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INFANT AND CARETAKING ENVIRONMENT

INVESTIGATION AND CONCEPTUALIZATION OF ADAPTIVE BEHAVIOR IN A SYSTEM OF INCREASING COMPLEXITY

Introduction

The assignment of bringing together one's "research perspective, research philosophy, methods, and findings" in one autobiographical account presents some rather obvious and many more subtle difficulties. It is obvious that such a contribution cannot be in the usual format of a scientific paper. And it is difficult to generate a personal synthesis and at the same time to offer it as a research contribution. It has seemed feasible for me only to try to organize and communicate in some reasonably concrete way the course that my work and thought have taken over the last score of years. During that score of years my career in clinical child psychiatry has become largely a commitment to certain problems of early developmental research, in particular, a concern with the question of organization itself in personality development.

A Red Thread

The opportunity that research in child psychiatry presented to me was of gaining at least some perspective of a dismaying complex universe, one that is rapidly becoming more complex as the knowledge of every aspect of the bio-

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logical process widens. From my original dismay has emerged the conviction that what it is essential to understand is the way coherence, integration, or "unity of the organism" can be achieved and maintained in an individual engaged in interactions with surroundings of great and apparently increasing complexity.

I assume that the synthesis Dr. Anthony has asked for concerns those gaps between the more formal and objective communications of my scientific publications. These gaps contain the personal information, influences, and rationalizations referred to by Polanyi (1959) as the "personal coefficient of knowledge." In his discussion of Polanyi's position Wallerstein (1973) described this aspect of the world of natural science as related to "realities created by acts of perspective and interpretation." He went even further to propose that "even the world of natural science is a man-created reality, a particular way of looking at and giving meaning to the facts of nature [p. 18]."

In fact, the recent address given by Robert Wallerstein as outgoing president of the American Psychoanalytic Association provides a most fortuitous frame of reference for an essay intended, as I have assumed, largely for an audience of psychiatric professionals. In this paper Wallerstein pursued the relatively neglected problem of the construction of the world of outer reality as itself a "psychic instance," pointing to the necessity of going beyond the notion of an outer reality as an "average acceptable environment" in conceptualizing psychic organization. He argued that it is insufficient now to make such a generalizing assumption in formulating the role of the ego as mediating among an id, a superego, and an outer reality. Wallerstein concluded that

... until recently, cultures, no matter how different, each contained a conservative tradition that children reared within the reality of each could expect to complete their days within that system of demands—the basis for the conception of the stable and the average acceptable. It is in our generation that our life task has become fundamentally different to survive successfully within a reality matrix in which the adaptive requirements are being radically and vangourly transformed within the lifetime of each of us as individuals, rather than slowly over the many generations history of a people. In maintaining our psychic integration under such circumstances, we need all the understanding that psychoanalytic study of all the interacting pressures upon us can give [pp. 31-32].

For such an understanding are needed new, more detailed, and more explicit conceptualizations of the adaptive process in relation to personality development, especially conceptualizations that can account for psychic integration in the face of an increasing complexity, both within the individual and in his encounter with his environment. Just as information—processing models, introducing cybernetic control in regulation, have replaced hydrostatic models of behavior organization, so also relatively simpler biological models of adaptation such as those based on the use of an "average acceptable environment" may have to be replaced by more inclusive formulations.

Biologists long have been thinking about the problem of organization of behavior, extending the framework provided by a concept of adaptation. A wealth of leads has been offered from this source for students of interpersonal adaptation, such as those given by Mason (1968) or Ashley (1952). Psychopathology can be viewed as a failure of integrative mechanisms as easily as it can be viewed as a consequence of conflict. However, as Mason has pointed out, just as in biological research relatively less attention has been paid to problems of synthesis than to those of analysis, so in psychiatric research less attention is given to understanding the genesis of ego strength than is given to the genesis of conflict.

When one views the empirical data of human interpersonal behavior, he finds disturbingly paradoxical functions that must be accounted for in the same individual. Both integration and differentiation must be accounted for by the same model. Can factors introducing complexity also provide mechanisms for synthesis and simplification? Can more sophisticated models of adaptive behavior representing processes of basic regulation also suggest more adequate models for the so-called "higher functions" of the human, functions such as cognition, self-awareness, or "inner perception." In fact, polarity in the arrangement of the forces with which the adapting organism must cope are so ubiquitous in the natural world (e.g., night and day, heat and cold, activity and rest, input and output) that it would not be surprising if a key to the comprehension of adaptive mechanics in development could be found in the organism's confrontation with and resolution of oscillating or opposing tendencies.

For me, the traditional training and concerns of clinical psychiatry initiated the guiding questions and provided research direction. The primary concern of the psychiatric clinician is with the "person"—an essential coherence synthesizing components interacting in the greatest complexity. In the therapeutic encounter, if the sensing of and the attention to the facilitation of essential coherence is neglected in favor of any one element over others, the therapeutic process soon becomes compromised or obstructed. The central question arises almost at once: How are the events in an interpersonal interaction to be related to the generation of changes in the organization of a
personality, especially to improvement of the integration of its component parts—its coherence?

In the early 1950s the way the organization of a child's character became established was attributed largely to the effect of the maternal character on the actual caretaking interactions of a mother with her child. The above question, stimulated by speculations about the therapeutic process, could be as easily asked about the developmental process: How do the events in the rearing interaction influence the organization or coherence of the child's personality in the first place? Might there be basic processes by which interpersonal interaction influences organizing functions in the human that are common to both levels of inquiry? Much theory revolves around the role of 'object relationships' in this process, and synthesizing conceptualizations have outlined the major steps in the development of object relationships, not at all a simple concept in itself. However, in the early 1950s few had looked in any systematic way at any appreciable sample of individuals for the actual course of events taking place between mother and infant over the first few years.

A Longitudinal Naturalistic Perspective of Interaction Between Infant and Mother

It seems now purely a stroke of good fortune that shortly after I had completing training in child psychiatry at the Judge Baker Guidance Center and the J. J. Putnam Children's Center, Dr. Eleanor Pavensetd invited me to join her group as a research psychiatrist. The opportunity to participate in a detailed naturalistic study of the early mother-child relationship was a most fortunate beginning for my experience in developmental research and is only part of the larger debt that I owe to Dr. Pavensetd. It was in 1954, some time after she had founded the Boston University Child Guidance Clinic, that the longitudinal study entitled, "The Effect of Maternal Maturity and Immaturity on Child Development" (Pavensetd et al., 1954) was launched under her direction. The aim of the project was primarily to contribute to clinical child psychiatry. It's hypotheses reflected an awareness of and a commitment to holistic issues in a conceptualization of organization in developing personality. For example, one of the hypotheses of the project proposed "that the degree to which a mother perceives and interacts with her child as an 'individual in its own right' will correlate directly with the level of maturity of her personality and with the level of maturity reached by her child at six," (each of these clusters being defined in terms of variables described on the observational level).

The effort to document such a proposal one way or the other gives evidence of the clinician's confidence in the child's ability to make inferences from a synthesis of clinical material, as well as evidence of a certain aplomb in confronting the many levels of inference involved. This effort also illustrates again the essential place of synthesis in the attitude of the clinical-therapeutic approach to the psychiatric enterprise. Synthesis, after all, may not be a pitfall but is the very essence of that which we seek to understand in early developmental research.

A brief description of this initial naturalistic longitudinal project is given here as a background for discussion of the work that led from it:

Beyond the documentation of a natural history, the groundwork of a body of data was laid, which made it possible to ask specific questions of the role of developing object relationship in the ensuing organization of the child's personality. The design of subject groups, the systematic schedule of observations, tests, and interviews, and the guiding hypotheses made this possible. The subjects consisted of 100 primiparous mothers, meeting basic criteria for normalcy. There were selected during their second and third trimesters of pregnancy from a general hospital prenatal clinic over a three-year period. The selection was on the basis of close agreement of a detailed characteristic assessment of each with one of three maternal character profiles which had been drawn up to represent the most immature, the most immature, and a middle group. It was expected that the contrasting behaviors exhibited in child-rearing by these three different groups of mothers would provide an empirical basis for studying the relationships between events experienced by a child and features of his or her character at an outcome point, namely, the first year at school or the sixth year of life. It was considered that outcome in the development of a personality organization in the child could not be judged from empirical data before such organization had sufficiently consolidated. Therefore, the guiding hypotheses of the study, which related maternal character variables, interactional variables, and variables defined for the child's characteristic development at six, were proposed only in terms of an outcome to be assessed during the child's first year at school. The application of hypotheses in the data depended on detailed definition of both maternal and child character variables in terms of empirical criteria derived from behavioral observation and clinical experience.

As has been pointed out, the investigation of relationships by this method is a type of clinical research, depending on the synthesis of evidence and depending on a level of inference by which psychoanalytic concepts can be applied in categorizing and assembling empirical data. A feature of a longitudinal study such as this, which is one of its greatest strengths, is that it repeated observations at different times and under a variety of circumstances can provide the data from which such inference reasonably can be drawn. The redundant and consistent become apparent, as does any deviation, once a trend has become established in the data.

