Intellectica, 1998/1-2, 26-27, pp. 149-180

Daniel BULLOCK*

Social Interaction, Language Games, and Cognitive Convergence Rate[1]

A clearer view of human intelligence and cognitive development emerges if human-class intelligence is recognized as inherently a socially distributed phenomenon. Such recognition follows scrutiny of a *convergence rate hierarchy* that characterizes the phylogenetic development of intelligence in the biological lineages leading to modern humans, because the examination reveals social interaction to be necessary for all the newer interactive modes in this hierararchy. Combining these concepts with the concept of "language game" from Wittgenstein's later work yields a theoretical basis for rejecting the skeptical conclusions reached by Fodor and others regarding the open-endedness of human cognitive development.

Key words: intelligence, language, social interaction, cognitive development, Wittgenstein

L'interaction sociale, les jeux de langage et le taux de convergence cognitive. Le développement phylogénétique de l'intelligence dans les généalogies biologiques qui conduisent aux êtres humains modernes est caractérisé par une hiérarchie dans leur taux de convergence. L'examen de cette hiérarchie révèle que l'interaction sociale est indispensable pour l'ensemble des modes d'interaction les plus récents. Il s'ensuit que le développement cognitif humain est mieux compris si l'on reconnaît que l'intelligence de type humain est un phénomène qui est intrinsèquement socialement distribué. La combinaison de ces concepts avec celui du "jeu de langage", tiré de l'oeuvre tardive de Wittgenstein, crée une base théorique permettant de rejeter les conclusions sceptiques de Fodor et d'autres concernant la nature ouverte du développement cognitif humain.

Mots-clés : intelligence, langage, interaction sociale, développement cognitif, Wittgenstein.

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* *CNS Department, Boston University, 677 Beacon Street, Boston, MA 02215, USA; E-mail: danb@bu.edu*

[1] *Substantially updated and revised from Bullock (1987).*

> "Man ... owes this immense superiority to his intellectual faculties, to his social habits, which lead him to aid and defend his fellows, and to his corporeal structure. ...Through his powers of intellect, articulate language has been evolved; and on this his wonderful advancement has mainly depended" (Darwin, 1871/1981, 46-47).

> "Does a child learn only to talk, or also to think? Does it learn the sense of multiplication before — or after it learns multiplication?" (Wittgenstein, *Zettel*, 324.[2])

Though human history appears somehow discontinuous from prior natural history, our sense of theoretical order creates a need to comprehend it as another chapter of that history. Darwin pointed to articulate language as the agent of discontinuity, while suggesting that a mosaic of intellectual powers, social habits, and bodily form enabled the evolution of language. In one sense this seems unarguable, but the quoted passage exhibits a subtle problem. Darwin appears to treat intellectual faculties and language as separate things, and as fixed phenotypes. He says that language *has been evolved*, as if its development were complete. Though Darwin may not have thought of language this way, many others observers have, and do.

One who did not treat language as a fixed phenotype, and ultimately for Darwinian reasons, was Ludwig Wittgenstein, whose later work contains many ideas of great value to cognitive developmentalists. Unfortunately, few cognitive scientists are familiar with Wittgenstein's legacy, and among those who are, misunderstandings abound. Some have cited Wittgenstein as if he would answer the questions posed in his book *Zettel* (quoted above) with "only to talk" and "before". In fact, the Platonist bases for such answers were analyzed and rejected by Wittgenstein. Other commentators have read passages like the following and concluded that Wittgenstein was a behaviorist:

> One of the most dangerous of ideas for a philosopher is, oddly enough, that we think with our heads or in our heads. The idea of thinking as a process in the head, in a completely enclosed space, gives him something occult (*Zettel*, 605-6).

This passage and others show that Wittgenstein did not endorse any thesis of psycho-physiological parallelism. But attention to the passages's subtleties and a broader study of his work also show that Wittgenstein did not endorse behaviorism. What Wittgenstein abhorred were occult, i.e., non-naturalistic, descriptions of mental phenomena.

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2 Numbers associated with citations of Wittgenstein's work are section numbers, not page numbers, because the latter vary across various editions.

Though this abhorrence is universal among behaviorists, it is also typical of cognitive scientists.

While several cognitive developmentalists (e.g., Rosch, 1978; Bruner, 1975; 1983) have explored the research implications of Wittgensteinian themes, many aspects of his naturalistic view of mental life remain to be assimilated. Herein, I hope to further that assimilation by showing how his recurring themes clarify issues of intellectual development. And by taking a constructive tack, I hope to help retire the view that Wittgenstein's relevance for cognitive science is primarily critical. My argument is that Wittgenstein's emphasis on social-interactive "forms of life" can be taken as the starting point for a new type of answer to such questions as: How can intelligence be treated as an evolving product of natural history? What is a non-question-begging explanation of human intelligence? What are the recurring weaknesses in prior attempts to provide such explanations? Why is it that, having given an account of humans' internal representational capacity, we would still lack an understanding of what separates human intelligence and intellectual development from that observed in our nearest animal relatives, or in the electronic progeny produced to date? A Wittgensteinian answer highlights the diversity of roles played by modes of interaction, both social and asocial, symbolic and nonsymbolic, in cognitive development.

Wittgenstein's Legacy. Wittgenstein's legacy includes a set of prescriptions and a set of constructions.

Prescriptions. Wittgenstein's later work exemplifies the attitudes characteristic of a good naturalist and ecologist. The student of mental phenomena is enjoined to scan widely and to respect the diversity that such scanning inevitably turns up. Such respect is legitimized by the Darwinian thesis that diversity and variability are essential aliments of evolutionary processes, whose fundamental role must not be occluded by misguided efforts to discover the 'true' essences of natural kinds. A related message is that conceptual analyses are often starved because analysts arbitrarily restrict their diet of examples. For example, analyses of language prior to Wittgenstein focused too exclusively on one variety of language use: propositions. Any generalizations about language that were based soley on a study of propositions were bound to misrepresent linguistic, and thus mental, reality. As a corrective, Wittgenstein worked to reveal the great diversity in language forms and functions, thus building a basis for speech-act analyses (e.g., Austin, 1962; Searle, 1969) and other contextualized analyses of language and cognition (e.g., Chapman & Dixon, 1987; Harrison, 1973; Hendriks-Jansen, 1996; Lakoff, 1987; Stewart, 1994; Taylor, 1995).

An exclusive focus on propositional forms and on associated issues of inference and representation misrepresents mental reality by desocializing it, and by masking its dependencies on, and connections with, other aspects of the natural world. As Bruner (1983) has emphasized, conventional language originates in a communicative channel, as a more powerful means to the already established goal of managing others' attentional states. Thus language is rooted in (but is not reducible to) a phylogenetically and developmentally prior matrix of goal-directed social interactions. To neglect this matrix is to begin to distort our view of our mental life. To combat such distortions, Wittgenstein constantly brings our attention back to the humble supportive matrix without which even the loftiest processes of mental life would have no purchase. Thus his description of the plight of linguistic formalists in his 1954 *Philosophical Investigations (PI)*:

> "[In trying for a purely formal analysis of actual language] we have got onto slippery ice where there is no friction and so in a sense the conditions are ideal, but also, just because of that, we are unable to walk. We want to walk: so we need *friction*. Back to the rough ground!" (*PI*, 107).

Like ecological psychologist J.J. Gibson (1966), Wittgenstein was acutely aware of the problems arising from "air theories" of mental phenomena. Attention to the matrix should allow us to construct an alternative type of theory, a naturalistic "ground theory" of mental development (see Bullock, 1981). In cognitive studies, among the sources of inattention to the supportive matrrix are the arbitrariness and disconnectability of non-iconic representations. To combat the associated "bewitchment of intelligence by means of language", Wittgenstein showed how words like "game", "language", and "tool" mask diversity — often so much that what we learn about one exemplar of a category (e.g., propositions) tells us very little about another exemplar of the category (e.g., requests). This line of thinking led to his famous suggestion that natural language categories are based on context- and purpose-dependent judgments of featural overlap (family resemblance categories, Rosch, 1978; Adams and Bullock, 1986; Lakoff, 1987) rather than on logical rules such as set union or set intersection. The observation serves as a general tool for promoting theoretical advance: When we use a word like "intelligence", what diversity are we masking, and what can be learned by resisting the word's masking effect (by studying the diversity)?

