstractable from $\underset{\wedge}{Y}$ there will always exist some $\underset{\wedge}{Y}$-pattern dimensions $\underset{\wedge}{\tilde{y}}_h =_{def} [g_h\underset{\wedge}{Y}]$ which facilitate $\underset{\wedge}{\tilde{y}}_k$ in the sense that although only a small proportion of value combinations on $\underset{\wedge}{\tilde{y}}_k$ and $\underset{\wedge}{\tilde{y}}_h$ are jointly realizable, it is salient $\underset{\wedge}{\tilde{y}}_k$-values, not vacuous ones, that must accompany salient values of $\underset{\wedge}{\tilde{y}}_h$. (Note that "facilitation" so defined is indeed a version of competetion, one which can be thought of as "negative" competition in contrast to the usual sort wherein one salience competes with another.) Facilitation reaches its limiting extreme when $\underset{\wedge}{\tilde{y}}_h$ and $\underset{\wedge}{\tilde{y}}_k$ a-derive from $\underset{\wedge}{Y}$ by the very same abstractor $g_h = g_k$, in which case any values $\tilde{\underline{y}}_h$ of $\underset{\wedge}{\tilde{y}}_h$ and $\tilde{\underline{y}}_k$ of $\underset{\wedge}{\tilde{y}}_k$ are jointly realizable only when $\tilde{\underline{y}}_h = \tilde{\underline{y}}_k$. But weaker similarity between abstractors g_h and g_i can also make $\underset{\wedge}{\tilde{y}}_h$ facilitative of $\underset{\wedge}{\tilde{y}}_k$. For example, define <u>Skew$_{10}$-checkeredness</u> exactly as ordinary Checkeredness (p. 162f., above) except that for Skew$_{10}$-checkeredness the value of shape measure $\underset{\wedge}{z}_{sq}$ for any grid-bounded surface patch $\underline{b}$ of an object is redefined to attain its maximum of 1 when $\underline{b}$ is a flat rhombus with angles $90^\circ \pm 10^\circ$, and decreases from there as $\underline{b}$'s shape increasingly diverges from this rhomboid ideal. Then whatever the degree of an object's ordinary Checkeredness (= Skew$_0$-checkeredness), this will be very close to its degree of Skew_{10}-checkeredness even though these two variables are by no means perfectly correlated. Again, in figure/ground patterning, let $\underset{\wedge}{X}_{\alpha}$ continue as before to specify position and size of the red disk uniquely displayed (whenever it is) in stages of a certain cartoon process, while $\underset{\wedge}{X}_{\gamma}$ specifies position, size, and shape for figures picked out in the same cartoon series by the delimiter 'The red-cored yellow corona in __'s display' which refers, when successful, to a boundary-distinct uniformly yellow display region that completely surrounds exactly one red disk. Then each salient state of $\underset{\wedge}{X}_{\gamma}$ is compatible only with two states of $\underset{\wedge}{X}_{\alpha}$, one regular and the other saliently anomalous. For if $\underline{o}$'s display contains just one red-cored yellow corona, specification of this entails a regular state of $\underline{o}$'s red disk unless that is nonvacuously anomalous through a plurality of red disks in $\underline{o}$'s display.

[[Since real-life abstractive practices, both deliberate and intuitive, tend to avoid simultaneous recognition of pattern dimensions that are strongly facilitative, we incur little loss of generality by presuming that none of the dimensions in our present hypothesized pattern array $\underset{\wedge}{\tilde{Y}}$ appreciably facilitates any other. But alternatively, our discussion here will be unaffected by allowing any given $\underset{\wedge}{\tilde{y}}_k$ in $\underset{\wedge}{\tilde{Y}}$ to be a package of pattern dimensions that facilitate one another.]]

So what sort of dynamics might we be able to write for $\underset{\wedge}{\tilde{Y}}$-patterning in $\underline{C}$? Under the exhaustiveness stipulated for $\underset{\wedge}{\tilde{Y}}$, any dynamics for micro-array $\underset{\wedge}{Y}$ in stable domain $\underline{C}$ should confer on each $\underset{\wedge}{\tilde{y}}_k$ in $\underset{\wedge}{\tilde{Y}}$ a domain-stable molar dynamics

$$(49\text{-}\underline{k}) \qquad \text{In } \underline{C},\ \ \underline{\tilde{y}_k f} = \phi_k(\underline{\tilde{Y}}, \underline{\tilde{Z}}, \underline{e}_k)$$

wherein $\underset{\wedge}{\tilde{Z}}$ is a tuple of molar input dimensions which with luck are identifiably few and $\underset{\wedge}{e}_k$ is a $\underset{\wedge}{\tilde{y}}_k$-specific composite residual that we shall pretend is negligible. You may also find it helpful to suppress distraction from $\tilde{\underset{\wedge}{Z}}$ by presuming that this can be held constant at a particular value $\underline{\tilde{Z}}$ for arbitrarily long successions of system stages in $\underline{C}$, so that in each run so controlled, with $\underset{\wedge}{e}_k$ quasi-constant at a null value $\underline{e}_0$, the righthand side of (49) can be simplified to $\psi_{Zk}(\tilde{\underset{\wedge}{Y}})$ ($\psi_{Zk}(\_) =_{def} \psi_k(\_,\underline{\tilde{Z}},\underline{e}_0)$). But even with the roles of $\tilde{\underset{\wedge}{Z}}$ and $\underset{\wedge}{e}_k$ in $\tilde{\underset{\wedge}{y}}_k$-determination idealized to vanishing, (49)'s complexity is still hopelessly beyond human comprehension insomuch as roughly speaking its transducer must give non-null weight to most $\tilde{\underset{\wedge}{Y}}$-dimensions with which $\tilde{\underset{\wedge}{y}}_k$ is competetive.[42] Yet discarding all but a manageably small subtuple of $\tilde{\underset{\wedge}{Y}}$ on the right in (49) as residuals would presumably sacrifice nearly all the $\tilde{\underset{\wedge}{y}}_k\underline{f}$-variance accounted for by $\tilde{\underset{\wedge}{Y}}$ in $\underline{C}$.[43]

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[42]More precisely, if $\tilde{\underset{\wedge}{y}}_h$ and $\tilde{\underset{\wedge}{y}}_k$ are competetive (either unconditionally or conditional on other $\tilde{\underset{\wedge}{Y}}$-dimensions), then by the argument roughed in by our remarks on (48), in order for the domain $\underline{C}$ of $\tilde{\underset{\wedge}{Y}}$'s dynamics to be stable $\tilde{\underset{\wedge}{y}}_h$ and $\tilde{\underset{\wedge}{y}}_k$ cannot both be decoupled from the other. To be sure, since only one-way coupling is mandatory, this allows such logical possibilities as that the dynamics for $\tilde{\underset{\wedge}{Y}}$ imposes an ordering on its components such that each $\tilde{\underset{\wedge}{y}}_k$ is decoupled from every $\tilde{\underset{\wedge}{Y}}$-component that follows it in this ordering. Even if such extreme cases did not seem improbable, however, they would still not alter the <u>prevailing</u> pervasiveness of coupling here.