A most intensive schedule of data collection was carried out, with remarkably little missing data, by a multidisciplinary team, which numbered as many as 15 at one point. They were spaced at regular intervals every two to four weeks for the three to four years during which the most intensive sequential data collection was carried out. Besides the variety of contacts, and their irregular repetition, upon which we relied to provide a fair picture of the child and his or her relationships in different situations and environments, objectivity was enhanced by 1) Tape recordings of interviews, which followed an associative structure in the first half-hour and a standard sequence of items in the second; 2) Three standardized observational situations consisting of teacher examinations, developmental tests, and play interviews, 3) The use of multiple observers (one for the mother's behavior,
Although it had been designed and initiated as a 10-year investigation with hypotheses relevant only to an outcome at age six, the entire project was terminated approximately at its midpoint, when necessary further funding could not be obtained. Completed data had been collected on some 22 subjects over the first 36 to 40 months of life with consistent data on the remaining 8 only through the first 1½ to 2½ years of life. Needless to say, the transcription of all tape-recorded interviews, dictated observations, home visits, and testings, examinations, play interviews, etc., resulted in voluminous data on each pair, which although remarkably encompassing became equally difficult to organize, reduce, analyze, and communicate. The problem remaining in 1959, then, was to analyze these data without the hypotheses, part of the design, or any of the outcome data. Nevertheless the struggle with this problem provided most of the incentive for the research that has followed. Although we could not know at the time, by dint of the rather enormous personal effort of Dr. Pavensiste and her colleagues, later on a detailed outcome observation was carried out anyway over the first year at school for the 22 subjects having the most complete early data.

In salvaging the extraordinarily rich documentation of interaction and development over the first three years of life, we felt we should at least communicate something of the striking range of behaviors we had encountered in the rearing observed in our three subject groups. In making comparisons we wanted to stay at the level of observed behavior in mother-infant interaction. But short of 30 case histories, how could these essential differences be defined and compared systematically from one mother-infant pair to the other over a three-year span? What were the salient variables and how were they to be related over time?

As a solution at least for communicating the essential clinical differences between the courses followed by the different infant-mother pairs—we formulated an epigenetic sequence of the adaptive issues negotiated over the first three years in the interactions between each mother and infant. The sequence was common to all pairs, but the actual behaviors, through which the adaptive adjustments were carried out, were idiosyncratic (Sander, 1962, 1964).

The sequence and its rationale represented the intertwining of ideas about the adaptive process from a wide variety of sources—from the work of others and from our own experience of interviewing mothers and observing their interactions with their babies. The basic perspective was the biological viewpoint of the living organism: from the cell upward, living organisms are actively self-regulating and, at the same time, of necessity exist in a continuous intimate exchange with essential support factors provided by the surround. There is an obvious polarity inherent in this view: attention to either cannot

be given at the expense of the other. There are mechanisms of active self-regulation and there are essential factors whose source is provided by a surround. The content of behavior must be accounted for in a specific context.

A most useful resolution of this polarity rests on cybernetic theory. The information-processing model is applied to the adaptation between the self-organizing components—the infant and the mother—and the adapted state then consists of a relatively harmonious coordination between them, consistent with the conditions for existence of each. With one component, the infant, rapidly growing and consequently rapidly changing, new qualities and quantities of infant behavior are constantly being introduced into the content of interaction. The regulation of infant functions, based on behaviors that have become harmoniously coordinated between mother and infant, will become perturbed with the advent of each new, and usually more specifically focused and intentionally initiated, activity of the growing infant. Thus adaptation or mutual modification on a new level is required. Since the behavioral innovations by the infant are often aimed at a progressive assumption of control of situations as the widening of his scope of self-regulation encroaches on the environment (i.e., he becomes more vigorously alloplastic), these changes impinge critically on the mother's long-established strategies of self-regulation (i.e., especially strategies for the control of extrinsic variables as a means of regulating her own intrinsic variables). The interactional picture is best organized in terms of the epigenetic sequence in which this progression of relative coordinations is achieved.

The levels that represent this sequence on the basis of empirical data were selected from the experience of interviewing the mothers regularly and systematically over the first three years of their participation in the longitudinal study. It became apparent that each mother was experiencing times of relatively greater worry and stress, which were then followed by times of relatively greater harmony in her role as a mother. After we had followed 10 or 15 of the mothers, we could even begin to predict, for a given age, the area of stress or the area of success the mother might report. A perspective emerged, and a relatively simple sequence of the usual course of interactional events

* It should be kept in mind that this is an account of interaction and is not intended as a summary of developmental steps. Furthermore, any sequential sequence will be seen to parallel the developmental sequence proposed by others, e.g., Mahler (1968). These will be noted upon briefly below and referred to in part; it should be evident, however, that within the scope of this paper a comprehensive cross-referencing cannot be undertaken. The interaction between a growing infant who has arrived with a particular endowment in regard to the regulation of his functions and a maternal character whose various facets will reveal themselves at different points in the infant differentiates new capabilities for determining his actions. The sequence illustrates a progressive differentiation, on the part of both the mother and the infant, of behaviors contributing to their exchanges—a progressive differentiation of increasing complexity. The fact that a sequence of adaptive issues between mother and infant was proposed primarily as a way of organizing observational material for analysis, does not mean an unawareness of or disinterest in the contribution of other factors, e.g., fathers, or other influences in the child's interpersonal environment.

1 This research was supported by the Supreme Council of the Scottish Rite.
TABLE 1
Adaptive Issues Negotiated in Interaction between Infant and Caretaker

<table>
<thead>
<tr>
<th>Issue</th>
<th>Title</th>
<th>Span of months</th>
<th>Prominent infant behavior that became coordinated with maternal activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Initial regulation</td>
<td>Months 1-3</td>
<td>Basic infant activities concerned with biological processes related to feeding, sleeping, elimination, postural maintenance, etc., including stimulus needs for quieting and arousal.</td>
</tr>
<tr>
<td>II</td>
<td>Reciprocal exchange</td>
<td>Months 4-6</td>
<td>Smiling behavior that extends to full motor and vocal involvement in sequences of affectively spontaneous back-and-forth exchanges. Activities of spoon feeding, dressing, etc., became reciprocally coordinated.</td>
</tr>
<tr>
<td>III</td>
<td>Initiative</td>
<td>Months 7-9</td>
<td>Activities initiated by infant to secure a reciprocal social exchange with mother or to manipulate environment on his own selection.</td>
</tr>
<tr>
<td>IV</td>
<td>Focalization</td>
<td>Months 10-15</td>
<td>Activities by which infant determines the availability of mother on his specific initiative. Tends to localize need-meeting demands on the mother.</td>
</tr>
<tr>
<td>V</td>
<td>Self-assertion</td>
<td>Months 14-20</td>
<td>Activities in which infant widens the determination of his own behavior, often in the face of maternal opposition.</td>
</tr>
<tr>
<td>VI</td>
<td>Recognition</td>
<td>Months 18-36</td>
<td>Activities (including language) that express perceptions of own state, intentions, and thought content.</td>
</tr>
<tr>
<td>VII</td>
<td>Continuity (conservation of self as active organizer)</td>
<td>Months 18-36</td>
<td>Activities rupturing and restoring coordination on an intentional level. (Intended and directed aggressive behavior in equilibrium with directed initiations aimed at facilitating restoration of interactional concordance.)</td>
</tr>
</tbody>
</table>

INFANT AND CARETAKING ENVIRONMENT

The sequence is listed in Table 1 with the time span in the longitudinal course over which it was most usual for the adaptation to occur.

For evaluation of the data collected, each of the adaptive levels listed was worded as an open-ended question, an “issue” to be negotiated between infant and caretaker, which represented the degree to which harmonious coordination was reached by the pair in relation to the interactive behaviors designated for that level and over the time span indicated.

**Issue I: Basic Regulation**

In the first three months of life the mother’s worries usually concern the problem of establishing, by her caretaking procedures, a regulation of the basic functions of her infant, such as feeding, sleeping, and elimination, so that they become both relatively predictable and relatively comfortable for her as well as harmonious with the household. Effects during this time appear to be bidirectional or reciprocal—infant on mother and mother on infant—with changes or modifications of behavior mutually conforming. An initial, reciprocally chained contingency consists of change of infant-state-caretaker intervention and vice versa. The “state” of the infant represents a first level of synthesis of coherence within the multiple physiological subsystems of the infant and is characterized by periodicity or rhythmicity. This suggests that influences modifying state regulation in the neonate obey rubrics that determine phase control of biologic rhythms. Phase synchrony between mother and infant in regard to the periodicities of relative activity and quiescence of each represent a second level of synthesis, now within the regulatory system instead of the individual. One of the features most idiosyncratic during the first three months is the extent to which the infant is helped or compromised in beginning to determine aspects of his own regulation. On the part of the mother trial-and-error learning gives way to ideas of what “works” and to the feeling of confidence that she now knows her baby's needs and can specifically meet them, while not jeopardizing her own needs and the remaining obligations of her day.

**Issue II: Reciprocal Activation**

The second three months—fourth, fifth, and sixth—are usually a period of relative delight, in which reciprocal behavior and reciprocal conformity be-

* For each issue several categories of items were individually rated as evidence for or against the adaptation and the degree of harmonious adjustment that had been reached. All evidence that could be discovered in the record both for and against was extracted and drawn on in the evaluation of the items. Agreement between independent analysts on the evaluation of such major trends, when taken in these large time blocks and based on extensive and repeated documentation, is not impossibly difficult (Snyder, 1969).
come more differentiated and actively directed by each. The mother develops active social reciprocations with her infant around the spontaneous development of smiling play. Both come to participate in this with delight and mounting expressions of exuberance as the period wears on. This proposition that the affect of joy and delight, as a concomitant of reciprocal social chaining, is established here as the criterion indexing the occurrence of an interpersonal “fitting together.” The total and vigorous involvement of the infant’s voluntary motor system as part of heightened social play represents a new and additional mechanism of behavioral integration for the infant in relation to affect.

