

Transactional Models  
of  
Antisocial Behavior Development

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A conviction widely shared among human beings is that we can learn much about what something is from how it came to be. The quest for developmental understanding of ourselves has ranged from religious and scientific cosmologies to children's queries and theories about the "facts of life". In the study of psychopathology, it has assumed a particular urgency because we hope to discover those influences by which the course of psychological functioning might be altered for better or worse. Knowing where to look for such influences matters a lot.

Of course, beyond the canons of scientific method, our guides in scientific investigation are our theoretical frameworks. They shape our perceptions and direct our attention in ways that may prove more or less fruitful. By establishing the contexts in which specific hypotheses are formulated and tested, they create and limit the opportunities for discovery.

The embrace of a developmental perspective, in our efforts to understand psychological dysfunction in children and adults, has itself constituted a theoretical revolution (Cicchetti, 1984). Within the emerging "macro-paradigm" known as *developmental psychopathology*, however, lies the same diversity of developmental models that has marked the established field of developmental psychology. In seeking to explain how and why a child might acquire a behavioral problem, developmental psychopathologists typically invoke and debate long-familiar and controversial themes.

My aim in this paper will be to explore the implications of a relatively new developmental model for our understanding of a particular behavioral disorder. I shall argue that this model offers important conceptual and practical advantages over its conventional alternatives, and yields important insights into a serious and costly social problem. My plan will be to discuss its underlying logic, its past applications, and its future potential.

### Developmental Models

How does a developmental account of a phenomenon differ from a purely descriptive one? At the heart of developmental theory is the notion of temporal change. Whatever develops moves in a succession of steps—which can be strikingly large or infinitesimally small—from a more basic to a more advanced condition (Van Geert, 1994, p. 20). The goals of a developmental theory normally include an explanation of why a particular path might be followed, or a particular endpoint reached, when other possibilities are conceivable. Students of biological and psychological development must account for generally complex structure and function in organisms. What mechanisms or

processes lead to the physical and psychological makeup of an individual? How and why do its characteristics vary across the life cycle?

Among the oldest and most familiar models of development are those that treat it as a unilateral process, if indeed as a process at all. The ancient view known as *preformationism* asserted that an organism begins in a fully structured albeit miniscule condition, and simply grows in size. We may patronize this view, quaintly depicted in homunculus drawings, as the notion of an ignorant age, but some scholars argue that it covertly persists in certain modern theories. For example, the view that development is essentially maturation, directed by genes toward a predetermined outcome, allows for increases in an organism's observable structure during epigenesis; but the emerging structure has nonetheless been prefigured as information in the genetic code (Sameroff, 1995; Thelen, 1989).

A more flexible type of developmental model admits influence from multiple sources. For example, nutrients might enhance the rate, or teratogens deflect the course, of an otherwise "prescribed" ontogenetic progression. To the extent that multiple factors contribute independently of one another to developmental outcomes, we might (in the parlance of statistical analysis) describe their influences as *main effects*; to the extent that these factors moderate one another's contributions, we might describe their influences as *interaction effects* (Sameroff, 1975).

Main-effects models have guided much research concerning developmental outcomes. For example, the classic nature-nurture debate has spurred investigators' efforts to assess the respective magnitudes of genetic and environmental contributions to individual differences within populations, expressible as heritability coefficients for physical or behavioral traits such as disease susceptibility or intelligence. Disentangling these contributions is an avowed goal, and possible confounds or interactions between them are viewed as challenging complications (Rende & Plomin, 1995).

