A.F. Kalverboer

11. The biopsychology of caretaker-infant interaction and 'early risk of deviance'

Abstract

After a short discussion of the concepts 'risk' and 'optimality', the main focus is on how various disciplines, such as ethology, developmental neurology and cognitive (information processing) psychology, may contribute to the study of 'mechanisms' involved in early caretaker-infant interaction and neurobehavioral development. Research on early visual attention illustrates how a detailed study of a specific adaptive system may contribute to the conceptualization of possible risk mechanisms, which play a role in caretaker-infant interaction.
Finally, the state of the art of infancy research into the clinical conditions Attention Deficit Hyperactivity Disorder and Autism is discussed, and a number of implications for future research are formulated.

Risk of neuro-behavioral deviance

The concept of 'early risk' originates from the early sixties when so-called risk registers were published in the U.K. They contained information about a variety of factors which might contribute to the chance of physical disease or psychopathology (Sheridan, 1962). At that time there was already the problem of how to identify a particular condition as a 'risk-condition'.

There are at least three implicit assumptions in applying the term 'risk' (Kalverboer, 1988, p.115):

- knowledge of the adverse effects for development
- knowledge of the place where a cutting point could be put between risk and non-risk values of a certain factor, and
- knowledge of the conditions under which a potential risk factor becomes a real danger for the development of the organism.

Generally, such knowledge is not at all or only insufficiently available.

Clearly enough, in isolation, most so-called risk factors have (almost) no implications for further neurobehavioral development. This is clear for obstetrical conditions, which may affect the development of the Central Nervous System, such as preterm birth or asphyxia, as well as for early neurological conditions, such as hyperexcitability and apathy (see for a critical discussion, Horowitz, 1992).

In recognition of this, in the late seventies, Prechtl introduced the concept of 'optimality' to replace the risk concept (Prechtl, 1980). He argued that we have knowledge about the biological function of particular behavioral systems, such as rooting, sucking, orienting, postural control, reaching and grasping. In his view we are able to define the 'optimal' function and structure of such a behavior, taking into account the maturational level of the organism (in particular the nervous system) at that stage of development. Re-

fined neurological examinations (as developed in the Department of Developmental Neurology of the University Hospital in Groningen, the Netherlands, by Beintema, Touwen and Prechtl) can provide us with so-called optimality scores, for the nervous system as a whole as well as for particular subsystems, such as postural control, sensori-motor functions, reaching and grasping patterns etc. The lower an optimality score for a particular system, the higher the chance that adaptational qualities will have decreased. The most important accomplishment was that thinking in terms of particular pathological signs, which was the basis of the earlier 'risk' concept, was replaced by thinking in terms of 'biological' functions of systems. Such a functionalist approach holds that 'the morphology, physiology and behavior of a developing organism serve to meet ends that are peculiar to particular phases in development. It assumes the presence of age-appropriate actions imbued with specific adaptive functions, such as communication and exploration, and a mutual fit between organism and environment at all times in development' (Beek & Hopkins, 1992, p.425). The assessment of such 'ontogenetic adaptations' is a core function of the developmental neurological examination. In this context the concept of 'optimality' is adequate. Applying it to other domains, such as that of obstetrical complications or the quality of the social environment, may, however, be less useful, as in such a domain a theoretical basis for the application of the concept is lacking (for a further discussion, see Kalverboer, 1988).[1]

Further developments with respect to the dynamics of organism-environment interactions were necessary to make progress in a more functionally oriented study of possible roots of neurobehavioral deviance. Transaction models were coined, which gave credit to the continuous mutual dependencies between behaviors of partners in developmental processes (Sameroff, 1975). Improvements in the methodology of longitudinal approaches, eventually combined with cross-sectional studies, went hand in hand with a great increase in sophistication of statistical techniques (see the series of European Science Foundation volumes, published by the ESF network, 'The Longitudinal Study of Individual Development' between '85 and '90, in particular Magnusson and Bergman (1990), and Magnusson, Rudinger and Bergman (1991)). These developments, which have their latest cumulation in the 'dynamic systems perspective' and the interest in 'transitions in development', provided the tools for more sophisticated and more valid approaches to the study of neurobehavioral deviance. (See for a critical discussion of this approach and its

[1] Notwithstanding the fundamental gain by replacing the concept of 'risk' by that of 'optimality', for clinical use the optimality concept did not turn out to be particularly useful. Predictions were even less clear, replacing 'risk' scores by 'optimality' scores (Molfese & Thompson, 1985) and similar problems arose with respect to the necessity of age-norms, and decisions about 'cutting points'. Without going in detail, I will use in the rest of this chapter the term 'risk' for groups of individuals, who are thought to have a relatively high chance of 'adverse' developmental outcomes.

present status, among others, Beek & Hopkins, 1992). Early main-effect models have, via transaction models, been replaced by system-approaches. Old clinical notions, which already indicated the complicated manner in which effects of early brain damage might be dependent on the context in which the organism develops, could now be formalized. Partly, such notions became the basis for the ELO-collaborative program (Experimental Longitudinal Studies on Caretaker-Infant Interaction) in the Netherlands. In the next paragraphs the main focus will be on:

- why early caretaker-infant interaction attracted so much interest, and
- how various disciplines approach the study of normal and deviant development in the domain of early interaction.