Constructions. Though Wittgenstein considered himself a conceptual therapist — a curer of misunderstandings — he also constructed the kernel of a new theory. Kuhn (1970) suggests that some such constructive work is always necessary in practice. To successfully displace a well-entrenched vision of reality, it is necessary to offer an alternative vision. Conceptual therapy, like any other therapy, is never neutral. Either the would-be therapist offers a substitute mode of living or thinking, or the attempted therapy fails: The man on the flying trapeze lets go of the first trapeze only if a second is swinging within reach.

Wittgenstein's first move toward constructing the kernel of an ecological theory of meaning was to ask about the criteria governing our everyday use of the word "meaning". His second move was to examine existing theories of meaning. And his third move was to note how the theories fell short of capturing the richness implied by our everyday concept. Explicating our everyday concept required him to begin the dual processes of mechanistic specification and of locating the variegated phenomena lumped under the word "meaning" within a wider range of natural phenomena. Among the theories that Wittgenstein found wanting, two of the most important were that the meaning of a word is (1) the thing for which it stands (or an image of the thing for which it stands) or (2) a mental activity that accompanies the word as it is spoken. The first proposal exemplifies associationist theory, and the second exemplifies rationalist critiques of associationist theory. Wittgenstein rejected both accounts, on grounds that to establish a table of correspondences between sound-shapes (words) and things (or pictures of things, or mental acts) is only a preliminary to meaning. To fix the representational status of items in the table, they must be put to use in a particular way. A similar point was made by Anderson (1976) when he argued that a cognitive model that presents only a format for internal representations, without also specifying the procedures that will make use of the structures built in that format, is really only a preliminary to a cognitive model. Without the procedural specification, such structures only have representational status *by courtesy*, as it were. To borrow the term for embryonic tissue before it takes its final form and place in the body, we might call such structures *presumptive*, rather than grounded, symbol structures.

Wittgenstein encapsulated his insight, that representational status or meaning is a distributed property dependent on customary usage, with now famous remarks like the following:

> To imagine a language means to imagine a form of life (*PI*, 19).

> For a *large* class of cases — though not for all — in which we employ the word "meaning" it can be defined thus: the meaning of a word is its use in the language (*PI*, 43).

> Hence it would be stupid to call meaning a 'mental activity', because that would encourage a false picture of the function of the word (*Zettel*, 20).

> Only in the stream of thought and life do words have meaning (*Zettel*, 173).

Wittgenstein's emphasis on meaning as culture-specific use led many to treat Wittgenstein as a relativist, as did Bloor (1983) in the book *Wittgenstein: A Social Theory of Knowledge*. However, the phrase "relativity of knowledge" hides a diversity of positions, and Wittgenstein signaled the need for caution regarding his intentions in the following passage, where he poses to himself the "relativity of truth" question:

> So you are saying that human agreement decides what is true and what is false?" — It is what human beings *say* that is true or false; and they agree in the *language* they use. That is not agreement in opinions but in forms of life. (*PI*, 241)

In this passage Wittgenstein drives a wedge between agreement of beliefs and agreement about language conceived as a set of representational/instrumental devices and their modes of deployment in activities. Though all knowledge is in one sense relative, objectivity or veridicality is not in direct competition with relativity. The relativity that Wittgenstein acknowledges as ineliminable is one of finitude, of necessary selection by non-omniscient subjects. The symbol-enriched form of life lived by any human social group facilitates encounters with a finite number of aspects of the natural and artificial world, never with all possible aspects. In particular, representational forms and uses typically coevolve, and exemplify both a function-selects-form and a form-constrains-function principle.

From this perspective, there are two types of departure from objectivity. One type comprises lies and everyday mistakes, both of which are made within the horizons established by a language-game or form of life. The second type is an ill-adapted language-game, e.g., the one once played by chemists who postulated the existence of phlogiston. Some who give Wittgenstein a conventionalist reading take him to suggest that every language-game has equal claim to our loyalties. But this is a mistake. He passionately battled against the bewitchment of our intelligence by means of language, and his method was to expose and abandon the ill-adapted, free-sliding language-games played by many prior philosophers. Wittgenstein did argue that one language-game cannot typically be reduced to others (Danford, 1978), and that language should not be seen as striving toward some single, ideal, form. But this anti-reductionist thesis does not warrant an equal-merit stance toward different language-games. His anti-reductionism should also not be taken to imply opposition to mechanistic explanations of human action. Nothing about a mechanistic explanation requires that it be reductionist, in the relevant sense.

Although he pursued neither himself, a social theory of intelligence is closer to the spirit of Wittgenstein's later work than a social theory of knowledge. What is the difference between the two? The latter suggests a concern with developmental products (knowledge structures), and with how such products are relative to social status. It typically leads to increased skepticism (and often cynicism) regarding knowledge claims. The former suggests a need to reform standard accounts of what intelligence is, by socializing them. It focuses on the question of how we may be more intelligent, or at least differently intelligent than we might otherwise be, because of our sociality. It need not promote skepticism regarding knowledge claims. Wittgenstein's rejection of the facile skepticism of prior philosophers, as well as his caveats regarding reading him as a simple conventionalist, undercut attempts to use Wittgenstein’s analysis to justify relativism. Thus I question the following passage from Millikan (1984, p. 332):

> Descartes and then Locke, it is said, opened an era in which philosophers sought vainly to reach the world through a veil of ideas. ...They placed themselves behind this veil by beginning with a vision or theory of mind as a realm in which ideas lived but which was outside the world these philosophers wished to reach with their ideas — the world, at least, of nature. Today, influenced ... by Wittgenstein and Quine, there is a new school of philosophers who live behind a veil of ‘theories’, entangled in ‘language games’ or in the ‘logical order’. They too have placed themselves behind a veil by beginning with a certain vision or theory, this time a theory about language ... floating loose from the rest of the world.

The phrase "influenced by Wittgenstein" leaves it unclear whether Millikan thinks that Wittgenstein was an early member of this new school of philosophers, or whether his ideas regarding language-games have been mis-appropriated by this new school. My reading is that like the realist Millikan, Wittgenstein had an abhorrence of "air theories" of our mental life, and he invented the term language-game precisely to show how our representations are parts of, and are articulated with other parts of, the world. This is made clear in the following sketch for a primitive language-game, which Wittgenstein reveals to be a mosaic phenomenon consisting of representational and non-representational parts, as well as socially shared habits for relating such parts to one another and to ongoing activity:

> I shall call the whole, consisting of language and the actions into which it is woven, the "language-game".
>
> A gives an order like: "d-slab-there". At the same time he shews the assistant a colour sample, and when he says "there" he points to a place on the building site. From the stock of slabs, B takes one for each letter of the alphabet up to "d", of the same colour as the sample, and brings them to the place indicated by A.
>
> ...What about the colour samples that A shews to B: are they part of the *language*? ...It is most natural, and causes least confusion, to reckon the samples among the instruments of the language (*PI*, sections 8 and 16).

Far from cutting language loose from the remainder of the world, the language-game fixes the representational status of presumptive symbols by anchoring them within a matrix of actual activities and objects. Notably, Wittgenstein reckons the humble color samples among the instruments of the language. This serves a dual function: it secures due status for the matrix factors without which presumptive representational forms would remain presumptive, and invites recognition that the representational forms are of the same type, i.e., also objects in the world.