A limiting assumption of factorial models—with or without interaction terms—is that the factors affecting development are not themselves affected by what develops. The possibility that various agents or factors might influence one another, at each step in a developmental process, distinguishes a more versatile scheme known as the *transactional* model (Sameroff, 1975; Sameroff, 1995). The contemporary view of embryogenesis, in which transactions between genes and their local environments cascade to drive cell differentiation (Dawkins, 1985, p. 121), provides an elegant example. Differences in the chemical environment form at opposite sides of a fertilized egg, and are transmitted upon mitosis to the daughter cells, where they elicit differences in gene expression. As the divergent patterns of gene expression direct the further

synthesis of cellular chemicals, they amplify the environmental discrepancies that initiated them. Highly specialized cell structure and function thus emerge after several generations of cell division.

Research guided by the transactional model seeks to elucidate patterns of mutual influence in developmental processes. These can occur within various domains, and on various levels and time scales, of systemic organization. An example that contrasts in these respects with the one just given involves transactions between caretakers and their children. In a study of fetally malnourished infants, Zeskind and Ramey (as cited in Sameroff, 1995) found that an educational component, added to an intervention program involving "social work, medical, and nutritional services" (p. 665), averted declines in developmental quotient expected over the ages of 3 to 18 months for infants who were underweight. An increased maternal responsiveness elicited by the infants receiving this component had apparently mediated this effect.

In focusing attention on what happens at each step in a temporal sequence, transactional models adhere more faithfully to the general concept of a developmental progression than their simpler counterparts. But the analysis of influence patterns in any study domain can pose daunting challenges. The strategy and craft of much scientific investigation have been honed on the isolation of individual cause and effect relationships. Methods of understanding influence and outcome in systems of interacting components are more novel and tentative (Kelso, Ding, & Schoner, 1993). I shall speak more to this issue in later sections.

### Antisocial Behavior

Few social problems have inspired as much consternation, or prompted as much remedial effort, as behavioral tendencies labeled *antisocial* or *conduct disordered*. They are among the most costly to endure in psychosocial and economic terms, and the most difficult to modify once firmly established (Caspi & Moffitt, 1995). They are also in ascendance, as least as indexed by increasing frequencies of psychiatric diagnosis and criminal activity in the United States and other Western countries (Hinshaw & Anderson, 1996; Maughan & Rutter, 1998). While many state and local governments in recent years have increasingly channeled resources into law enforcement and criminal justice, members of the mental health community have increasingly sought to understand how these behavioral problems develop and how they might be prevented.

As discussed in a meticulous review by Hinshaw (1996), on which the following summary is largely based, conceptualizations of antisocial behavior

have richly varied. Different kinds of activity may be viewed as antisocial, reflecting the many ways in which human community can be disrupted. Individuals may also differ from one another systematically, not only in their core symptom presentations but also in the origins, correlates, and courses of their disturbance. All of these differences have proven relevant to attempts at description and classification.

At the most general level of empirically based, dimensional taxonomies of childhood behavioral problems, antisocial patterns have consistently resided within broad-band symptom clusters distinguished by an outward or active rather than an inward or passive style of symptom expression. For example, in the widely used schemes developed by Achenbach (1995), they belong to problem groupings known variously as *Externalizing* or *Undercontrolled* as opposed to *Internalizing* or *Overcontrolled*.

On a more specific level, a robust distinction has existed between antisocial behaviors involving interpersonal aggression and those involving rule or property violations. The terms *overt* and *covert* correspond roughly to these problem types, as do such narrow-band behavioral syndromes as Achenbach's *Aggressive* and *Delinquent* subscales of Externalizing behavior.

Within the clinically oriented, categorical framework of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 1994) a distinction has been made between a milder condition labeled *Oppositional Defiant Disorder (ODD)* and a more severe one labeled *Conduct Disorder (CD)*. Differences in their defining symptoms aim to reflect a developmental progression, and indeed nearly all children evincing CD have evinced earlier ODD, although many children diagnosed with ODD never progress to CD. The diagnosis of CD also specifies childhood- or adolescent-onset, based on the presence or absence of at least one symptom before age 10. It conflates, however, the aggressive and non-aggressive problem types noted above.