[43]More precisely, residuating all but a small number of $\tilde{\underset{\wedge}{Y}}$-components in (49) should let this account for scarcely any more $\tilde{\underset{\wedge}{y}}_k\underline{f}$-variance in $\underline{C}$ than achieved by dynamic-baseline predicting of $\tilde{\underset{\wedge}{y}}_k\underline{f}(\underline{o})$ to be the same as $\tilde{\underset{\wedge}{y}}_k(\underline{o})$. In practice, the errors of this baseline forecast are relatively small compared to the total variance of $\tilde{\underset{\wedge}{y}}_k$ in $\underline{C}$; but it is appreciable further reduction of baseline errors that is the real challenge for a science of $\tilde{\underset{\wedge}{y}}_k$.

The practicalities of $\tilde{\underset{\wedge}{y}}_k$-prediction under these circumstances dictates that we forsake $\tilde{\underset{\wedge}{y}}_k$'s dynamics in the entirety of $\underline{C}$ and try instead to capture only what Strong Domain Constriction reduces this to in run segments wherein $\tilde{\underset{\wedge}{y}}_k$-values are mostly salient while all but a manageably small subtuple of $\tilde{\underset{\wedge}{Y}}$'s other components remain vacuous. Specifically, suppose that $\tilde{\underset{\wedge}{y}}_k$ is one component of a smallish subtuple $\tilde{\underset{\wedge}{Y}}_a$ of $\tilde{\underset{\wedge}{Y}}$ whose dimensions tend to acquire or lose salience roughly as a block, and that when $\tilde{\underset{\wedge}{Y}}_a$ is mostly salient the state of $\tilde{\underset{\wedge}{Y}}$'s remainder $\tilde{\underset{\wedge}{Y}}_{[a]}$ is usually all vacuous. Assume also that if any dimension in $\tilde{\underset{\wedge}{Y}}_{[a]}$ has more than one vacuous value these are virtually identical in their relevance to $\underset{\wedge}{\tilde{Y}}_a\underline{f}$. (This is another condition to be worked into a technical explication of "vacuous" patterns.) Then if $\underline{C}_a$ is the constriction of $\underline{C}$ to (more or less) just those $\underline{o}$ in $\underline{C}$ for which $\underset{\wedge}{\tilde{Y}}_{[a]}(\underline{o})$ is all vacuous, there will be a local-salience dynamics

(50-a) In $\underline{C}_a$, $\underline{\tilde{Y}}_a\underline{f} \;=\; \Psi_a(\underline{\tilde{Y}}_a,\underline{\tilde{Z}},\underline{E}_a)$

for $\underset{\wedge}{\tilde{Y}}_a$, conditional on vacuity of $\underset{\wedge}{\tilde{Y}}_{[a]}$, that may still be more complex than we can handle unless the dimensionality of $\underset{\wedge}{\tilde{Y}}_a$ is <u>very</u> small or Ψ_a is especially simple, but at least gives us a fighting chance at comprehension. And of course if there exists such a local-salience dynamics for $\underset{\wedge}{\tilde{Y}}_a$, we can expect the same will be true for many other not-generally-disjoint blocks $\underset{\wedge}{\tilde{Y}}_b$, $\underset{\wedge}{\tilde{Y}}_c$, etc. of $\underset{\wedge}{\tilde{Y}}$-components. Each local-salience subdomain $\underline{C}_a$ ($\underline{C}_b$, $\underline{C}_c$, etc.) and the molar dynamics therein that characterize mostly-salient pattern values on $\underset{\wedge}{\tilde{Y}}_a$ ($\underset{\wedge}{\tilde{Y}}_b$, $\underset{\wedge}{\tilde{Y}}_c$, etc.) therein, i.e. (50) with substitution for $\underline{a}$ as appropriate, is a <u>mode of action</u> (not to be confused with the mode-facets of mental attributes) for the system from which these are abstracted.

Be clear, however, on the SLese suboptimality of (50) and its like. Their emasculating defect is the inherent ephemerality of their domains even when persistence of vacuity in $\underset{\wedge}{\tilde{Y}}_{[a]}$ ($\underset{\wedge}{\tilde{Y}}_{[b]}$, $\underset{\wedge}{\tilde{Y}}_{[c]}$, etc.) is not further disrupted in $\underline{C}$ by real-world disturbance from inputs $\underset{\wedge}{Z}$ and $\underset{\wedge}{E}_a$. It is, to be sure, logically possible for runs under (50) to continue indefinitely in $\underline{C}_a$ so long as $\underset{\wedge}{\tilde{Y}}_a$ has no partition $\underset{\wedge}{\tilde{Y}}_a = [\underset{\wedge}{\tilde{Y}}_{a1},\underset{\wedge}{\tilde{Y}}_{a2}]$ in which $\underset{\wedge}{\tilde{Y}}_{a1}$ and $\underset{\wedge}{\tilde{Y}}_{a2}$ are competetive but decoupled from one another in $\underline{C}_a$ (cf. discussion of (48).) But even were (50) to be that rarity, a salient-pattern dynamics with long-term stability, it would only preclude that other blocks $\underset{\wedge}{\tilde{Y}}_b$, $\underset{\wedge}{\tilde{Y}}_c$, etc. of $\underset{\wedge}{\tilde{Y}}$-components whose largely-salient states conflict with nearly all largely-salient states of $\underset{\wedge}{\tilde{Y}}_a$ can have appreciable runs of salience in this system. Yet if runs in $\underline{C}$ do often switch from one action mode to another, even our knowing the salient-pattern dynamics within each of these would not tell us when a currently active mode is about to subside, or which mode will follow, or how to predict the salient pattern at onset of a new action mode from the salient patterning that closed out the run in the one just preceding. These are technically intricate issues whose embodiments even in cartoon dynamics are tedious to discuss, nor can we trust the mode transitions in such simple artifices to be typical of natural systems. So let me venture without argument that although onsets and exits of action modes may prove predictable to some modest extent in some systems, prospects for predicting $\underset{\wedge}{\tilde{Y}}_b(\underline{o})$ from the $\underset{\wedge}{\tilde{Y}}_a$-states of $\underline{o}$'s close precursors across the shift from action mode $\underline{C}_a$ to action mode $\underline{C}_b$ appear bleak. And for that matter, the diversified short-run action modes that figure in the system's long-term behavior may well be far too profuse for us to learn many of their distinctive dynamics unless there are strong transducer similarities within broad groups of these modes that can be characterized by common identifiable law-schemata.