This point can be sharpened by following through on Bruner's suggestion of continuity between language and selective attention. Language socializes and explosively expands the mechanism for selective attention. The latter is in essence a filtering device used to create a new "re-presentation" by highlighting a subset of the information in a more primary presentation. From this perspective, language games function not to veil reality but to enable shared focus on subsets of reality. A necessary side-effect of all selective re-presentations is a de-emphasis of task-irrelevant information, but in trade the language-game allows the subject to apprehend more clearly the information subset that it highlights.

It might be replied that in Wittgenstein's example, the knower stands behind the veil of the human's naive color space representation, which is 'inadequate' by comparison with the physicist's theory- and instrument-based description of light and surface reflectivities. However, Wittgenstein blocks such skeptical conclusions by recalling that representations function within — and should be judged adequate or inadequate within — some particular behavioral cycle. For the purposes of a given task, a representation may capture the relevant aspects of the world, yet may also prove inadequate for some new class of purposes, such as those of the research physicist. Indeed, *purpose-specificity is the normative condition of a representation*. Thus, for example, the color of an apple as we perceive it truly predicts (under normal conditions) its edibility. As Gibson would say, we see that the apple affords eating. It is an illicit maneuver to use the physicist's criteria for what counts as a veridical representation of light or surface reflectivity (which criteria are determined by the physicist's purposes) to judge the adequacy of representations evolved to serve different purposes, e.g., that of using color to decide whether an apple or fig is worth the climb. To become skeptical of claims to knowledge in all such cases is to illicitly presuppose the existence of some representational format that would prove equally good for all purposes.

Thus to acknowledge the purpose-relativity of our procedures for representing, as Wittgenstein certainly did, is not to warrant a free-floating skepticism about knowledge claims. Such skepticism results from a failure to appreciate what representations normatively are within a naturalistic framework (the focus of Millikan, 1984). As shown below, the normative purpose-relativity of representations can be used to combat another type of skepticism that has dogged cognitive studies since ancient times: namely, skepticism regarding experience-based growth in the power of the child's representational system. For example, Fodor's (1975) critique of Piaget's thesis of interaction-based growth in cognitive powers cannot be maintained once the issues are clarified with the aid of a social theory of intellectual development constructed with the aid of Wittgensteinian insights.

A SOCIAL THEORY OF INTELLECTUAL DEVELOPMENT.

Wittgenstein's observation about the tendency of words to hide diversity can be used as a lens to promote a clearer view of intelligence. In answering the question of what intelligence is, most theorists have been biased by the image we have of ourselves as big-brained creatures. This image has led to what Gould (1980) criticized as a 'brain-centered' view of human evolution. Thus to explain human intelligence, most theorists focus on encephalization, i.e., on growing a bigger, more elaborate, brain. Throughout, intelligence is thought of as something that is localizable within the skull. Yet, when we begin to vary our diet of examples of human intelligence in action, we find that intelligence is *not* something localizable within a single skull, and that such a brain-centered view of intelligence is actually *more* distortive of the reality of human-class intelligence than of the kinds of intelligence observed in other species. Human intellectual potential is unique for the extent to which it requires social embedding in order to be realized according to the normative developmental pattern. The brain is a device with prodigious potential, but it remains a mere lump of protoplasm unless it is involved in the kinds of interactive behavioral cycles that allow its internal states to actualize their potential representational statuses. For humans the content and structure of the requisite interactive cycles — which *constitute* our intelligence — have become thoroughly dependent on social processes, which cannot, in principle, be localized within a single skull. To be ecologically valid when thinking of our kind of intelligence, we must re-cognize it as a socially-distributed phenomenon. Far from being a mystical proposal, this ecological perspective removes many of the false mysteries engendered by the physically bizarre view that "thinking is a process in a completely enclosed space".

A socializing syllogism. Sociality's constitutive role in intelligence, or at least in the kind of intelligence humans exhibit, can be established via an argument focused on a core aspect of evolutionary dynamics: the rate of development of novel adaptive phenotypes. Thus:

1. Intelligence can be defined as the power of an adaptive engine to use neuro-muscular resources as a means to maintain an adaptive fit with a dynamic environment.

2. Because environments are unpredictably dynamic, even the more intelligent creatures (e.g., those which have significant internal-simulation capacities) are constantly drifting away from adaptedness.

3. In environments that change quickly, there is selection pressure for adaptations that promote rapid convergence toward new states of fitness. Such adaptations might be called "second-order adaptations".

4. Because these second-order adaptations contribute to the power of the adaptive engine, they too, if achieved via neuro-muscular mechanisms, are constituents of intelligence.

5. Species can be located within a *convergence rate hierarchy* (Bullock, 1983; 1984; Fischer & Bullock, 1984) on the basis of the speed with which average members move toward new states of (neuro-muscularly based) adaptedness after environmental changes. By 1 through 4, this convergence-rate hierarchy (Table 1 and Figure 1, below) is also a hierarchy of levels of intelligence.

6. Examination of the convergence-rate hierarchy within our phyletic lineage shows that social relationships and modes of social interaction

play an integral role in determining species' relative positions within the hierarchy.

7. Therefore, sociality must be considered to be a definitive constituent of human-class intelligence. Moreover, it may be a necessary constituent of human-level intelligence in general.

This argument places the problem of intelligence in a naturalistic context, and defines intelligence in terms of both a functional and a structural criterion. The functional criterion focuses on improvements in rate of achieving new adaptations. The structural criterion insists that such rate gains be achieved via increased power to adaptively utilize one's neuro-muscular resources. This rules out our counting as intelligence-based the strategy of having larger litters of individuals with less learning potential — a strategy actually 'chosen' by many extant biological lineages (Eisenberg, 1981). By focusing on rate, and correlatively on the idea of second-order adaptations, the argument emphasizes the idea that intelligence essentially involves more than having a grab-bag of stock solutions to adaptive problems ("first-order adaptations"). Higher intelligence requires sophisticated provisions ("second-order adaptations") for adding to one's stock of solutions in an open-ended way.

A major point of the argument is that the constituents of human-class intelligence are heterogeneous. *Any* adaptation that promotes rapid convergence toward new states of adaptedness gets counted among the constituents of intelligence. If a new neural circuit that allows better pattern registration and more robust learning and memory emerges (Grossberg, 1982), that counts as a constituent of intelligence. If a new tendency emerges to attend to others' performances, and this facilitates rudimentary imitation, that also counts as a constituent of intelligence — as does the culturally-transmitted practice of encoding continuous quantities with the aid of standard measures and the modern number system. Allowing such heterogeneity within the category of constituents of intelligence amounts to treating *intelligence* as a family resemblance category (Wittgenstein, 1952; Rosch, 1978). This tactic allows escape from the brain-centered view of the development of human intelligence and opens the way to a more adequate survey of intelligence's natural constituents.

Modes of interaction and intelligence. Among the most important constituents of intelligence, because of their central role in generating new adaptations, are the *modes of interaction* available to a species member. A survey of such modes reveals that there is a 'cline' (Givon, 1979) from relatively asocial modes to modes that are either pragmatically or logically dependent on social relations (Feldman & Toulmin, 1976; Haroutunian, 1983; Premack, 1972). Consider first some relatively asocial modes. The human infant's interactive repertoire includes capacities for spontaneous visual search and scanning (e.g., Haith, 1980), for tactile exploration, for orienting to sounds, and for the famous circular reactions that were studied by Piaget (1962). Such modes, though they have an organization of their own that is partly rooted in brain organization, require external aliments if they are to perform their normative developmental functions, which include, among others, the generation of new, adapted, representations and coordinations (Bloch & Bertenthal, 1990). Scanning builds up representations of particular forms. Circular reactions allow the discovery of particular transformative relations (e.g., Bullock et al., 1993). Such interactive modes are essential for the realization of cognitive potential. Though any single interactive mode might be eliminated without causing irremediable cognitive deficits, some substitute mode will have to be found if remediation is actually to occur (see Kaufmann, 1980, ch.3). To get a clear view of the developmental role of such modes is to recognize as normative that cognitive potential has coevolved with mechanisms for its realization (Bullock, 1983), just as plants that use pollen transfer for propagation have coevolved with the insects that serve as one mechanism for the realization of their reproductive potential. In the case of cognition, this coevolution has been such that *actual* intelligence, like actual reproductive power, is as much a matter of realization mechanisms, i.e., interactive modes, as it is a matter of structural potentials afforded by a highly differentiated and plastic brain.