At the same time the principal activities of caretaking, such as diapering, dressing, or the beginning of spoon-feeding, are being accomplished more and more through active, reciprocal coordination of the actions of each. Anyone who has tried to feed a five-month-old his cereal knows the coordination it involves— and the effort needed by each to achieve it. The emergent, active, and for the most part now voluntarily controlled, contributions of the infant to the organization of behavioral configurations are here carried out in relation to direct and immediate coordinations with the actual motor configurations of the mother, rather than, as somewhat later on, accomplished as a consummation of intrinsically held, goal-directed schemes.

Issue III: Infant Initiative

The third three months—the seventh, eighth, and ninth—find the infant expressing increasingly clear, independent, directed initiative of his own to explore the world as his motor apparatus develops and creeping is possible. It is assumed that what is appearing here, at the time of emergence of object constancy (in Piaget’s sensorimotor theory), is the beginning guidance of behavior by inner imagery. The strength of intentionality or goal-directedness is guiding action here first becomes recognizable at times when exploratory aims are blocked. The mother experiences a first active bifurcation in the direction of the child’s initiative: toward her, or away from her. 1 This early level of active independent organization of his world often meets a very basic ambivalence in the mother. The baby’s activity can be interpreted as aggressive, rejecting, or naughty on the one hand, or precocious, gratifying, and stimulating on the other, with consequent patterns of reinforcement or interference becoming characteristic for the pair.

1 The emergence of an initial level of autonomy from a previously more “symbiotic” relationship has been described by Mahler (1968) as the “hashing” process. The relationship of these interactions levels to the phases of autism, symbiosis, and separation-individuation proposed by Mahler involves a somewhat different perspective from which the progress of change in behavioral organization over these time spans also can be viewed. The relevance of one of these perspectives to the other would require extensive additional discussion, which is not possible in this paper.

The presence of a basic affective state regulation in the infant, maintained by already stabilized and adapted exchanges with the caretaking environment at this age level, should permit a relative “disjoin” of the active exploratory initiative of the infant. The already-adapted exchanges no longer come into the arena of interactional modifications. On the other hand, the presence of instability in infant states or in the caretaking environment, there would be a tendency of regulatory needs to preempt the infant’s action in the service of restoring the stability of basic functions.

Issue IV: Focalization

Over months 10, 11, 12, and 13 the advent of locomotion and the extension of the capacity to direct one’s own activity and express specific intentions by it sets up the opportunity for the child to settle the extent to which his mother is available to him. This is an availability as a specific response to the child’s bid—not just care in general. It begins the intended manipulation of a person now, instead of an object, and is associated with a potential widening of the bifurcation of directions of reinforcement or interference begun in the previous issue.

One mother will be gratified by this special knowledge of her baby’s needs for her and her capacity to act specifically on them. Another mother experiences the child’s directed and more specific, intended demands at this time as exceedingly threatening—something to be escaped from or defended against. The ambivalent availability of the mother, which may have been subtly evidenced earlier, may now be dramatized openly as her limits begin to be set. If her limits are consistent and constructive, we find the mother has a certain confidence that even if she yields to her child, the child will eventually turn away from her to wider horizons of his own. The pressure the child exerts at this time varies with the ambivalence of the mother in responding to him. If her availability is certain, he can turn to greater novelties; if she tries to run away, he is demanding; if she reacts to threat by aggression, his demand may provoke her attack or her surrender. Thus is illustrated the im-

In Ashby’s model (1952) “disjoin” represents the temporary and semi-independence (i.e., partial or relative independence) of a subsystem, which is made possible by a rich network of connections in the system. Inasmuch as over these months there appears to be a rather early emergence of the infant to inhibition by the mother, there should be an advantage to the infant if its active exploratory function of building sensorimotor schemata is not too “closely joined” to basic physiological regulation, ensuring that the effect of a mismatch does not become catastrophic. It may be that the basic physiological implications of experiencing a “mismatch” may be determined by the level of “disjoin” or exploratory function over this chronological period. Failure of a rich network of connections through this period to permit such a disjoin perhaps accounts for the significance of the “depressive position” in the dynamics proposed for this period (Wimsatt, 1954). The relevance of Ashby’s model is made clear in Glassman (1973), “Persistence and Loose Coupling in Living Systems.”
importance of a concept of balance or equilibrium for negotiating the levels of adaptation.

This extension of scheme building to an active manipulation of the mother as a total person occurs at the close of the first year. In the first year of life maternal responsibility has traditionally been viewed as experienced by the infant in terms of whatever particular need was in ascendancy at the moment—the "part object." This state of affairs may eventuate in a "fragmentation" of object relations, if this unifying issue of "focalization" is not adequately negotiated. Thus we encounter another of the multiplicity of mechanisms by which synthesis or integration is effected when developmental change is viewed from the perspective of adaptive behavior in an infant-caretaker system.

The successful negotiation of a reasonable set of conditions for, and of limits to, a predictable availability of the mother has appeared from the study of our material to be closely associated with a preservation of the same basic affect of delight that has marked interpersonal "fitting together" since issue II. Depending on adequate negotiation of the issue of focalization, the same affect becomes available for the next in sequence, namely the turning of investment and attention to widening mastery of the world beyond the mother.

**Issue V: Self-Assertion**

In the 14-20-month period there emerges a new capacity of the child to organize his world actively, to assert himself, and to widen his initiative to determine and select his own direction of activity. The child's aim at this time often seems to be to possess the initiative for its own sake. When his directions tend to run counter to the mother's wishes or the household rules, the issue is raised of the degree to which or the areas in which this assertion will be successful. There appears to be a shift in the content of the toddler's awareness during this time, and he becomes more sensitive to various visual and auditory stimuli and to events within his own body. Spitz (1957) has proposed that during this period the toddler has a heightened awareness of his own intentions; at the same time his wishes are being restricted as part of the imposition of rules and the constraints of socializations. Spitz associates this process with the emergence of the "I" experience.

The child's initiative, obviously, is not all in a direction away from or contrary to the mother but is balanced by bids for reciprocation with her. The probability of success for the latter he has been determining in the previous issue, a probability that now provides the context in which he can pursue his own inner intentions and the independent plan of action stemming from them. This pursuit extends the bifurcation of direction of investment toward and away from the mother begun in issue III. The heretofore relatively coherent progression of adaptations based on the differentiation of new levels of coordination with the mother through the reinforcement of matching reciprocations with her is now complicated by gratification and reinforcement arising from the successful realization of the toddler's own idiosyncratic intentions, goals, and plans of action. It will be seen at once that if the previous reinforcement and gratification have been connected with the achievement of a reciprocal exchange with the mother, we are now encountering a new phenomenon. The appearance of success and gratification begins to become evident as the infant maintains his own inner aims even if they are in opposition to rather than in reciprocation with the mother. In other words, guidance of behavior on the basis of the pleasure of realizing inner aims can take precedence at times over the more familiar (pleasurable) reinforcement of finding a coordination with the parental caretaker. Whereas before this period the child has reacted to separation as an upsetting event, now he himself initiates separation, both physical and psychological. The importance of a stable basic regulation has to do with a context in which the child can begin dimly to recognize his own role in determining actions, i.e., that he is pursuing his own intention rather than reacting to a lead. The emergence of autonomy as here proposed is based on the further differentiation of awareness—especially that of inner perception, which sets the stage for the "disjoin" of the self-regulatory core. The next two issues are particularly concerned with this process.

**Issue VI: Recognition**

At the beginning of the second year of life and over approximately the same time span as the previous step, the other side of the bifurcation becomes evident as the rapid development of secondary-process functions heralds a new level of increasingly differentiated communication between infant and mother. Speech and the child's capability of predictably communicating inner experience and intentions so that they can be read by the empathetic mother make possible a confirmation for the child of his inner perceptions in an actual exchange. This is communication based on a new level of inner awareness rather than the sensorimotor level of physical objects or of direct encounter. The development of speech is a necessary condition for interactions that can now idiosyncratically and specifically convey the child's experience of his own feelings, his fantasies, his play objectives, etc.

The issue here is how much the mother and child will develop and broaden their reciprocal coordinations on this level, especially in the face of

The relevance of issues VI and VII to Mahler's (1968) rapprochement adphase and the establishment of "object constancy" is that the two issues are constructed here as a concurrent polarity necessary for a "decentering formulation" in the structuring of constancy of self as a framework for subsequent self-regulation. These points will be taken up in some extent below.
disharmony consequent to this issue of self-assertion and the subsequent related behaviors of directed aggression, which will be described in the following step. The stimulus to develop a new level of communication may arise in part from its success in maintaining reinforcement through reciprocity with the mother on a new level of symbiotic representation and language, while the older, sensorimotor avenues of interaction now become involved in the disruptive encounters.