Within both empirical-dimensional and clinical-categorical approaches, a distinction has repeatedly been made between those behaviors considered frankly antisocial and others, involving inattention, impulsivity, or hyperactivity, considered also to be socially disruptive but more benign. Constructs devoted to the latter include Achenbach's *Attention Problems* syndrome and the DSM-IV's *Attention Deficit/Hyperactivity Disorder (ADHD)*.

The classificatory schemes outlined above accommodate considerable diversity among behavior patterns identified as antisocial. Investigators have increasingly recognized the need for careful attention to diagnostic heterogeneity in conducting and interpreting research on antisocial behavior.

Some clarity has accordingly emerged from an otherwise confusing body of extensive work.

Children similar in apparent diagnostic status (e.g., conduct disorder) may well differ in the developmental trajectories and correlates of their disorder. A particularly significant distinction has been made by Moffitt (1993) between antisocial behavior problems having an early onset and unremitting course (termed *life-course-persistent*) and those having a late onset and transient course (termed *adolescence-limited*). Individuals evincing the former pattern show higher levels of severity, interpersonal aggressiveness, and social maladjustment than those evincing the latter, and they are more likely to have problems with inattention, impulsivity, and hyperactivity, as well as neuropsychological deficits.

These findings help to explain the attention increasingly devoted to developmental trends in research on antisocial behavior. Recent reviews of the relevant literature (Caspi & Moffitt, 1995; Maughan & Rutter, 1998) discuss efforts to identify and explain patterns of longitudinal stability and change.

The term *continuity* is used to denote stability in levels of antisocial behavior. Insofar as behavioral norms vary with age, symptom levels must be indexed against age-specific problem-behavior frequencies. The tendency for some individuals to maintain normatively high problem levels across developmental transitions, while varying in the types and breadth of their problem behavior, is known as *heterotypic continuity*. Variation in antisocial behavior levels, such as the increase that occurs briefly during adolescence in some individuals, is known as *discontinuity*.

Explanations of antisocial behavior must account for temporal patterns of continuity and discontinuity, identifying those factors that promote the emergence, maintenance, remission, or changing expression of disorder. Etiological hypotheses can accordingly be characterized and criticized with respect to the developmental models they invoke.

Main-effects models attribute continuity to stable features of either the individual or the environment. For example, male sex, irritable temperament, inattentiveness, hyperactivity, impulsivity, neuropsychological dysfunction, and low autonomic reactivity, are all enduring personal attributes identified as significant risk factors for early-onset, persistent antisocial behavior (Maughan & Rutter, 1998). A family history of antisocial behavior, possibly spanning generations, has also proven highly predictive, apparently exerting influence through genetic inheritance, persistently dysfunctional socialization practices, or both (Caspi & Moffitt, 1995; Hinshaw & Anderson, 1996).

Conversely, main-effects models attribute discontinuity to changing individual or environmental features. For example, treatment with stimulant

medication has reduced noncompliant as well as inattentive behavior in hyperactive children (Lytton, 1990), whereas deterioration or improvement in parental monitoring have respectively predicted increased or decreased delinquent behavior in preadolescent boys (Patterson & Bank, 1989).

Main-effects models are challenged by the difficulties of pinpointing variables as specific causes of disorder. Risk factors often interact; for example, the combined effect of multiple personal liabilities in predicting severe and persistent disorder is much greater than the sum of their individual effects (Maughan & Rutter, 1998). Moreover, risk factors identified in one domain may operate through mechanisms in another; for example, low autonomic reactivity is hypothesized to impair avoidance learning from punishment in socialization processes (Hinshaw & Anderson, 1996). Instances of moderating or mediating relationships among variables have increasingly undermined main-effects models, prompting investigators to consider more elaborate alternatives. It is the exploration of one such alternative, the transactional model, to which I now turn.