When we ask what modes of cognitive-development-promoting interaction individuate our lineage, and ultimately our species and particular communities, we find a rich array of social-relations-based modes of interaction, i.e., modes that are either pragmatically or logically dependent on social relations for their normal expression or development. Examples of such modes can be taken from the convergence rate hierarchy shown in Table 1. At each level a mode is added to the species repertoire, and because each new element enables faster convergence toward new adaptations, as schematized in Figure 1, each counts as a constituent of intelligence.

Consider first level 5, distinguished by the emergence of exploratory play in our lineage's modal repertoire. Exploratory play may seem to be just as asocial an interactive mode as the infant's visual scanning. However, its placement after social attachment in the hierarchy is based on the hypothesis that exploratory play is a relatively fragile mode that achieves its normal expression only when the individual is in a state of felt security, which serves to buffer the individual against the fears generated by novelties encountered in the course of play. Such felt security, in turn, depends on the quality of the social relationships between the would-be explorer and others in the social group. If this hypothesis is correct (see Fagan, 1981), then exploratory play - undoubtedly a key driver of cognitive development - is pragmatically dependent on social relations.

Table 1. A hierarchy of factors affecting convergence rate.

1. Natural Selection (NS).
2. NS + Reflex Conditioning (RC).
3. NS + RC + Conditionable Goal Directed Activity (CGDA).
4. NS + RC + CGDA + Affective Bonding/Communication (ABC).
5. NS + RC + CGDA + ABC + Exploratory Play (EP).
6. NS + RC + CGDA + ABC + EP + Constructive Imitation (CI).
7. NS + RC + CGDA + ABC + EP + CI + Purposive Teaching (PT).
8. NS + RC + CGDA + ABC + EP + CI + PT + Presyntactic Symbolic Communication (PSC).
9. NS + ... + CI + PT + PSC + Syntactic Symbolic Communication (SSC).
10. NS + ... + CI + PT + PSC + SSC + Writing (W).
11. NS + ... + CI + PT + PSC + SSC + W + Advanced Literacy (AL)

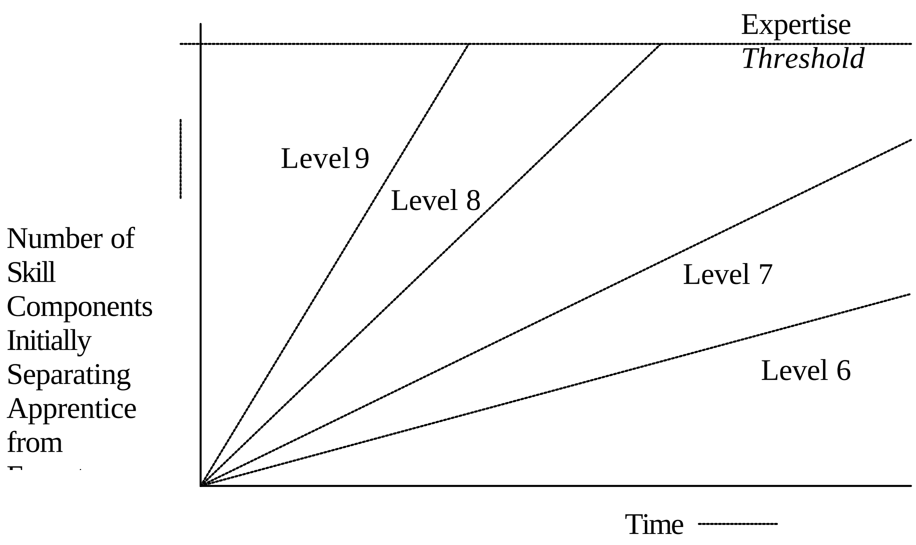

Figure 1. A schematic illustration of convergence rates at four levels of social-cognitive development

Level 6 of the hierarchy marks the emergence of constructive imitation, a mode of interaction that is more than merely pragmatically dependent on social relations because it is a socially-constituted phenomenon. Constructive imitation occurs when an individual, in order to recreate some performance observed in another, must learn a new way to use his or her neuro-muscular resources (Guillaume, 1926/1971). Thus constructive imitation is, by definition, both developmentally progressive and an inherently social phenomenon. Constructive imitation also has a huge impact on convergence rate (Bandura, 1971), and thus qualifies as a constituent of intelligence. First, it affords observers rapid convergence toward particular adaptive solutions that have been discovered by some other member of the group. Second, it allows rapid convergence toward new modes of interaction discovered by others, which modes have the potential to generate further adaptive solutions. I can imitate your intricate technique of chipping sharp flakes from stone for immediate use as scrapers. But I can also imitate your technique of probing the universe for its secrets, e.g., your way of playing with different types of stone and different percussive methods.

When constructive imitation entered the species repertoire as a dominant mode of interaction, our type of intelligence passed a threshold to become normatively a socially-distributed phenomenon. Once the pattern of intellectual development comes to depend on frequent operation in the imitative mode, it follows that much of an individual's achieved adaptive power is an inheritance from others' problem-solving efforts. In such a species, the individual's actual power to arrive at new adaptive solutions is a joint function of imitative propensity and mnemonic or inventive efforts by members (including self) of the social network. Thus the individual's adaptive power is best measured by looking jointly at the individual's imitative propensity and at the groups within which the individual interacts and freely shares information. This measure of adaptive power will be different for different individuals because of differences in imitative propensity and in group memberships. Because the power so measured is socially-distributed, and is just what we have called intelligence, it follows that we should consider intelligence to be normatively socially-distributed in any species where imitation has become a dominant mode.

This point already requires that we de-emphasize the skin as a critical boundary in discussions of the referent of "intelligence". Yet, even more of the imitative mode is socially-distributed than we typically realize, because it has been complemented by further social developments (see also Kaye, 1982). To see how, ask how often an imitator's success depends on a helping hand from the model. Level 7 in the hierarchy marks the emergence of purposive teaching, which amounts in most contexts to aiding the would-be imitator's attempts to construct a skill (or other cognitive structure) which matches that of some model. Perhaps the simplest way to teach is to take the time to repeat an act so as to create for the imitator a prolonged opportunity to function in the imitative mode.

This repeats the pattern seen in the case of exploratory play: social relations support operation within modes of interaction that would not otherwise exist, or would not otherwise exist in the same form, or be manifested with the same frequency. But the pattern transmutes once imitation is combined with purposive teaching. In the case of exploratory play (at least as abstracted here) the social other acts as a mere affect modulator, and one could imagine getting the same effect with, say, a drug of some sort. With level 7, the intelligence of the other comes into play, and this leads to a kind of adaptive co-development (see Fischer & Bullock, 1984). The innovation at level 7 effects the *closing of a modeling circuit* that necessarily has its parts distributed in different individuals (Bullock, 1983; 1984). The innovation at level 7 amounts to completion of an integrated, but complex, phenotype — a phenotype that is, in our case, species-characteristic.

Such intermeshing, achieved by activation of complimentary circuits in different individuals, has precedent in the domain of reproductive behavior and in the domain of emotional communication. However, the modeling circuit is special because the intermeshing it achieves is more dynamic and open-ended: any performance exhibited by the other can come to serve as a 'topic' for the imitative 'conversations' made possible by the level 7 mode. This socially-distributed circuit should have a status in our theories of intelligence equal to the circuit that enables visual scanning, or the circuits that exist within the brain to ensure such basic intellectual powers as the ability to learn new things without overwriting what was learned in the past (see Grossberg, 1982). Whereas the scanning circuit builds new codes, and whereas the latter circuit stabilizes extant codes against erosive influences, the modeling circuit serves both functions.