Early caretaker-child interaction

Psychoanalysis has 'in fact' laid the basis for the current day strong interest in the mechanisms playing a role in early social interaction and attachment development, and in the significance of these processes for later socio-emotional and cognitive functioning. Bowlby was the first to indicate how the scientific approach of the ethologists was the main road to the empirical study of the mechanisms, which were in part pre-scientifically formulated in psychoanalysis (Bowlby, 1969). Ethology, rooted in evolutionary theory and thinking in terms of 'survival value' of behavioral systems, could provide us with insight in the complex dynamic interactions between internal and external causal factors in the 'ontogeny of adaptational patterns'. Bowlby also saw the significance that early 'biologically rooted' responses, such as orienting responses, head turning and sucking, grasping and clinging, have for the ontogeny of social adaptations. Developmental neurology elaborated on these notions by introducing mechanisms, such as 'postural control' and 'organization of behavioral states'. In 1963 Prechtl wrote a short but rather influential article on 'mother infant interaction in the child with MBD' (Prechtl, 1963). It suggested how particular qualities of children's behavior patterns, such as lack of stability of posture and orienting behavior and instability of behavioral states might, affect the caretaker's ability to properly interact with the infant. In Prechtl's view such 'non-optimal' patterns could contribute to the caretaker's emotional instability and decrease his/her ability to adequately react to the infant. Such caretakers' reactions could increase the possibility of adverse effects of early brain dysfunction. A study like this indicated that knowledge of the child's repertoire would not be sufficient to understand how early brain dysfunction might affect later socio-emotional and cognitive development: developmental processes should be understood within their psychosocial contexts. Consequently, behavioral phenomena such as 'lack of responsiveness' and 'lack of exploratory activity', which are frequently reported in children with the neurological 'apathy' and 'hyperexcitability' syndromes, began to be understood in terms of the dynamics of such children's interactions. This led, in 1979, to the following statement (in Kalverboer, 1979, p.65): 'A simple 'interaction' model would possibly suggest that the lack of responsiveness of children with the apathy syndrome directly affects the behavior of the caretaker; there may

be too little appeal for stimulating and contacting those children who are inactive or disorganized. A more complex interaction model would suggest that, in such children, stimulation would not only be less frequent but also less adapted to the structure of the infant's own activity. Disorders in the child's behavioral patterning may contribute to the development of a lack of contingency between actions of the child and the social partners. Non-contingent stimulation may interfere with learning and with the development of initiative' (Papousek, 1977; Watson, 1977). Apathetic children and so-called hyperexcitable children, who have inconsistent states and an inconsistent temporal organization of their motor behavior, may be particularly prone to negative effects of exposure to non-contingent stimulation.

Interconnections were further differentiated by researchers such as Schaffer and Collis (1982), who with great refinement showed how the infant's exploration of the wider environment develops out of mother-infant's mutual gazing. Papousek introduces the concepts of 'intuitive parenting' and 'intuitive didactic' (Papousek & Papousek, 1987), referring to an, evolutionary based, mechanism which is at the basis of the caretaker's subtle and developmentally profitable interactions with the infant: e.g., mothers may show just those behaviors which maintain the infant's alerted state and guide their orienting reactions, and may show facial expressions which positively affect the infant's mood. The caretaker has a great quality to read and interpret children's expressions in terms of their attention, mood and state (Papousek & Papousek, 1993).

In parallel, cognitive and clinical developmental psychology provided us with concepts, such as 'responsivity' and 'sensitivity', which could be meaningfully linked to the biological systems studied in ethology and developmental neurology.
These approaches particularly allow for the study of inter-individual differences in the quality of caretakers' abilities in relation to children's behavioral and expressive patterns. How can they contribute to our insight in risk mechanisms for (neuro-)behavioral deviance? This will be the subject of the next paragraph. The emphasis will be on the study of caretaker-infant interaction and its follow-up in groups at risk, exemplified by the case of the 'preterm born child' and the possible relevance of such early interaction studies for later outcome, exemplified by two clinical entities: Attention Deficit Hyperactivity Disorder and Autism.

Early interaction and neurobehavioral deviance: the case of the 'preterm born child'

Preterm birth (generally ≤ 37 weeks of gestation) is one of the numerous factors which may contribute to an increase of the risk of brain damage and behavioral disorder. The effects may be most varied, not in the least due to the widely diverging concomitants of 'prematurity' and the complicated way in which physical and overall conditions (e.g., incubator, conditions in the family, health of the caretaker etc.) may interfere with an optimal development. When interested in 'risk mechanisms', such as behavioral patterns, reaction tendencies or physical features that may directly play a role in the child's cog-

nitive and social development, 'preterm birth' is not a valid category.

The study by Wijnroks (1994) is an example of how the study of early interaction in a group at risk can be brought to the level of 'mechanisms'. Three points are crucial in such an approach:
1) how does the behavioral repertoire in infants at risk differ from that of another child?
2) which particular problems may this give to the caretaker?
3) which qualities of the caretaker are important in coping with such problems?
A short comment on each of these points:

re 1: Early brain disorder may have specific as well as non-specific effects on functional development. Specific effects include e.g., various forms of hemiplegia: they are related to impairment of particular areas of the brain. Non-specific effects may relate to more widespread and 'diffuse' damage to the brain. They may imply general qualities of children's behavioral organization, such as inconsistencies in the maintenance of states, postures and orientations; stereotypes in behavioral patterns and a general slowing down of reactions.