In any case, even if these problems are to some degree surmountable, they remain just that--formidable <u>problems</u> that generally make understanding/predicting molar dynamics in a complex system horrendously less tractable than envisioned in the classic SLese paradigm of a domain-stable low-dimensional dynamic system with inductively accessible transducer.

<u>Heuristic 2. Molar photography.</u>

Despite their many virtues for education in the SLese methodology of pattern dynamics, cartoon processes appear too distant from mentality to promise substantive principles with much carry-over for a science of mind. But there is a second arena of physical picturing phenomena, adjoint to the psychology of perception, well worth thoughtful study as a poor man's version of stimulus reception that detaches from the deeper mysteries of perception's internal composition the challenge of distal macro-stimuli. I shall speak to this only briefly, barely enough to set the problem. Yet in one fashion or another this is a wilderness that <u>must</u> be tamed if we are ever to achieve an honest SLese account of sentient-man-in-his-world.

Nowhere in molar psychology are the problems of cognitive holism closer to hand--if we are willing to reach out for them--than in perceptual theory. Commonsensically, perception is a process wherein some s-at-t becomes aware that-p through the mediation of sensory events in s-circa-t produced by the state of affairs signified by the that-p proposition. This criterion is far too narrow to be a good psychonomic definition of perception (e.g., it makes no provision for perceptual error, and I have already urged why mental science had better remain wary of representational aboutness); nevertheless, it motivates stipulation that a cognitive theory of perception must try to describe the environmental sources of $\phi_i$ings-$F_j(a_k)$ in terms roughly translatable into concepts out of which mental contents $\{F_j(a_k)\}$ are compounded. That is, a science aiming to illuminate the epistemic character of perception must salvage and build upon as much as it can from folk psychology's views on world/percept relations both fore and aft.

Indeed, molar psychologies of all persuasions, behavioristic and personality-theoretic as well as mental, have in practice almost always chosen to characterize stimulus input primarily as holistic properties of commonsense objects in the organism's geographic neighborhood. With deliberate lack of precision, let us call such features of the organism's surround distal macro-stimuli. These traditionally contrast with proximal micro-stimuli, which are aspects of the physical materials or energies penetrating some point-like region of the organism's receptive surface. It has long been evident that most outer-world effects upon the mentation and behavior of organisms are mediated by the aggregate of proximal micro-stimuli; and it is fairly straightforward to formalize the latter as values of domain-stable micro-variables $\{[x_i^*\mu_j]\}$ whose module selectors $\{\mu_j\}$ correspond to coordinates of sensory-surface patches over which t-core variables $\{x_i^*\}$ can be proliferated in whatever dimensions of energy wavelength, chemical concentrates, etc., are needed to appraise local impingements. The SLese docility of proximal micro-variables is undoubtedly why the most advanced modern work on stimulus reception (again see DeValois & DeValois, 1980; McArthur, 1982) takes micro-events on an idealized retina (pixel array) as the first stage of systemized input. For molar psychology, however, proximal stimuli are just mediators which, if in need of recognition at all, are to be systemized as lawful consequences of the <u>distal</u> molar environment. The question is, can we in fact identify such laws with SLese effectiveness?

It would be perverse to seek macro-stimulus explanations for impingements on individuated receptor patches, since the very point of molar psychology is to rise above the moil of molecularities whose bearing on commonsensical traits/thoughts/deeds can be severed by Input Abstraction. But molar abstraction over <u>distal</u> <u>micro</u>-<u>events</u> → <u>proximal</u> <u>micro</u>-<u>stimulations</u> → <u>central</u> <u>micro</u>-<u>effects</u> causal sequences makes clear that the impact of distal macro-stimuli on percepts and other cogitations are fully mediated by macro-patterns of proximal stimulation. (See the early work of J. J. Gibson for putative examples.) The organizational differences between proximal stimulus patterns and full-blooded cognitive percepts seem sufficiently large[44] that

[44]In particular, neither proximal stimuli nor the sensory "images" which appear to be their most direct CNS consequences manifest anything like the subject/predicate structure so prominent in the syntax of verbalized mental contents. Deciphering the psychonomic nature of propositional structure and the mechanisms by which it is imposed upon (or extracted from?) pre-propositional afference is the most profound challenge that continues to confront cognitive psychology.

whatever laws may relate these proximal mediators to distal macro-stimuli are bound to be much simpler than whatever laws of cognitive perception result from composition of (<u>a</u>) distal→proximal macro-stimulus principles into (<u>b</u>) the lawful determination of perceivings by (inter alia) proximal pattern stimuli. Molar psychology is not obliged to identify laws (<u>a</u>) and (<u>b</u>) as steps toward SLese insight into cognitive perception; but if it proves incapable of disclosing even (<u>a</u>), we had best write off our hopes for a science of mental systems whose inputs are the distal macro-environment.

I suggest, therefore, that we have much to learn from trying--seriously trying--to spell out SLese principles under which distal macro-stimuli determine proximal stimulus patterns. And to set aside whatever complications may arise from obscurity in what substances/energies penetrating what organic surface regions should be taken as the micro-stimuli from which proximal patterns abstract, I propose further that we initiate this inquiry by shifting to its close inorganic counterpart, molar photography. We know that when a modern Polaroid camera is appropriately loaded with unexposed film, the shutter flashed, and the film squeezed through developing chemicals, the pigments stably embedded in the resultant photograph are arranged in a highly distinctive patterning due to particulars of the camera's environment at the moment of exposure. For convenient reference, call the latter the photograph's exposure scene. With intracamera variables such as lens setting and chemical details of the pre-exposed film and its post-exposure development held constant to be refashioned by Strong Domain Constriction into implicit sources of transducer parameters, what are the laws that tell how a photo's picture qualities--i.e., its values of molar variables which appraise how its pigments are patterned--result from molar properties of its exposure scene?