The modeling circuit also helps solve a unique and fundamental problem associated with intellectual plasticity. Allowing one's development to be fundamentally open-ended requires relaxing instinctive guidance (Stenhouse, 1974). If not accompanied by compensating provisions, this could be disastrous, because the individual could be left without procedures for coping with the tasks of life. The level 7 mode (which, as the Table indicates, incorporates many prior modes) is nature's mosaic solution to this problem. With its assembly, evolution had effectively pieced together a way to make development both closely regulated and essentially open-ended. The evolving adult, as nurturant teacher, came to assume more and more of the burden of ensuring that the child's development would follow an adaptive trajectory, thus allowing the success of children who, because of weaker control by instinct, were at greater freedom to extend the frontiers of cultural practice.

Because the modeling circuit enabled our intelligence to become socially-distributed in a much more pervasive sense than that of a species classifiable at any prior level of the convergence rate hierarchy, level 7 was a watershed in the evolution of intelligence. Yet, it is hardly the last chapter in the story of interactive modes as constituents of intelligence. The next section returns to Wittgenstein's concept of language-games, which as interactive modes are distinguished by their use of arbitrary symbol systems.

Before that return, it is instructive to consider a potential objection to the foregoing. Some may balk at treatment of the level 7 mode as a complex phenotype. It may seem to violate some well-established paradigm to treat between-brain circuits on the same footing as within-brain circuits. However, to treat the modeling circuit differently because it is socially-distributed - to think it somehow less legitimate a constituent of intelligence, or less genuine a phenotype, for *this reason* - is to surrender to the prejudice that the skin-boundary should be the final arbiter in judgments of what intelligence is, and of what phenotypes are. Such surrender is a mistake. The reference case here is the brain considered as the seat of intelligence. Yet the brain itself is unique precisely for the extent to which - unlike other organs such as the liver or pancreas - its normal morphogenesis (Bullock, 1998) depends on interactions with structuring influences from beyond the skin. The brain has made a career of ignoring the skin's claim to be a boundary! Moreover, if we look at how relatively asocial interactive modes are enabled by neural circuits, then we find an anticipation of the distributed, mosaic solution. For example, the macro-circuit that enables infant visual scanning has critical sub-circuits scattered over at least a dozen spatially segregated neural regions (Grossberg & Kuperstein, 1986/1989). In short, the only paradigm that the socially-distributed modeling circuit violates turns out to be a false image of how the real brain actually accomplishes intelligent functions. It is entirely "in character" for the brain to evolve to become something that develops normally only when embedded within a social network of a specially evolved type, namely one in which imitation is complemented by purposive teaching.

A similar reply can be made to the objection that something logically dependent on the participation of two individuals can't be called a phenotype without violating standard biological practice. In fact, both logic and current practice recommend using the word in such contexts (Dawkins, 1982). If beavers' dams, bower birds' bowers, and mating rituals are all proper phenotypes (and they are), then so is the imitation/teaching mode and the distributed brain circuit that makes it possible in any particular social unit.

HUMAN-CLASS INTELLIGENCE CONSTITUTED BY LANGUAGE-GAMES.

> "An intention is embedded in its situation, in human customs and institutions. If the technique of the game of chess did not exist, I could not intend to play a game of chess. In so far as I do intend the construction of a sentence in advance, that is made possible by the fact that I can speak the language in question." (Wittgenstein, *PI,* 337)

This section concerns how the developments noted in the prior section potentiated the emergence of human-class intelligence. It also explicates mistakes made by such writers as Fodor (1975) and Chomsky (1965) who, unlike Wittgenstein and later functionalists (e.g., Croft, 1995), have tried to treat language as a fixed phenotype. The effort reinforces the theme that our kind of intellectual development is remarkable for being closely regulated yet also essentially open-ended, a pattern that appears impossible to achieve in a less fundamentally social species.

A first step is to define **language-game** in such a way as to ensure appropriate generality. In particular, a definition is needed that allows the inclusion of mathematics because mathematics provides an especially clear instance of how language-games play a constitutive role in human-class intelligence. Such an inclusive definition is consistent with Wittgenstein's views:

> Do not be troubled by the fact that languages (2) and (8) consist only of orders. If you want to say that this shews them to be incomplete, ask yourself whether our language is complete; — whether it was so before the symbolism of chemistry and the notation of the infinitesimal calculus were incorporated in it; for these are, so to speak, suburbs of our language (*PI*, 18).

Like the concept of intelligence, the concept of a language-game can be specified via both a functional and a structural criterion, as follows (from Adams & Bullock, 1986, pp. 159-160):

> ..."language-games" is quite an apt term for the various language-informed activity modes elaborated through cultural evolution. When the *games* component of "language-games" is stressed, we are reminded that there is great diversity across exemplars of language (e.g., naming, counting, greeting) just as there is diversity within the class of games (e.g., games of skill, games of chance, card games, ball games, etc.). We are also reminded that linguistic devices are of vital importance in the performance of certain *activities*; they are not merely representational devices (Austin, 1962; Searle, 1969). Finally, we are reminded that linguistic phenomena, like the events that may be observed on a game field, are simultaneously constrained by physical law, biological functionality, and social convention. When the *language* component of "language-games" is stressed, we are reminded that whatever activity mode we are discussing owes part of its form to the participation of linguistic structures. Thus "language-game" is shorthand for an organized, culturally transmitted mode of activity, performance of which depends on, and provides the rationale for, some particular linguistic device. ...The particular mode of activity (e.g. quantificational activity involving the range of terms "all", "some", and "none"; or rhetorical activity involving terms like "equality for all" and "enemy of the people") both depends on, and provides the rationale for, the linguistic device. Neither the mature form of the mode of activity, as such, nor the linguistic device, as such, is prior to the other. In practice they must emerge together.

The core idea here is that constructing a new mode of activity frequently involves, as a constitutive process, learning both a new symbol system and a method of deploying it. Here one is tempted to think that the mode of activity already exists in its mature form, and that the symbol system is added on at the last moment for the purposes of interpersonal communication. This construal is one pole of an ancient debate about the relations between language and thought: language is *mis*construed as the mere outward garb of thought, which is presumed capable of taking the same form without the participation of language.

This misconstrual can be blocked by studying examples where a more primitive mode of thought is superceded by another mode that clearly depends on mastery of a new language-game. Consider the case of a painter who faces the general problem of making a living and the immediate problem of painting a ballroom floor that is made from an unfamiliar material. The general problem places a premium on completing the ballroom without wasting time and other resources. The efficiency (read 'adaptive power') of the painter's solution will depend on the nature of his representation of the problem. Consider first a relatively primitive representation. The painter looks over the ballroom and remembers a similar job done last year. But that room is remembered as being smaller than the present one. So the painter resolves to mix more paint than he remembers having mixed for the former job. He does so, but something goes awry, and he mixes either far too much paint or far too little.

Now consider a relatively sophisticated solution, based on a qualitatively different representation of the problem. Along perpendicular walls of the room, the painter lays out rows of unit squares. He then counts the rows to derive a length and a width, and multiplies the two numbers to derive the area. Next he mixes a small, standard amount (say a half liter) of paint and tests to see how many unit squares worth of floor it will cover (; this is necessary because different kinds of flooring are more or less absorbent, etc.). To be quite precise, he assesses his test-plot coverage in terms of fractional parts of unit squares. He then divides the quantity of unit-squares-covered into the total area, thus deriving the number of standard paint quantities he needs to mix. He mixes two percent more than the computed number to allow for undetected variations in absorbency, etc.

Though there is much in common between the two painters - both exhibit a kind of practical reasoning, for example - their modes of interaction are quite different. The second painter's mode is built up from a number of prior innovations that have become the common social inheritance of members of our culture. *Area* is no longer treated solely as an enclosure bigger or smaller than some remembered enclosures. Instead, it is treated *in the terms* made available by mastery of the representational paradigm, as something constructed by multiplying unit squares. Moreover, though the painter may not understand why, his possession of this concept of area amounts to being more intelligent, in just the sense discussed throughout this paper. For this class of problems, the culturally transmitted representational paradigm allows rapid development of responses that are closer to what an expert on this ballroom and this type of floor would do without need for calculation (see Figure 1).