These are the characteristics which are typically observed in relation to generalized dysfunction of the brain, frequently found in children after pre- and perinatal complications, such as preterm birth. They may impair the child's ability to adequately react to its social and physical environment in that they imply a less integrated and less flexible organization of body postures ('overstretching'), visual orientation and goal-directed movements; less differentiated emotional expressions and less 'readable' intentions and an impaired and inconsistent 'motivation' to be in interaction with the social and physical environment (e.g., the apathy syndrome).

re 2: As indicated above, characteristics may impair the conditions for 'learning by experience' as behavior-effect connections may be less consistent and predictable (Kalverboer, 1983). As the social interaction situation (social partners presenting their infants with contingent stimulation) is the condition *par excellence* for learning and habituation, such infants may fail to learn by contingency perception and may become less motivated to actively explore the environment. They may also destroy the caretaker's expectations about the infant's responsiveness and emotional expressiveness: the infant is less cuddly and less 'interested' in the mother, as indicated by a lack of orientation towards the partner's face, etc.. Furthermore, this may interfere with daily life routines with respect to feeding, caretaking, sleeping, etc..

re 3: Caretakers' qualities important in coping with these children's characteristics are those which are subsumed under the umbrella term of 'sensitivity': the ability to properly perceive the infant's intentions and emotions and to adequately respond to the infant's signals. A basic requirement is, what I would call, an 'approach tendency'; this implies a tendency to be engaged with the infant and pay attention to it, which is rooted in an attitude of 'acceptance'.

These are 'ideal-typically' sketched mechanisms which may play a role in caretaker-preterm interactions. These notions may be useful in setting the pace for detailed empirical research: however, they greatly overgeneralize connections

and overestimate effects: only a minority of 'preterms' show these characteristics and even if these patterns are there, there is 'the self-righting tendency of the organism' (Dunn, 1976; Waddington, 1975), the ability, whose limits are still largely unknown, to compensate for eventual adverse effects of the caretakers' inability to precisely modulate behavior in pace with the infant's actions and reactions. Wijnroks's study is an example of an attempt to go more precisely into the mutual dependencies and their possible implications in early mother-infant interaction in preterms. But it is only a first step towards a better understanding of possible 'interactional' roots of neurobehavioral deviance. How could further progress be made? Here, we may first consider what ethology, (developmental) neurology and cognitive psychology may contribute to the study of early social and cognitive processes in view of the risk of neurobehavioral deviance. This is the subject of the next paragraph.

Approaches to early risk of neurobehavioral deviance

The *ethological* and *developmental neurology* approaches to (human) ontogeny are rooted in a long history of biological thinking. Having escaped from the old nature-nurture dichotomy, ethology has primarily become the scientific study of ontogenetic adaptations in the species and the individual, aiming at the general rules which govern developmental processes. A basic notion is that of an 'intrinsic' relationship between the developing organism and its (natural) social environment, rooted in the evolution of the species. The organism is provided with a repertoire of 'modal action patterns' (this term replaced the previous one of 'fixed action patterns', see Baerends & Groothuis, 1992). These are action systems or signaling systems, which are considered to be biologically rooted, and to which the caretaking environment is 'biologically' adapted. This approach comes back in Papousek's concepts of 'intuitive parenting' and 'intuitive didactics' (Papousek & Papousek, 1987). The ability of the caretaker (particularly the mother) to refinedly adapt vocalizations to the emotional state of the infant is a case in point. She is able to induce and maintain the infant's positive mood by 'baby talk', which is even found in the sign language of deaf mothers to their hearing babies (Papousek, personal communication).

An important derivative of the ethological approach is its method of direct observation of complex adaptive behaviors in natural conditions and the morphological analyses of behavioral patterns in order to gain insight into their function and causation. This procedure has become largely integrated in developmental psychological research, although much research, especially in the area of the study of early temperament, unfortunately lacks the theoretical clarity and methodological precision of the ethological approach which is necessary in the longitudinal study of neurobehavioral relationships in children (see also Kalverboer, 1988, p.129-130).

By developing the field of 'developmental neurology', Prechtl introduced biological thinking into medicine: to his view, the study of brain-behavior development should find its starting point in the observation of biologically rooted adaptive systems and in the analysis of

how they are embedded in the organism's behavioral states.

Procedures for the refined assessment of nervous functions from birth onward through school age were developed by scholars such as Beintema and Touwen (Prechtl & Beintema, 1964; Touwen, 1976). They allowed for an analysis of ontogenetic adaptations in terms of their functional quality, so that 'optimality' scores could be given to the CNS as a whole as well as to specific subsystems, such as postural control, the organization of behavioral states, goal directed reaching and grasping. Because of its clinical implications it opened the way to the study of individual differences with respect to the vulnerability of the developing infant for later neurobehavioral deviance. However, notwithstanding its clear potential for improving the study of mechanisms in early caretaker-infant interactions and their consequences, so far its impact has been limited. This is partly due to the time-consuming neurological assessment procedures and partly to a lack of progress in integrating neurological notions into thinking about the dynamics of organism-environment interactions.

The most significant progress in research on neurocognitive relationships is at present found in the work on prefrontal functions by Diamond and Goldman-Rakic (1985) and Diamond (1988). These authors claimed that specific advances in infants' cognitive development (in particular avoiding the Piagetian 'A not B error') are mediated by particular neuroanatomical changes in the dorsolateral prefrontal cortex. Also particularly promising is research on the development of the visual system and visual attention by Johnson, Posner and others (Johnson, Posner & Rothbart, 1991; Johnson, 1990). Such studies may provide insight into the biological constraints set to social and cognitive developments: some adaptations (transitions) are simply not possible before a certain level of maturation of particular systems in the nervous system has been reached. For example, functioning of the frontal eye fields pathway, the onset of which occurs between 2 and 4 months of age, is a prerequisite for the execution of anticipatory eye movements and for the planning of saccadic eye movements (Johnson, 1993, p.276).