For this exercise to serve its intended purpose, certain guidelines must be heeded. First of all, we are to work out laws of molar photography written in SLese format

(51) $\quad$ In $\underline{D}_c$, $\quad \underline{Y}_c = \Psi_c(\underline{X}_c, \underline{E})$,

wherein $\underset{\wedge}{E}$ comprises residuals that we seek to minimize, and $\underset{\wedge}{Y}_c$ and $\underset{\wedge}{X}_c$ both have an a/t-derivational structure that is also to be articulated. More specifically, these laws are to describe selected molar properties of the photos $\{\underline{o}\}$ in a certain camera-wise homogeneous domain $\underline{D}_c$ of developed photographs[45] as values of a well-

[45]What counts as a "photograph" is reasonably commonsensical except for its temporal boundaries. We can afford to ignore this obscurity, since it does not much matter whether we take any particular $\underline{o}$ in $\underline{D}_c$ to include a photo's entire lifetime of fixed pigmentation until fade or injury, or only some selected shorter segment of this.

defined compound variable $\underset{\wedge}{Y}_c$ whose domain includes $\underline{D}_c$. And the exposure-scene features they hold responsible for $\underset{\wedge}{Y}_c$-values are likewise to be expressed as alternative states of a compound variable $\underset{\wedge}{X}_c = [X^*_k \underline{f}_k : \underline{k} \in \underline{k}]$ constructed from variables $\{\underset{\wedge}{X}^*_k\}$ over environmental objects whose coupling with photos in $\underline{D}_c$ by the camera/scene locus structure is constituitive of site-selectors (translocators) $\{\underline{f}_k\}$. That is, each $\underset{\wedge}{X}^*_k \underline{f}_k(\underline{o})$ is to scale some tuple of possibly-relational properties of a certain possibly-compound part of $\underline{o}$'s exposure-scene picked out by $\underline{f}_k$. (We allow that in some cases $\underline{f}_k(\underline{o})$ does not exist, whence $\underset{\wedge}{X}^*_k \underline{f}_k(\underline{o})$ is anomalous.) Secondly, <u>the properties corresponding to values of these environmental variables $\{\underset{\wedge}{X}^*_k\}$ are to be mainly distal macro-stimuli</u>. That is, for each $\underline{o}$ in $\underline{D}_c$, most t-core components $\{\ulcorner \underset{\wedge}{X}^*_k ; \underline{f}_k(\underline{o}) \urcorner\}$ of compound exposure event $\ulcorner \underset{\wedge}{X}_c ; \underline{o} \urcorner$ should paradigmatically be scene constituents of sorts that a discerning human observer might perceive, at least were he a skilled photographer wise in the techniques of his art. Thirdly, the molar photo properties scaled by $\underset{\wedge}{Y}_c$-values are to be a-derivative just from the arrangements of pigmentation over the geometrically organized parts of developed photos without regard for how these may relate to other things. In particular, we do not allow states of $\underset{\wedge}{Y}_c$ to be defined as being <u>of</u> something in the exposure scene. (Thus, the property signified by '___ is a picture of two boys chasing a dog' is not acceptable here.) And finally, it is especially important that domain $\underline{D}_c$ be <u>cinematically stable</u> in a sense that needs a small digression to clarify.

Pattern processes in a sequence of stages from the same enduring photograph are in the main exceptionally lethargic. However, a cinematic photo series taken in close succession with the same camera can also be viewed as a system progression whose successive stages are different enduring photos in the order of their exposures; and in such a sequence the action can be lively indeed, albeit cine-dynamics is not our concern here. Let us say that a photo $\underline{o}'$ is the (immediate) "cinematic successor" of a photo $\underline{o}$, abbreviated $\underline{o}' = \underline{f}_c(\underline{o})$, just in case $\underline{o}'$ is the first photo taken after $\underline{o}$ with the same camera.[46] Then photo domain $\underline{D}_c$ is "cinematically stable" iff, for

[46]To minimize concern with pigment fixation and negative-to-positive image transfer, I implied earlier that our camera is a Polaroid. But any camera will do so long as we include the appropriate film-development details on the list of constancies in $\underline{D}_c$.

almost every $\underline{o}$ in $\underline{D}_c$, $\underline{f}_c(\underline{o})$ exists and is also in $\underline{D}_c$. Clearly this is wanted of $\underline{D}_c$ if (51) is to model how molar features of visual stimulation result from a retina's exposure to its distal surround, the impingements upon which change from moment to moment with eye movements within an environment that is itself generally in flux. But more crudely, the bottom line for (51) is simply that $\underline{D}_c$ should be broad enough to contain a non-negligible proportion of all Earthly photographs--not because we intend wide-scope prediction/explanation of photo patternings, but because we want to devise ways of characterizing exposure scenes that may also serve as an effective SLesing of what in the visual environments of most stages of most ocularly endowed organisms matters for their molar reactions thereto.

And why should breadth of domain be a problem for (51)? Because for each $\underline{o}$ in $\underline{D}_c$, the components of $\underset{\wedge}{X}_c(\underline{o})$ are to include enough properties of enough things in $\underline{o}$'s exposure scene to account fully, or nearly so, for $\underline{o}$'s $\underset{\wedge}{Y}_c$-patterning. Ordinary language suggests many different types of scenic "things" that (51) might recognize, ranging from such abstract categories as places, articles (ordinary objects), and surfaces/contours/edges to far more particularized thing-kinds like hills/valleys/rivers/skies, rocks, plants/animals, tools, fires, mists, shelters, documents, etc., etc. It is scarcely feasible for $\{\underline{f}_k(\underline{o}): \underline{k} \in \underset{\sim}{\underline{k}}\}$ to inventory all things of all conceivable sorts in $\underline{o}$'s exposure scene; but we do need this to be a judicious selection, from among all commonsensical and perhaps not-so-commonsensical ways to parse $\underline{o}$'s exposure scene, of some manageable macro-thing array whose SLesable attributes jointly suffice to determine $\underset{\wedge}{Y}_c(\underline{o})$ under a transducer that is not hopelessly incomprehensible. Unhappily, it is a considerable task to verbalize even a few such things and their properties relevant to any one photo $\underline{o}$--a considerable step beyond defining thing-specifiers for a cartoon display--much less to work out a listing sufficient to determine $\underset{\wedge}{Y}_c(\underline{o})$ for a given choice of pattern dimensions $\underset{\wedge}{Y}_c$. And far worse, we want these things to be picked out of $\underline{o}$'s exposure scene by site-selectors $\{\underline{f}_k\}$ that do the same for $\underline{o}$'s cinematic successors $\underline{f}_c(\underline{o}), \underline{f}_c^2(\underline{o}), \ldots$ together with many other photos as well.

