The Development of the Mediated Mind

Sociocultural Context and Cognitive Development

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9

Acquiring Art, Spoken Language, Sign Language, Text, and Other Symbolic Systems: Developmental and Evolutionary Observations From a Dynamic Tricky Mix Theoretical Perspective

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The power of symbolic systems to mediate and organize people's experience of the world is central to modern cultures. For many years, Katherine Nelson's work has touched on developmental processes underlying acquisition of symbolic systems, especially spoken language. This work has substantially influenced interest in and empirical research on how multiple factors dynamically converge to support children's progress in complex symbol systems. More broadly, over the past 20 years, there has been a strong expansion of studies on children's narrative, vocabulary, syntax, and literacy development that strive to capture the embeddedness of children's learning in meaningful, socially rich, scaffolding exchanges with those more expert in these systems—adults in most studies, but with some attention as well to siblings and peers. Implicit in much of this work is that children's progress in other symbolic systems—notably, art, music, dance, and multidomain productions—may similarly depend on the "who and how" of the child's interactions with other more expert symbol users. This chapter argues that the writing of Nelson and her colleagues converges very well with other investigators in identifying key theoretical processes, remarkable individual differences, and many rich patterns of child–other interactions that have the potential to contribute to specific developmental advances by the child.

THE DYNAMIC TRICKY MIX THEORY

One organizing frame is the theoretical model we term the Dynamic Tricky Mix theory. Using this particular dynamic systems model helps to differentiate (among many potentially supportive patterns) interactive patterns that fail to support learning, those that support modest rates of learning, and those that scaffold the highest rates of learning. Progress in making such differentiations is reviewed, and then leveraged to suggest research pathways to further understanding. Comparisons are sought among what is known about children's acquisition of art skills, sign language, multiple subdomains of spoken language, and to a brief extent for written language and mathematics. Comparative discussion also covers language-delayed children, autistic children, and typically developing chilren. Finally, all these issues are explored for a quite different period of human development—physical evolution and cultural evolution across the periods from 300,000 to 2,000 years ago.

Dynamic Tricky Mix theory emphasizes that multiple complex conditions need to "cooperate" and converge to support learning (K. E. Nelson, 1991a, 2001; K. E. Nelson, Heiman, & Tjus, 1997; Nelson, Perkins, & Lepper, 2003; K. E. Nelson & Welsh, 1998). This convergence is a dynamic process, requiring coordination in real-time episodes (cf. Damasio, 1999; Peltzer-Karpf, & Zangl, 2001; Thelen & Smith, 1994). A comparison to the complex dynamic systems contributing to tornado production is in order. Once formed, tornadoes are easily tracked phenomena even though it is tough to predict exactly when and where potentially favorable conditions will converge. Similarly, in many instances, effective dynamic convergence in learning episodes may be "found" through observation even though it may be difficult to predict in advance when and where the "tricky" convergences will occur. As Fig. 9.1a suggests, children will LEARN only when there is some above-threshold level of dynamic convergence of different kinds of learning con-

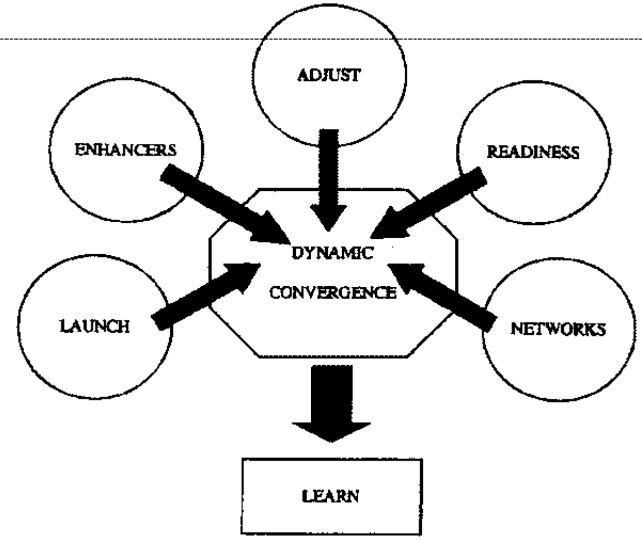

FIG. 9.1a. Dynamic Tricky Mix Model.

ditions. The LEARN acronym is just one way of organizing these partly overlapping categories of conditions: Launching, Enhancing, Adjustment, Readiness, and Networks.

Launching Conditions

Launching conditions (L) require some involvement in a relevant activity that includes new challenges. These conditions also include at least minimal attention and abstraction and storage in long-term memory of some partial information about the challenges. For example, children learning to read might encode into long-term memory some partial representation of text structures that are challenges for their current developmental levels; some information about the placement of *who* could be encoded, as for relative clauses such as "*The girl who has new purple shoes won the race.*" Similarly, children learning a new lexical item, such as *purple* or *fiffin*, may at first encode a simple association between some part of the spoken word and some part of the accompanying context.

Active involvement with the context that carries challenges does not happen automatically. The mere desire for engagement with others may serve as a stepping stone to language learning. In fact, Slomkowski, K. Nelson, Dunn, and Plomin (1992) showed that extroversion may contribute to language learning. Longitudinal relations between temperament and vocabulary knowledge are suggestive of the contribution of extroversion to language acquisition. For these children, the intrinsic desire to be a part of the larger social system may serve as an essential foundation for learning. For children whose desire to engage with others, for whatever reason, is less strong, optimal learning may only occur with help from the larger social system, as in playful episodes initiated by a parent, grandparent, or older sibling. Note also that some launching conditions, such as relatively high attentional capacity, and temperamental variables may be relatively stable over time, but they are surely subject to influence by factors such as mood and expectancy. In addition, what motivates a child to engage in a task may vary from day to day, hour to hour, or minute to minute. Continual adjustment in response to the child by the larger social system and by the child in regard to the larger context supports paths toward the avenue of optimal learning.

Enhancing Conditions

Learning of complex symbol systems depends heavily on enhancers (E; e.g., paraphrases, salience enhancers, challenge-carrying recasts, rapid interplay of multiple information channels in multimedia) that minimize competing processing demands and that specifically scaffold comparison and abstraction processes in working memory. Other examples of enhancers are adult emotional availability (Pressman, Pip-Siegel, Yoshinaga, Jubicek, & Emde, 1998), adult and child strategies that fit learning goals as well as the current context of learning, and attributions to the child for effort and success (Dweck, 1990, 2000) Learning of new communicative skills may further be enhanced by settings and strategies that bring out the child's focused attention, persistence, planfulness, and monitoring of plans (cf. Bransford, Brown, & Cocking, 2000; Perkins, 1993).

More broadly, each culture finds its ways of embedding language and other symbolic systems within purposeful social activity. Language incorporates a multitude of specific language structures but is not reducible to these; instead, it is inherently social in nature. Thus, the learning of language is dependent on and enhanced by others' guidance toward the acquisition of shared meaning. This sociability of language is at the heart of Katherine Nelson's conception of the socially shared symbolic system: The meanings of the symbols (words, grammar, narratives) contained within a language are social constructions that emerge within a social matrix. Language acquisition is essentially a social practice that occurs within a socially shared symbolic system (K. Nelson, 1986, 1998). Acquisition may obey similar processes through different cultural circumstances, with the particular persons (e.g., siblings, aunts, parents) and the particular interactions that help provide the convergent mixes necessary for acquisition varying substantially both within and across cultures (cf. Allen & Crago, 1996). Parents, older siblings, and other social partners whose own positive social and emotional adjustment are regularly part of social transactions can be powerful contributors to a child's development in symbolic domains, because they can help induce the

child's current online processing efficiency and because they may influence longer term adjustment skills in the child. Acquisition will fail, as is the case with some autistic children, or falter (Baker & Cantwell, 1982) when there is a lack of establishment of the fundamental social processes that launch the child's engagement in language and provide enhancers of continued engagement and effective processing of language.

Adjustment Conditions

Crucial adjustment (A) processes in the learner are influenced by developmental status and by partner, setting, and many other variables. Some adjustment steps are almost always required to promote processing of relevant changes (Damasio, 1994; K. E. Nelson, 1987, 1989, 1998, 2000). As part of such adjustment processes, the child will apply new strategies, will find pleasure in different aspects of the challenges, and will be attuned to different aspects of the situation continually throughout the learning experience. When a preschool child repeatedly tends to show poor social, emotional, and motivational adjustment during learning episodes, there are risks for development of relatively low cognitive and social skills (Cole, Michel, & Teti, 1994). In contrast, when such regulation goes well, positive expectancies of an interesting learning activity, low anxiety, high self-esteem, appropriate emotional states, and friendship and emotional bonding have an opportunity to dynamically converge with other learning conditions. In fortunate interactive cycles across time, improving adjustment conditions in the child learner accompanied by similarly positive behaviors in the child's partners may help to ratchet up the likelihood of overall favorable mixes and thus the probability of learning.

Readiness Conditions

Readiness conditions (R) incorporate background aspects of preparedness for new challenges. The child's characteristic temperament, attentional resources, intelligence, effects of recent stressors, memory capacity, pattern detection capacities, and potentially levels of any (to-be-discovered) language-specific in-built representations or mechanisms are examples.

Network Conditions

Neural networks (N) must be intact and appropriately active during learning episodes. As learning proceeds toward stable structures with flexibility across contexts, new structures require thorough integration into representational networks. Convergent learning conditions favoring such integration include relatively low immediate demands for learner response, many enhancers, smooth adjustments (see conditions above), and some sustained active processing. To this end, the processes building increasingly effective neural networks are also dynamic system processes with similar competitive aspects operating over very different time scales in evolution (Elman et al., 1996; Lieberman, 2000; Nakisa & Plunkett, 1998). Both in individual brains and in species evolution these dynamic processes allow for—but do not guarantee—emergence over time of qualitatively new organizational levels (Gould, 1989).

These conditions are revisited throughout this chapter with particular attention to the potential roles of different kinds of event sequences—from very local, 15-second episodes, to those within an hour or so, to longer term cross-situation recurrences and scripts—and to individual differences among children.

CHILDREN'S SYMBOLIC DOMAINS AND CONVERGENT MIXES:ASSUMPTIONS OF AND EVIDENCE FOR DYNAMIC TRICKY MIXES

From the Dynamic Tricky Mix theoretical perspective, multiple predictions for the acquisition of new structural levels in all symbolic domains follow. These general predictions are examined, and then children's acquisition of particular symbolic domains are discussed.

Many interactional episodes of apparent relevance to learning first language, literacy, or any other symbolic domain will have no effect on acquisition. This prediction follows from the necessity for any learning of achieving a threshold level of LEARN convergence in the midst of ongoing interaction. Being "close" in the sense of some conditions being favorable will not support learning unless, as in certain chemistry reactions, a fuller set of well-timed conditions co-occur and interact.