The label we have given to this aspect of the sequence of adaptive coordinations in the progression of mother-infant interactions is recognition. It gives ascendency to a new level of awareness in negotiating adaptation for both mother and toddler. The experience of coordination (here matching of a particular communication between partners) must constitute a first level in the experience of self-recognition, namely, realization that another can be aware of what one is aware of within oneself, i.e., a shared awareness. It is assumed that this level marks the beginning potential for awareness of a self-organizing core within—actually a core that from the outset has been operative in the service of regulation at the more biological level but is now in a position to be accorded a new priority in the guidance of behavior. Thus, while the progression of interactions can be looked on as belonging to an ontogeny of regulation, it involves and even may in part rest upon an ontogeny of awareness. Negotiation of this issue sets the stage for the establishment through the next step in the epigenetic sequence of continuity or constancy in the content of self-recognition (self-constancy being analogous to the object constancy of Piaget's sensorimotor theory).

The importance of this phase for later adaptive flexibility in the personality is that self-schemata cannot be modified without, at least for a time, an access to perception or awareness. Further, the achievement of a basic capacity for eventual self-recognition provides a basis for a sense of continuity in the human organism. This permits relatively greater independence from variation in outer or environmental regularities, upon which organisms at a more primitive level depend for stability.

**Issue VII: Continuity or “Self” Constancy**

In the latter half of the second year the bifurcation in the progression of interactions with the mother widens with the appearance of a new quality in aggressive and destructive behavior. This is a quality of directedness and intentionality in these behaviors, which up to this time have been seen usually as more immediately reactive to frustration or externally imposed conditions. Now they appear elective and initiated by the child in directed and provocative moves, often at some time removed from the defining of a rule or “don’t”—most often first toward objects of the material environment and then toward the mother in the testing of an intended interpersonal encounter.

The restoration of a previously adapted equilibrium between toddler and caretaker environment, which has been perturbed by the child's new capacity to carry out intentionally destructive and directed acts of aggression, provides the condition necessary for a key experience of "reversal" in regard to self-constancy. The intentional disruption of previously reinforcing and facilitating exchanges with the caretaker disrupts the toddler's newly consolidating self and body representational framework. Reexperience of his own coherence, again at his own initiative or by outreach from the caretaker, provides a situation from which "self" constancy as an inner structure can be established. An interpersonal equilibrium in the infant-caretaker system is critical in terms both of providing the experience of the taking of a contrary position and of still providing the experience of specific recognition by the familiar caretaker when the intention resumes to restore facilitating reciprocation again. The necessity for reversibility in establishing self-constancy on the basis of "self-schemata" as "operations," in Piaget's sense, gives a rationale for some of the child's employment of directed destructive or aggressive behavior in the second 18 months of life. Should the caretaker be unable to differentiate or fail to aid in restoring the facilitating self as the toddler had previously experienced it, the toddler's own familiar "good self" as a constant frame of reference would be impaired. In conceptualizing this issue as related to and immediately following issue VI, we envisioned the process as paralleling the notion of reversal in Piaget's sensorimotor theory, whereby operations become abstracted from action and thus freed for new combinations in thought.

The self-representation as a scheme has been discussed by Sandler and Rosenblatt (1962) and in this issue can be considered as gaining abstraction and thus mobility as an operation. Self as active initiator or as active organizer is thus "conserved."

The difference between mother-infant pairs in the way such directed intentional aggression was handled was striking in the range of tolerance to intolerance of any such testing. The ambivalent mother, who is in considerable doubt about setting her limits, permits more than another, but eventually she too comes to the point of standing her ground, usually by an angry display long overdue. After this, if the prior step has been negotiated, there follows an

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11 This has been suggested by Spitz (1957): "The achievement of the faculty of judgment on the level of the capacity to signify 'no,' either by gesture or by word will be found to correspond to the achievement of reversibility in terms of Piaget's Theory (1956) [p. 144]."
alating of the intensity and frequency of elective and provocative clashes with her.

An issue depending on experiences of "reversal" in establishing self-containment, and introduced by the new capacity for directed aggression, may or may not be negotiated. The longitudinal data lead us to believe that optimally there may be an age-appropriate span to which this collaboration is limited. After 30-36 months the child becomes increasinly able to anticipate and consequently to conceal inner content that has been so ingeniously revealed in the expression of his intentions and wants between 15 and 30 months, associated at that time with an awareness shared between infant and caretaker via expectations held in common by both. After this age level, concealment (and "defense") renders inaccessible, even to the child himself, the awareness providing a relatedness between the elements necessary for this essential step.

This sequence of levels constructs an ontogeny of interactive regulation in the infant caretaker system, at each level involving new elements that represent integrations of old accomplishments epigenetically. The sequence suggests as well an ontogeny of awareness, the characteristics which are becoming organized through the sequence of adaptations. As increasing numbers of elements enter the repertoire of coordinated behaviors and expectancies and constitute new contexts for action, even finer discriminations become targets of exploration and scheme formation and are drawn into the interactive regulatory process. Research contributions to an ontogeny of awareness have already begun in investigations based on the use of the novelty or surprise reaction in early infancy (Bower, 1972; Charlesworth, 1964) or the focusing of attention (a major means of regulating motility even in the neonate), especially the patterns of attentive focus developing in the exchanges between infant and caretaker (Stern, 1971). Piaget (1973) has commented on the role of both conscious and unconscious aspects of early cognitive development, basing this theoretical position on the relationship of consciousness in scheme formation to the assumption, which he attributes to Chaparelle, that it is mismatch that provokes arousal and conscious experience. This is essentially the same notion as that proposed by others also (e.g., Hunt, 1961; Von Holst, 1950).

In tracing the extension of sensorimotor scheme-building of the infant in interaction with his caretaking environment, we have followed the emergence of his increasingly clear intentionality. Spitz (1957) suggests that this sets the stage for the emergence of the self at around 15 months of age in terms of the toddler's perception (awareness) of his own intention during the restriction of his volitional execution of his intended aims, an experience frequent at 15 months. Certainly the perception of, or inference of, direction of intentionality continues to play a major role in the regulations of interpersonal behavior. In the concept of the emergence of the self framework as an essential self-regulatory mechanism in the second 18 months of life, much remains to be clarified regarding access to awareness, particularly the relationships between "inner" perception and feedback to expectations or goal-directed activity, i.e., the child's synthesizing of readouts of his own state as context and goal-directed activities as content.

**Recapitulation and Summary of Issues**

The first issue, in which coordination between activities of infant and caretaker takes place (months 1, 2, and 3), is the level of the basic regulation of infant states. Idiosyncracies in the organization of the self-regulatory characteristics of each partner demand a certain specificity in the modifications necessary for achieving harmonious reciprocal coordination, with wide variation to be found in different infant-caretaker pairs in the role accorded infant cues in determining the adaptation.

The second issue (months 4, 5, and 6) concerns the timed "fitting together" of the more active, voluntarily directed reciprocal behaviors characteristic of social (smiling) play and of the caretaking interactions of this period (e.g., diapering, bathing, and feeding of solids). The affect of joy or delight becomes established as a criterion for precision in the matching of interpersonal reciprocations.

The third issue of coordinations (months 7, 8, and 9) concerns the adjustments between infant and caretaker necessary to accommodate the more active initiation by the infant of the now more evidently intentional, goal-directed activities and the rapid acquisition of a widening repertoire of motor skills. Patterns of facilitation and interference (i.e., regulation) of infant initiative and intentionality become defined.

The fourth issue in which interaction must be coordinated between infant and caretaker (months 10-13) concerns the extension of the manipulatory activities of the infant from the area concerned with material objects to one concerned with active, intentionally directed manipulation of the responses of persons, especially the caretaker. The extent of availability of the caretaker's response to an intentional bid of the infant is being determined and is thus, in the usual nurturing situation, determining the extent to which and the conditions under which the chief regulatory element of the infant's environment, namely, the caretaker, can come within his repertoire of active self-regulatory schemata.

The fifth issue (months 14-20), at the time of new gains in locomotor freedom, requires adjustment between infant and caretaker in terms of those

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12 See Spiegel (1959), also for his review of the self in relation to psychoanalytic metapsychological considerations.
new self-assertive behaviors of the infant deliberately (intentionally) initiated against the wishes and limitations of the caretaker. The restriction to volition at this time appears to be associated with an especially keen awareness of the intention, or inner motivational state, that is being frustrated.

The sixth issue (extending over the second 18 months of life) concerns coordinations achieved on the level of newly appearing "secondary-process" functions in the toddler, of representation and expression, stemming from his "inner" perception of his own intentions and his own state, his own fantasies or wishes, etc., and depending heavily on the development of language for communicability. In the "fitting together" at this level, the toddler can experience that another is aware of what he is aware of within himself, providing an experience of personal recognition in a shared awareness and possibly facilitating a consequent capacity for self-recognition. Relatively stable infant-mother coordination at this level provides a context in which basic strategies can become established, allowing the child to use this awareness of "inner" events to guide his own behavior.

The seventh issue, paralleling the previous issue in time (the second 18 months of life), concerns the adjustment being made in regard to directly provocative, aggressive, and destructive behavior. The dimensions of the affect of anger in the caretaker environment come in for active exploration, exposing the toddler's self framework, which is being consolidated in issue VI, to disruption. Restoration can be initiated by either the toddler or the caretaker, but it is proposed that (reciprocal) coordination at this level provides essential experiences of continuity of the self framework, especially when the toddler's interaction is in the context of his being in, or taking, a contrary position vis-à-vis the caretaker.