This Wittgensteinian example of thought constituted by a new language-game matches what Piaget held to be paradigmatic of cognitive development: a highly fallible strategy based on perceptual-mnemonic estimation is replaced by a more robust strategy based on explicit quantitative calculation. Yet Wittgenstein is diametrically opposed to the view, commonly attributed to Piaget, that thought always develops first, and is only later mapped by language for the purposes of communication. The apparent paradox can be eliminated by taking account of two factors. As noted, Wittgenstein used "language" as a synonym for the open-ended collection of socially-learned games we play with representational paradigms, whether the latter be image-based, word-based, or formula-based. Merely to learn to distinguish and concatenate sound-shapes (presumptive words) would not count as learning a new module of the language for Wittgenstein. In short, rote speech, which Piaget dismissed as mere language learning, Wittgenstein would count, at best, as only a preliminary to language learning. If the second painter had merely learned the multiplication table, without learning any application of it, he would not be credited with learning the language-game by Wittgenstein. Piaget would say that he had learned some language, but without understanding.

Noting this basic difference in how Piaget and Wittgenstein use the phrase "language learning" closes much, but not all, of the gap that initially appears to separate them. Wittgenstein remains distinct from Piaget for his greater sensitivity to the symmetry of consequences produced by dissociating thought from language or language from thought. Piaget felt a need to decide in favor of either language's or thought's claim to developmental priority. And, after noting the dissociability of genuine understanding from mere speech, he decided in favor of thought's claim to priority. However, as indicated in the quote from Adams and Bullock (1986), Wittgenstein saw that claiming priority for either element in the traditional dispute was a mistake. Parallelling the observation that one can have rote speech in the absence of genuine understanding is the equally valid observation that one cannot have genuine understanding in the absence of *some* speech-based or other representational paradigm. For when we analyze particular cases, we find that to dissociate or subtract out the representational devices is also to destroy thought. One is left with mere occult wisps, not with *understanding*. As in the case of the two painters, any advance to a new mode of adapted thought involves mastering both a representational paradigm and a method for deploying it. There is no learning the method of deployment (no understanding or thought) without some representational format to deploy! In short, once one uses the word "language" in Wittgenstein's sense, the very disjunction of language and thought as distinct sets becomes problematic. At best, one can maintain that language is a subset of thought: language comprises that subset of representational paradigms that are socially shared and socially transmitted.

One of the problems with the narrower Piagetian construal of language is that it invites (but does not logically require: see Flanagan

(1984) and Haroutunian (1983)) the sort of skeptical views regarding cognitive development that Fodor (1975) recently tried to defend. If one does not explicate the dependency of new modes of thought on the invention and social transmission of new representational paradigms, then the field is open for Fodorian claims that cognitive development is a matter of realizing the potential of some pre-existing representational paradigm (or a small number of successively maturing representational paradigms). Here there are no genuine learning-based increases in the power of the developing child's conceptual system, because all candidate increases may be treated either as maturational (genuine, but not learning-based) or as mere alternative realizations of potentials already present in some general, preformed or "matured", representational paradigm. Though perhaps learning-based, such alternative realizations would not count as true increases in the system's representational powers.

Having elaborated the distinction between a presumptive symbol system and a true linguistic device, language-game analysts are innoculated against such skepticism regarding learning as an engine of genuine expansions of our conceptual horizons. In the following passage, Wittgenstein exemplifies the typical case in which children learn a new way of thinking by learning how a symbol system may be deployed in actual life, a learning process which transforms the presumptive representational paradigm into a genuine linguistic device:

> Does a child learn only to talk, or also to think? Does it learn the sense of multiplication *before* — or *after* it learns multiplication? (*Zettel*, 324).

Wittgenstein answered the first question with "also to think", the second with "after". If either after or during, then one kind of cognitive development involves the "senseless" learning of how to play a symbolic game with a set of discriminable tokens according to arbitrary rules, accompanied by learning to map some of the constructions found in that symbolic microcosm onto particulars of interactive experience, which together lead to a restructured understanding of those particulars and a 'conferral of sense' on the heretofore senseless symbol game.

In this paradigm of cognitive development, the first aspect involves learning what may be called a raw pattern defined over presumptive symbols. The second aspect involves learning how to apply this pattern to structure interactions with some other aspects of the world, and, as a consequence, learning a sense for the presumptive symbol system. In this scheme, the adaptive learning cycle is divided into two parts governed by different principles, just as the great cycle of adaptation by variation and natural selection is divided into two such parts. It is this insight that is absent from Fodor's (1975) treatment of concept development, and from many other treatments within the conceptualist tradition (see Kaufmann, 1980). It is also this insight that the phrase *language-game* helps us remember, by reminding us of a characteristic human capacity: the ability to playfully work out (and, later, socially transmit) arbitrary games played with symbols and standard samples — in the painter's case, a game involving unit squares and number construction played according to the rules of arithmetic. Here the working out can be playful in the sense that it need not be constrained at every moment by an extrinsic concern for representational adequacy. Yet such activity is constantly generating presumptive representational paradigms that have the potential of informing new, serious, modes of interaction. So understood, the concept of a language-game becomes decisive in the battle against conceptual preformism.

Because Fodor (1975) lacks Wittgenstein's insight, he finds it natural to presuppose that the learner must know how a presumptive representational paradigm will be applied before it has been learned as a raw pattern, and before any attempt to discover how it might prove relevant to some reference domain. This peculiar presupposition is tied up with his initial decision to restrict "learning" to cover only the process of *judging whether* a particular representation validly applies, in what must then be a prespecified way, to a domain of reference. This reduces all learning to the case of testing the validity of a belief, which, as we saw earlier, always happens within the horizons established by the language-game. Left out of Fodor's picture is the kind of non-explicit learning (and training in the use of a paradigm) that serves to establish the language-game itself. It is Fodor's procrustean definition of learning that leads him to the mistaken conclusion that nothing in cognitive development genuinely counts as a learned increase in the representational power of the child's conceptual system.

From the present perspective, Fodor effectively lops off all of part 1, and fundamentally distorts part 2, of the learning cycle that produces our cognitive development. By resisting such procrustean efforts, Wittgensteinian and Piagetian cognitive developmentalists ally themselves with both the poets and the mathematicians in a two-millenia struggle against preformist nativism. To deny the first part of the learning cycle is to ignore the sort of esthetic or pattern-focused play that is constantly extending the potential representational powers of pure mathematics, art, and literature. Moreover, to distort the second part of the cycle, by assuming that the *way* a new symbol system is to be mapped onto other aspects of the world is predetermined, is to deny the creative aspect of comprehending a new metaphor (see Lakoff &

Johnson, 1980) or of discovering a genuinely novel way to make "real world use" of what was theretofore a pure mathematical construction. In each of the latter cases, a mapping often doesn't exist until the presumptive representational paradigm and the potential reference domain "rub against each other" to generate an epigenetic event, to again use the language of embryology. Hence the resulting mapping (which Wittgenstein called a "method of projection") may be literally unprecedented in its nature. The nature of the method of projection worked out between Riemannian geometry and the properties of physical space-time was something genuinely new on the cognitive landscape. The concept of a two-phase learning cycle helps us see the working out of this mapping as an epigenetic *event* in the natural history of human cognition.

Preformists recommend a fundamental misconstrual of such events based on another — widely validated yet locally inapplicable — paradigm of our experience. Again from Wittgenstein:

> It is difficult for us to shake off this comparison: a man makes his appearance — an event makes its appearance. As if an event even now stood in the door of reality and were then to make its appearance in reality, like coming into a room (*Zettel*, 59).