#### Transactional Models of Antisocial Behavior

Although investigators have increasingly conceptualized the development of antisocial behavior in transactional terms (Caspi & Moffitt, 1995; Maughan & Rutter, 1998), relatively few studies exist that clearly and specifically document transactional processes. In what follows, I shall discuss what I have uncovered, providing some historical background and then reviewing pertinent empirical work in detail.

The earliest discussion of transactional processes in the child development literature evidently occurred in an influential paper by Richard Q. Bell (1968), which challenged a dominant, contemporary assumption that parents unilaterally influenced their children during social interaction. Bell cited several sources of evidence suggesting that children's characteristics and behavior influenced adults' dispositions and actions towards them. These ranged from common sense observations of parents' reactions when infants cry, to studies finding differences in parental affection towards members of sibling pairs, or correlations between parenting attitudes and the presence or absence of birth defects.

Bell went on to hypothesize mechanisms by which children elicited specific types of parental response. Noting that parents had "a repertoire of actions to accomplish each objective" (p. 88), he distinguished between their *upper-* and *lower-limit control behaviors*, aimed respectively at homeostatic decreases or increases in the "intensity, frequency, [or] competence" (p. 88) of

their children's behaviors. He furthermore asserted that children might or might not, in turn, reinforce parental responses towards them. Thus, he argued that influences operating between parents and children were truly bi-directional.

In the decades that have passed since Bell's paper, several investigators have elaborated upon his ideas, and have marshaled evidence in both normal and atypical developmental domains of child-elicited parental control behaviors (e.g., Bell & Chapman, 1986) and of reciprocal influences between children and their social environments (Sameroff, 1995). Regarding the development of aggressive behavior in particular, two studies examining bi-directional relationships between childhood temperament and parental socialization provided some of the earliest evidence that transactional processes play a role.

### Temperament, Socialization, and Aggression

The first of these studies comprised an effort by Olweus (1980) to trace pathways of causal influence from individual and familial factors in childhood to aggressive behavior in adolescence. Subjects were sixth- and ninth-grade boys, sampled unselectively from a Swedish urban school district, for whom peer ratings of aggression were obtained to construct an outcome variable. Retrospective parental reports of early childhood behavior and parental socialization practices were obtained to construct four predictor variables. The first and second respectively measured a "negativistic" maternal attitude and an "active, hot-headed" child temperament, during the first five years of childhood; whereas the third and fourth respectively measured a "permissive, lax" maternal attitude towards aggressive child behavior and the parents' "frequent use . . . of power-assertive" child discipline techniques, during "somewhat later periods in the boy's life" (pp. 648-649).

Olweus undertook separate path analyses for the sixth- and ninth-grade cohorts, in which he specified the first two predictors as causally prior to the second two. In each case he found a significant direct path from early childhood temperament to adolescent aggressiveness, but also a significant *indirect path* that led through maternal permissiveness during middle childhood. Olweus interpreted the latter path as evidence that the child's early aggressive tendencies fostered the mother's tolerance for aggression, which in turn fostered the child's later aggressiveness.

A strength in Olweus's study was the use of different informants for the predictor and outcome measures, which avoided the risk of inflated correlations between them due to rater biases, but a corresponding weakness was the use of parental retrospective report for both the temperamental and socialization

measures. It is noteworthy, then, that a similar pattern of reciprocal influence between child and parent behavior was found by another method in the other relevant study of temperament and socialization.

Maccoby and Jacklin (1983) obtained measures for children, first at 12 and then at 18 months of age, both of “difficult” temperament from mothers’ reports of their negative emotionality and resistiveness, and of “socialization pressure” from mothers’ observed efforts to guide and direct them at assigned tasks in laboratory sessions. They found among boys that relatively high socialization pressure at age 12 months predicted decreased temperamental difficulty at age 18 months, whereas relatively high temperamental difficulty at age 12 months predicted decreased socialization pressure at age 18 months. They noted that mothers “appeared to be backing off from strong efforts to teach or to guide boys who resisted being guided”, and inferred from this “the basis for an escalating cycle . . . in which a difficult child is creating an interpersonal environment that will not serve to modify his difficult temperament, but may instead exacerbate it” (p. 83).