Conceptualizations of Adaptive Behavior

The rationale for proposing an epigenetic sequence of interactional adaptations as an approach to the understanding of emerging character organization is suggested by a number of widely different sources. These sources can be but briefly touched upon here. They are intended as a stimulus for the reader's reflection on the sequence of interactional issues and on the relevance of an adaptive model. Behavioral details of interpersonal interaction can be ordered by such a model and hypotheses suggested that relate idiosyncrasies of adaptation with idiosyncrasies of character organization. This is not intended as a comprehensive review of relevant literature but includes only a most limited selection from those sources that have contributed to this viewpoint.

From the psychoanalytic point of view, Erikson's (1950, 1959) proposal of an epigenetic sequence of adaptations through mutual and reciprocal adjust-

ments between infant and caretaking environment was the basis of his concept of a sequence of stages in personality development. This contribution opened a whole new vista for the conceptualization of mechanisms responsible for "ego" development. Basically the sequence of adaptations proposed in our work can be seen as merely filling in the smaller details of Erikson's first two issues of basic trust and autonomy, and as implementing his basic plan of adaptive behavior in a biologic system, in which we discern four basic assumptions.

1. A lawful relationship connects the actual characteristics of behavior of the interactors in the infant-caretaking situation and the organizing of certain features of the child's personality during that time.

2. There is a balance between the polarities constraining the interaction, with a crucial alternative or "issue" for each stage determining the direction of the outcome and settled by decisive encounter.

3. In the history-dependence of the organic system a generalization of early, more specific adaptive strategies later on broadly underlies the biases of ensuing adaptations (e.g., organ mode to social modality).

4. With increasing complexity consequent to growth and differentiation, there are necessary corresponding capabilities maintaining a coherence or unity of the individual—i.e., "ego identity" and, later on, "integrity." Just what mechanisms underlie these capabilities has been of central interest.

The interactional, adaptive framework is only a leaf taken from the biologist's notebook. The biological literature is the major source of data and the conceptualizations of adaptive mechanisms in systems consisting of components in exchange. Adaptation most basically can be envisioned as being determined by mechanisms related to maintenance of the regulation of functions of each partner. The bonding between the interacting components, which keeps them exchanging as an enduring system, stems from the requirement that regulation of the intrinsic processes of each be provided by the properties and activities of the other. In other words, on the simplest level exchange (interaction) is determined by a requirement for regulation. One of the perspectives that the biological approach provides is that the concept of the "unity of the organism" relates to an organism functioning in its proper environment, i.e., its situation of evolutionary adaptation. A major difficulty in conceptualizing at the psychological level arises from a tendency to view the organization of behavior as the property of the individual rather than as the property of the more inclusive system of which the individual is a part.

The notion of an epiogenesis in adaptive behaviors within a biological system has been elaborated from the viewpoint of embryologists, for example, in the work of Bertealunffy (1952), and Weiss (1949). The former, a principle architect of "systems" theory, has pointed out that from the most primitive

13 Also see Spitz (1959).
level upward, two features characterize all matter that can be said to be living. Namely, "primary activity" and "organization." Adaptation cannot be conceived of adequately as a simple matter of cause and effect, stimulus and response, or the passive enduring of proximities. The living machine must be considered as already running, the complexly governed interactions with its support system already being specified as the conditions for the living state.

At the cellular level Weiss (1949) explored the neuroembryological mechanisms of adaptation governing the relations between the central and peripheral components of the nervous system and formulated the viewpoint of adaptation that has been the most useful. His definition (1969) of a system in the sense in which it is being used here clarifies a number of points:

Pragmatically defined, a system is a rather circumscribed complex of relatively bounded phenomena, which within these bounds, retain a relatively stationary pattern of structure in space or of sequential configurations in time in spite of a high degree of variability in details of distribution and interrelations among its constituent units of lower order. Not only does the system maintain its configuration and integral operation in an essentially constant environment, but it responds to alterations of the environment by an adaptive redirection of its componental processes in such a manner as to counter the external change in the direction of optimum preservation of its systemic integrity. . . . The complex is a system if the variance of the features of the whole collective is significantly less than the sum of variances of its constituents. . . . In short, the basic characteristic of a system is its essential invariance beyond the range of flux and fluctuations of its elements of constitution. By implication this signifies that the elements, although by no means single-tracked as in a mechanical device, are subject to restraints of their degrees of freedom so as to yield a resultant in the direction of maintaining the optimum stability of the collective. The terms "coordination," "control" and the like, are merely synonymous labels for this principle (pp. 11-12).

And in relation to the central thread of this essay, one might add the term integration.

From the vast contribution of investigations in the areas of ethology and animal behavior have come a number of widely inclusive perspectives of interactive regulatory mechanisms constituting adaptive behavior in the organism-environment system and relevant to both phylogeny and ontogeny (e.g., Heide, 1966, Uexküll, 1934). The most relevant work of T. C. Schneirla (1959) and his colleagues has seemed to be the study of the mechanisms by which "ontogeny progressively frees processes of individual motivation from the basic formula of prepotent stimulative intensity relationships." (See also Rosenblatt et al., 1961.)

Cybernetics and its offshoot, information-processing theory, have provided a body of more formalized conceptualization by which the adaptive and self-organizing behavior of biological systems can be represented. This formalized conceptualization has been of enormous influence in bringing a wide range of phenomena under simplifying propositions that model much of the apparent complexity of the living process.

One of the basic notions is that the system possesses inner criteria to which new inputs are matched. A certain "error signal" results if there is a mismatch. This activates effector apparatus which can then carry out activities to reduce the error signal. If these activities repeatedly require certain modifications necessary to achieve a match (e.g., in encountering consistent features of the environment) the modifications become part of the inner criteria. The criteria (or schema) then comes to represent the environment-relationship more precisely. Miller et al. (1960), have expressed these points in their concept of the TOTF unit as the basic unit of behavior. The cogency of the information-processing model for the developmental process has been suggested by D. MacKay (1956). He proposes that an inner criterion on which an error signal is based must itself have an ontology, differentiating more specifically from earlier more global routines. The information-processing model provides a means of visualizing the organization of self-modifying system, which can take a changing relation to environment into account in terms of changes within itself as it maintains goal direction. In his application of the model to an understanding of neurophysiology and especially the regulatory function of the brain stem, Pribram (1963) emphasizes the optimal response of the system when such changes take place relatively slowly and by small increments. This provides an optimal "error signal" to which the system is best suited to respond. The concept of an error signal optimal for acquisition of new behavioral schemata sheds further light on the picture we have drawn of regulation and its relation to the sequence of interactional issues.

The governing in biologic systems is in large part carried out through cybernetic or feedback control in which part of the output is fed back as input to the system, and, in terms of its match or mismatch against criterion governing output. Such systems tend to oscillate and are usually in a continuing cycle of variation requiring constant input to maintain the limits of control to any enduring existence of the system. This input can be provided by a second cybernetic system so a given state in one system provides the criteria for the control of the other, each system then setting a bias on the other, locked, so to speak, in a reciprocating or phase-synchronized relationship (Sander, 1969).

Contributions of cybernetic theory and the information-processing model to the problem of adaptive and integrative mechanisms have been suggested by a wide variety of investigators (e.g., Bowlby, 1969; von Holst and Mittelstaedt, 1950). Hunt (1961) has provided a most comprehensive perspective of the relevance of the information-processing model in organizing data that relate early experience to cognitive development and especially to the conceptualizations of Piaget. In 1965 Hunt broadened this perspective in stating his theory of intrinsic motivation and proposing its role in psychological development. In this theory he suggests a three-stage epigenetic development of intrinsic motivation in the infant.

Piaget (1936) anticipated far in advance, and yet in detail, the essentials that have been described above for the information-processing model. His sensorimotor theory first combined the essential elements of the model in implementing his preoccupation with the mechanisms of adaptation.

Piaget's "schema" obviously proposes a basic mechanism of integration. For the schema all prior experiences of a particular kind are drawn upon in de-
terminating the necessary modifications to achieve a consistent match in a new accommodation. In other words, by means of schemata the history of the system is integrated with the present context in organizing the final common path of action.

Polarity and the processes of the equilibration of polarities (e.g., decentering) form a central theme by which integration is carried further. Piaget (1969) summarized the three lessons that he drew from biology and that have never ceased to illuminate his thinking:

1. The first is that all adaptations of the organism... imply the closest interaction between organism and environment... No subject without action on objects and no objects without a structuration contributed by the subject... [The second is that] any biological adaptation implies two poles by virtue of these interactions, on the one hand, it is an accommodation, i.e., a temporary or lasting modification of the organism's structures under the influence of external factors; and on the other... A complementary pole, the assimilation pole, which has the task of integrating external factors into the organism's structures... A third analogy is obviously necessary: if biological or cognitive adaptation requires two poles, they both tend toward total harmony by means of successive equilibrations. From the enthelographic regulations, whose fundamental stage Paul Weiss called "re-integration," or from the numerous cybernetic circuits described by Waddington at the heart of his "epigenetic landscape," up to the self regulations which study the means of mental development is continuously bringing to light, we find a quite remarkable continuity... We are struck by the generality of these vital fundamental processes, whose knowledge is just as indispensable to the psychologist as to the biologist.