What threatens to crush this aspiration of breadth for (51)'s domain is the enormous diversity of exposure-scene layouts for different photos even in one cinematic succession much less in an abundance of them. For example, imagine mounting a miniturized camera on your head to take an extended series of photos as you proceed about your daily affairs. What correspondences can you establish among things visible in the various exposure scenes through which you successively pass--bedroom, bathroom, kitchen, garage, roadway, quad, office, classroom, lab, gym, faculty club, etc.--by virtue of which one thing in each of these transient surrounds is picked out by the same $\underline{f}_k$ for the photo exposed to that scene? To be sure, we have already anticipated need to let $\underline{f}_k(\underline{o})$ be nonexistent for occasional $\underline{o}$ in $\underline{D}_c$. But $\underset{\wedge}{X}_c$ would be hopelessly mega-dimensional in (51) were $\underline{D}_c$ to achieve cinematic stability only by taking $\{\underline{f}_k\}$ to be a collection of site-selectors any one of which finds proper values in the exposure scenes of only a vanishingly small proportion of $\underline{D}_c$-photos. The difficulty here is not anomaly of $\underset{\wedge}{X}_c(\underline{o})$-components as such, but getting $\underset{\wedge}{X}_c(\underline{o})$ to be a listing of $\underline{o}$'s exposure-scene features that is humanly comprehensible, one that we can actually write down and convert by a practical algorithm for Ψ_c-computation into description of $\underline{o}$'s predicted $\underset{\wedge}{Y}_c$-patterning.

To make this problem clear, suppose that we attempt the most commonsensical approach to exposure-scene inventory by taking each $\underline{k}$ in $\underset{\wedge}{X}_c = [\underset{\wedge}{X}^*_k \underline{f}_k : \underline{k} \in \underset{\sim}{k}]$ to index a particular continuant thing $\underline{s}_k$ (or a tuple of them if $\underset{\wedge}{X}^*_k$-states are relations) and defining $\underline{f}_k(\underline{o})$ to be $\underline{s}_k$'s momentary stage at the time $\gamma(\underline{o})$ of $\underline{o}$'s photographic exposure. Since spatial relations among camera and scene parts at the moment of film exposure are important components of the scene-state alternatives ranged by variables $\{\underset{\wedge}{X}^*_k\}$, we need no constraints on how unobstructedly close $\underline{s}_k$ is to camera at time $\gamma(\underline{o})$. So to let $\underline{D}_c$ contain all your daily-routine photos, include in $\underset{\sim}{k}$ an index for every continuant thing that radiantly impinges upon your camera at any time during your transport of it. Then for each photo $\underline{o}$ in your personal cinematic series, $\underset{\wedge}{X}_c(\underline{o})$ includes the $\underset{\wedge}{X}^*_k$-state at time $\tau(\underline{o})$ of all such continuants $\{\underline{s}_k\}$ in your extended life-space--a description of your bedroom things at $\tau(\underline{o})$ and bathroom things at $\tau(\underline{o})$ and kitchen things at $\tau(\underline{o})$, etc.--regardless of how close you were to them at that moment. Not even this construction fully precludes anomalous components in $\underset{\wedge}{X}_c(\underline{o})$ (cf. the state of your breakfast toast when $\tau(\underline{o})$ is much later that day); but for the most part, if $\underline{o}$ is regular on $\underset{\wedge}{X}^*_k\underline{f}_k$ so are $\underline{o}$'s cinematic successors. And although most of $\underset{\wedge}{X}_c(\underline{o})$ is irrelevant to $\underset{\wedge}{Y}_c(\underline{o})$ (e.g., states of things in your kitchen have little bearing on the pigmentation of photos shot in your office), the fragment of $\underset{\wedge}{X}_c(\underline{o})$ that does matter should suffice to determine $\underset{\wedge}{Y}_c(\underline{o})$ if the dimensions of thing-specification in $\{\underset{\wedge}{X}^*_k\}$ have been astutely chosen. So it might seem that we have in principle achieved our goal here--except that in practice, we could scarcely begin to list all these continuant things that $\underline{k}$ is supposed to index, much less expand the list to cover photos taken in similar fashion under camera transport by other carriers in other circumstances.

It is hard not to dispair that laws of molar photography having cinematically stable domains are impossible of attainment, with a similar conclusion following for psychonomic stimulus reception. And indeed, it would be foolish to flinch from acknowledging this limitation's likelihood in our plans for psychology's scientific future. Even so, there remains one prospect for broad-domain SLesing of distal macro-stimuli that may yet prove practical. This is to describe the molar environments of receptive entities (unexposed photo films, sentient organisms, or whatever) by an array of thing-specifiers whose delimiters are various fleshings of frame

(52) The $\underline{i}$th most prominent thing of kind $\underline{K}$ in ___'s surround.

Although descriptor schema (52) is horrendously programmatic, it is far less empty than first impression may accredit. The $\underline{K}$-alternatives it admits are to be whatever small number of broad categories prove needed to regiment similarities/differences in how sources of macro-stimulation emit or modify flows of materials/energies toward receptants and what specification dimensions efficiently describe (with a minimum of anomalous values) the major respects in which things of a kind differ. Whether a thing is opaque or translucent or radiant, whether or not its spatial boundaries are mostly sharp discontinuities enclosing a compact spatial region (lumpy vs. ropey vs. smeary vs. ?), that is the stuff of which _K_-distinctions are to be made. Above all, these stimulant kinds are to yield for each receptant _s_-at-_t_ a physical-salience ranking of its nearby kind-_K_ things under which _s_'s input at _t_ from the less prominent _K_s is masked or otherwise overshadowed by input from more prominent ones of the same or other kinds. Our hope for (52) is that although the totality of _K_-things that can pervade a surround is unbounded, occlusions and remotenesses will keep any one receptant from being appreciably affected by more than a prominent few--which is to say that whatever a law of distal-stimulus reception might accomplish through inclusion of arbitrarily many form-(52) delimiters should for the most part improve only negligibly upon what can be said with but a modest fixed number of these for any one _K_.

Of course, even if a manageably small number of form-(52) delimiters can provide all the site selection we need for effective description of distal stimulation, we also have to build these into an array of thing-specifiers adequate to account for the molar reception consequences we have chosen for study. And that too is ground for dismay. Consider, for example, that we will certainly want _K_-thing specifications to include size, shape, location (distance and direction from receptant), and pigmentation or luminance. Size and location should be relatively straightforward to dimensionalize even if each _K_ requires its own version of these. But how should we parse contrasts in form and color among things whose particular _K_-classification does not sharply constrain those? What are the major much less minor axes of variation in momentary shapes even of mammals (starting, say, with limb positions) not to mention insects and plants. And what array of color features are appropriate to specify the newspaper and TV displays to which you reacted last night?