High variability of learning rates will be expected for individuals across relevant learning contexts and also between individuals even when contexts appear quite similar. This follows because threshold levels of convergence are required for any learning to occur, and because for above-threshold levels the rates of learning will accelerate as dynamic mixes become increasingly favorable on multiple converging components. The variability predictions also are based on the observation that there are manifold patterns in which learner Readiness characteristics and all other components will either succeed or fail to converge dynamically within the online temporal windows of interaction events. These windows frequently will be only 5 to 20 seconds long, and in many other instances (e.g. early dyadic narratives) will be in the range of from 1 to 5 minutes.

Sustained rapid growth by a child will be relatively rare, for all the reasons so far articulated on trickiness of mixes, but it will occur under predictable sets of circumstances—precisely when positive dynamic mixes are themselves sustained and very highly positive. Examples of individual children achieving very high and sustained growth rates with the support of exceptional dynamic mix conditions have been reported for early literacy (Soderbergh, 1977), sign language and speech bilingualism (Maxwell, 1983; P. M. Prinz & E. A. Prinz, 1981), and art skills in the preschool years (Golomb, 1995; Ho, 1989). Again, however, note that when a child is in a potential learning activity, the LEARN components need to converge at a *threshold* level in real time, as in 10- to 60-second interactive episodes with a social partner and/or a book or video or computer, in order for any learning to take place. Beyond threshold, as the dynamic mixes become more and positive in their convergence online, learning rates are expected to increasingly accelerate. When the mix is very strongly positive in terms of all components, challenges are so readily and deeply processed that learning from single or otherwise quite rare events is likely. When the Dynamic Tricky Mix remains highly positive over many consecutive episodes, a condition of deep enjoyment and absorption in the activity of learning called "flow" may occur (M. Csikszentmihalyi & I. Csikszentmihaly, 1988). Figures 9.1b to 9.1e illustrate how across different occasions convergent mixes of learning conditions may generally improve but may also on occasion stall. By a hypothesized 10th episode in a series of increasingly successful learning episodes, as in Fig. 9.1e, high positivity in all LEARN categories is present and these converge to produce very high rates of learning.

Children sometimes learn readily from a single occasion, establishing representations in long-term memory that guide appropriate generalization and application of new symbolic structures to new contexts occurring days or weeks later. This kind of deep learning from infrequent, "rare" events is possible because some

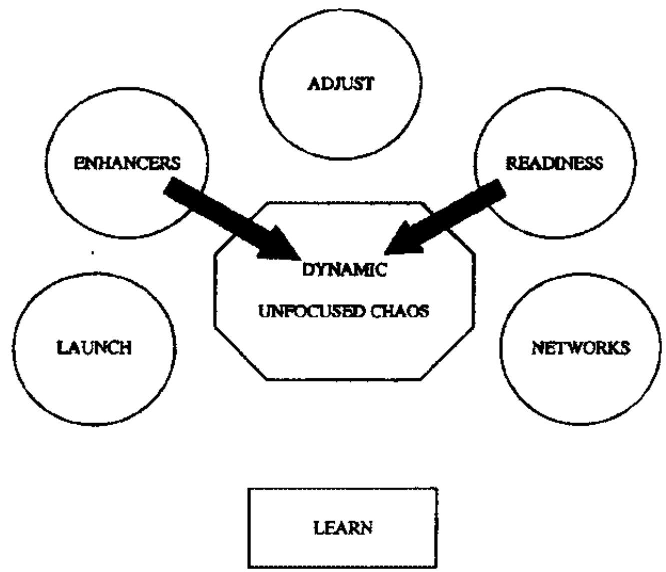

FIG. 9.1b. Unfocused Chaos.

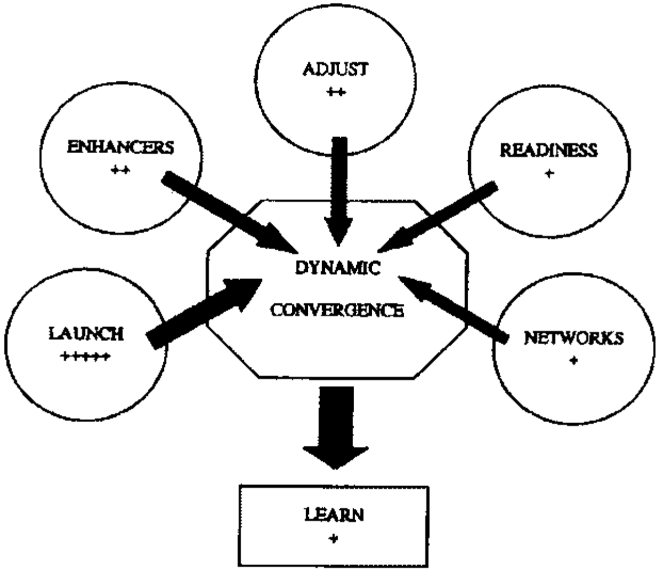

FIG. 9.1c. Positive Spirals, Episode #1.

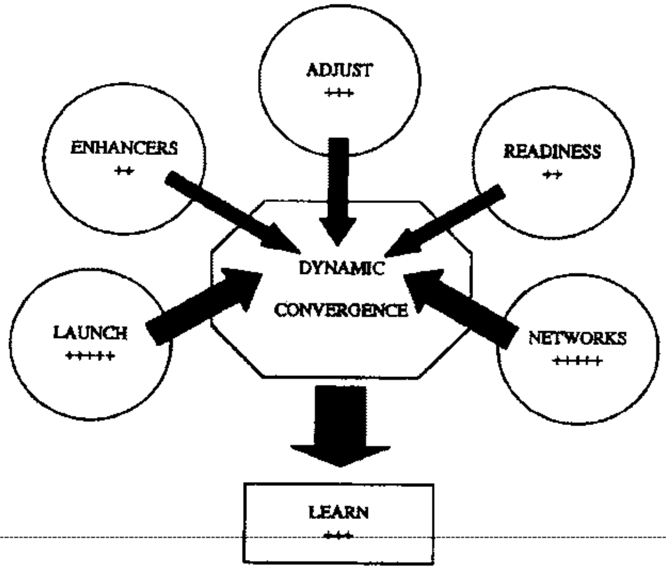

FIG. 9.1d. Positive spirals, Espisode #2, Generally Increasing Positivity.

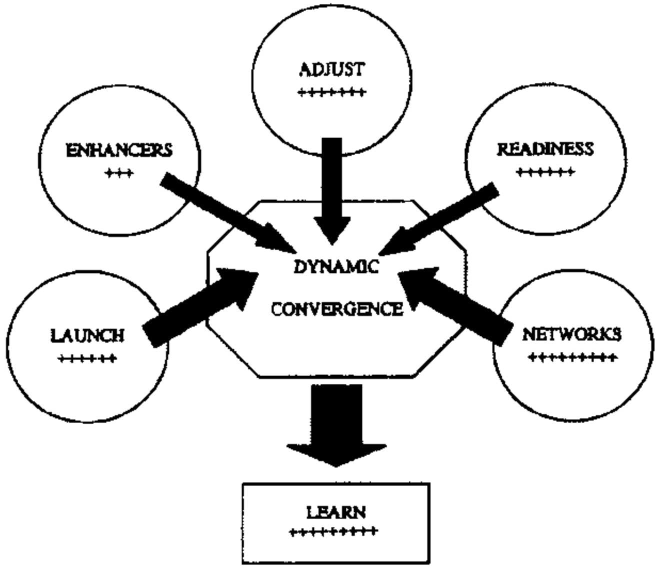

FIG. 9.1e. Positive Spirals, Episode #10, Very High Positivity Building on Prior Episodes.

rare occasions provide high positivity in all relevant components of a Dynamic Tricky Mix. Demonstrations from experimental work with controlled input for young children have been especially clear for 1½- to 3-year-olds learning new nouns such as "fiffin," "lobster," or "lubnik" (K. E. Nelson, 1982, 2000; K. E. Nelson & Bonvillian, 1978). Naturalistic work also suggests that this kind of learning takes place for many young children (e.g., Bates, Bretherton, & Snyder, 1988; L. Bloom, 1991; Carey, 1978; Leopold, 1939). Children typically appear Ready in terms of abstraction mechanisms by about 18 months of age to learn in this fashion, but the field is open for appropriate tests of whether younger children may also be prepared. As with related phenomena of fairly rapid learning covered in the next section, the individual child's focused cognitive engagement with the situation and the adjustment of social–emotional processes must dynamically converge in the brief window of time when word-to-be-learned and referential event co-occur in a highly processable frame.

Many variants on cultural patterns that serve as successful enhancers of symbolic skill growth are expected because there are few enhancers that are necessary for all children. At the same time, there will be some enhancers that are necessary for children with one set of Readiness characteristics and other enhancers that are necessary for children with another set of Readiness characteristics. The requirement of online complex nonlinear convergences for learning by individuals may lead to some theoretical and practical frustrations—the math, literacy, or language example presented to a child and transcribed as data by a researcher may have no relevance to learning because it receives no "uptake" by the child. Understanding of when learning does and does not take place requires more differentiated analyses of multiple learning conditions.

Children with different combinations of temperament and cognitive characteristics for example may respond very differently to potential catalysts and may require quite different enhancers to achieve a threshold of growth for a particular domain and stage. High within-group variability along these lines can be expected for children without any disability as well as for children who are deaf, language delayed, developmentally delayed, autistic, or with some motor disabilities (cf. von Tetchner & Martinsen, 2000). Likewise, the sources of powerful mediation toward effective mixes may sometimes come from the much-studied interactions between mothers and children, but at other times will arise from independent book reading, exploration of art books and other media, child–child interactions, and overheard and overseen interactions by the child of adult–adult and child–child interactions.

Multiple biological differences will contribute to pace and patterns in symbolic system acquisition, but these will play out in very complex fashion depending on the way in which these aspects of Readiness for a child accompany different dynamic mixes overall. As just one example, children with Down Syndrome have serious memory and abstract limitations compared with more typically developing children. The implications of these in-built biological differences, however, have changed dramatically in the last 20 years. Now the child–adult interactions are richer in language complexity, enhancers, discourse challenges, and expectations of substantial progress by the child in language. Consequently, language and instruction based on language have improved greatly compared for the children of the current generation versus the prior. More broadly, for children in general there are tremendous variations in attention, processing at all levels, and temperament that would appear to put larger numbers of children at high risk for difficulties in language acquisition than the number that do develop language disabilities. Taking a longer historical view, for ordinary children today as compared with 500 years ago, it is far more likely that the children with biological-based risks for language learning difficulties will receive substantial "cushions" of positive interactional mixes and will go far toward full mastery of a complex language. This point, and a much further reach into humans' past cultural and biological foundations, is elaborated in later sections.