Cognitive psychology traditionally aims at a refined analysis of the individual's information processing, largely 'borrowing analogies from the digital computer. While this may be perfectly appropriate for theories focusing on the steady-state adult mind, difficulties arise when studying development' (Johnson & Morton, 1991, p.4). We completely agree with Johnson and Morton that cognitive psychology is prone to conceptualizing development in terms of a succession of steady states and neglect mechanisms of change. However, other approaches to development, such as the Piagetian and even present-day systems approaches, also run the risk of just formulating successions of steady stages (notwithstanding lip service to so-called transactional models) and insufficiently account for the dynamics of developmental processes.

In the information processing approach the organism is considered as a system with a limited capacity for processing information. It is bound to react selectively, therefore. By automatization, processing capacity can be saved (Shiffrin & Schneider, 1977): such automatization may be impaired in children with neurological problems associated

with less stable physiological processes (Porges, 1976). 'Such an 'autonomic imbalance' may manifest itself in very early stages of development, indicated by disorders in sleep-wake regulation and the child's inability to maintain a state of alertness during a longer time' (Kalverboer, 1988, p.132).

Ethological and information processing approaches may complement each other, in that the former 'has traditionally postulated 'drives' or 'motives' but does not delve further into the characteristics of information processing systems which are the prerequisites for the development of adaptive behavior', (Kalverboer & Hopkins, 1983, p.9), whereas the latter generally lacks consideration of implications of information processing deficits for adaptation in the daily environment and of possible effects of social conditions on the development of information processing strategies (Kalverboer & Hopkins, 1983; Johnson & Morton, 1991). Until recently, a crucial concept in developmental neurology, namely that of 'regulation of behavioral states', in which state reactions are embedded, was not accounted for in the structural information processing models as developed by Sternberg (1969) and Shiffrin and Schneider (1977). In the meantime, Sanders' extensions of the original models have accounted for the energy-supply of the information processing system (Sanders, 1983). Terms in this model such as arousal, activation and effort, refer to the fact that selective attention (or in general the quality of information processing) depends on how reactions are embedded in the behavioral state of the organism. Such a development may help to bridge the gap between cognitive and biologically derived approaches to the study of risk of neurobehavioral deviance. This will be discussed in the next two paragraphs, which focus on the possible precursors in early infant development of Attention Deficit Hyperactivity Disorder (ADHD) and Autism.

The case of early visual attention and ADHD

In this paragraph I will slightly deviate from the caretaker-infant interaction paradigm by discussing recent developments in the study of early visual attention, in particular of the posterior attention system (PAS). The function of this 'detour' is twofold: first it may illustrate how various approaches to the study of adaptational systems may be mutually beneficial and, second, it may indicate how results of detailed studies on a specific adaptational system, such as the PAS, may be fed back to the caretaker-infant interaction condition and help in conceptualizing possible risk mechanisms.

Early visual attention: a possible mechanism for ADHD?

By the late sixties, ethologists had already started to systematically study specific sensory and perceptual systems to disentangle the complexly interwoven determinants of early social imprinting. Bateson's studies on how approach/avoidance tendencies differently relate to the novelty/familiarity aspects of the social and physical environment in different phases of ontogeny are an example of this approach (Bateson, 1972). The study of such basic perceptual preferences helped to obtain greater understanding of the

mechanisms of early social bonding as previously studied by Lorenz.

Now, the behavioral study of early caretaker-infant interaction in the human is in the process of adapting this combined natural history-laboratory experiment approach. An in point case is the longitudinal study of visual attention, in particular of the Posterior Attention System.

Attentional processes are crucial in early interaction and learning processes but have, until recently, been largely overlooked in infant research. Orienting reactions indicate children's focus of interest. Mothers go through a lot of trouble to attract children's attention. In later phases of development 'mutual gazing' indicates how attention is shifting from an interest in the nearby environment (in particular the mother's face) to more remote aspects of the environment. And exploratory activity develops out of face-to-face contact (Schaffer, 1971). Impairments in orienting behavior (either due to a lack of postural control, or to impairments in oculo-motor functions or visual acuity or to insufficiencies in attentional capacities) may have a strong impact on the quality of the interaction process and negatively affect the caretaker's emotional reactions. Studying the determinants of such 'visual attention' impairments may shed light on possible implications for later deficits, such as ADHD (see also Wijnroks, 1994). They may also impair children's learning abilities.

There exists a visual attention system which is involved in directing the focus of vision and modulating the processing of visual input. It is separate from, although intimately related to, the visual system, which is involved in the processing of information received through the eyes (Butcher & Kalverboer, in press).

In order to improve our understanding of the processes that may contribute to a clinical condition, such as ADHD, in prospective studies two sorts of approaches have traditionally been applied:
1) the study of groups thought to have been exposed to a factor that might have impaired the condition of the brain or/and the 'internal' environment in which it develops, such as pre- and dysmaturity, pre- and perinatal complications, such as asphyxia, or metabolic disorders, such as PKU (phenylketonuria) or CH (congenital hypothyroidism), and
2) the study of relatively complex early childhood characteristics, such as 'a difficult temperament'.
Almost inevitably, such studies could not provide insight into mechanisms playing a role in the development of later ADHD; concepts were too diverse and, especially in infant studies, too diffuse, and an adequate theory was lacking.