Yet dispair remains premature. When a law of molar responding calls for specification of the *i*th most prominent *K*-thing in a receptant's surround, it does not generally want a *rich* description of this stimulant's properties, but only such selected aspects thereof as matter for the particular response alternatives this law abstracts. Thus, there is no unconditionally correct way to dimensionalize the shapes of nearby creatures or the coloration of signal displays to which a receptant is exposed; rather, that turns on what reactivity patternings under what domain preconditions we have selected for study. So while pursuit of appropriate specification dimensions for *K*-things is indeed daunting, we can still hope that our search's target, relative to a sufficiently clear conception of what is to be accounted for, is manageably finite.

But doesn't this relevant-input relativity (really a rather obvious point) undermine the heuristic value of molar photography for a science of mind? For even if we do come up with cinematically stable detailings of (51) that moreover translate nicely into domain-stable laws of how distal macro-stimuli produce patterns of light-impingement within eyeballs, we would still have little confidence that the retinal-image counterpart of photo dimensionalization $\underset{\wedge}{Y}_c$ abstracts a proximal-patterning space even roughly aligned with the one that mediates between distal environment and central mentation. However, this demurrer overlooks that our heuristic's main intent is to educate us in *how* to work out genuine SLese principles of macro-stimulus reception. If we ever get far enough in this exercise to verbalize actual dimensions of exposure-scene features and photo patterning, we would expect many of the site-selectors $\{\underline{f}_k\}$ and t-core variables $\{\underset{\wedge}{X}^*_k\}$ constituting $\underset{\wedge}{X}_c$, as well as many retinal-impingement abstractions corresponding to dimensions in $\underset{\wedge}{Y}_c$, to warrant serious psychonomic study even if we suspect that some other parsing of distal and proximal stimulation will eventually provide a superior account of folk-psychology's version of visual perception. That seems especially likely if $\{\underset{\wedge}{X}_k^*\}$-values precisify commonsense attributes of everyday perceptual objects while we have chosen to characterize $\underline{D}_c$-photos by the particular pigmentation dimensions in $\underset{\wedge}{Y}_c$ precisely because these are patternings that can be fully explained by the $\{\underset{\wedge}{X}_k^*\}$-kind properties of things to which photos of sort $\underline{D}_c$ are linked in fashion $\{\underline{f}_k\}$. And if we break off this inquiry before reaching any realistic fulfillment of prospect (51), any instructive preliminary sketch of molar photography will be equally illuminating as a first-approximation to distal→proximal macro-stimulus reception in visual organisms.

Coda: The SLese future of mental science.

Previously in this essay, after speculating on the proper direction for a science-of-mind's movement beyond ordinary language toward a more technically servicable vocabulary of mental ascriptions, I suggested that the most commonsensical dimensionalizing of thought would take each conceivable combination of an open mode (type of mental act) with a propositionally structured content (complex idea) of some basic sort to identify a two-component cognitive variable $[\phi_i \underline{F}_j(\underline{a}_k)]$ whose value-pairs are grades of its mode crossed with intensities of this moded content's activation. I have no great confidence that precisely this formalization will prove best, especially for treatment of cognitive mode; but no plausible alternative is yet in sight and it seems pointless to search for one until we have verbalized a sample repertoire of the specific mental attributes our primary cognitive variables are to systematize and have begun to rough in some of the regularities that supposedly govern these. Whatever details may evolve, any SLesing of cognitive space that recognizably reconstructs commonsense mentation will have the overall methodological character of plethorically many competetive pattern dimensions a-derived from a substrate of neurological micro-variables--mainly because almost certainly that is what contrast sets of primary mental attributes in fact are.

It follows that the competetion/decoupling/domain-ephemerality linkage illustrated for cartoon processes in Heuristic 1<u>b</u> largely thwarts psychology's aspiration for mental dynamics with the domain stability we have come to expect of an advanced science. My previous loose sketch of this bind (pp. 198-203) applies directly to mental systems once we take array $\underset{\wedge}{\tilde{Y}}$ there to comprise cognitive variables and agree that whatever format we choose for detailed definition of any particular $\underset{\wedge}{\tilde{Y}}$-component $\underset{\wedge}{\tilde{y}}_k$, its range includes salient (<u>contra</u> vacuous) values that are appreciably competetive with salient ideation on many other dimensions in $\underset{\wedge}{\tilde{Y}}$. (Recall that treating the salient/vacuous contrast as binary is just a quick-and-dirty simplification.) Clearly that is true of joint ideational arousal no matter how mode of entertainment may complicate the story of this, and also regardless whether we take "arousal" to vary continuously from vivid to null like degrees of Checkeredness or to be a more categorical idea-present/idea-absent difference tied to some delimiter 'the μ_k-idea in __'s thinking' for variably determinate specifications of a unique idea with determinable character μ_k. Although I have not previously aired this latter format as an option for cognitive variables, it too merits consideration if we suspect that entertaining an idea is more akin to cartoon display of a molar figure-on-ground than to a display's being checkered or multi-ringed. Indeed, thing-specification of ideation seems especially appropriate to currently popular information-processing views of cogitation as a flow of parcel-like "items" shunted with assorted transformations from one internal location to another, like circulation of blood cells or postal processing of mail. Even so, an absence of μ_k-ideation differs at most negligibly from its presence at null intensity. Both are vacuous (noncompetetive) alternatives to more vigorous variants of μ_k-thinking that severely interfere with conjointly vigorous thoughts on other dimensions of cogitation however these are specified in detail.

So according to Heuristic 1<u>b</u>'s generalized conclusion, our only real chance at formulating dynamics for some chosen cognitive variable $\underset{\wedge}{\tilde{y}}_k$ under which $\underset{\wedge}{\tilde{y}}_k\underline{f}$ is decently predictable just from $\underset{\wedge}{\tilde{y}}_k$ and a manageably small array of additional cognitive and noncognitive molar variables is to look for an assortment of disjoint restricted laws of $\underset{\wedge}{\tilde{y}}_k$-change, each conditional on special conditions (domain constraints) under which all but a select few of other cognitive variables are quasi-constant at vacuity. Thus roughly speaking--*very* roughly--we need one law to describe how vigor of arousal and degree of confidence in *belief that it will rain tonight* changes when accompanied by *suspecting that the noise just heard was thunder* while *trying to scrape off the gum* but saliently thinking nothing else, another law for change of vigor/confidence in this same *belief that it will rain tonight* conjoint with *noticing that the jade tree needs water* while *remembering how subdued Mary seemed at lunch* and *resolving to be less critical next time* when no other ideas are salient, still another law for flux of effort at *trying to scrape off the gum* while actively thinking at most ..., and so on, and on and on.