There is currently much interest in applying sensorimotor theory to the process by which the child gains lawful relationship with aspects of his interpersonal environment (see Escalona, 1963; Gouin-Decarie, 1965; Hunt, 1961). The polarity referred to by Piaget (Piaget & Inhelder, 1969) in the development of "object relations" is the polarity of self and other. The decentering of affectivity onto the other as an alternative to the self is part of a single integrated process correlated with cognitive decentering.

The chronology of interactions described above and the correlated epigenetic sequence of adaptive issues can also be viewed as an effort to apply Piagetian concepts. The concept of equilibrium, for example, can be here represented empirically in the achievement of stable interpersonal coordinations. These levels of adaptation provide a sequence of contexts permitting widening options (increasing selectivity) from which a next level of differentiation can take off in building interpersonal coordinations and schemata of interpersonal relations.

An application of Piagetian concepts to the empirical material of our longitudinal study, as assembled under issues VI and VII, can be suggested. These contrasting interactions represent a polarity, i.e., interactional coordination versus divergence. (In psychanalytic terms this could be expressed as the polarity of libidinal and aggressive drives or, in Mahler's formulation for this age period, as the polarity existing in the rapprochement subphase of the separation-individuation process.) In terms of our emphasis on an ontogeny of awareness in focusing the infant's initiation and intentionality, the harmony achieved in the negotiation of the sixth and seventh issues should be considered also in its relation to emerging self-awareness (see Spitz, 1957) and the establishment of an initial conservation or constancy in the structuring of self.

Here there is opportunity for an inner decentering between polarities of self-awareness: the self as facilitated and coordinated (issue VI) and the self as neglected and not coordinated (issue VII). If the interactive regulation existing between the toddler and his caretaking environment allows an option for exercise of choice, or behavior initiated by the toddler, a conservation of self-as-initiator or of self-as-active-organizer should harmonize the polarity. The failure of a self-constancy here would leave the child vulnerable to polar oscillations in terms of the interaction that happened to be current, a vulnerability in regulation that would powerfully determine that child's subsequent adaptive strategies.

Finally, Ross Ashby's (1952) conceptualization and mathematical derivation of the "origins of adaptive behavior" provides a remarkable model for adaptive behavior in an increasingly complex system. Drawing on the same Bournaki school of mathematics as did Piaget, Ashby provided a mathematical derivation for usable definitions of many of the usually imprecise terms thrown about when we speak of adaptation, systems, regulation, etc. In addition he derived principles of adaptive mechanics that account for some of the usually more difficult areas to be explained in adaptive behavior—for example, system, regulation, essential variables, the law of requisite variety, channel independence, adaptation time, use of the recursive situation, temporal and partial independence, and the mechanism of disjoin of a subsystem made possible by constancy or stability (richness of equilibria) within a complex system. This mechanism of disjoin makes possible differentiated adaptations with the environment at the level of subsystems, so that perturbation of or in the "disjoined" subsystem does not spread to the rest of the organism.

If we approach the early organization of infant behavior in terms of principles of adaptive behavior in an infant-caretaker system, the problem of coherence or integration takes on a somewhat different color than when it is considered one of the many functions of the individual to be attributed to his "ego." A whole array of mechanisms becomes evident that contributes to the
"coherence" of the organism functioning within the caretaking system to which it is adapted. In fact, different contributions can be identified for each of the seven issues.

The adaptations appropriate to each level may contribute basic interpersonal strategies or interactional parameters in the sense that they become characteristic constituents of the interactive regulations involved in later, more differentiated interpersonal adaptations. The adaptations related to each issue do not represent something established once and for all, but they are successive contributions to the maintenance of a continuous regulative process in interpersonal interactions.

Mechanisms of synthesis and integration must advance pari passu with increasing differentiation if "adaptation time" (Ashby, 1952) is not to become unduly prolonged: Ashby suggests that under conditions providing a richness of "regions of stability" or equilibrium in interactive regulation, the self-organizing core could itself gain relative "disjoint" as a subsystem and thereby possibly a "temporary and partial independence." Under these conditions such a subsystem would be capable, within limits, of participating in ensuring perturbations of adaptive encounters with the surround without the perturbation's spreading over the whole complement of subsystems that constitute the more basic biological functions of the individual. Ashby's argument thus provides the rationale that a "self" or self-organizing subsystem is essential to the regulation of adaptive behavior in a system at the critical level of complexity. 11

11 Complexity in behavioral adaptation should increase with the richness of the behavioral repertoire available (the law of requisite variety; see Ashby, 1958), thereby increasing the number of possible selections of appropriately differentiated behaviors when conditions permit options (i.e., in Ashby's terms conditions that do not displace "essential variables" from their regions of stability; such displacements would limit selectivity by precluding behavior to restore basic regulation). Such necessary complexity appears to accompany complexity in social interaction and communication. For example, a provocative question, motivating the detailed investigations by Dr. D. Plang (in personal communication to the author) and his colleagues regarding communication in the squirrel monkey, is why such a relatively small creature with such a relatively simple habitat has evolved such highly complex communicational behavior. If Ashby's model is right, the advantage gained in predator avoidance or food gathering for the squirrel monkey may be less important than the gain in complexity of repertoire, regions of stability, and, consequently, selectivity made available for the self-organizing function. The critical step in human evolution may have been at the point of both complexity and stability at which the organism's own "state" itself became conscious, i.e., both coherent enough and recurrent enough to become a criterion for match.

The information-processing model, in the general sense being used here that it is mismatch that leads to perception and consciousness, indicates that an ontology of interpersonal regulation must indeed be also an ontology of awareness. For both, the conceptualization of the infant and the caretaking environment as a system is central, with an ontology of awareness depending heavily on characteristics of "state" as context and on goal-oriented activities as content.

Investigation of Interactive Regulation in Three Infant-Caretaking Systems

The longitudinal study, therefore, led to a viewpoint about how to apply conceptualizations of the adaptive process to early human development. It is a particular viewpoint of adaptive behavior by which data from the first 18 months of life can be related to the second 18 months of life and the biological level can be related to the psychological level. Therefore in 1963, when the opportunity arose through the National Institute of Mental Health research development program to begin a new program of investigation, we decided to study the infant and caretaker as a system with a more detailed examination of the mechanisms of regulation, their relation to interactions and to events within the system, and their changes over time. One of our findings when we rated and assessed the sequence of infant-mother interactional issues was that the characteristics of negotiation of the first issue tended to predict the negotiation of subsequent issues, at least through issue VI. In other words, if we assessed the characteristics of adaptation between the partners right at the outset, when the system was first getting underway, we might gain basic insight into the idiosyncrasies of adaptation that that particular system might show at subsequent levels of coordination, and something like an adaptive potential or adaptive capacity for any given infant-mother pair might be indicated.

To investigate differences in adaptive progress in different systems, one should have access to some striking but uniform contrast in infant-caretaker "fitting together," which should not be confounded with differences in endowment of the infants. The contrast in harmony of "fitting together" Ideally.

| Table 2 |
| Design for Investigation of Interactive Regulation in Three Infant-Caretaking Systems |

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Caretaking period 1 (0-10 days)</th>
<th>Caretaking period 2 (11-28 days)</th>
<th>Caretaking period 3 (29-56 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>Nursery</td>
<td>Single caretaker (X or Y) rooming</td>
<td>Foster home</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>Single caretaker (X or Y) rooming</td>
<td>Single caretaker (Y or X) rooming</td>
<td>Foster home</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>0-5 days</td>
<td>6-10 days</td>
<td>11-28 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural mother</td>
<td>Natural mother at home</td>
<td>Natural mother at home</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rooming at home</td>
<td>rooming at home</td>
<td>rooming at home</td>
</tr>
</tbody>
</table>

11
should be studied only over a limited time span, so that the extent of recovery from perturbation to the system can be examined. For such an investigation we wanted measurement that would be reasonably precise without upsetting naturalistic observation. The subject samples to be observed also had to provide a contrasting analysis without experimental manipulation. Three samples of normal infant–caretaker pairs were chosen for study, nine pairs to be in each sample. The first two samples had specific contrast in caretaking condition; the third sample consisted of neonates reared by their own experienced, multiparous mothers. We used five principal methods of data collection over the first two months of postnatal life to get parallel observation of several infant variables and several caretaker variables that would be quantitative and would occur frequently enough and over a long enough time span to permit the identification of significant changes in values or the appearance of a regular recurrence or a relative stability of values.

**Design**

The study sample consisted of three groups of nine normal11 infants each (Table 2). Two groups were composed of infants given up by their mothers for adoptive placement and cared for by surrogate mothers. Of these the infants in group A spent the first 10 days in the newborn nursery being cared for by the usual nursery staff (multiple caretaking) on a fixed 4-hour nursery feeding schedule. These infants were then shifted to an individual rooming-in arrangement in a regular hospital room, where each infant was cared for by a single caretaker on a demand schedule 24 hours a day for the next 18 days. At the end of the first four weeks the infant was placed in a regular agency foster home and was there followed for a second four-week period.