Improvements in the quality of such studies were due to developments as those exemplified by the Groningen ELO project on preterms. Attempts were made to develop paradigms based on theoretical considerations on how the infant's behavioral organization (e.g., its postural control, state regulation, orienting behavior) might affect its ability to experience and perceive contingencies in social and specific task (contingency learning) conditions. Problems in later social and cognitive development might be partly mediated by the caretaker's ability (expressed in terms such as 'sensitivity' and 'sensitive responsiveness') to adapt to children's intentions in a refined fashion. By knowledge of the constraints set to the child by the maturation of the nervous

system and by particular impairments, that might affect the child's adaptive capacities further insight into the development of neurobehavioral problems could be obtained. However, the conclusions necessarily remained at a broad level and the contributions to theory development necessarily remained rudimentary.

Two more recent developments, partly running parallel, offer new perspectives in the study of early risk for neurobehavioral deviance. One is the development of brain imaging techniques which increasingly allow for the identification of brain involvement with a high amount of specificity, at the anatomical level as well as that of processes in the brain in particular task conditions (for a further discussion, see Kalverboer, 1988). The other is the precise study of particular adaptive systems, such as the Posterior Attention System, the PAS, in combined longitudinal cross-sectional designs and in relation to the development of the nervous system as well as to particular sensory or sensory-motor systems (such as the visual system). Johnson, Posner and Rothbart (1991) in particular have paved the way for the precise measurement of specific 'markers' of such systems (such as 'disengagement', 'inhibition of return' and 'anticipatory looking' as markers of the PAS) and presented thoughtful discussions on how such markers may relate to nervous system development and affect daily life adaptations (a case in point is the implication which the development of the PAS might have for a particular aspect of the infant's 'temperament', namely 'soothability').

However, little is still known about such an attentional system's ontogenetic course, due to a lack of sufficiently refined and dense longitudinal studies in which experimental measurements of 'markers' and possible 'control parameters' are combined with precise daily life observations and valid examinations of nervous system development. Such a study is now underway in the Department of Developmental and Experimental Clinical Psychology in Groningen in close cooperation with the Departments of Developmental Neurology and Paediatrics and with Posner's neurocognitive laboratory in Oregon. Children ('normal' and 'brain damaged') are followed bi-weekly, from 2 to 6 months onward, with respect to their visual attention development. Laboratory experiments are combined with continuous measurements on general neurological and visual systems (visual activity and visual fields development).

Studies of this kind may be complemented by ethological analyses of daily life interactions and cognitive processes in order to validate how particular systems may contribute to more or less optimal adaptations. Ultimately, they may shed some more light on the issue of early risk mechanisms of later clinical conditions.

Early risk of autism

In the fifties and sixties there was a lively interest in mechanisms involved in Infantile Autism, triggered mainly by ethology. Researchers such as J. and C. Hutt, Richer and Tinbergen contributed to this development. Autism seemed a clinical condition, typically suited to study based on ethological models, such as Schneirla's approach-avoidance models and on notions trying to relate specific autism 'markers', such as 'gaze-aversion' or 'movement-stereotypes', to internal causal factors (level of arousal of particular systems), in interaction with external causal mechanisms, such as sensory and social deprivation (Hutt & Hutt, 1968; Hutt & Ounsted, 1970; Tinbergen & Tinbergen, 1972). Richer elaborated on Tinbergen's work by executing refined observations of autistic children's interaction patterns (Richer, 1976). Findings were interpreted in terms of the aberrant development of the balance between specific internal systems, such as the 'timidity'-'sociality' systems, due to inadequate social stimulation. Bowlby's ideal of ethology as the discipline *par excellence* for unravelling mechanisms underlying autism seemed to become reality. However, after sceptical discussions with child psychiatrists and later evidence for brain damage as an important determinant of an autistic development (Rutter & Schopler, 1987; Rutter et al., 1994), ethology's contributions to this issue faded, and from the mid-seventies almost no systematic ethological studies on early risk for autism have appeared. This may be partly due to the piecemeal approach and low interest in human development in present-day ethology. Psychology's contribution has long been mainly psychophysiologically and pharmacologically triggered (see Porges, 1976), with clinically oriented researchers searching for neurotransmission systems (such as the serotonine system) which were particularly involved.

In developmental psychology, present day interest in autism is largely focused on the developmental course of 'theory of mind' in autistics. There is growing evidence that many autistic children have particular difficulties with 'theory of mind' tasks, which assess the ability to conceive of mental states of oneself and others in order to predict and explain actions (Baron-Cohen, 1991; Happé, 1994; Premack & Woodruff, 1978; Sparrevohn & Howie, 1995). This deficiency is thought 'to provide a causal account of the psychological deficit (biologically caused) that gives rise to the syndrome-specific impairments in socialization, imagination and communication' (Happé, 1994). Such a deficit in the ability to mentalize (which manifests itself in an inability to take hints, understand beliefs, distinguish lies from jokes, etc.) is thought to largely account for the impairments in socialization, imagination and communication found in autism.