### Coercion Theory

Some of the strongest empirical evidence of transactional processes in the etiology of antisocial behavior has emerged from a program of meticulous investigation conducted by Gerald R. Patterson and his colleagues. One aspect of this work has comprised the study of overt social interactions within the families of children who were either normal or clinically referred for conduct problems. Viewing these interactions from a social learning perspective, Patterson has argued that conduct disorders develop in a context where family members actively learn to coerce one another through aversive interpersonal exchanges. The definitive statement of this *performance theory* was made in a now-classic book (Patterson, 1982), *Coercive Family Process*, on which the discussion of this section is closely based.

Patterson’s analyses were grounded in detailed naturalistic observation. Noting that global judgements about behavior reflect significant informant biases, and that mere frequency counts of events preclude the analysis of temporal sequences, Patterson and his colleagues devised a procedure for observing and recording family members’ moment-to-moment interactions in their home environments. Known as the *Family Interaction Coding System*, it afforded a variety of categories for noting the occurrence of both *prosocial* and *aversive* behaviors at six-second intervals.

With the aim of demonstrating that dispositions toward prosocial and antisocial behavior are modified by environmental contingencies, Patterson

adopted three-step event sequences as the principal units of behavioral analysis. Each sequence comprised an *antecedent (A)*, a *response (R)*, and a *consequence (C)*. Key hypotheses concerned the ways in which positive or negative consequences could alter *functional relations*; that is, conditional probabilities  $p(R|A)$  that particular responses would follow particular antecedents.

One class of hypotheses concerned whether or not desirable consequences positively reinforce children's aggressive responses. Arguing that elementary forms of aversive behavior are both innately present and readily learned through observation, Patterson hypothesized that their future performance is promoted, maintained, and refined by past rewards. Although his own and other investigators' studies showed that benefits (such as toy possession or parental attention) often followed aggressive behaviors, he cautioned that rigorous evidence of their status as reinforcers was modest. He also found minimal differences between families of normal and referred children in the likelihoods that rewards followed aggressive behavior.

More interesting findings concerned the effects of undesirable consequences on children's aggressive responses. Patterson discovered that a parent's aversive reactions tended to interrupt aversive behavior in a normal child but to prolong it in a referred child. Also, a sibling's aversive reactions tended to prolong aversive behavior in either a normal or a referred child, but did so more strongly in a referred child. Patterson used the term *punishment acceleration* to denote increases in antisocial behavior that follow aversive consequences,<sup>1</sup> and attributed its frequent occurrence in referred children to ineffectual discipline techniques. In particular, he noted that parents of these children reacted to antisocial behavior more frequently than did those of normal children, but they did so by expressing disapproval or criticism without intervening to stop the behavior, a practice he called *nattering*.

So far I have discussed only parents' and siblings' effects on children. Patterson's most remarkable findings, however, flowed from the studies of bi-directional influence permitted by his sequential data, in which parents and children could each be regarded as providing the other's environmental contingencies. Figure 1 presents my own illustration of a hypothetical scenario that Patterson discussed (pp. 143-145). It shows how an extended sequence of interpersonal exchanges can be subdivided into a series of overlapping antecedent-response-consequence (A-R-C) units. In this example, a mother

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<sup>1</sup> Although he coined this term, Patterson also observed that the phenomenon was not well conceptualized as punishment.