"Butterfly Effects" will be common. That is, initial conditions and conditions fairly early (but not initial) in acquisition of complex domains often will have large consequences for the nature of the domain organization much later in development. If a child in initial stages of language acquisition receives very highly positive dynamic mixes, rich in challenges and converging social and emotional adjustments and enhancers, and if that child is also early in brain maturation compared to peers, an early onset of extensive language may then influence many con-

current aspects of building varied cognitive representations that in turn will mutually influence later language progress and a relative centrality of language in the child's awareness, self-concept, and cultural identity. Similarly, at the ages of 5 and 6 years, the child's level of language and organization of language may reflect the child's "butterfly profile" evident before age 2 years. The child's current representations of the world echo early communicative propensities to be, for example, a "nominal relier"—e.g., a child who is concerned with basic level object names, such as *dog*, *cookie*, *sock*, or a social butterfly who has few, or none, such nominals in their first 20-50 words but rather many social-expressive chunks such as *do-it- again*, *thank-you*, and *see-you-later* (K. Nelson, 1973; K. E. Nelson et al., 1985).

The following sections presesnt applications of Dynamic Tricky Mix theory, including passive sentence acquisition, varied lexical and syntactic acquisitions, narrative development, and art development.

Lessons from Children's Acquisition of Passives

In order to acquire mastery of the overall syntax of any language, a child must succeed at acquiring many different individual structures. Among a set of interesting complex structures that have received considerable attention are passive sentences. For passive sentence acquisition, an acquisition model has been delineated within Dynamic Tricky Mix theory. This model incorporates a comparison/contrastive component highly similar to that in Nelson's Rare Event Learning Mechanism, providing an emphasis on the processing steps involved in noticing new challenges, abstracting structure, storing gestalt exemplars as well as structural descriptions, and retrieving and comparing exemplars that occurred in input at widely separated times (cf. K. E. Nelson, 1977, 1980, 1981, 1987, 1989, 2000, 2001; cf. also Bohannon & Stanowicz, 1989). In Dynamic Tricky Mix theory, these processing steps contributing to acquisition always must be seen as dependent on and as co-occurring with the broader set of online convergent dynamic processes that are jointly emotional, social, motivational, and executive in nature. A fortunate, tricky mix must converge if any progress in passive acquisition is to occur. As more becomes known about such mixes, increasing the frequency and positivity of the mixes should lead to accelerations of passive acquisition rates under well-specified positive mixes.

Seven stages in the acquisition of passives are laid out in Table 9.1. First consider the common aspects of development, regardless of language, culture, and varied interactional patterns within a culture. A key phenomenon in syntax acquisition is Launching *some* representation of the structure. This is not automatically given either by biological representations of syntax that anyone has so far documented or by simple infusion of exemplars in "input" within hearing of a child. Stage 1 in passive acquisition begins with the first new representations in long-term memory that bear in any way on passives, often with isolated gestalt,

TABLE 9.1

Dynamic Tricky Mix Acquisition States for Passives

Stages	*Comparison/ Contrast*	*New LT Storage*	*Structural Description (SD)*	*Hot Spot*	*Verb Analysis*	*Similar Structure Map*	*Total # LT Exemplars; illustrative changes*
1. Initial launch	Discrepancy detected	Gestalt	X	X	X	X	1
2. Beyond Catch-22, exemplars stored	More exemplars	Gestalt exemplars Isolated by-clauses Isolated lexical adjectival passives	By-clause discrepant	Yes	X	X	3 Gestalt sentences 2 isolated by-clauses
3. Active internal analysis	LT set analyzed	Partial structural d.	Partial	Highly active	X	X	3 Gestalt sentences 2 isolated by-clauses
4. Exemplars & descriptions expand	LT set & new	Fuller structural d. New exemplars Hot spot verbs favor	Partial, improving	Highly active	Yes. *Get* favored over *Be*	X	5 Gestalt sentences, some produced 5 isolated by-clauses 3 sentences with s.d. 4 favored verbs, with multiple sentences

TABLE 9.1 (cont.)

Dynamic Tricky Mix Acquisition States for Passives

Stages	*Comparison/ Contrast*	*New LT Storage*	*Structural Description (SD)*	*Hot Spot*	*Verb Analysis*	*Similar Structure Map*	*Total # LT exemplars; illustrative changes*
5. Structural descriptions refined	LT set & new	New structural exemplars	Nearly full	Highly active	Yes, improving *Be* Passives, most kids	Partial	8 Gestalt sentences, some produced 10 sentences with s.d. Verbs clustered by similarity, related examples of variation
5. Structural descriptions refined	LT set & new	New structural exemplars	Nearly full	Highly active	Yes, improving Be Passives, most kids	Partial	8 Gestalt sentences, some produced 10 sentences with s.d. Verbs clustered by similarity, related examples of variation
6. Speed of retrieval& consolidation of passive	LT set & new	Full structural d. New exemplars. Consolidate, speeding reorganize networks	Full	Highly active	Yes, extensive	Modest, fairly complex	10 Gestalt sentences, some produced 10 sentences with s.d.
7. Consolidation ofpassive	LT set & new	Full structural d.	Full	Now inactive	Yes, extensive	Full, most complex	20 sentences with s.d. Note: no access now to Gestalt sentences or isolated by-clauses of earlier steps

unanalyzed sentences. These are somehow registered as salient and/or discrepant from other sentences and the structural syntactic representations already in long-term memory. Why some children begin in different ways is not well understood, but by Stage 2 in English there are idiosyncratic differences in which gestalt sentences are available in long-term memory plus a special focusing of attention and abstraction called a *Hot Spot* in acquisition. Within this hot spot children soon have some separate representation of passive by-clauses and identification/tagging of such clauses as discrepant from other syntactic representations (e.g., of *by the house, or by his book*). Acquiring a structure for which at first Catch-22 circumstances seem to apply—high structural complexity and no initial representation—becomes feasible because each step toward acquisition is a partial one and at each stage richer long-term data have been stored so that new interactions and exemplars now support pattern detection and abstraction based on a richer and richer set of exemplars and prior analyses, not just the data of the most recent conversational sampling. By Stage 3, the beginnings of structural descriptions occur along with more verbs treated in isolation as "verb islands" (Tomasello, 1995). The hot spot of enhanced salience and enhanced retrieval priming for anything related to passives is very evident at Stages 4 and 5 and so is the continued build-up in long-term memory of gestalt sentences, isolated by-clauses, and increased numbers of verbs placed in passive context. For many, but not all, children, *get* passives are favored over *be* passives at Stage 4 but both are represented by Stage 5. At Stages 5 and 6, both verb analyses and structural detail on passives improve. At Stage 6, considerable consolidation of structural descriptions and related networks occurs, and speeding of processing of passives occurs. By Stage 7, former gestalts and isolated by-clauses are excluded from systematic representations. However, within organized networks there is redundant information that includes passive structural descriptions, storage of verbs in a manner that reflects their similarities, and particular sentences with their full structural descriptions. Comparisons and retrieval during passive sentence comprehension and production accordingly can be facilitated by different levels of abstraction and different concrete instantiations of the passive.

From Dynamic Tricky Mix theory it is strongly predicted that interesting individual variations on acquisition pathways will occur when individuals encounter very different sets of input exemplars, different enhancing dialogues, and different social and emotional qualities in interactions that carry input exemplars. One replicated finding is that rates of passive acquisition can be accelerated considerably by new focused conversational presentations of passives within recasting dialogues. An example would be to recast "*Buffalo bump wagon*" or "*The buffalo bumped the wagon*" (child's utterance) as the adult reply "*Yes, the wagon was bumped by the buffalo.*" As this example illustrates, and as argued consistently by Nelson and colleagues (e.g., K. E. Nelson, 1977, 1980, 2000; K. E. Nelson & Welsh, 1998), "recasts" provide relevant child-system/challenge comparison possibilities

regardless of whether the child produces an error in their "platform" utterance. Across 2 to 20 sessions of dialogue treatment, with each session carrying around 20 to 25 recasts into passives, children initially lacking the passive have shown quite rapid passive acquisition. This has been shown in language-typical children (N. D. Baker & K. E. Nelson, 1984; K. E. Nelson, S. M. Camarata, Welsh, Butkovsky, & M. Camarata, 1996) and in children with specific language impairment (SLI; S. Camarata, K. E. Nelson, & M. Camarata, 1994; K. E. Nelson et al., 1996; K. E. Nelson, Craven, Xuan, Arkenberg, & Lauck, 2002). The most recent intervention work has identified important characteristics of adult clinicians' passive recast patterns that are related to the acquisition pathways shown by children with SLI. Most notably, in contrast to the input in English reported for naturalistic samples, the clinicians' passives were most often *be* (rather than *got*) passives and most often irreversibles such as *The bicycle was ridden by the boy* (rather than reversible, as in *The cat was chased by the dog*). Sensitivity to these input particulars was shown by earlier, relative to naturalistic, acquisition by these children in intervention of both irreversible passives and *be* passives, as Tables 9.2 and 9.3 demonstrate.

According to dynamic tricky mix theory, a child must be ready for acquisition in terms of already-established linguistic and cognitive levels and in terms of intact-enough attentional, memory, and pattern detection and abstraction mechanisms. The SLI children in the studies just reviewed demonstrated such adequate

TABLE 9.2

Input in Intervention Shifts SLI Children's Use of *be* and *get*

	be	*get*	*All Passives*
Input examples of passives, treatment	93%	7%	100%
10 SLI children, 5–7 yr, treated	77%	23%	100%
Language normal children, 5–8 yr. (Marchman et al., 1991)	10%	90%	100%

TABLE 9.3

Input and Acquisition of Four SLI Children, Treatment Input Influences Reversibility

	Reversible	*Nonreversible*	*All Passives*
Input examples of passives, treatment	31%	69%	100%
4 SLI children, 6–7 yr, treated	11%	89%	100%
Language normal children, 5–7 yr (Horgan, 1978)	53%	47%	100%

Readiness, despite their slow overall progress in language acquisition. But often it is easy to underestimate a child's readiness. In the case of readiness for passives, most earlier work concentrating on Indo-European languages such as English, French, and German led to the impression that typical 8-year-olds were ready for passive acquisition but that 1½- to 4-year-olds usually are not. For example, Sinclair (1968) from a Piagetian perspective suggested that reversible mental operations of the sort seen in Concete Operations (e.g., conservation of liquid quantities) were a necessary foundation for passives. Naturalistic work in English, German, and Hebrew all converged in indicating that passives typically emerged after age 4 and that acquisition frequently is an extended process over multiple years with completion often as late as 9–11 years of age (Horgan, 1978; Marchman, Bates, Burkhardt, & Good, 1991). But most naturalistic samples in these languages fit within a Dynamic Tricky Mix account of very poor convergent mixes for passives—infrequent adult passives and with most of those exemplars not patterned into facilitative dialogue sequences such as child-platform/adult-recast. In sharp contrast, when either naturalistic circumstances or focused intervention provides relatively frequent passives within positive, converging social-emotional interactions then passive acquisition readiness has been demonstrated easily in 1½- to 4-year-olds. In English, the growth recasting intervention studies with language-normal children fit this conclusion (N. D. Baker & K. E. Nelson, 1984; K. E. Nelson et al., 1996). Strong converging evidence is shown by work on early acquisition in K'iche', Zulu, Sesotho, and Inutikut (Allen & Crago, 1996; Demuth, 1990). In Inutikut it is especially clear that passives are richly embedded in positive social-emotional dialogue situations, that there are varieties of those dialogues, and that part of the converging mix that contributes to saliency and acquisition of passives by the children is that passives are highly useful ways of communicating certain messages that are difficult to otherwise convey.