The contrast between Wittgenstein and the preformists can be characterized in terms of two types of generativity. Wittgenstein, Piaget, and others have recognized, as a fundamental type of cognitive developmental phenomenon, the kinds of generativity that result from playing with changes in both the local structuring laws of a symbol system and in methods of projection. Preformists, to the contrary, have limited themselves to the type of generativity that results from tracing the implications of a fixed set of axioms applied in a predetermined way (see also Bullock, 1981).

From this perspective, it becomes easy to see a second point at which Fodor's argument — that there is an innate language of thought which bounds our cognitive development — has gone wrong. It *is* the case, as Fodor argues, that in order to learn the normative sub-activities involved with a new representational paradigm (such as the sub-activities of choosing equal unit squares, of laying unit squares end-to-end without gap, and of counting unit squares) one often uses already-available perceptual descriptors. However, none of these sub-activities, taken alone, amounts to the new representational paradigm. The latter depends on patterned deployment of the sub-activities. Neither this patterned deployment, nor any conceptualization enabled by it, can be adequately captured in terms of pre-existing descriptors. Thus Fodor's treatment conforms to the preformist norm by being implicitly reductionist: it presupposes that what is true of the part (the sub-activity) is also true of the pattern into which the part is woven.

To salvage any of his argument, Fodor would have to shift ground and argue that there are constraints on human pattern learning itself, i.e., constraints on what can be learned as a presumptive representational paradigm. While this might prove a fruitful tack, it would no longer amount to arguing that there is an innately bounded language of thought. As we have seen, the raw pattern, by itself, is not yet a genuine linguistic (representational) device. It is only a preliminary. Thus there is no way for Fodor to salvage his preformist claim that intellectual development cannot involve genuine learning-based increases in the representational power of our conceptual systems. Quite the contrary: *the mosaic combination of our relatively arbitrary pattern-learning and pattern-application-learning abilities precludes the possibility of treating language as a fixed phenotype*.

In summary, culturally transmitted language-games play a constitutive role in human-class intelligence. Much of what is recognizable as human intellectual history has been made by the coalescence of new language-games that have enabled the rapid generation of whole families of conceptual innovations, which in turn have multiplied the speed with which we could solve many classes of problems. Our linguistic culture can be likened to a giant glass ball, filled with representational paradigms and modes of interaction augmented by each generation, and kept aloft by many hands. The modeling circuit ensures the safe transfer into the hands of the next generation. Anyone lacking either the social-interactive competence needed to learn the subset of language-games played by a particular community of problem-solvers, or lacking sufficient opportunities to learn them at the knees of community members (see Collier, 1994), will lack the *actual* intelligence needed to participate fully in the community's life — whatever the person's intellectual *potential* may have been. Moreover, contrary to the claims of Fodor, new language-games do not merely fill out a space already delineated by some pre-existing language of thought. They are the instruments by which we break beyond the current limits of language and thought.

This is not to say that there are no limits on human cognition. My arguments against Fodor's thesis are not pertinent to many other proposals regarding constraints on human cognition. In particular, nothing I have said contradicts the thesis of various neo-Piagetians (e.g., Case, 1980; Fischer, 1980; Fischer & Bullock, 1981; Halford, 1982) and linguistic functionalists (e.g., Hawkins, 1994; Lieberman, 1984) that there might be an upper bound on the momentary complexity of human information processing. Nor have I argued against the thesis that our cognitive growth is biased by predispositions, some of which are open to being either confirmed, or 'over-written', by experience (e.g. Bates & MacWhinney, 1982; Bickerton, 1981, Croft, 1995). These ideas have considerable merit, and complement the ideas presented in this article. Moreover, no theory of language-games as constituents of intelligence will be complete until we explicate the determinants of selective transmission of language-games: the modeling circuit is an adaptive filter rather than a passive conduit. A balanced view will encompass the extra-representational aspects of language-games, including the dynamics of group commitment to, and rejection of, competing language-games (Goody, 1977; Spiro, 1984).

CONCLUSION: SIX SYNDROMES, WITH BRIEF COGNITIVE THERAPY.

Several related habits of thinking work to obscure our view of the cognitive landscape. It is useful to list some of these conceptual syndromes, and to prescribe a brief 'therapy' for each. Along the way, the major themes of this article will be revisited.

Table 2. Prescriptions for six conceptual syndromes.

SYNDROME	PRESCRIPTION
essentialism	population thinking; family resemblances; purpose-relativity of representations
preformism	epigenesis; 'snow mounds'
downward projection	deductive vs. empirical solutions; hierachical dependencies among language-games
false disjunction	alternative set relations
atomist reductionism	cognitive-social co-evolution; construction grammar
encapsulation	mosaic evolution; convergence-rate explanations

Table 2 lists six syndromes. Paired with each is a conceptual alternative which, once assimilated, tends to loosen the syndrome's hold on our thinking. The first syndrome is *essentialism*, the presumption that all the natural phenomena named by a given term must share a single set of distinctive features, which define the 'true' nature of the class of phenomena. Biologists overcame this syndrome by learning to think in terms of evolving populations rather than in terms of perfect members of eternal species. Wittgenstein overcame it by learning to think of categories by analogy with families, whose members, though distinguishable from members of other families on the basis of features, nevertheless fail to exhibit any universally shared set of such distinctive features. Without the essentialist presumption, it is hard to continue to believe that a single representational paradigm — the one that captures the referent's essence? — might be equally good for all purposes. Thus a rejection of essentialism is dual with the insight that it is the normative condition of a representation that it be purpose-specific. The prescriptions listed in Table 2 are therefore to recall facts about biological populations, overlapping family resemblances, and the purpose-relativity of representational paradigms.

A second pervasive syndrome is *preformism*. Preformism is a species of pseudo-explanation best understood in contrast to the paradigm for genuine developmental explanations, which, following Piagetian and embryological precedent, may be called the epigenetic paradigm (see Molenaar & Raijmakers, 1997). The latter involves explaining how new order emerges in nature as a result of interactions among pre-existing factors which, though also exhibiting an order, are notably *different* in form than that which emerges. A preformist 'explanation' deviates from the epigenetic paradigm in one critical way: it implicitly or explicitly gives the pre-existing factors the same structure as the emergent order. Thus it makes no real progress in understanding how new structure emerges in nature, at least not beyond noting that some 'new' structures arise by the reproduction of prior structure. Well known theories of Fodor and Chomsky are both preformist in the sense that both effectively reduce all the later structure seen in mature individuals to structures present at birth. This raises an important distinction for developmental psychology: the distinction between nativists and preformists. Nativism, considered as the expectation that there must be tremendously rich structure present at birth, is a positive force in developmental psychology. However, nativism coupled with preformism, the view that all subsequent structures were effectively included in the initially given set, is a disaster for developmental studies — whether of star formation or concept formation.

The remedy for preformism is to focus on the need to explain the emergence of *new* structures. In embryology, epigenetic explanations displaced the preformist homuncular theory long ago, hence the first entry under prescriptions in Table 2.

The second entry, 'snow mounds', alludes to the following example. Imagine that you come upon a rectangular path freshly cleared of snow (see Figure 2). In the middle of the path is a flower bed now completely covered with snow. At each end of the bed is a mound — an elevated region — of snow. How did the snow mounds emerge? The preformist would be happy to conclude his search by finding that an oddly shaped cloud (rectangular, with thickenings at both ends) had dropped the snow in the pattern found, or that the person shoveling the snow had purposely built up the mounds (thus matching some pre-existing image that instantiates the same form).