Figure 1. A-R-C Analysis Units for Extended Event Sequence

A-R-C Unit	Messy Room (aversive)	Mother Scolds (aversive)	Child Whines (aversive)	Mother Talks (neutral)	Child Quiet (neutral)	Direct Effect of Consequence
1	A <sub>1</sub>	R <sub>1</sub>	C <sub>1</sub>			Punish R <sub>1</sub> [Decrease p(R <sub>1</sub>   A <sub>1</sub> )]
2		A <sub>2</sub>	R <sub>2</sub>	C <sub>2</sub>		Negatively Reinforce R <sub>2</sub> [Increase p(R <sub>2</sub>   A <sub>2</sub> )]
3			A <sub>3</sub>	R <sub>3</sub>	C <sub>3</sub>	Negatively Reinforce R <sub>3</sub> [Increase p(R <sub>3</sub>   A <sub>3</sub> )]

responds to her child's messy room by scolding him, and he starts whining. She then begins talking palliatively, and he stops whining.

As shown in the figure, individual events can play multiple roles in promoting functional relationships. For example, in the first A-R-C segment, the child's whine serves as a punishing consequence for his mother's scolding. In the second segment, it becomes his negatively reinforced escape response from the same scolding. And in the third segment, it becomes an aversive antecedent for his mother, from which her palliative talking becomes her own negatively reinforced escape! Clearly, reciprocal influences are tightly woven into these interactions.

Patterson's example furthermore illustrates his observation that negative reinforcement naturally occurs for a successful punishment escape response; in this case, by the child from his mother's scolding, and by the mother from her child's whining. Noting that escape and avoidance responses are far more readily acquired than extinguished, Patterson argued that this type of interaction increasingly fosters both the child's aggressiveness and the mother's permissiveness, a phenomenon he called the *reinforcement trap*. He went on to show both that family members of referred children negatively reinforced each other's aversive behaviors more frequently than those of normal children, and that experimental increases in negative reinforcement schedules produced expected increases in children's aversive responding.

### Maintenance and Generalization

The research I have reviewed so far has implied that transactional processes contribute to the development of aggressive behavior in a familial context. A further question concerns their involvement in two crucial facets of antisocial behavior, namely, its durability and pervasiveness. Two relatively recent studies do provide some evidence that reciprocal influences between children and their environments outside the home foster the maintenance and generalization of antisocial behavior.

Olson (1992) followed aggressive behavior and peer rejection longitudinally in Head Start preschoolers. With an attention to event sequencing reminiscent of Patterson's (1982) studies, she coded boys' interactions with other members of small, mixed-sex play groups for aggressive and non-aggressive behaviors, at the beginning, middle, and end of a single school year. She also obtained teacher ratings of their conduct problems, and peer ratings of their negative social status and aggressive tendencies, at the beginning and end of the same period.

Olson found that positive correlations between peer rejection and observed aggressiveness, peer-rated aggressiveness, and teacher-rated conduct problems emerged early in the school year. But she also discovered a temporal progression in the observed interactions between highly aggressive, disliked children and their peers. At first, these children were likely to initiate aggressive behavior towards their peers without reciprocation, but by the end of the year, their peers had begun to *target* them selectively, initiating aggressive actions that drew aggressive responses! Thus, these children's earlier behavior had evidently fostered an environmental change that reinforced it, making their aggression increasingly reactive in the role of victim.

Patterson and Bank (1989) also followed conduct problems and peer relationships longitudinally. Noting other investigators' findings that antisocial behavior fostered peer rejection, they hypothesized that peer rejection likewise fostered antisocial behavior, by limiting contacts and activities with normal children and encouraging associations with deviant ones. The authors developed a structural equation model to study the continuity of antisocial behavior, and found that boys' poor peer relationships contributed more strongly than their antisocial behavior, at grade four, to predictions of their antisocial behavior at grade six.

#### Status of Transactional Models

The studies discussed in this paper clearly support the usefulness of transactional models in our efforts to understand antisocial behavior. These models present viable alternatives or supplements to more conventional explanations of behavioral stability and change. Important questions, however, remain about their scientific merits. Can their necessity or validity be defended? Do they open up new avenues of fruitful investigation? In what follows I shall suggest grounds for an attitude that might be described, in the words of Patterson and Bank (1989, p. 199), as "mildly skeptical but enthusiastic".