Varied Language Acquisition Phenomena

There are many demonstrations that learning in 1½- to 5-year-olds of new lexical and syntactic structures can be triggered by a relatively modest set of input exemplars embedded in meaningful, positive social interactive occasions spaced over 3 days to 6 months. At the same time, however, there are tremendous individual differences in which new symbolic structures are acquired from seemingly similar experimental presentations. Moreover, the acquisition pathways for those structures undergoing acquisition show extensive individual differences in such characteristics as how quickly and appropriately generalizations are made to new sentence and new object/action/event contexts. This section explores just a few ways in which dynamic mix perspectives help illuminate these phenomena and how findings from particular investigative procedures need to be seen in the broader context of work in the field.

Consider the work of Tomasello and his colleagues on made-up ("nonce") verbs and nouns and observed differences between 2-, 3- and 4-year-olds. Across 6 to10 sessions in about 2 to 3 weeks, exposures to new verbs (*dakking*) and nouns (*wug*) are interwoven in repeated demonstrations (e.g., 10) that also vary the particular context in which the novel word is embedded. Strong individual differences are seen in each of a series of studies. Tomasello and colleagues (Akhtar & Tomasello, 1997; Tomasello, 1995; Tomasello, Akhtar, Dodson, & Rekau, 1997) stressed that children with overall language levels of 2-year-olds, as compared with those with 3-to-4-year-old language levels, are less capable of rapid learning of new lexical items and that when they do learn they generalize less readily, suggesting more "item-based" representations rather than representations placed in a systematic set of already-established lexical and syntactic structures. Verbs, because of presumed greater complexity of their relations with contexts and other syntactic structures, are seen as harder to acquire than nouns. From the Dynamic Tricky Mix view, many of these findings are predictable from the particular kinds of encounters children experienced. In large part, *verb islands* and other *item- based* sorts of learning patterns may rest more on the particular exemplars and convergent language and social framing contexts than on the stage of cognitive and language development for the child. Only a few frames for teaching (e.g., "Look! Gopping, gopping!") and eliciting new productions (e.g., "What are these?" "What did I do?") were employed, so there can be little confidence that for children at a particular language level the procedures for verbs were as "well-mixed" as those for nouns. From the Dynamic Tricky Mix perspective, it is essential to see that the younger children may be quite capable of more rapid and more extensive, more generalized learning if only a rich and different mix of conditions is provided. There are many diverse contextual frames under which children may be facilitated in their initial abstractions, in their tentative deployment of such abstractions for verbs or passives or nouns or any structure (cf. Strohner & K. E. Nelson, 1974), and in further inferences and abstractions derived from long-term data converging with exemplars presented online in particular discourse situations (cf. Bowerman, 1985; Carey, 1978; Clark, 1971; Maratsos & Chalkley, 1980; Maratsos & Deak, 1995; K. Nelson, 1988). Thus, it is highly probable that the complexity of learning verbs as compared to nouns varies depending on child and context.

Also consider investigations in which nouns and/or verbs have been studied in their acquisition by 18- to 28-month-olds across several months rather 2 weeks (e.g. L. Bloom, Tinker, & Marguilis, 1993; Mervis & Pani, 1980; K. E. Nelson, 1982; K. E. Nelson & Bonvillian, 1978). Looking only at learning and generalization that has taken place in the first 2 weeks, as in the studies by Tomasello and colleagues, it becomes evident that it is only an occasional child who has already shown such progress and the progress is shown for only a minority of the words under investigation. But the capacity of most of these children to do such learning is shown by the learning that emerges for each child who is seen across several months—again, with important by-child differences in which words are acquired. All of these results are comprehensible if a young child learner is Ready in terms of mechanisms, but learning about particular words on particular occasions and across occasions depends on the particulars of online momentary convergence of many favorable conditions.

A great many conditions need to converge for word learning. These include abilities to detect and abstract speech elements (Nittrouer, Manning, & Meyer, 1993; Jusczyk, 1993; Jusczyk, Frederici, Wessels, Svenkerud, & Jusczyk, 1993), sensitivity and awareness to phonological units (Bowey, 1996), the ability to hold phonological representations in queue (Gathercole & Baddeley, 1990; Gathercole, Hitch, Service, & Martin, 1997; Gathercole, Service, Hitch, Adams, & Martin, 1999), the ability to inhibit proponent responses, and more. These various abilities ebb and flow throughout linguistic learning (Arkenberg & Ryalls, 2003), resulting in differences in the mix of conditions for different children at different points of time and in different situations. Furthermore, Network representations may drastically differ for children of different ages (reflecting different levels of linguistic experience). Related arguments are that the overall relative long-term stability in environmental conditions for mammalian species members has resulted in neural systems that are essentially "prepared" for evolutionarily expected input (Greenough, Black, & Wallace, 1987). Although much of the evidence for this type of experience-expectant system resides in visual perception, an analogy can surely be made for auditory systems as well. Similar arguments concern the evolution of memory systems that anticipate the need for selective retrieval not only of highly related structures or events, but also the retrieval of inconsistent or contrasting information that helps to set boundary conditions on new abstractions and on the deployment in particular online contexts of particular language or other symbolic structures (Klein, Cosmides, Tooby, & Chance, 2002).

Returning to the consideration of syntactic structures acquired under experimental intervention covering several months, as with the work on passives discussed earlier, very similar kinds of individual differences and contributing processes can be seen. In syntax acquisition, a converging pattern is seen across different laboratories. When intervention procedures include convergently mixed combinations of challenging syntax (passives, past tense, relative clauses, etc.) and interested, positive adults placing such challenges in recasting of children's utterances (as in the passive acquisition covered earlier), acquisition rates have been strongly accelerated. Evidence that the mix of conditions just described underlies the accelerated rates, rather than merely modeling with increased frequency the target structures, comes from direct comparisons with more standard nonconversational treatment procedures. Moreover, these results are seen in both language-typical children (N. D. Baker & K. E. Nelson, 1984; K. E. Nelson, 1977; K. E. Nelson et al., 1996) and children with Specific Language Impairment (S. Camarata et al., 1994; Fey, Cleave, & Long, 1997; Fey, Cleave, Long, & Hughes, 1993; K. E. Nelson, 2001; K. E. Nelson et al., 1996; Robertson & Weismer, 1999).

As Dynamic Tricky Mix argues, children at similar language ages but different overall cognitive levels will bring different cognitive Readiness into the online mix of conditions for syntax acquisition in these studies. This viewpoint helps explain the otherwise surprising finding that 6-year-old SLI children, with their well-documented low rates of prior progress in language, learn at rates that match or exceed those of language-matched younger children with no history of language delay.

If social-emotional adjustment factors truly contribute to dynamic converges online that affect learning of varied kinds of new communicative challenges, then this should be a measurable phenomenon. So far there are just a few such studies that have helped to account for children's rates of language progress and serve to illustrate new methodological steps stimulated by the theory. In each of the studies, videotapes of two early sessions of intervention were analyzed to determine the child's "enjoyable engagement" or "social-emotional-cognitive" engagement. As Dynamic Tricky Mix theorizing predicts, children's higher enjoyment/engagement scores early in intervention were predictive of larger learning gains across several months of intervention. These developmental gains were shown in syntax for children with SLI in Haley, S. Camarata, and K. E. Nelson (1994), in syntax for language-typical children in Newby (1994) and K. E. Nelson and Welsh (1998), and in reading levels and language levels for autistic children (Heimann, K. E. Nelson, Tjus, & Gillberg, 1995; Tjus, Heimann, & K. E. Nelson, 1998, 2001). In related research that is naturalistic and longitudinal rather than interventionist, Hart and Risley (1995) found that positive "Feedback Tone" (including responsive recasts and positive affective tone) by the parents of children at 1 to 3 years of age predicted child language level at age 3 and at age 9. Similarly, Nicely, Tamis-LeMonda, and Bornstein (1999) demonstrated that children's more rapid language development in the period from 9 to 21 months is associated with high levels of maternal attunement (matching) to infant affect at 9 months. In each of these studies with some measurement of affective patterns, part of the dynamic mix contributions to language learning may have rested on positive and well-attuned affect of parent to child on particular learning occasions. But another important contributor may be the positive kinds of cycles illustrated earlier in Figs. 9.1a to 9.1e, with a build-up within the same dyad that continues interactions across many occasions of more and more positivity and attunement at the emotional, social, and expectancy levels.

So far, empirical work on either lexical or syntactic or narrative structures in children has not provided differentiated evidence on what adaptations of dynamic mixes are needed to reach thresholds of acquisition for children at different cognitive and language levels between about 6 months and 6 years of age. However, it is almost certain that there will be some enhancers that are necessary for children with one set of Readiness characteristics and other enhancers that are necessary for children with another set of Readiness characteristics (cf. Bransford et al., 2000; Kaiser, Yoder, & Keetz, 1992; K. E. Nelson, 1991a, 2000, 2001). Similarly, beyond the thresholds of launching acquisition the mix of conditions that may move a 2-year-old toward really high acquisition rates may prove substantially different as compared with similarly optimal conditions for a 4- or 6-year-old.

Lessons from Acceleration in Narrative

Many arguments have been presented that improved, decontextualized narrative abilities before school entry should enhance children's success in literacy activities at school (e.g., Bruner, 1986; Fey, Catts, & Larrivee, 1995; Fivush, 1991; Gillam, McFadden, & van Kleeck, 1995; Peterson & McCabe, 1991; Snow & Dickinson, 1990). In one study, training mothers toward increased quantity and quality (including many recast elaborations) of narrative discussions across one year with their 4-year-olds led the children one year after the intervention (the children now averaged 5 years 8 months) ended to hold narrative skill advantages. Specifically, seven children receiving the narrative intervention as compared with seven nonintervention children produced more sophisticated narratives in terms of spatial and temporal context and uniqueness of information (Peterson, Jesso, & McCabe, 1999). However, most prior studies on training preschool children in narrative skill have been limited in their low specificity of procedures and outcomes, as well as by few children as participants. Similarly, without yet showing which among many potential contributors are causal, a variety of studies indicate that more literacy activities by parents themselves and by parents with children, more extended decontextualized narrative sequences in adult-child dialogues, and related variables are often associated with higher narrative skills and better reading achievement when children are at the kindergarten to grade 2 levels (e.g., Blachman, 1997; Snow & Dickinson, 1990). High potential remains for larger, well-specified studies in this domain, particularly because strongly positive dynamic mixes of enjoyment, social engagement, and multiple kinds of challenges—vocabulary, syntax, narrative structure, and pragmatic conversational skills—all can be incorporated in explorations of varied narratives. Naturalistic work makes clear that within the same stretches of 10 minutes or so of dialogue, a child may encounter challenges and scaffolds for progress in any of multiple domains, including self-concept, memory, emotion understanding, scripts, narratives, vocabulary, syntax, phonology, and pragmatics. Valuable explorations along these lines with identification of many potential enhancers of language acquisition progress have been provided by, among others, K. Nelson (1998), Fivush (1994), Fivush and Slackman, 1986, Hudson (1990, 2002), Hudson and Shapiro (1991), and Snow, Perlmann, and Nathan (1987).