The infants in group B (also going to adoptive placement) went directly into rooming in (usually 24 hours after delivery), where they had a first single surrogate-mother caretaker from day 2 through day 10 and were shifted to a second such caretaker from day 11 through day 28. These infants were always on a demand schedule while cared for in the hospital. After the first four weeks they also went to foster homes, where we continued to observe them for a second four weeks.

Group C was composed of infants of experienced, multiparous mothers. These infants were cared for by their own mothers, in rooming in for five days, and then were followed at home for the remainder of the eight-week study period.

Groups A and B were designed to elicit differences in infants cared for over the first 10 days by multiple caretakers on a rigid feeding schedule, i.e., one not allowing modification of timing of caretaker intervention, in contrast to caretaking by single caretakers on infant-demand feeding schedule. The subsequent caretaking conditions (from day 11 onward) were the same for groups A and B, i.e., single surrogate mother rooming-in 24 hours per day and infant-demand feeding. The assignment of infants to the two groups and to the two nurses who did most of the rooming-in surrogate mothering was unbiased. Group C provided a basis for comparison rather than a strict control group. Obviously home rearing by a mother differs in many ways from hospital and foster rearing. Group C was designed to provide normative data for the parameters measured, with which to compare the more closely monitored group A and B infant–caretaker pairs.

**Methods of Data Collection**

The four methods employed are briefly described.

1. **Around-the-clock observation.** Experience with the infants and the mothers in the longitudinal study impressed us with the obvious fact that adaptation between a mother and her infant is not carried out only in the time units customarily sampled in mother and infant observations but in all 24 hours of the day. “Relationship” must first involve being together.

Observation around the clock can be carried out if one considers that the continuous observation of even one variable of a complex system provides an observational window on the state of that system over time. For example, if one could measure automatically, around the clock and day after day, only the infant's presence in or absence from the bassinet, one could derive a great deal of information about the pattern and the change in pattern of caretaking events. **Couple this variable with one monitored from the infant while in the bassinet—for example, time of the occurrence of crying—and one has a means of observing interactions between infant and caretaker.**

Essentially, the monitor was a recording bassinet, operating without instrumentation of the baby; it utilized an Esterline-Angus event recorder moving at 12 inches per hour to record continuously, by separate pens in parallel, several channels of digital inputs. These represented (a) small summations of infant activity obtained via air mattress, a strain gauge, an amplifier, and an integrator system; (b) infant crying (occurring while the infant was in the bassinet); (c) the caretaker's removal of the infant from the bassinet, the duration of the removal, and the return of the infant to the bassinet; and (d) the proximity of the caretaker to the bassinet.

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10 "Adaptation and Perception in Early Infancy," U.S.P.L.S. III:176, carried out in collaboration with G. Sechler, Ph.D., H. Julia, Ph.D., and R. Burns, M.D.

11 Normality was precisely defined and controlled by prenatal history, observation of delivery, and postnatal examination.
2. **Observation of time of onset of awake state and sleep state for group A and B infants during the first month of life.** These observations of clock time of major change of state were made by the registered nurses acting as surrogate mothers with high reliability in terms of a simple dichotomous definition based on eyes' remaining open or closed over a span of at least five minutes. These observations by nurses fully accustomed to 24-hour duty and to accurate charting permitted an around-the-clock correlation of the monitor with the observed state and gave information about the periodicity of state changes in the infant—their day-night distribution and the striking individual differences between infants who had been reared by the same surrogate mother.

3. **Observation of feeding interaction.** Daily during the first month of life and twice weekly during the second month, a feeding was observed and recorded in real time on a Rustrak 4 key event recorder. The feeding was divided into three phases: prefeed, feed proper, and postfeed. Coded entries recorded various infant states; mutual regard between infant and feeder; infant regard of feeder's face; postural change for feeding, burping, visual regard, or "other"; insertion and removal of nipple; onset and end of sucking; signs of infant distress; intensity of stimulation, etc. These measures were mostly durations and frequencies. The amount of formula taken was recorded for each period of "nipple-in-time" by having the feeder put the bottle down on a scale instead of the table.

4. **Systematic observations of infant behavior on experiencing visual stimuli.** Approximately twice weekly in the first month and weekly in the second month of life the infant was presented a series of stimuli, each for a one-minute duration, at a 10-12-inch distance, with a 15-second interstimulus interval. The stimuli consisted of the following sequences: (a) a line drawing of a face; (b) the experimenter's face still; (c) nodding, (d) in full social approach using smile, voice, and movement to elicit infant attention, (e) a line drawing again, (f) the mother's face still, (g) nodding, (h) social, (i) a line drawing again, (j) the experimenter's face still, (k) nodding, (l) social, (m) a line drawing again. Using the same Rustrak 4 key event recorder, occurrence and durations of the following behavioral categories were made in real time: look, look-excite, look-excite-vocalize, look-excite-smile, look away, eyes closed, fuss. "Looking" included any orientation of infant gaze to the whole stimulus or any part of it, including its periphery and including gaze with one eye only. The testing of the infant was carried out only in optimal states of quiet alertness.

The analysis of data generated by these many variables, which were measured repeatedly on the three groups of neonates over their first two months of life, cannot be covered within the scope of this chapter. A number of findings have been reported (Burns et al., 1972; Sander, 1969; Sander and Julia, 1966; Sander et al., 1969, 1970, 1972), and others will be reported in the near future. Many of the findings are relevant to the adaptive process in an interactive regulatory system, contributing toward answers to basic questions although not fully answering them. For example, one asks: How early does an interactional bonding between infant and caretaker become established? Which infant variables appear to play a primary role in this process? What are some of the effects on the adaptive process of a limited perturbation of the system at this early point?

In regard to the first question, our evidence confirms the impression that a "bonding"—that is, a specific adaptation between the infant and the individual providing sole care—is established within the first 10 days of postnatal life. In this adaptation it is assumed that the infant's idiosyncrasies of regulation have become coordinated to some extent with the caretaker's idiosyncrasies. This adaptation was shown by the immediate and significant increase in 24-hour crying output on day 11 for group B infants, who had experienced a change in surrogate mother on that day, an increase in crying that persisted for a number of days. (The same two surrogate mother nurses cared for all but one of the group B infants. Each new infant subject admitted to the study was assigned to one or the other alternately in an unbiased way, so that on day 11 infants went as often from nurse A to nurse B as from nurse B to nurse A.)

The feeding data demonstrated the same effect of change of caretaker on day 11 for group B as did the crying variables. "Distress events" during feeding, which over the first 10 days of life had settled down for group B infants to a low level relative to the number occurring for infants in group A, also showed a sudden, significant, and persistent rise at day 11 for the group B infants. (Distress events consisted of the number of episodes during the feeding of spitting up, crying, gagging, vomiting, turning away, etc.) In current research we are pursuing the question of which variables will be the most sensitive indicators of perturbation of the initial coordination with a single caretaker.

In regard to the second question, certain infant variables do appear to play a primary role in the interactions through which regulation is carried out. The important variables are those related to the various "states" of the infant. These evidence oscillation or periodicity, both in the active and quiet cycles of REM and N-REM sleep and in the longer epochs of wakefulness and sleep. It seems evident that the sequence infant-state-change—caretaking-intervention is a first and most basic contingency and that caretaker-intervention—infant-state-change is an equally basic contingency, which bonds links the pair in reciprocally regulated relation from the very outset. We have encountered marked individual differences in the length of the gross sleep and awake epochs characteristic of such bonds.
each infant. The relative length of these two epochs is significantly intercorrelated, suggesting the existence of individual differences in an epoch "duration factor." The modification of the overall lengths of sleep and awake epochs and of their day–night distributions is one of the important sites of adaptive pressure as the caretaker seeks to bring her infant's 24-hour temporal organization into some coordination with the 24-hour pattern of events in the household. The data suggested that the shifting of epoch length toward shorter or longer periods may be related to the style of caretaking of the particular nurse who is doing the surrogate mothering.

Research on biological rhythms has made a key contribution to the conceptualization of the adaptive process and the temporal organization of interaction in the system. This contribution is an insight into the control of the phase relations of oscillating systems, which makes synchrony between them possible. Phase control involves quite a different array of mechanisms from those included in the traditional stimulus–response or learning perspective (see Aschoff, 1965). Franz Halberg (1960) has concluded that "Temporal organization of physiologic function usually involves a circadian time structure, with great although not unlimited plasticity. . . . By synchronization with environmental routines integrative circadian systems gain adaptive value. Temporal coordination in physiology has both integrative and adaptive facets. Periodicity analysis provides for resolution of adaptation as a function of integration and vice versa."

Figure 1 shows the progress of infant and caretaker variables over the first 10 days of life in the nursery (group A) and in the single-caretaker rooming-in situation (group B). Not only do crying and motility continue to increase under the nursery (group A) condition, but they remain greatest in the 12 night hours. In the rooming-in (group B) condition, not only are motility and crying at a much lower level and not only does a shift occur between days 4 and 6 to their predominance in the 12 day hours, but also a synchrony appears between the larger epochs of activity and crying in the infant and both the time of occurrence of and the duration of caretaking interventions.