#### Present Findings

A significant strength of the studies reviewed above is the plausibility and coherence of their findings. None of them contradicts established facts about the kinds of risk factors, such as aggressive temperament or dysfunctional parenting, thought to be important in the etiology of antisocial behavior. Rather, each of them elaborates on the processes by which these factors might contribute. Moreover, a distinctive theme emerges in results obtained from diverse hypotheses, samples, and methods, namely, that

*reciprocal influences gain power through mutual reinforcement; that is, through positive feedback.* This type of principle lends unity to seemingly diverse phenomena, and shows how explanations that have sometimes been opposed might well be reconciled (Dodge, 1990). It is frankly obscured, however, by any models that separate developmental inputs and outcomes into mutually exclusive categories.

Another strength of these studies is their reasonable claim to ecological validity: their measures were drawn largely from reports or observations of children's behavior in the very naturalistic settings to which findings must generalize. A possible concern, however, is whether or not the results obtained for Patterson's clinically referred samples would hold for conduct disordered children and their families in the general population.

By the same token, with the notable exception of Patterson's coercion reinforcement experiments, a pervasive weakness of these studies is their non-experimental design. Although statistical techniques such as structural equation modeling may help to clarify relationship patterns among multiple variables, investigators cannot discount the possibility of unknown correlates affecting outcomes unless they manipulate predictors.

### Future Directions

Two significant obstacles impede a more rigorous study of pathogenic transactional processes. First, experimental manipulations that exacerbate risk factors tend to pose ethical problems.<sup>2</sup> Secondly, experiments that do authenticate specific cause and effect relationships rarely answer crucial questions about the combined effects of multiple causes. In the rest of this paper, I shall outline a response to these difficulties. Although it cannot redress all the drawbacks of limited experimentation, it can provide an alternative to our heavy reliance on correlational procedures, such as structural equation modeling, to study systemic phenomena.

Let me begin by returning to Patterson's (1982) seminal studies of family members' interactions. Patterson made an important distinction between the short- and long-term sequelae of particular events. He noted, for example, that in the negative reinforcement scenario discussed earlier, the mother and child each gained immediate relief from aversive stimuli while forging maladaptive relationship patterns. He applied the terms *structure* to the functional

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<sup>2</sup> For an interesting twist, however, see Patterson's (1982, p. 181) remark that mothers assisting experimental manipulations of their children's coercion reinforcement apparently benefited from the learning experience.

relationships that exist among temporally adjacent events, and *process* to the long-term alterations that occur in these relationships.

As I stated earlier, a fundamental task of developmental theory is to explain structure. In models that emphasize unidirectional influence, such as genetic or environmental determination, previously existing structure is essentially transmitted to an organism. In the transactional model, however, the organism is changing the structures that affect it, and may actually sharpen their definition through positive feedback. For example, in Patterson's hypothetical scenario, the mother's and child's developing response dispositions are also each other's developing environmental contingencies.<sup>3</sup>

These considerations raise doubts about the extent to which structure must predate development. An approach that presses these doubts has been to view all the agents and factors in a developmental process as parts of a system, and inquire *how order emerges within the system* (Thelen, 1989). Regarding a mother and child as a dyad, for example, we could ask: For a particular set of initial events and response dispositions, given certain learning principles, what kind of interaction style might evolve? Putting the matter another way, we could also ask: For which sets of initial events and response dispositions, given certain learning principles, might a mutually coercive interaction style evolve?

These are challenging questions! One of Patterson's most ambitious undertakings was his effort to elucidate structure and process in family members' moment-to-moment behavior through contingency analysis and experimental manipulation. He observed that this task was made especially difficult by the multitude of intra- and interpersonal factors that influence ongoing human interaction. We can in fact imagine a mother's responding in any of several ways to her child's whining on a given occasion, based on what is happening with her. Each response could pull the mother-child dyad in a particular direction. How can we determine the kind of order, if any, that should emerge in such a system?