Lessons from Acceleration of Art Skill Acquisition

From a dynamic systems framework emphasizing real-time convergence of social, emotional, motivational, and cognitive conditions, similar interventions with enriched mixes should support rapid learning in art and language. To date there is just one study that jointly sought acceleration in art and language through positively mixed learning conditions (Ninkovic & K. E. Nelson, 2001). Skilled artists "conversationally" introduced for 5- to 7-year-olds challenging new grammatical structures (passives, relative clauses, etc.) and new drawing structures (occlusion, perspective, shading etc.) in the context of ongoing favorable emotion regulation and social engagement. For example, skilled artists not only scaffolded artistic advances, but also provided recasts targeting more advanced linguistic structures in an effort to promote acquisition of these structures. So, for example, children who drew a picture of a pig were shown in an adult's art "recast" that objects could be drawn in front of others to indicate that the pig was behind something. In addition, these children were provided with linguistic recasts. Thus, a child who simply said "*See the pig*" received more structurally complex utterances such as, "*Yes, that is the pig who is hiding.*" Challenges were playful, emotionally positive continuations of what the child had already expressed in drawing or language (video analysis confirmed these patterns). Learning over base rates was accelerated strongly, and each of the children learned each of the art and language structures targeted. As predicted, creativity on general measures also advanced (cf. Torrance & Ball, 1984), based presumably on gains in skills and on strengthened general expectations that new challenges could be met in flexible and playful fashion. Over many positive episodes in this 5-month afterschool program, it is clear that children not only can learn significant new symbolic skills but that their characteristics as learners may change in ways that will increase the probability that effective dynamic mixes will be created in new contexts (cf. Dweck, 2000).

A series of other studies also demonstrates that in the unusual instances in which there are highly challenge-enriched (art challenges) and socially positive interactions with artists, young children typically respond with strong acceleration of art skill acquisition (Aronsson, 1997; Caldwell, 1997; Golomb, 1992, 1995; K. E. Nelson & Pemberton, 2003; Paley, 1995; Pemberton & K. E. Nelson, 1987; Thomas & Silk, 1990; B. Wilson & M. Wilson, 1982). Two examples of how preschool children's art complexity levels changed when given recasting sequences in art, a child drawing followed by a more advanced adult drawing on the same topic continuing in "conversational" cycles in art, are given in Figs. 9.2 and 9.3 (K. E. Nelson & Pemberton, 2003; Pemberton & K. E. Nelson, 1987). These rapid gains in intervention studies of 10 hours or less reveal a high Readiness for acquiring new symbolic representational skills in art when an artist interacts with interest, positive emotional tone, and challenges with a child of 3 to 5 years who contributes to the conversational communicative cycles of interaction at their own entry level of art. For children who go on to become truly expert, the levels of symbol system complexity in art become akin to the complexities of language and music, and such high-level art supports a vast and flexible range of communicative expression distinct from that achievable in language or music.

The Readiness of child learners in the preschool years 1 to 5 is in some ways best illustrated by the most exceptional rather than the most typical cases. This dis-

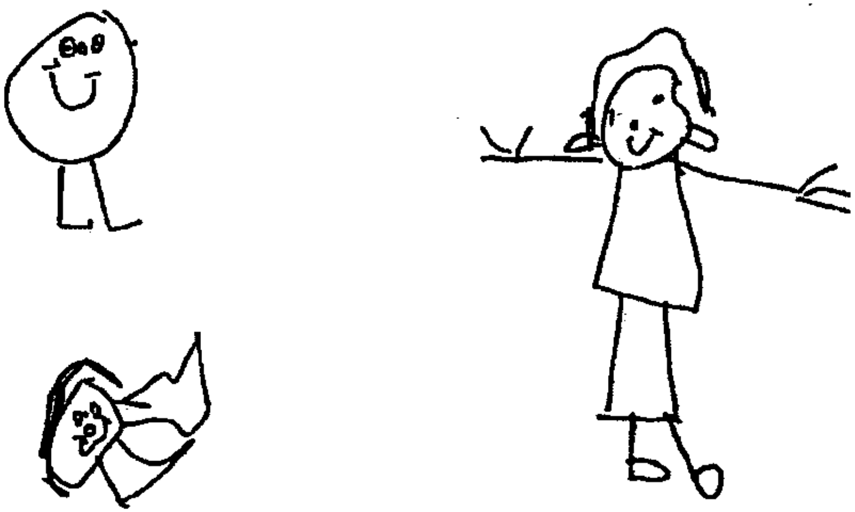

FIG. 9.2. Pretest drawing on left, post-intervention on right (from Pemberton & Nelson, 1987).

FIG. 9.3a. Pretest drawing before dialogues with artist.

FIG. 9.3b. Posttest drawing after dialogues with artist (from Nelson & Pemberton, 2003).

cussion considers just a few such exceptions in the light of Dynamic Tricky Mix theory. The beautiful artwork of Stephen Wiltshire has been published in such books as *Floating Cities* (Wiltshire, 1991). Two examples are shown in Figs. 9.4 and 9.5. His detailed creation from memory of ornate buildings is particularly striking. Stephen's beginnings symbolically are exceptional because his preschool and school age language skills were extremely limited, his art flourished during the same period, and he struggled to move beyond severe autism. With exceptional exposure to art Launching challenges accompanied by rich socioemotional enhancers, through adolescence and into his twenties Stephen's art continued to advance. Language and social skills did gradually improve during the same period, through many attempts at rich scaffolding that still leave open how far Stephen will proceed in these domains. Stephen's career is a very well-documented case of how far artistic development can go when language and social skills remain at fairly early stages (Sacks, 1995).

FIG. 9.4. Stephen Wiltshire drawing of Venice scene.

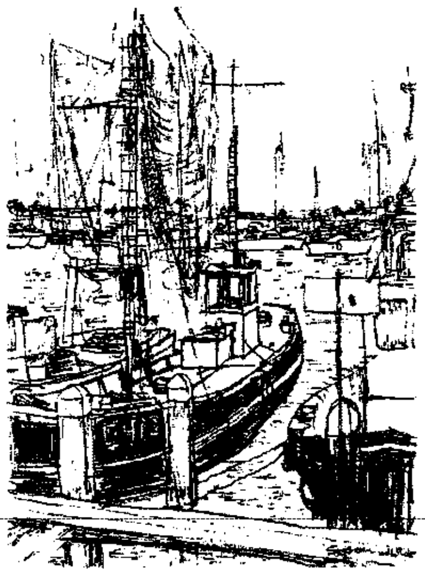

FIG. 9.5. Stephen Wiltshire sketch of boats in harbor.

Lessons from Acquisition of Multiple Symbolic Systems

From the individual child's point of view, it may not seem particularly "tricky" to acquire 2 or 3 languages to fluency by age 6 years. From the Dynamic Tricky Mix perspective, "all" that is required is that the child have emotionally and socially engaging conversations in each language, that a full range of language structures be included in such conversations, that processing enhancers (e.g., conversational recasts, dramatic stories with recast or recast-like sequences) are also part of the mix, and that the child strongly engage the social communicative interactions. Only 2 to 10 hours per week of such rich mixes are likely to suffice for acquiring each language. Indeed, when such conditions have been documented the acquisition of multiple languages in the preschool period is usually observed (cf. de Houwer, 1995; Fillmore, 1989). For adults, rapid progress in acquiring a second or third language is unusual but appears sensitive to the same availability (usually rare) of rich dynamic mixes, including strong processing enhancers such as recasting patterns on a regular basis (Nichols, Lightbown, & Spada, 2001).

The flexible Readiness of children at 1 to 5 years of age when given rich dynamic mixes of learning conditions is also illustrated by acquisition of language in mixed modes. For example, spoken language and text and sign language emerge together under rich conditions (Maxwell, 1983). Text and spoken language proceed together at ages 2 to 3 for some children (e.g., Soderbergh, 1977). And other well-documented cases of bilingual acquisition of sign language and spoken language also are available (P. M. Prinz & E. A. Prinz, 1981; Wilbur, 1987).

In the preschool period, mastery of language accompanied by acquisition of world-class skills in art have been seen in the case of one Chinese girl who, by age 2, became part of her artist father's community of artists studying at his studio. Challenges to launch her progress in art thus could come from her father's paintings, from his student's paintings, and from the artistic dialogue among this community. High positivity in her father's emotional stance and ways of encouraging her art were also part of the mix. This girl, Yani, sent her paintings on international exhibit by age 8 and continued on the path to become an accomplished artist in adulthood (Ho, 1989). Substituting for the moment language for art, it is not at all unusual to find that children encounter sufficiently positive dynamic mixes for acquisition of first languages in the preschool period and continue on to be fluent first language users as adults. What is unusual, as with Yani, is to see anything like the richness of dynamic mixes for art in the preschool that approach the richness of what most children encounter in language.

Complex, expert art, music, dance, and mathematics do involve high-level communication. Theories of children's development of symbolic systems thus need to take into account the Readiness of children to acquire very complex art and other complex symbolic systems in the preschool when the dynamic mix of conditions approaches for these systems the richness of convergent learning conditions typical in the case of spoken language. The question of whether an individual child is more biologically ready to acquire one symbolic system than another can only be given a plausible answer if the child has encountered nearly identical richness of learning conditions for the systems being compared.

DYNAMIC MIXES AND DEVELOPMENTAL PROGRESS ACROSS INDIVIDUAL LIFESPANS AND ACROSS EVOLUTIONARY TIME

In *Language in Cognitive Development*, K. Nelson (1998) provided a fascinating discussion of how ordinary children in their development may parallel or fail to parallel the kinds of long-term changes across evolutionary time that Donald proposed. Nelson stressed several similarities: (a) Early stages of event representation are nonsymbolic, but may be quite complex; (b) a second stage of symbolic, but nonlinguistic, representation follows; (c) "full" syntactically governed language greatly expands and mediates narrative in language and also mediates a vast expansion of perspective taking, reflection, analysis, planning, and organizational abilities; (d) complex and often formal theories and narratives depend on an extended period of further learning which often extends over middle childhood and adolescence and sometimes extends over most of the modern lifespan. Differences Nelson stressed are that modern human infants learn from culturally embedded social interactions that richly scaffold in interesting ways the child's progress in all stages of nonsymbolic and symbolic representation, that these social interactive conditions are likely vastly different than those in place during pre-hominid and early hominid groups, and that there are many ways in which the developing representations of event, action, nonlinguistic symbols, and symbolic language are intertwined rather than neatly separated into stages.