Before you conclude from this, however, that we can never identify more than a uselessly tiny fragment of the laws that govern mental processes, note that restricted dynamics such as these may well come in open classes characterized by *meta-laws* such as schematized by

(53) If any variables $\underset{\wedge}{z}_0, \underset{\wedge}{z}_1, \ldots, \underset{\wedge}{z}_m$ and some restriction $\underline{D}$ of their domain intersection satisfy conditions $\Gamma(\underset{\wedge}{z}_0, \underset{\wedge}{z}_1, \ldots, \underset{\wedge}{z}_m, \underline{D})$, then for some residual composite $\underset{\wedge}{e}$ of $\underset{\wedge}{z}_0$-sources independent of $\underset{\wedge}{z}_1, \ldots, \underset{\wedge}{z}_m$ it is a law that in $\underline{D}$, $\underline{z}_0 = \phi(\underline{z}_1, \ldots, \underline{z}_m, \underline{e})$.

To appreciate the force of (53), be clear that its only schematic terms are '$\underline{m}$', 'Γ', and 'ϕ'. That is, were (53) to be fleshed out into a fully meaningful English statement, '$\underline{m}$' would be replaced by a numeral, 'ϕ' by reference to a specific transducer, and 'Γ' by an ($\underline{m}$+1)-ary predicate expressing a rather complex conjunction of relational and nonrelational conditions on various subtuples of its arguments which, *inter alia*, specify ranges for $\underset{\wedge}{z}_0, \ldots, \underset{\wedge}{z}_m$ compatible with ϕ and t-derivations for some of $\underset{\wedge}{z}_0,\ldots,\underset{\wedge}{z}_m$ from others. In contrast, '$\underset{\wedge}{z}_0$',...,'$\underset{\wedge}{z}_m$' and '$\underline{D}$' are bound logical variables (i.e. placeholders for names in the scope of a quantifier) that remain such in any embodiment of schema (53), but later become instantiated by reference to particular attribute-alternatives over a particular restricted object-domain when this completed 2nd-level generality is <u>used</u> to infer one or another 1st-level law of kind Γ.

[[As illustrated immediately below by associative models of ideational arousal, versions of (53) that arise in practice are likely to quantify over placeholders not for names of variables and domains as such but for subordinate terms out of which descriptions of variables and domains are compounded. And in extensions of schema (53), 'Γ(__)' and 'ϕ' may be elaborated as 'Γ(__,$\underline{a}$)' and '$\phi_{\underline{a}}$', respectively, with '$\underline{a}$' abbreviating an additional array of universally quantified terms. A meta-law of this expanded form would then convey an open class of Γ-kind laws within which the transducer of each instance-law adapts to certain particularities of its variables and domain.]]

In mental-science embodiments of (53), when $\langle \underset{\wedge}{\tilde{y}}_0, \underset{\wedge}{\tilde{y}}_1, \ldots, \underset{\wedge}{\tilde{y}}_m \rangle$ is a tuple of variables and $\underline{D}_h$ a local domain of which $\Gamma(\underset{\wedge}{\tilde{y}}_0, \underset{\wedge}{\tilde{y}}_1, \ldots, \underset{\wedge}{\tilde{y}}_m, \underline{D}_h)$ is jointly true, $\underset{\wedge}{\tilde{y}}_0$ and some but far from all of variables $\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m$ will be dimensions of ideation, presumably with $\underset{\wedge}{\tilde{y}}_0 =_{def} [\underset{\wedge}{\tilde{y}}_{\underline{i}}\underline{f}]$ for $\underline{i}$ one of integers $1,\ldots,\underline{m}$ and $\underline{f}$ some excursion step. The remainder of $\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m$ will range over selected subspaces of experience-residues (information stores, memory traces, associations, habits, means-ends-readinesses, or their like), motivational dispositions (preferences, attitudes, need-presses, etc.), abilities, character traits, and what else have you. Part of '$\Gamma(\underset{\wedge}{\tilde{y}}_0, \underset{\wedge}{\tilde{y}}_1, \ldots, \underset{\wedge}{\tilde{y}}_m, \underline{D}_h)$' will require certain conceptual ties between our descriptions of this array's cognitive variables on one hand and its noncognitive ones on the other. For example, it may entail that when $\underset{\wedge}{\tilde{y}}_0$ and $\underset{\wedge}{\tilde{y}}_1$ are Intensity-of-thinking-idea-μ_0 and Intensity-of-thinking-idea-μ_1, respectively, $\underset{\wedge}{\tilde{y}}_2$ is to be an experience-residue variable whose description cites both μ_0 and μ_1 in a certain way. Thus according to the simplest classic model of ideational arousal, how strongly s thinks μ_0 at time t+1 is *ceteris paribus* a multiplication-like function jointly of s's μ_1-thought intensity at t and the strength of s's $\mu_1 \rightarrow \mu_0$ association. The association is distinct from but described in the same individuating terms as the particular episodic ideas with which it is functionally connected.

[Slightly less simplistically, classical association theories envision that if $\tilde{y}_{\mu_i}$ and $\tilde{c}_{\mu_i \mu_j}$ or more briefly $\tilde{y}_i$ and $\tilde{c}_{ij}$ are respectively Intensity-of-μ_i-thinking and Strength-of-μ_j-to-μ_i-association for any given ideas μ_i and μ_j, then the process of thinking an arbitrary idea μ_0 is governed under certain poorly specified boundary conditions (domain restrictions) by

$$\tilde{y}_0\underline{f} = (\underline{c}_{01} \dot{\times} \tilde{y}_1) \dot{+} \ldots \dot{+} (\underline{c}_{0n} \dot{\times} \tilde{y}_n)$$

wherein subfunctions $\dot{\times}$ and $\dot{+}$ are multiplication-like and addition-like, respectively, and the μ_i whose intensities are $\{\tilde{y}_i : \underline{i} = 1, \ldots, \underline{n}\}$ comprise a sufficiency of ideas relevant to μ_0, one of which should be μ_0 itself to account for the perseveration of this idea once aroused. (Note that since 'μ_0','μ_1',...,'μ_n' are only placeholders for particular idea-names, what we have here is the outline of a meta-*law as envisioned by (53).) Further elaboration of this model--which is highly instructive as a SLese exercise even if long obsolete as a serious account of mentation--needs *inter alia* to be more specific about the scaling of ideational intensity and association strength, to include variables additional to ideas and their associations as conjoint sources of μ_0-arousal, and above all to offer some rationale--even if only a domain-restriction fiat--for limiting ideational control of μ_0 to a particular finite choice of $\mu_1, \ldots, \mu_n$. From there, attempting to run dynamics for several competetive ideas simultaneously under this model may help you to appreciate the problems of molar dynamics that I have tried to overview here in more general terms.]]