Fortunately, a discipline exists—or at least is itself emerging—that can address this question (Kelso et al., 1993; Thelen, 1989). Known as *dynamic systems theory*, it seeks to elucidate processes of self-organization in systems comprising many components. It posits that the features of components, and the conditions under which they interact, may conspire to amplify some activities and suppress others. This phenomenon, called *synergy*, can induce stable regularities in otherwise haphazard component behavior.

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<sup>3</sup> For an interesting parallel in evolution, see Dawkins's (1985, pp. 178-192) discussion of the refinements that predators and prey continually foster in one another via natural selection.

We could build on Patterson's coercion theory with a dynamic systems analysis of human interactive behavior. The response dispositions and learning principles affecting human encounter would correspond to the features and circumstances of interacting components. Principal aims would be the discovery and characterization of synergistic processes, for which such phenomena as mutual reinforcement would be likely candidates.

A question that remains is how to conduct this kind of analysis. With what tools and techniques might we study self-organizing processes? An approach that has become increasingly practical is to represent the components and processes of a dynamic system with an active computer model. Building such a model clarifies important assumptions and hypotheses about the system to be investigated, whereas studying the model's behavior discloses their implications and consequences.

A modeling technique advocated by one investigator (Van Geert, 1994) employs ordinary spreadsheet software. The rows of the spreadsheet correspond to successive moments in time, and the columns to variables describing the system state. Figure 2 schematically depicts a rudimentary behavioral model of parent-child interaction, in which Patterson's hypothetical example is presented. The basic idea is that response probabilities maintained in the *Disposition* columns generate events recorded in the *Behavior* columns, and that event contingency information is accumulated in the *Experience* columns. The use of Experience data to modify succeeding Disposition values would reflect the feedback effects of past consequences on future behavior.

In actual practice we might work with different event descriptions and probability relations. But we can already see how modeling facilitates investigation. We could, for example, vary model attributes representing learning rates or initial response dispositions to reveal their hypothetical impact on system evolution. We could then compare these theoretically derived relationships with empirically observed ones.

A final point about computerized dynamic models, whether built using spreadsheets or other means, warrants mention here (Van Geert, 1994): they allow us to combine the effects of multiple factors, and to project them over various time scales. This matters greatly because many interaction processes, such as feedback, are inherently *non-linear*; that is, their long-range effects are not merely multiples of their short-range effects, and must be gauged through successive activity cycles called *iterations*. In a model of coercion theory, for instance, many iterations might well be needed to track the progression from specific social interactions to general relationship patterns.

Figure 2. Spreadsheet Model of Bi-Directional Influence

Time	Child Disposition	Mother Disposition	Child Behavior	Mother Behavior	Child Experience	Mother Experience
1			Mess			
2		$p(\text{Scold} \text{C-Mess})$		Scold	$p(\text{M-Scold} \text{Mess})$	
3	$p(\text{Whine} \text{M-Scold})$		Whine			$p(\text{C-Whine} \text{Scold})$
4		$p(\text{Talk} \text{C-Whine})$		Talk	$p(\text{M-Talk} \text{Whine})$	
5	$p(\text{Quiet} \text{M-Talk})$		Quiet			$p(\text{C-Quiet} \text{Talk})$
.		...		...	...	
.	...		...			...
.		...		...	...	

### Conclusion

In this paper, I have discussed transactional models of development in regard to the etiology of antisocial behavior problems. In reviewing the limited but noteworthy empirical research, I found support for the hypothesis that reciprocal influences contribute distinctively to the establishment, maintenance, and generalization of conduct disordered behavior. In discussing methodological aspects of this research tradition, I explained how further investigation could be moved conceptually and methodologically in the direction of dynamic systems theory, and showed in particular how this might be done for the classic example of Patterson's coercion theory.

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