However, until now the interpretation of experimental data has been far from unequivocal. One explanation, proposed by Russell and colleagues (Russell, Mauthner, Sharpe & Tidswell, 1991; Hughes & Russell, 1993), is that autistic children have an 'inability to disengage from the object'. According to Russell 'the autistic child's failure on false belief tasks does not reflect a mentalizing deficit, but rather a specific difficulty in overcoming the perceptual salience of the object in the real location'. Russell et al.'s claim is that particularly for autistic chil-

dren knowledge of physical reality is more salient than knowledge of mental reality. Although these authors do not consider the salience hypothesis and the theory of mind view as necessarily opposed, they stress the difficulties in sorting out 'the conceptual issues in this area'. In any case, their view suggests the importance of attentional mechanisms such as 'disengagement' and 'inhibition of return', as discussed in the previous paragraph.

Other authors, such as Klin, Volkmar and Sparrow (1992), indicate that the social dysfunction in autism involves 'very basic and early emerging social behaviors which are typically present prior to the time at which even the earliest precursors of a theory of mind apparently emerge' (Klin et al., p.861). Such behaviors, for instance, 'not showing anticipation of being picked up by caregiver' and 'not showing affection toward familiar people', bring us back to mechanisms in early caretaker-infant interaction. Also, Mundy and Sigman's argument (1989) that autistic children do not show joint attention behaviors which develop prior to pretence in the normal child (see also Mundy, Sigman & Kasari, 1993), seem to indicate that autism may result from a deficit which is typically present in normally developing infants prior to the time at which metarepresentational skills may emerge.

One may speculate that studies, such as those mentioned earlier on the development of visual attention, can in the future give new impulses to a more fundamental approach to the search for early factors that may contribute to autistic development and to these factors' possible 'prementalistic deficits'. Visual orienting behaviors have classically been a main entrance to the study of autism. Present day work by Johnson and colleagues on the development of face-recognition seems also particularly relevant (see Johnson & Morton, 1991). Such approaches connected to refined analyses of social interaction and vocalization processes, form a basis for future developments in research on the roots of autistic phenomena. Such a line of 'clinically' triggered research is also of the utmost theoretical importance as clinical entities, such as autism, open the way to studying developmental mechanisms in deviant conditions which, at least in the human species cannot, fortunately enough, be realized through experimental manipulation.

Discussion

Interdisciplinary cooperation may be particularly fruitful, if not necessary, in the study of caretaker-infant interaction and its implications for further social and cognitive development. However, each discipline has its own set of concepts and theories. This may be a hindrance for the cooperation between, and crossing the borders of, disciplines. Purification of concepts such as 'arousal', 'attention', 'state organization', etc. is required to fruitfully interrelate findings obtained by different disciplines.

Can methodologies and experimental procedures presently applied in specific disciplines, be applied or borrowed/ adapted in such a way that brain-behavior studies can become more fruitful theoretically? There are interesting examples of such attempts. A case in point is the application of the Piagetian 'A not B error' task, an object-retrieval task, in frontal-

lobe monkey research, and a 'detour task', known to be sensitive to frontal lobe involvement in monkeys, in the study of human infant's cognitive development (Diamond, 1988; Diamond & Goldman-Rakic, 1985). This exchange of procedures contributed to a greater insight into the role of prefrontal areas in the execution of more complicated cognitive functions (so-called executive functions).

Why did various approaches not contribute more to the study of early human communication, notwithstanding their potential? Ethology refrained from theory-building with respect to the human species, being locked in a one-sided interest in non-verbal communication and the study of specifically selected subgroups, such as newborns and autistic children. Early Harlow and Suomi studies on the impact of early deprivation on social development had no follow-up. Only recently, researchers such as Johnson and Posner have given new impulses to the study of particular adaptive systems in the human.

'Developmental neurology' made a major contribution to early-risk research by introducing biological concepts into our thinking about nervous system development. Concepts, such as 'state regulation' and 'behavioral organization', which are now at the center of attention in information processing approaches to clinical phenomena such as ADHD, are largely derived from developmental neurology. However, there is a stagnation in that present day researchers of early interactional processes don not find their discussion partners in developmental neurology. No theoretical progress is visible which further elaborates on notions such as those already expressed by Prechtl in the early sixties with respect to mother-infant interaction in MBD.

- 'Cognitive psychology' has to recognize that adequate developmental processes can only be understood by the direct study of how the organism's information processing potential changes in the course of ontogeny and how it is used in daily life adaptations in various conditions. Furthermore, procedures have to be developed which allow for the study of information processing in children from very young ages onward. A positive exception is formed by the procedures, developed by Posner and coworkers for the study of the PAS, which are currently being adapted in our laboratory for the application in a dense longitudinal study on early visual attention development in infants from 2 to 7 months of age.
- Longitudinal studies combined with cross-sectional analyses, which relate the collection of natural history data to experimental manipulations, are required for gaining further insight in the dynamics of development (see Hopkins, Beek & Kalverboer, 1992, for a discussion) and the possible determinants of developmental discontinuities. The ongoing problem of the 'applicability of concepts and measures over a larger age range' is thoughtfully discussed by Pickles and Rutter (in Magnusson et al., 1991). A first prerequisite for connecting data obtained in various stages of development, e.g., with respect to 'early temperament' and later attention deficit, is that concepts are theoretically well-founded and properly operationalized. There is still ground to be covered.

References

Akyürek, A. & Kalverboer, A.F. (1982), Stereotypic and automanipulative behavior of autistic children. *Psychological Reports, 50*, 63-67.