And '$\Gamma(\underset{\wedge}{\tilde{y}}_0,\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m,\underline{D}_h)$' in our conjectured mental-science embodiment of (53) must also put restrictions on $\underline{D}_h$ under which, roughly speaking, its members have vacuous values on all variables that nonfacilitatively compete with $\underset{\wedge}{\tilde{y}}_0,\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m$ except insofar as some avoidance of competetive unrealizability may be subsumed under the residual disturbance in *law

$$\text{In } \underline{D}_h, \quad \underline{\tilde{y}}_0 = \phi(\underline{\tilde{y}}_1,\ldots,\underline{\tilde{y}}_m,\underline{e}) \quad .$$

(Somewhat more precisely, it is variables that compete with certain translocations of $\underset{\wedge}{\tilde{y}}_0,\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m$, depending on the detailed locus structure of this *law, that must be constrained to vacuity in $\underline{D}_h$. A complicated story lurks herein, about which I am trying to be evasive.) But '$\Gamma(\underset{\wedge}{\tilde{y}}_0,\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m,\underline{D}_h)$' needs not, conversely, require all dimensions $\underset{\wedge}{\tilde{y}}_0,\underset{\wedge}{\tilde{y}}_1,\ldots,\underset{\wedge}{\tilde{y}}_m$ to be fully salient throughout $\underline{D}_h$; so principles of elicitation (salience onset) remain accessible under this rubric.

Establishing even one or two such meta-laws with near-negligible residuals would be a major achievement for cognitive research. Indeed, this would betoken so spectacular an advance in cognitive psychology's SLese maturity that I haven't the heart to expand (cf. p. 202f., above) upon how empoverished in recursive systemacy would be the 1st-level domain-ephemeral laws so aggregated despite their unbounded abundance. The very concept of domain-stability, much less its active pursuit, lies so far beyond the ken of contemporary molar psychology that to make much of mentality's recalcitrance in that regard would be at par with scorning a child's constitutional ill-suitedness for flight when it is still fumbling at learning to walk. There will be time enough to bemoan the limits on a feasible science of mind when SLese reconstructions of folk psychology begin to press against that asymptote.

Still, we had best also be making plans for what to do with cognitive psychology should this indeed prove incapable of soaring with the premier sciences. And for that a brief return to our molar-photography heuristic is instructive. Suppose that we do, in fact, make some honest effort to search out laws of molar photography in compliance with the guidelines above. (Note that this study needs only to be conceptual--i.e., armchair analytic--since presumably we already know all the relevant micro-principles. So it is deterred by none of the usual practical impediments to empirical research.) Then one of three outcomes should result. The first, and happiest, is that we do indeed manage to identify form-(51) molar-photography laws wherein domain $\underline{D}_c$ is repetition-stable, disturbances by residual $\underset{\wedge}{E}$ are small compared to the effects of identified input array $\underset{\wedge}{X}_c$, and most environmental features captured by $\underset{\wedge}{X}_c$-states are comfortably molar at the level of commonsense perceptual objects. Although our reflections above (pp. 210-212) do not encourage sanguinity over this prospect, neither do they show it to be hopeless; and it is, after all, not uncommon for ambitious undertakings to suffer prolonged discouragement before winning through to success. If we do discover how to write well-SLesed laws of molar photography with repetition-stable domains, it should require only routine extensions to give us a SLese dimensionalization of distal macro-stimuli on which domain-stable laws of cognitive perception can be based. (Actually, extensions to include distal macro-stimuli whose proximal consequences are primarily non-visual may not be all that routine. But let us be optimistic.) And although that is not enough to ensure the availability of domain-stable laws of post-perceptual ideation, it would at least give us important impetus in that pursuit.

Secondly, it is conceivable that although principles of micro-physics do not abstract into repetition-stable laws of molar photography for which SLese formalisms are well-suited, we can nevertheless comprehend how holistic properties of exposure-scenes account for photographic picture qualities by means of some style of explanation quite different from SLese. I find it exceedingly difficult to imagine what such an explanational alternative might be, unless it is some nonverbalizable _verstehen_ in which I am myself deplorably deficient. (Don't scoff: If only _verstehen_ provides comprehension of human psychology in depth, as some would have it, why cannot this deal with holistic features of the inorganic world as well?) Yet it is premature to insist that SLese is the only communication format in which intellectually rewarding generalities can be expressed. (_I_ think so; but if I did insist, would you believe me?) And if there do exist effective ways to predict/explain/understand holistic phenomena that elude SLese regimentation, perhaps molar photography is the setting wherein we can diagnose what these are and work out how molar psychology might usefully exploit them.

Finally, we may reluctantly decide that abstraction of intelligibly stable molar-photography principles from the laws of micro-physics is impossible. If so, a similar conclusion is inescapable for cognitive perception, nor have we reason to expect greater domain stability in other cognitive regularities whose input variables are as grossly holistic as I posit of ideation. That means we can dismiss our aspirations for a hard science of mental systems. To be sure, this is far from putting quietus to psychonomic science. It does not even discourage our hopes for a rich repertoire of cognitive laws, so long as we are resigned to these having domains insufficiently stable for useful integration. But it does insist that if we want to develop a science of organisms as dynamic causal _systems_, we had better break the choke-hold of naive mentalism that has once again tightened down upon our conceptions of inner events. Folk psychology and cellular neurophysiology are not the only levels of molar organization on which zoological functioning can be investigated. We must not surrender our license to search out finely quantifiable patterns of input/output regularities and the inner mechanisms these inductively reveal in whatever conceptual units we can _discover_ to have the greatest SLese systemacy. If these prove to be very like folk psychology's parsings of the outer world and human ideational/motoric reactions thereto, so much the better. But that is still very much an open question.

We need, in short, a resurrection of behaviorism. Not of specific mid-Century behavior theories, whose primordial treatments of, inter alia, stimulus structure and experience traces are clearly obsolete. And certainly not of the largely mythological positivistic behaviorism that proscribed theories of the inner organism as idle fancy. The behaviorist ideal which takes seriously the old-fashioned scientific distinction between evidence and hypothesis, which seeks to shape our models of psychonomic mechanisms by tough-minded inference from sceptically hardened data on which mentalistic interpretations have not been imposed at the outset, that is the doctrine whose revival to counterbalance current cognitive science's runaway aprioricism has become urgent.