Nelson also argued that it is important to learn more about the specific online embeddedness of individual children in the process of acquiring new levels of representation in language and other domains. This point is highly compatible with the Dynamic Tricky Mix theoretical perspective that has been applied to children with disabilities as well as to ordinary children, and one that serves as a launching pad for comparisons of developmental changes across individual lifespans to those across evolutionary time. In the comparative discussion below, the similarities and differences drawn from Nelson's and Donald's accounts and a range of related issues are addressed. Throughout, there is considerable emphasis upon similarities in dynamic processes, but this should not be taken to indicate that differences do not need to be examined between modern individual development and cultural change and the longer span changes in physical, genetic makeup and in cultural symbol systems and their transmission. As just one example, one bundle of developmental and societal issues is raised when a modern 2-year-old encounters poor-quality day care that is thin in challenges as well as converging social-emotional positive conditions, and a different bundle of individual, species, interspecies, and cultural issues is raised when two genetically distinct early hominid groups face similar rapid shifts in climate, food, predators, and disease (cf. Cosmides & Toobey, 1987; Deacon, 1997; Johanson & Blake, 1996).

First, compare a subset of modern children with Specific Language Impairment (SLI) at ages 2 to 4 years to a subset of *Homo Erectus* in the approximate period of 500,000 to 400,000 years ago. In each chosen subset, assume that for an extended period—say 5 months for the SLI children chosen, and 5,000 years for the *Homo Erectus* subset—there is no advance whatsoever in symbolic systems. What are the changes in the mix of conditions that would lead in the next period of the same length to acquisition of significant new levels of symbolic communication? Challenges to representational complexity need to occur and to be combined with contexts that minimize attention to distracting stimuli and that incorporate social and emotional and mnemonic scaffolding of sustained attention and processing. It is unknown whether the factors that promoted good adjustment and effective processing online for middle to late *Homo Erectus* are more like conditions that function in that fashion for 1-, 2-, or 3-year-old children or for bonobos, gorillas, or chimpanzees who in special enriched interactional mixes have made progress in acquiring varied symbolic systems (cf. King, 1999). Equally for individual *Homo Erectus* and the modern child with SLI, progress toward more complex representations mentally and more complex communicative expressions will depend on some online episodes in which these kinds of convergences occur within frames of from 5 to 30 seconds or so. Positive dynamic mixes sustained over some longer episodes of several minutes to several hours will also be relevant for a smaller number of acquisitions. Finally, successful individual learning episodes need to recur for most acquisitions—spaced over weeks and months and years. Moreover, very rapid and sustained progress will depend on the kinds of increasingly positive sets of conditions illustrated in Figs. 9.1a to 9.1e. Then, of course, gains by individuals in the evolutionary context will be contributors to shifts over generations only if there is successful cultural transmission and/or an impact on survival or reproductive rates for individuals with varying levels of achievement in symbol system use and/or invention. Note, however, as Gottlieb (2002) argued, that for mice and women (and men) shifts in behavior during a lifetime can contribute to what happens in the next generation even without genetic change, and such behavior shifts also may lead to consequences at the levels of natural selection and genetic mutation and recombination.

Despite these substantial similarities in the kinds of convergent processes at work in acquisition, some striking differences in how development proceeds are apparent as well. Enhancers for learning and invention available from social partners to scaffold processing seem almost certainly to be less frequent and less powerful in a prelinguistic *Homo Erectus* community than in a modern literate society. Adjustment processes, emotionally and socially, would no doubt involve some significant differences too.

A further, fundamental difference applies. Modern 1-year-olds and 3-year-olds rarely perish if they fall a bit behind their peers in the pace of their early symbolic or later language-based symbolic development. But under certain mixes of circumstances, being ahead of other *Homo Erectus* in symbolic communication skill may insure survival rather than death. Individuals who are better able to share and respond appropriately to such simple messages as *don't eat, turn left, stop, follow (this) path*, and *meet there* (let alone, *Run to the tree now to avoid being eaten by the crocodile*) may live longer and be more likely to pass on their genes. This is a scenario, of course, for selective survival of the most "symbolically fit" brains and the shift across generations toward more complex brains that will support learning of increasingly complex symbolic systems (cf. Deacon, 1997; Donald, 1991), and that once launched can lead to co-evolution of cultural development, display and transmission of ever-increasing communicative complexity, and brains that support such complexity. From the Dynamic Tricky Mix perspective, however, it is essential to see how fragile the progress of acquiring symbolic systems turns out to be both in modern preschool periods and in early hominid evolution. The saving grace in both contexts is that despite the difficulty of bringing all needed components for significant developmental change together online with good timing and convergence, there are many distinct patterns that do achieve this. So, overall, one can expect that only a small minority of social interactive episodes will directly support developmental progress, but that successful episodes can be co-constructed by the participants, like successful cooking achievements, in many particularized recipes.

Now move the scenario along in time. Compare the same window of several months of development for SLI children to early *Homo Sapiens* during the period that Donald (1991) described as Mythic. During this period in evolution, it is suspected that different communities displayed vastly different levels of symbolic communication. The Challenges potentially to be learned by children and by adults thus include particular within-group symbolic systems, particular out-group communication alternatives, and the social-interactive strategies (which also are challenges to be learned by the next generation) that support both transmission of existing communication systems and the expansion of those systems. Again, when learning succeeds for any of these challenges, convergent positive dynamic mixes are required at the level of individual learners and when these are well above threshold quite rapid learning will occur. In at least a few locales, a rich record suggests by about 3,500 years ago the devotion of considerable financial resources and planfulness to increase the probabilities that a small minority of children (perhaps only 1% of a community) would encounter symbol-system challenges and social scaffolding of learning symbolic systems, as in the Egyptian community of Deir-el-Medina where many sorts of artists, hieroglyphic carvers, and artisans lived in comfortable lodgings with plentiful supplies of paint, carving tools, stone, wood, papyrus, metal, and so forth (R. Hagen & R. Hagen, 1999). Along with priests, kings, queens, and others receiving the highest levels of education, these artists and their children almost certainly were using symbols to some extent on the reflective, systematized levels of symbols, including external records of events and ideas that Donald (1991) places in the final Theoretic stage of development. In societies like Egypt and Mesopotamia in the period from 4,000 to 3,000 years ago, and in Mesoamerica beginning around 2,500 years ago, there were elites with mastery of considerable complexities in spoken language, forms of written language, poetry, narrative, painting, sculpture, dance, music, myth, mathematics, religion, drama, and architecture. For the less elite of these societies, symbol use may have been far more restricted even in spoken language and mental lives may have been primarily at the Mythic, oral narrative level. No one knows at what point it became commonplace for the vast majority of children in every culture to achieve high levels (but still with plenty of individual variability in final language levels achieved) of spoken language complexity.

Considerable mystery surrounds the status of language at around 30,000 years ago. What is clear, in contrast, is that many different symbolic systems were in evidence and that incontestable art creations survived. Art in the form of paintings, with clues therein to the occurrence as well of music and dance and ritual. Art in the form of sculpture. Art in the form of rock carvings from multiple continents. Flutes and other musical instruments were also available. What is known (cf. Tattersall, 1999) about such art and other symbolic productions suggests some strong parallels with modern human infants and toddlers as portrayed by Katherine Nelson. It appears plausible that for modern human forbearers before highly complex language emerges, there are rich mixes of varied ways of using symbol-action sequences. With variations across communities, these may have included not only drawing and painting but some mime and drama, sculpting, art as painted on the body and designed into clothes and grave decorations, dancing, singing, and perhaps other music, words, and "multimedia" mixes. This stress is similar to Donald's up to a point. But the Dynamic Tricky Mix perspective suggests even more variability, more unevenness, in within-community and between-community symbolic status and also in which symbolic profiles (how much art, words, dance, music, etc) were displayed. Donald (1991) found "uncontestable" the claim that spoken language has been part of modern human behavior for all of the last 50,000 years. However, for existing traditional societies that are very "stone age" in certain patterns of living, there is no hard evidence that their levels of languages complexity are similar to those existing 50,000 or even 20,000 years ago. Many other inferences have been drawn concerning the levels of language that would be "required" for certain levels of hunting, or tool use, or varied levels of cooperative behavior, but to date wildly different inferences have been made by different scientists (e.g., Johanson & Blake, 1996; Johanson & Shreeve, 1989; Jolly, 1999; Stringer & McKie, 1996; Tattersall, 1999). Moreover, there is no hard evidence of the vocabulary, syntax, and narratives of any hominids living more than about 10,000 years ago. Going further back in time, the available artifacts and fossil remains both become increasingly sparse and inconclusive. Donald's hypothesis that a stage of prenarrative mimetic (imitative mimes and other reenactments) representation was a precursor (from late *Homo erectus*, at about 300,000 years ago) to true language and narrative representation has some plausibility, but it too leaves indeterminate the particular modes of such mimesis. Overall, then, an open mind seems appropriate concerning the ways in which dance, art, music, spoken language, sign language, and symbolic dramas and rituals may have been interwoven at any point during the period from –300,000 years to –10,000 years ago. Whatever the mix of symbol systems in development, whenever survival rates favor those with more complex symbolic profiles, then genetic shifts across generations may build toward better and better brain foundations for the teachability and learnability of varied kinds of symbol production, symbol comprehension, or both. Moreover, even within a generation there may be expansions of the symbol systems and the strategies for successfully teaching them. Reduction or elimination of other hominid species by disease or by aggression from another hominid species may in some instances help conditions of easy hunting, foraging, or travel that will mix in a dramatically positive fashion with other converging conditions favoring symbol complexity advances. Climate changes, including some fairly dramatic ones in the course of a single hominid generation, may have favored both overall flexibility and flexibility in symbolic communication (cf. Deacon, 1997; K. Nelson, 1988; Donald, 1991; Stringer & McKie, 1996). Very rapid joint advances in the percentage of symbol users in a hominid community and in the complexity of the symbol systems will be expected only when the tricky convergence of highly positive dynamic mix conditions occurs generation after generation. More typically, there will be long plateaus in which a fairly stable level of symbol use prevails.