Baerends, G. & Groothuis, T. (1992), On modal action patterns in early human development. In Kalverboer, A.F., Hopkins, B. & Geuze, R.H. (Eds), *Motor development in early and later childhood: Longitudinal approaches* (pp. 74-88). Cambridge, Cambridge University Press.

Baron-Cohen, S. (1991), The development of theory of mind in autism: deviance and delay? *Psychiatric Clinics of North America, 14*, 33-51.

Bateson, P.P.G. (1973), Internal influences on early learning in birds. In: Hinde, R.A. & Stevenson-Hinde, J. (Eds), *Constraints on learning: Limitations and predispositions*. London Academic Press.

Beek, P.J. & Hopkins, B. (1992), Four requirements for a dynamical systems approach to the development of social coordination. *Human Movement Science, 11*, 425-442.

Bischof, N. (1975), A systems approach toward the functional connections of attachment and fear. *Child Development, 46*, 801-817.

Bowlby, J. (1969), *Attachment.* Harmondsworth, Middlesex, Penguin Books Ltd.

Butcher, P.R. & Kalverboer, A.F. (in press), The early development of visual attention. In Kalverboer, A.F. & Genta, M.L. (Eds), *Early development of cognition and communication. Special Issue Early Development and Parenting.*

Diamond, A. (1988), Differences between adult and infant cognition: is the crucial variable presence or absence of language? In: Weiskranz, L. (ed.), *Thought without language* (pp. 335-366). Oxford, Clarendon Press.

Diamond, A. & Goldman-Rakic, P.S. (1985), Evidence for the involvement of the prefrontal cortex in cognitive changes during the first year of life. *Society for Neuroscience Abstracts, 11*, 832.

Dunn, J. (1976), How far do differences in mother-child relations affect later development? In Bateson, P.P.G. & Hinde, R.A. (Eds), *Growing points in ethology* (pp. 481-496). Cambridge, Cambridge University Press,

Happé, F.G.E. (1994), Annotation: Current psychological theories of autism: The 'theory of mind' account and rival theories. *Journal of Child Psychology and Psychiatry, 35*, 215-229.

Hopkins, B., Beek, P.J. & Kalverboer, A.F. (1993), Theoretical issues in the longitudinal study of motor development. In: Kalverboer, A.F., Hopkins, B. & Geuze, R.H. (Eds), *Motor development in early and later childhood: Longitudinal approaches*. Cambridge, Cambridge University Press.

Horowitz, F.D. (1992), The concept of risk: A reevaluation. In Friedman, S.L. & Sigman, M.D. (Eds), *The psychological development of low-birthweight children. Annual Advances in Applied Developmental Psychology*, vol. 6, 61-88. Ablex, Norwood.

Hughes, C.H. & Russell, J. (1993), Autistic children's difficulty with mental disengagement from an object: its implications for theories of autism. *Developmental Psychology, 29*, 498-510.

Hutt, C. & Hutt, S.J. (1968), Stereotypy, arousal and autism. *Psychologische Forschung, 33*, 1-8.

Hutt, C. & Ounsted, C. (1970), Gaze aversion and its significance in childhood. In: Hutt, S.J. & Hutt, C. (Eds), *Behaviour studies in psychiatry*. Oxford, Pergamon, 103-121.

Johnson, M.H. (1990), Cortical maturation and the development of visual attention in early infancy. *Journal of Cognitive Neuroscience, 2,* 81-95.

Johnson, M.H. (1993), Cortical mechanisms of cognitive development. In Hogan, J.A. & Bolhuis, J.J. (Eds), *Causal mechanisms of behavioural development*. Cambridge, Cambridge University Press, 267-288.

Johnson, M.H. & Morton, J. (1991), *Biology and cognitive development: The case of face recognition*. Oxford, Blackwell.

Johnson, M.H., Posner, M.I. & Rothbart, M. (1991), The development of visual attention in infancy: contingency learning, anticipations and disengaging. *Journal of Cognitive Neuroscience, 3*, 335-344.

Kalverboer, A.F. (1979), Neurobehavioural findings in preschool and school-aged children in relation to pre- and perinatal complications. In Schaffer, D. & Dunn, J. (Eds), *The first year of life*. New York, Wiley, 55-67.

Kalverboer, A.F. (1983), Neurobehavioural organization at early age and risk for psychopathology. In Mendlewicz, J. & Praag, H.M. van (Vol. Eds), *Advances in biological psychiatry*, vol. 11, Biological rhythm and behavior. Basel, Karger, 80-94.

Kalverboer, A.F. (1988), Follow-up of biological high-risk groups. In Rutter, M. (Ed.), *Studies of psychosocial risk: the power of longitudinal data*. Cambridge, Cambridge University Press, 114-137.

Kalverboer, A.F. & Hopkins, B. (1983), General introduction: A biopsychological approach to the study of human behaviour. Special Issue Human Biopsychology. Kalverboer, A.F. & Hopkins, B. (Eds), *Journal of Child Psychology and Psychiatry, 24,* 9-10.

Klin, A., Volkmar, F.R. & Sparrow, S.S. (1992), Autistic social dysfunction: Some limitations of the theory of mind hypothesis. *Journal of Child Psychology and Psychiatry, 33*, 861-876.

Leekam, S.R. & Prior, M. (1994), Can autistic children distinguish lies from jokes? A second look at second-order belief attribution. *Journal of Child Psychology and Psychiatry, 35*, 901-915.