That "temporal coordination in physiology has both integrative and adaptive facets" has been documented beautifully, for both the normal and the neurologically at-risk neonate, by the work of H. Precht (1968) and his colleagues. These investigators have obtained simultaneous recordings from a number of physiological subsystems during extended six- to eight-hour polygraphic studies of neonate's cycling through subphases of sleep. The group of infants designated as hyperexcitable (and those who have been found later to pose greater behavioral difficulty in rearing) is found to show poorer "coherence" or synchrony between physiological subsystems at the points of change as they pass through REM to N-REM cycles. The distinctness of states in these infants is less clear than in the normal infant, making it difficult for the caretaker to read the cues indicating which state the infant is in. These are cues that usually guide the mother in selecting which intervention is in order or, indeed, whether an intervention is in order. The "state" itself, then, represents a summation or an integration of multiple subsystems comprising...
the infants' physiology. Phase synchrony between the cycling infant states and episodes of caretaker activity constitutes a next order of integration in the system. Variables that indicate the state of the infant\textsuperscript{18} may be among the most critical for assessment of both mechanisms of regulation in the infant and progress of adaptation between infant and caretaker.

The design described above has allowed us to chart the course of sleeping and waking over the first month of life, both in group A infants (who did not experience caretaking response as contingent on their changes of state) and in group B infants (whose caretaking was contingent on their changes of state). The day-night organization of sleeping and waking (i.e., sleeping more between 6 P.M. and 6 A.M. and waking more between 6 A.M. and 6 P.M.) became statistically significant within the first 10 days of life for group B infants but not for group A infants. However, within a few days after group A infants had been transferred from the nursery to the contingent caretaking environment of the surrogate mother who was coming in (on day 11) they abruptly showed a precipitous advance in 24-hour periodicity, with a significantly greater day-night difference in the organization of sleep and wakefulness between days 11 and 25 than was shown by group B infants during this time. Interestingly enough, this reaction of advance or precocity was shown mostly by the female infant, the male infant tending to show his most rapid progress in day-night differentiation when he had had the contingent caretaking of the group B condition during the first 10 days of life (Sander et al., 1972).

Although group A infants had exposure to a noncontingent environment only during the first 10 days of life, they continued to show marked differences from the group B and C infants over the remainder of the investigation (to end of second month of life). One of the most noteworthy differences was the variability between babies when they were examined week by week. Significant stability of rank order from week to week was never obtained for group A infants in terms of a number of variables, e.g., crying, sleeping, and "looking" time on perceptual testing. In other words, stable individual differences were less evident in group A. On the other hand, stable individual differences were most striking in the group C infants, in whom the interactional idiosyncrasies between infant and caretaker for a number of variables (e.g., crying before intervention) were already most strikingly evident by the end of the first 10 days. An illustration of the stability of rank ordering of subjects within groups over weeks 2-8 is given by Kendall's coefficient of concordance. Although group B and C infants showed different degrees of stability depending on the stimulus presented, group A infants never achieved a significant rank order correlation over these weeks for any of the stimuli used in the perceptual test, nor for rank ordering in terms of time spent crying during the presentation of visual stimuli. Both groups B and C had coefficients of concordance greater than the \( p < .025 \) level of significance for these stimuli.

The history dependence of the infant-caretaker system is illustrated also by other effects of first 10-day experience shown during the ensuing weeks. For example, group A infants evidenced significantly greater crying over the two months of the study in reaction to the presentation of visual stimuli on the perceptual test, indicating lower tolerance than the others in this situation for this particular kind of visual stimulation (i.e., the human face; see Figure 2). In relation to the notion of a connection between the consistency or stability of the system and the progress of visual discrimination or differentiation of the infant's reaction to visual stimuli, only the group C infants, reared by their own mothers, showed a significant difference over two months in the amount of time spent looking at the mother's face during the perceptual test in comparison with the amount of time spent looking at the stranger's face. In approaching interaction in the system from the viewpoint of an ontogeny of regulation, these data support the suggestion already made, that one is dealing also with an ontogeny of awareness. Furthermore, from this piece of evidence one might say that greater specificity and stability in initial adaptation may be associated with the earlier development of a more differentiated discrimination. From the adaptive viewpoint, however, an early and highly precise fitting together may create certain vulnerabilities for the infant should the system become unstable or be disrupted later. To place a value judgment on behavior, from the perspective of adaptation, one must know the environment and the adaptive tasks that the infant will be encountering later.

The research approach that we have been reviewing has provided a rich

\textsuperscript{18} Escalona (1962) was one of the first to call attention to the central significance of the infant's state for both investigator and mother. A current report by Anders and Hollman (1973) assesses the neonate in terms of sleep–wake states.

![Graph showing infant looking times in different environments](image-url)
source of hypotheses and possibilities for new research aimed at a better understan-
ding of the early organization of behavior and perhaps eventually per-
sonality. Although work is still going on in the study of data obtained in the
prior projects, survival in the research world demands new projects and new
data. The same general direction has been continued, that of investigating
mechanisms of the adaptive process in an infant-caretaking system, but
employing advances in technology and new methods.

In a current project being supported by the Grant Foundation entitled
"An Investigation of Change in Infant–Caretaker Interaction over the First
Two Weeks of Life," the monitoring basinset has been further advanced in
design so that recordings from the prone but otherwise free-lying infant in the basinset,
the occurrence and duration of five states of the infant can be recorded around
the clock, along with time of occurrence and duration of caretaking inter-
vention. The five states are awake and active, awake and crying, transitional
sleep, REM sleep, and N-REM sleep. The continuous 24-hour record ob-
tained is interfaced with computer tape storage through an optical scan system
that makes possible analyses of the complex sequence and the time series as
well as the usual statistical analysis of variables. The monitor discriminates a
range of differences in state regulation between infants within the normal
range and allows study around the clock of changes over the first week of life
in sleep cycling and in longer sleep–wake epoch characteristics. The monitor
now promises to be an instrument that will make possible a quantitative study
of the ontogeny of regulation in at-risk infants of various types and a way of eval-
uating a variety of caretaking regimens that will optimize their early
course of development.

As part of the same project, receiving Grant Foundation support, new
methods of precise analysis of interaction between the infant and his interper-
sonal world have been developed by Dr. William Condon. Dr. Condon has
developed a method of independent frame-by-frame analysis of sound track
and film track of neonates who have been filmed in the awake and active state
while being spoken to by an adult or for whom speech is being played on a
tape recorder. The frame numbers of the two tracks match, so that an analysis
can be made of the points at which change in movement configuration and in
speech occur, for example, at word or phoneme boundaries. As early as 17
hours after birth there is evidence of synchrony at microsecond levels between
the movements of the awake and active neonate and these linguistic
components of human speech (Condon and Sander, 1973). Dr. Condon’s work
constitutes evidence for a wholly unexpected microscopic level at which
bonding in the infant–caretaking system is taking place, and it opens a whole
new systems approach to the acquisition of language and to the paralinguistic
aspects of communicational behavior. Stern’s (1971) film analysis at the micro-
second level of the regulation of head turning and facing behavior between

mother and infant indicates that at 3½ months initiation of facing behavior by
one or the other can be reciprocally regulated at interactional levels of less
than a half second.

Recapitulation

These current findings provide evidence of the embeddedness of the
human infant in a microscopic interactive regulatory system as well as a
macroscopic one. The first question that comes to mind might be: How does
the individual ever extricate himself from the obligatory demands on behavior
that this necessity for continuous regulation imposes. However, the question is
misleading, since one is never extricated from the life support system or the
exchanges that it provides as long as life prevails. One asks, rather, how regula-
tory interactions are incorporated into behavioral organization in a way that
provides a measure of relatively stable continuity in the presence of both a
varying environment and a changing organism, so that new modifications and
adaptations can continue to differentiate within a reasonably brief adaptation
time. Ashby’s (1952) model of adaptive behavior in complex polystable
systems, along with other, already-existing ideas, has been drawn upon in the
construction of an interactive regulatory perspective that encompasses the
behavioral coordinations necessary for regulation both on the more biological
level of the first (18) months and on the more psychological level of the
developments of the second 18 months that are related to functions such as lan-
guage, representation, and inner awareness.

At each level we have tried to pay attention to the mechanisms of in-
tegration and synthesis that are represented by the interactive coordinations
relevant to regulation at that level. In an epigenetic sense the relative harmony
of reciprocal equilibrium between partners in the system sets the stage for
active differentiation of a next level, and finally for the partial and often tem-
porary independence or "disjoin" of a self-regulatory subsystem. These
subsystems are accessible in some degree to more conscious levels of function
and synthesize feedback elements related both to the ongoing "state" and to
active goal-direction. Intrinsic, matching criteria provided as a consequence of the
disjoin constitute a new basis now for continuity and self-constancy.

Perturbations of the system requiring adaptive modifications can begin to be
limited to modification in the "self" framework instead of requiring modifications
at all levels of linkage, including the biological level. Disjoin requires a
certain complexity ("requisite variety") of stable equilibria and in this sense
provides a solution for the initial, seemingly paradoxical, features of com-
plexity and coherence mentioned at the outset.

The synthesis of a number of views of the adaptive process appears to of-
for a way to order empirical interactional data of considerable diversity and complexity and to provide a hypothetical framework that can be applied to the ordering. The focus becomes centralized on the problem of regulation and its connection with the exchange between component parts of a system and with the necessity to define and determine the regularity or the relative stability of variables, as well as to determine the introduction of new behaviors. Obviously, in working from the empirical approach, one tends to carry observation and analysis to ever-finer levels but hopefully remains equally sensitive to concurrent determinants of synthesis and coherence.

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