In the view taken here, a tricky, precarious set of converging conditions is required for significant steps forward in acquiring symbolic systems by an individual in its lifetime or by a community or by a species. A speculative comparison of how available time might be used can now be offered. There are available strong experimental demonstrations (many briefly reviewed earlier in this chapter) of children's acquisition of substantial new symbolic levels after 16 hours or so of rich dynamic convergences in art, sign language, spoken language, and text. Assume that a child in just those 16 accelerated, very positive hours of learning acquired 1% of a symbolic domain. Then that 1% gain would have been achieved in .005% (.00005) of one rough estimate of a lifetime of 320,000 alert hours (e.g., 75 yr × 364 days × 12 highly alert hr). Similarly, from a punctuated equilibrium view of human evolution of both physical and cultural-symbolic characteristics, assume that certain 1% changes happen to be concentrated in particular dynamically convergent, rapid growth periods of just 1,000 years. These high acceleration periods contrast with the more typical average evolutionary rate—across no-growth, slow-growth, and high-growth periods—of just 1/10 of 1% (.001) change (one "Darwin") in any significant characteristic in 1 million years. Note that the hypothetical fast pace here in 1,000 fast growth years, represents a pace of 10,000 Darwins (1,000% change in a million years). Clues that this may not be too far-fetched come from analyses in the last 10 years of the same finch species Darwin studied and other organisms such as tropical fish, but in the face of dramatic environmental changes and survival differentials (Grant, 1986; Weiner, 1994). Measurable changes in the survivors of droughts and other environmental shifts indicate genetic changes in 1 to 10 generations, and with a pace that wildly punctuates the genetic stability when the environment is stable—40,000 to 60,000 Darwins!

Sum of Parallels Between Modern Children and Hominid Evolution

The previous comparisons strongly suggest that despite many contextual differences, some similar basic processes are at work in changes in hominid species characteristic biology and culture and changes in the symbolic skills across childhood for children in the 20th and 21st centuries. Plateaus with little or no change alternate with periods of moderate to rapid change. Change periods are created in large part by dynamic, real-time convergences in the lives of individuals that bring together challenges, readiness for the challenges, online emotional and social adjustment processes and strategic tools that support processing and learning of challenges, enhancers in terms of sheer amounts of time spent in interactions with varied symbol-using partners, contextual qualitative enhancers that also feed positively into attention and learning, and maintained neural networks that sustain efficient performance of already-acquired symbolic skills as well as further readiness for new learning.

Time scales, of course, differ depending on which steps forward are at issue. But across many thousands of years in evolution and many weeks in a child's life, an illusion of steady change may be created because progress has been measured at widely separated times and no "capture" is made empirically of the many potentially productive episodes that do not actually contribute to the developmental advances. Another angle of description on these phenomena is from exceptional but naturalistic cases of rich immersion and/or instruction totaling about 1,600 hours of excellent, deeply engaging dynamic mixes—sufficient in a great many cases for the achievement of complex, expert (still with room to grow, though) levels regardless of whether the symbolic domain is music, mathematics, literacy, sign language, spoken first language, second language, dance, drama, drawing, painting, or sculpture (B. S. Bloom, 1985; M. Csikszentmilhalyi & I. Csikszentmilhalyi, 1988; Ericsson, 1996).

Huge variability in both the biological makeup and the culturally embedded experiences of modern-day children also provide a significant window into processes relevant to human evolution. Among those variations are learning rate variations (even when conditions are highly similar), acquisition pathway differences, and differential sensitivities to potentially enhancing/debilitating environmental circumstances (cf. Fenson, Dale, Reznick, Bates, & Thal, 1994). Variability of individuals increases the chances that even if contexts for learning vary dramatically, some individuals will be able to learn even in those contexts with no learnability for the typical individual. Across evolutionary and individual history, the characteristics of the learner may change as a result of the contexts encountered (cf. Gottlieb, 2002). For individual children in the period between ages 1 and 5, if highly positive and supportive mixes of learning conditions concerning narrative, text, and first language vocabulary and syntax keep recurring, the child's Readiness by about 5 years for new learning contexts including those of school may be very richly enhanced. The child may learn readily in new contexts in part because the child contributes to the online convergences of conditions—most notably by positive expectancies, well-established emotional-social regulation strategies, and highly practiced, redundant, and frequently reorganized networks of already established knowledge to compare with new challenges of any kind (Bransford et al., 2000; Dweck, 1990, 2000; K. E. Nelson, 2000; K. E. Nelson & Welsh, 1998; K. E. Nelson, Welsh, S. Camarata, Heimann, & Tjus, 2001). Part of this pattern of increased readiness incorporates large individual differences between children because of their past cycles of interaction and their in-built biological profiles. But for most children when they establish the kinds of increasingly sophisticated "true language" representations in syntax, vocabulary, and narrative that Donald and Nelson discussed under the Mythic Stage and the Theoretic Stage, new learning of additional communicative structures and new learning in general will mix in new kinds of learning-to-learn Readiness along with all the other familiar components of Dynamic Tricky Mixes.

REAL CHILDREN VERSUS IDEAL CHILDREN AND THE NATURE OF LANGUAGE ACQUISITION

Around 300 BC there were no published accounts of the details of children's conversations with others and their progress toward language mastery, so Platonic notions of ideal forms innately prepared in children's minds had no grounding in language acquisition stages or in actual interactional observations. The same lack of grounding characterizes Chomsky's speculations in 1964 to 1968 (e.g., Chomsky, 1968) that an innately given language (later "organ") device underlies language acquisition in children. But, of course, the revolution in children's language studies has grown slowly across the period 1964 to current work, and there was very little in 1964 to guide anyone's theories. Nevertheless, since 1964, Chomsky and other writers who have endorsed his basic innate language organ/device have taken one of two stances toward the increasingly rich, crosslinguistic set of empirical studies on children's interactional communicative patterns and children's pathways toward language mastery, with Chomsky himself (e.g., 1986) actively avoiding examination of such evidence (cf. Hyams, 1986; Lightfoot, 1989), or instead selectively reviewing observations on actual children and their conversational experience so that only the small minority of convenient, friendly observations are cited to "demonstrate" the strength of Chomsky's position (e.g., Pinker, 1994). Within this literature defending Chomsky's position, five kinds of Ideal forms are assumed. "The child" is assumed to be one entity, in contrast to substantial biological variations covered by countless theorists (cf. Elman et al., 1996; Gottlieb, 2002; K. Nelson, 1981; K. E. Nelson, 1980, 1991a) and subsumed in Dynamic Tricky Mix theory under Readiness and Networks. "The input" is assumed to be for all children essentially the same and so impoverished, so chaotic, and so inconsistent as to force one to conclude that a child could only come to use language if it was innate. "The language organ" is assumed to be one organ (perhaps with some separate modules) distinct from the rest of the brain in some fashion. Language "acquisition" is seen as one process of triggering and selecting particular innate representations that fit with the child's language community, in contrast to the many variations on language acquisition pathways within culture that have been observed. "Language" is seen as formal, fixed linguistic structures (paradoxically changing in nature with the ebb and flow of competing linguistic theories) in the head, rather than as language embodied in social interactional goals and contexts.

Within the broader scientific community, there are many efforts that challenge all of these idealizations of the Chomskian approach. Scientific investigations can be seen to jointly seek accurate characterizations of the biological mechanisms contributing to learning language and other symbolic systems, understanding of both similarities and differences between spoken and signed languages and other symbolic domains, individual differences in social communicative interactions during childhood, individual differences among children in their makeup and in their pathways through language acquisition, and understanding of language itself. Many findings and theoretical conceptualizations arising in the context of these broader investigations have been touched on earlier in this chapter. Taking these together with a diverse set of scholarly writings in developmental psychology and cognitive science and child language (e.g., Bohannon, Padgett, K. E. Nelson, & Mark, 1996; Bonvillian & Folven, 1993; Bowerman, 1985; Elman et al., 1996; Mahoney, 1991; Maratsos & Chalkley, 1989; Maratsos & Deak, 1995; K. Nelson, 1998; Slobin, 1985), it is clear that there has been much progress in accounting for many aspects of the very powerful general learning and abstraction mechanisms the child brings to the specific tasks of learning spoken languages and sign languages, and moreover that there is much progress in explaining how the complexities of a vast and often abstract language system is constructed by children. In 1964–1968, it was merely questionable for Chomsky to claim that "the input" was chaotic and that there were no means of accounting for language acquisition without very powerful innate language-specific structures, but in 2002 it would run counter to a deep and broad literature to claim either that specific facilitators typically are lacking in conversational input or that innate mechanisms are required by default because no other acquisition accounts could plausibly deal with the complexity of language acquisition.

Next we take a closer look at exceptional children with Specific Language Impairment (SLI) or autism. When a child fails to progress in language acquisition for substantial periods, as is the case for most autistic children and some children with Specific Language Impairment, then the explanation from the Chomskian perspective must be in the genes, in a somehow "broken" language organ, rather than in any special deficiencies in an already impoverished idealized notion of "the input" available to children. Indeed, at an operational level the ways in which most children with severe language delay have been treated until recently is highly consistent with Chomskian notions—children are given very little treatment that incorporates adult broad fluency in language within engaging conversational episodes. Thus, self-fulfilling negative cycles are set up. Children with broken language organs are not expected to get better, do not get conversationally enriched treatment, and when they do not improve their language levels much across many years further negative expectations are set up for the next generation of language-delayed children. Longitudinal studies based on earlier ways of treating language delay show, unfortunately, that children with Specific Language Impairment were indeed likely to have later problems in adolescence and adulthood with language production and comprehension, literacy, and academic achievement (Aram, Edelman, & Nation, 1984; Records, Tomblin, & Freese, 1992; Strothard et al., 1998).

However, by now there are many exceptions to this pattern. These exceptions should be taken seriously. Consider documented cases when a child has not been making progress in language for many years, but then receives enriched language input as part of socially and emotionally engaging conversational interactions for about 2 or 3 hours per week over the course of 6 months to a year and shows excellent progress in acquiring language. Because arranging—naturalistically or in interventions—highly supportive conversational exchanges for language acquisition is very tricky and complex, and because children bring important individual differences in their temperament, emotions, and biological preparedness for learning complex systems, fitting stalled-then-fast acquisition patterns to Dynamic Tricky Mix theory is straightforward. Chomskian models bog down in the face of the evidence on when children stall and when they move forward in language acquisition. If the stalling at say age 4 or 5 by a child with SLI or autism is attributed to a broken or damaged language organ, then when some children not only show progress but end up acquiring a full language system (Bonvillian & K. E. Nelson, 1978; R. Koegel & L. Koegel, 1995) a Chomskian theorist could "accommodate" by reversing field and claiming an intact language acquisition device after all. But then there is a circularity rather than theoretical explanation, because the only evidence of the language organ appears to be success at language acquisition and success at language acquisition is attributed to the presumed language organ. A different approach to the biological contributions to language acquisition is

to recognize the great many ways in which human children differ in their profiles of strength and weakness in attention, memory, pattern abstraction, sequential planning of complex motor sequences, perception, and potentially language-specific mechanisms of some sort, and then to convergently seek evidence on how these individual patterns of Readiness in children play out under different mixes of social–cultural–interactive learning conditions to produce individual pathways in language acquisition. In this regard, make no mistake, multiple theories (including Dynamic Tricky Mix theory) attribute very powerful biologically in-built acquisition processes to children by typical maturational ages of from 6 to 12 months, and as maturation and learning proceed, the available processes for further acquisition become far greater in their power during the period from 1 to 4 years.