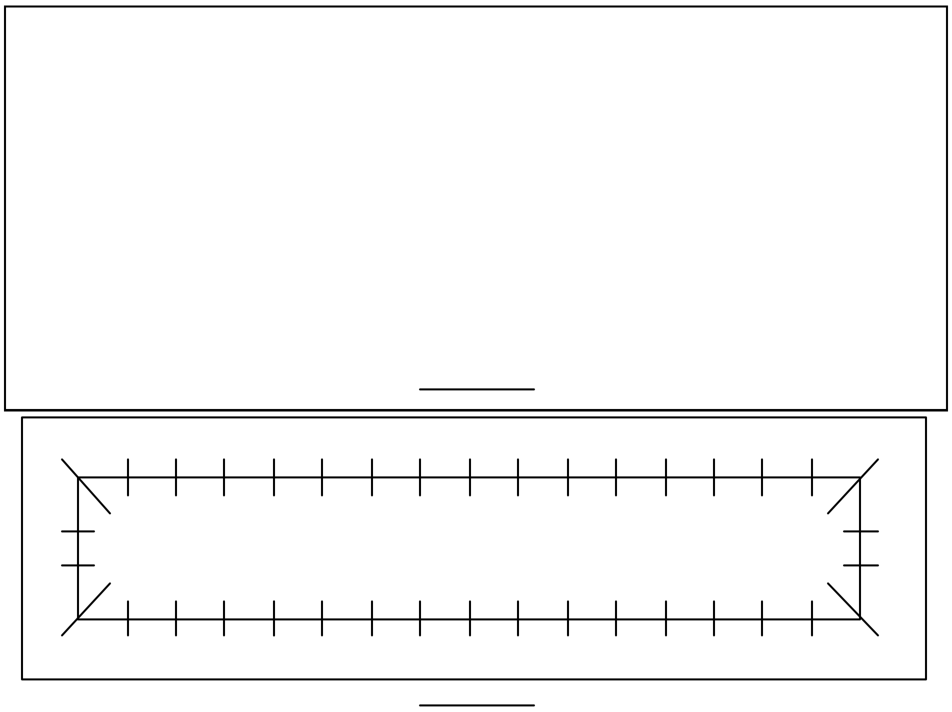

Figure 2. Snow mounds: How an initial geometry and an oriented process can conspire to generate a new structure.

The epigeneticist would be profoundly unhappy with either account. He or she would try to explain the *origin* of the structure, not merely its replication. In this case (for this is a true story) she would find that there were several pre-existing factors which together conspired to create the snow mounds, but that none of these factors had the same structure as the final pattern of snow. A right-handed shoveler working anti-clockwise around any path with a similar geometry will always generate more snow for the bed at its ends than at its middle, hence will always generate snow mounds. Yet neither the right-handedness, nor the geometry of the path and bed, nor the anti-clockwise motion have the snow-mound structure in them: the double mound pattern is a genuine emergent. Abundant similar examples can be found in the vast literature on nonlinear dynamical systems, part of which has recently addressed emergent properties of human voluntary movement (e.g., Beek, Peper & Stegman, 1995; Bullock & Grossberg, 1991, 1992; Haken, Kelso, & Bunz, 1985), including cultural modes such as cursive handwriting (Bullock, Grossberg, and Mannes, 1993). Some of this work has reached the point of reconstructing neural circuit mosaics within which intracellular biochemical dynamics are revealed to generate a time scale matched to that required for learned serial behavior (Fiala & Bullock, 1996).

The third syndrome, *downward projection*, is closely related to preformism. It involves seeing more in an early developing structure than is really there. Much of Piaget's special genius lay in his ability to overcome this tendency. This is clearest in his many experiments showing that the same solutions generated deductively by older children can only be generated by empirical assessments in younger children. Thus one cure for this syndrome is a familiarity with Piaget's experiments on deductive vs. empirical solutions. A closely related therapy for downward projection would be study of Wittgenstein's treatment of hierachical dependencies among language-games (e.g., Zettel, 421-424). The field of cognitive development has undergone periodic epidemics of downward projection, as researchers stumbled over each other to project ever more mature competencies into the heads of ever younger babes. What they overlook is that "sameness of meaning amounts to sameness of language-game and nothing less" (Adams & Bullock, 1986, p. 162).

The fourth syndrome is *false disjunction*. To ask whether language follows thought, or thought language, is to presuppose that language and thought are disjoint sets. If this presupposition is incorrect — as I've argued — then the very disjunction "language first or thought first" is false and can only lead to a muddle. Another false disjunction popular among developmentalists is that of nature vs. nurture. The persistence of this opposition retards refinement of developmental theory, as Dennett (1975) has pointed out. One way to see beyond the opposition is to note that *a type of nurture can be a product of nature*, a point exemplified by the convergence rate hierarchy. Among our most important *natural* abilities is the distributed ability to close the modeling circuit, yet the latter's reason for being is the provision of *cognitive nurturance*. Thus it is incorrect to maintain that a given explanatory factor must fall under the heading of nature, or nurture, but not both. The reason why the language-thought and the nature-nurture oppositions do not work is that what we really have are set-subset relations: a very substantial subset of what we call thought depends on mastery of language-games; a very substantial subset of what we are 'by nature' was selected to establish our unprecedented style of nurture. To escape the syndrome of false disjunction, one must entertain other possibilities for relations between classes.

The fifth syndrome is *atomist reductionism*. In the case of intelligence, this is the tendency to succumb to the ideology of individualism, and hence to underestimate just how much of the normative human developmental trajectory owes its present shape to the evolutionary and ontogenetic scaffolding provided by social interactions, especially nurturant social interactions. It is the habit of proceeding as if the kind of development we exhibit could have evolved in an asocial species. A good example of the syndrome comes from a study of a pair of neglected children who were discovered to have invented their own sign language (Goldin-Meadow & Feldman, 1977.) The authors argued that their data showed that deaf children could "acquire sign language without exposure to a model". Even if we accept the claim that the children in the study were not exposed to any adult gesturing, it must be noted that the children were exposed to each other, hence *had each other as models*. This is an extremely important point for an epigeneticist, but one likely to be overlooked by preformists! Among the remedies for this syndrome is one of the basic points of the convergence rate hierarchy: our cognitive potential has co-evolved with socially distributed mechanisms for its realization. Since those realization mechanisms have now been so distributed for many millions of years, much of our hypertrophied neo-cortex may have to be credited, as it were, to our social nature (Bullock, 1983; see also Humphrey, 1984). Another remedy, for a different strain of the malady, is to study construction grammar, which has strong Wittgensteinian roots via the work of Lakoff (1987). Here recent work (e.g., Goldberg, 1995) has developed serious alternatives to atomist (e.g., Fregean) treatments of the relationship between word and clause level meaning.

The final syndrome I have called *encapsulation* (see Bloor's (1983) related treatment of 'condensation'). This is the tendency to treat a property of some distributed system as if it were entirely attributable to (encapsulated within) some subset of the system. This syndrome underlies popular misconstruals of remarks like: "the gene for property A is on chromosome N"; or "language is localized in the left hemisphere". In this paper, I have exposed two examples of encapsulation. In the case of representation, I have shown that representational status, far from being located in a form, depends jointly on formats and procedures for using them within human activities. In the more general consideration of intelligence, I emphasized that our kind of intelligence is an essentiallly *mosaic* phenomenon: it depends on a conspiracy of many factors of diverse type. In particular, it depends on both social and asocial modes of interaction (and their aliments) as much as on plastic brain structures; without the former, the latter would never be able to achieve their representational statuses.

A first prescription for avoiding encapsulation is to study how evolution has repeatedly groped its way to mosaic (structurally distributed) solutions to adaptive problems. A second prescription is to study why mosaic solutions are the norm. Simon (1969) has argued that they are normative because they can be expected to take less time to evolve than non-mosaic solutions. If so, then what is essentially a convergence-rate argument helps explain the mosaic character of human-class intelligence — which I have schematized as itself a level within a convergence-rate hierarchy. Such a recursion of explanatory principles increases my confidence that explication of the convergence rate hierarchy can enable a principled treatment of human intelligence as a natural phenomenon (see also Bonner, 1982). If so, part of the credit must go to Wittgenstein, who was also careful to temper his claims to originality — as befits anyone contributing to the theory of intellectual achievement as a socially distributed phenomenon.

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