Magnusson, D. & Bergman, L.R. (Eds), (1990), *Data quality in longitudinal research*. Cambridge, Cambridge University Press.

Magnusson, D., Rudinger, G. & Bergman, L.R. (Eds), (1991), *Problems and methods in longitudinal research*. Cambridge, Cambridge University Press.

Mundy, P. & Sigman, M. (1989), The theoretical implications of joint attention deficits in autism. *Development and Psychopathology, 1*, 173-183.

Mundy, P., Sigman, M. & Kasari, C. (1993). Theory of mind and joint attention deficits in autism. In Baron-Cohen, S., Tager-Flusberg, H. & Cohen, D.

(Eds), *Understanding other minds: perspectives from autism. Oxford, Oxford University Press.*
Papousek, H. (1977), Entwicklung der Lernfähigkeit im Sauglingsalter. In: Nissen, G. (ed.), *Intelligenz, Lernen und Lernstörungen*. Berlin, Springer.
Papousek, H. & Papousek, M. (1987), Intuitive parenting: A dialectic counterpart to the infant's integrative competence. In Osofsky, J.D. (Ed.), *Handbook of infant development* (2nd ed.). New York, Wiley.
Papousek, H. & Papousek, M. (1993), Early interactional signaling: The role of facial movements. In Kalverboer, A.F., Hopkins, B. & Geuze, R. (Eds), *Motor development in early and later childhood*. Cambridge, Cambridge University Press.
Pickles, A. & Rutter, M. (1991), Statistical and conceptual models of 'turning points' in developmental processes. In Magnusson, D., Bergman, L.R., Rudinger, G. & Törestad, B. (Eds), *Problems and methods in longitudinal research*. Cambridge, Cambridge University Press, 133-165.
Porges, S.W. (1976), Peripheral and neurochemical parallels of psychopathology: a psychopathological model relating autonomic imbalance to hyperactivity, psychopathy and autism. *Advances in Child Development and Behaviour, 11*, 35-65.
Prechtl, H.F.R. (1963), The mother-infant interaction in babies with Minimal Brain Damage. In Foss, B.M. (Ed.), *Determinants of infant behaviour*, vol. 2. Methuen, New York, Wiley, 140-156.
Prechtl, H.F.R. (1980), The optimality concept. *Early Human Development*, 4, 201-203.
Prechtl, H.F.R. & Beintema, D.J. (1964), The neurological examination of the full-term newborn infant. *Clinics in Developmental Medicine, no. 12*. London, S.I.M.P./Heinemann.
Prechtl, H.F.R. & Beintema, D.J. (1968), *Die neurologische Untersuchung des reifen Neugeborenen*. Stuttgart, Georg Thieme Verlag.
Premack, D. & Woodruff, G. (1978), Does the chimpansee have a theory of mind? *The Behavioral and Brain Sciences, 4*, 515-526.
Richer, J. (1976), The social-avoidance behaviour of autistic children. *Animal Behaviour, 24*, 898-906.
Russell, J., Mauthner, N., Sharpe, S. & Tidswell, T. (1991), The 'windows' task as a measure of strategic deception in preschoolers and autistic subjects. *British Journal of Developmental Psychology, 9,* 331-349.
Rutter, M. & Schopler, E. (1987), Autism and pervasive developmental disorders: Concepts and diagnostic issues. *Journal of Autism and Developmental Disorders, 17,* 159-186.
Rutter, M., Bailey, A., Bolton, P. & Le Couteur, A. (1994), Autism and known medical conditions: Myth and substance. *Journal of Child Psychology and Psychiatry, 35*, 311-322.
Sameroff, A.J. (1975), Early influences on development: fact or fancy? Merrill-Palmer *Quarterly, 21-4*, 267-294.
Sanders, A.F. (1983), Toward a model of stress and human performance. *Acta Psychologica, 53*, 61-97.
Schaffer, H.R. (ed.), (1971), *The origins of human social relations*. New York, Academic Press.
Sheridan, M.D. (1962), Infants at risk of a handicapping condition. Monthly Bull.

Ministry of Hlth. Lab. Serv., vol. 21, 238.

Shiffrin, R.M. & Schneider, W. (1977), Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84*, 127-190.

Sparrevohn, R. & Howie, P.M. (1995), Theory of mind in children with autistic disorder: Evidence of developmental progression and the role of verbal ability. *Journal of Child Psychology and Psychiatry, 36*, 249-263.

Sternberg, S. (1969), Discovery of processing stages: Extensions of Donders' method. In Koster, W.G. (Ed.), *Attention and performance*, Vol. 2. Amsterdam, North-Holland.

Tinbergen, E.A. & Tinbergen, N. (1972), Early childhood autism: An ethological approach. *Supplement 10 to Journal of Comparative Ethology*, 1-53.

Touwen, B.C.L. (1976), Neurological development in infancy. *Clin. Develop. Med. 58*. London, Heinemann.

Waddington, C.H. (1975), *The evolution of an evolutionist*. Edinburgh, Edinburgh University Press.

Watson, J.S. (1977), Depression and the perception of control in early childhood. In Schulterbrandt, J.G. & Raskin, A. (Eds), *Depression in childhood: Diagnosis, treatment and conceptual models*. New York, Raven Press.

Wijnroks, L. (1994), *Dimensions of mother-infant interaction and the development of social and cognitive competence in preterm infants*. Thesis, University of Groningen, the Netherlands.