CONCLUSIONS

Painting, sculpture, dance, spoken languages, sign languages, text, mathematics, music, and multimedia—all are modern symbolic systems that are highly complex. Their remarkable complexity far exceeds any documented symbolic system 20,000 years ago. Children today are able to learn these complex communicative systems only because they bring very powerful cognitive and social learning mechanisms into any communicative interactions and because every culture provides ordinary children extraordinary quantities of social communicative episodes of some sort accompanied by sporadic richness of scaffolding specifically relevant to supporting the child's developmental progress in symbols. For most children, most of the time, language or other symbol system acquisition is not taking place. From the Dynamic Tricky Mix theoretical perspective presented here, learning rises above zero only when challenges are accompanied in real-time by dynamic convergence of positive motivational, social, emotional, and processing enhancers. When all key conditions become increasingly positive in such dynamic convergences, the rates of acquisition by children correspondingly increase as well. Accordingly, it is "tricky" and unusual to see a child show sustained high rates of learning over many years, but it is predictable whenever there are many recurrent social episodes in which there are highly positive convergences of learning conditions within and outside the child.

Acquiring systematic literacy skills or systematic fluency in a first language is a gradual process with the required acquisition of very many different structures and skills. This chapter lays out considerable detail about the acquisition of one syntactic structure, the passive. Children who would not be expected from the literature of 20 years ago to learn the passive easily, very young children under 30 months of age, and children with the significant language delays of SLI also with quite young language ages, have been shown to be quite Ready cognitively and linguistically. Newly described convergent dynamic mixes that support such surprising acquisition of the passive are provided by natural cultural variation supporting young children's acquisition in such languages as Inuktitut and Sesotho and also by recast conversational intervention in English for children with SLI. Thus, the most effective mixes of conditions for supporting early and rapid passive acquisition are similar to those that appear highly favorable for acquisition of social scripts, narrative structure, and a broad variety of syntactic and pragmatic skills. All of these involve the convergent mixing together of clear-cut complexity challenges to the child within small episodes where the child and others co-construct shared meanings in a positive emotional-social context that also provides occasional scaffolding enhancers such as recasting and paraphrasing, subtle questioning and prompting, and sensitive topic extensions. A sense of humor is often part of these dynamic mixes, and it certainly is in the case of excellent (judged by their students objective gains) tutors in mathematics, who rely on "indirect" ways of layering in challenges that have much in common with what has been described herein for facilitative language-learning contexts (Lepper, Woolverton, Mumme, & Gurtner, 1993).

The theoretical account in this chapter is primarily from the angle of the child as a learning system, supported or not supported by some convergence of enhancers (recast and narrative sequences, e.g.) and certain developmentally appropriate challenges and many other resources provided by social interactive partners. As Nelson (1998) advocated in her discussions of the "mediated mind," the primary account is of "the interplay of individual experience and the engulfing cultural communicative society" (p. 327). But in reality there are many kinds of systems with mutual influence over developmental time. One can move to the level of the child's parent or the child's clinician approaching interactions with the child. The adult not only brings certain communicative strategies but a whole system of strategies for interaction and for self-regulation, a certain temperament, and a specific constellation of knowledge and skills. Similarly, the child–adult dyad can be treated as a system in other analyses. Consider once again the detailed analyses of passive acquisition in relation to shifts in what happens within dyads on the level of particular passive exemplars embedded in particular discourse and social-emotional-cultural patterns. When the mix of conditions within the dyad includes richness of challenges and richness of adjustment and processing enhancers, early and fast passive acquisition is seen by the child. But there likely are child to adult causal influences operating here too, as when a child who shows early passive comprehension or produces simple early passives (evidence of a hot spot in acquisition) may influence the adult to provide still richer quantities of passives and richer qualities of passive scaffolds. Similarly, there are multiple levels of system analyses to apply to issues of match or mismatch between a child's characteristic ways of interacting socially and approaching challenges as compared with a particular adult's ways of being in the world and approaching the enculturation of a child generally and also specifically as regards the child's acquisition and use of language and other symbolic systems.

Shifts across many months and years in child learner and potential adult scaffolder may also be an essential part of children's varied success at mastering symbolic system. Positive expectancies of interesting interaction, high attentiveness, positive emotion, and smooth emotion regulation all are considered to contribute to positive and effective overall mixes of conditions for particular children on particular occasions of encountering challenges. But these contributing factors are also influenced over many occasions and months by the kinds of "engulfing" cultural interactions the child regularly experiences. Over time, some children will tend to bring more and more favorable conditions as learners and social partners, so that—other things being equal on new potential learning occasions—they will be more likely to experience dynamic convergence mixes leading to learning. This kind of positive cycling toward more and more positivity and learning could proceed in a way that generalizes across most learning contexts and social partners, or it could instead be confined to new interactions with particular social partners who have shared many prior positively toned and learning-effective episodes. Regardless of the particular patterns that unfold, common processes will apply, with learners and their social partners in transactional fashion influencing each other across time and thus helping to set up Readinesses in the learner and Enhancers in their partners that will be essential contributors to whatever dynamic convergences emerge on new occasions (Dweck, 2000; K. E. Nelson, 2000, 2001; Nicely et al., 1999; Sameroff & Fiese, 1989). Illustrations of these complex patterns over time have been given for passives in discourse in this chapter and in a range of prior work for syntactic structures and lexical acquisition and narratives (e.g., Bamberg, 2001; Bohannon et al., 1996; Fivush, 1991, 1994; Kaiser et al., 1992; K. E. Nelson & K. Nelson, 1978; K. E. Nelson & Welsh, 1998; K. E. Nelson et al., 1995; K. E. Nelson et al., 2001).

Sustained rapid advances by a child, a culture, or a species will be relatively rare for all the reasons so far articulated on trickiness of mixes, but it will occur under predictable sets of circumstances—precisely when positive dynamic mixes are themselves sustained and very highly positive. Important educational implications are that small but well-chosen perturbations have the potential to have very substantial positive effects on learner progress (cf. Bransford et al., 2000; Perkins, 1993). Research in the future should better elucidate the dynamic mixes associated with zero, slow, moderate, and turbo rates of developmental advances (cf. Campione & Brown, 1987; K. E. Nelson, 2001; K. E. Nelson, Perkins, & Lepper, 2003). To achieve this, more studies are needed that measure in an online dynamic fashion what Launching challenges are encountered, what processing Enhancers are present, what levels of emotional Adjustment and social engagement and expectancies are in place, what Readiness characteristics and Network characteristics are activated in the learner by the context, and what sorts of learning or stalling are emergent. In this search for refined developmental accounts, it should be remembered that art and music and mathematics are no less species-specific in natural contexts than language. When these other symbolic systems reach maximum complexity and fluency even if only in a small percentage of modern humans, the dynamic mixes that support such high-level acquisition need to be analyzed and compared with those that support successful and varied pathways to high language fluency. And in all such work on developmental theory care must be taken to recognize and in some ways work around the limits of any convenient abstractions such as "word," "sentence," "drawing," "concerto," "narrative," "language," "deferred imitation," "relative clause," "first derivative," and so on. None of these are things in the brain, but rather are meaningful only as emergent phenomena in real-time in dynamic fashion as part of the ongoing life of creatures with complex levels of consciousness, a body sense, goals, emotions, motives, expectancies, perceptions, and vast networks of representations available to parallel retrieval and reorganization (L. Bloom & Tinker, 2001; Damasio, 1994, 1999; Edelman & Tononi, 2000; Thelen & Smith, 1994).

Striking flexibility in acquiring diverse symbol systems is characteristic of modern humans, in part demonstrated by the full sweep of children's acquisitions considered in this chapter but also by a broader literature on exceptional children including those considered gifted and those considered autistic savants. Consider art, music, mathematical calendar and other calculations, spoken language, sign language, and architectural design. Each of these symbol systems may reach high levels of complexity and fluency without the other symbol systems being in place (Dawson, 1989; Gould, 1997; K. E. Nelson, 1991b; Obler & Menn, 1984; Sloboda, 1996). Dual mastery of exceptional combinations of these symbol systems also occurs, as in cases of deaf artists fluent in sign language but not in spoken language, or language-delayed children who become excellent in mathematics, art, or music before they reach even moderate complexity levels in spoken language. By contrast, in modern literate and industrial-technological societies the typical sequences of spoken language mastery followed (with just moderate overlap with late language acquisition stages) by acquisition of written language and optional mastery of music and/or mathematical systems or, quite rarely, significant art skill, barely scratch the surface of most children's Readiness for flexible symbol system acquisition. Put simply, typical sequences depend on typical patterns of dynamic mixes and the many interesting exceptions concerning what symbol systems are acquired depend on exceptional sorts of dynamic mixes. Circularity is escaped because both natural and planned "experiments" indicate that when exceptional rich challenges and supportive learning conditions are provided, then art, sign language, mathematics, and literacy often prove highly learnable in children with no prior history of such achievements.

Parallels with the long view back into evolution once again are intriguing. For the moment, imagine that the accumulated graphic records of Stephen Wiltshire's accomplished productions in art were discovered but with absolutely no record of Stephen's life circumstances or his fluency levels in spoken language, written language, or any other symbolic system. What inferences would be drawn of the language levels that would be "required" for such graphic complexity? If found in 2003 in an old farmhouse attic, typical 2003 language levels would no doubt be presumed. But shift the context of discovering Stephen's art to the caves of Spain and France, below bison and lions and hunters and voluptuous women painted 25,000 or more years ago on the cave roofs and walls, then considerable dissociation of art mastery levels and language mastery levels would be "legal" or plausible to most scholars. Considering more broadly, then, the status of potential symbol users 25,000 to 250,000 years ago, this chapter has argued that these early periods of symbol development reflected some of the same basic processes observable today across a full range of exceptional as well as typical development and interventionist as well as naturalistic investigations. Thus, it is highly probable that given a Ready-enough brain for complex symbols, the course of symbol-system development could follow many mixed modalities, that different dynamic mixes of conditions existed in different social groups and ecological and temporal niches, and that progress in each of the symbol systems (or mixed symbol systems) showed dramatic irregularities.

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10

Literacy and the Mediated Mind

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> The purpose of the science of cognitive psychology and cognitive development … is to study how human infants, children, and adults meet, master, and use cultural knowledge and cultural forms.
>
> —Katherine Nelson, 1996, p. 23.

Throughout her career, Katherine Nelson has attempted to expand the scope of developmental psychology beyond research on the isolated mind of the individual child. For example, her early work on language acquisition (e.g., Nelson, 1973) stressed the importance of function and social context in children's early concept formation. Nelson's later work, exemplified by her 1996 book, *Language in Cognitive Development: The Emergence of the Mediated Mind*, focused on the role of culture in cognitive development. In this book, Nelson argued that cognitive development is a process involving a system of different strands—including biology, psychology, and social processes—that contribute to the developing mind. Fundamental to this characterization of development is the process of cultural mediation. Nelson argued that from the very outset, children's knowledge of the world is mediated by virtue of being situated in a cultural environment. Culture mediates de-