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Contingent Parental Reactivity in Early Socio-Emotional Development

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Abstract

This paper explores the different functions that contingent parental reactions, induced by the infant's affective and intentional displays, may serve in early development. In particular, we shall examine the nature and role of affect-reflective imitative parental displays from the point of view of contingency detection theory (Gergely and Watson, 1996, 1999). First, a brief summary will be provided of the evidence (Watson, 1985, 1994) indicating the existence of an innate perceptual information processing mechanism, the 'contingency detection module' (CDM) (Gergely and Watson, 1999). The CDM is proposed to play a central role in a number of basic developmental processes such as the construction of the primary representation of the bodily self and the differentiation of and orientation towards social objects. Then we shall describe our 'social biofeedback model' of parental affect-mirroring (Gergely and Watson, 1996, 1999), which applies the notions of contingency detection theory to the particular case of empathic affect-reflective parental reactions. This model identifies a number of developmental functions that contingent and imitative parental interactions may serve during early socio-emotional development such as the on-line homeostatic regulation of the infant's affective states, the establishment of secondary representations of primary emotion states, and the sensitization of the infant to his/her internal affect states that play a crucial role in the development of emotional self-awareness and self-control.

In the second part of the paper we shall discuss some implications of our theory for developmental psychopathology. First, a new model of the etiology of childhood autism (Watson, 1994, Gergely and Watson, 1999) will be presented according to which this developmental disorder stems from a genetically based dysfunction of the CDM. Second, we

shall propose a new approach to the etiology of 'disorganized' (D) attachment that emphasizes the causal role of the particular type of 'deviant parental contingency environment' that maltreating parents, on the one hand, and dissociating parents suffering from unresolved loss or trauma, on the other, present to their infants during a critical period of the maturational unfolding of the CDM.

1. 1. The 'contingency detection module': An innate mechanism for the perception of causal efficacy of the self

Numerous studies have demonstrated that young infants are highly sensitive to the contingent relations between their motor responses and consequent stimulus events (e.g., Bahrick & Watson, 1985; Field, 1979; Lewis & Brooks-Gunn, 1979; Papousek & Papousek, 1974; Rochat & Morgan, 1995; Watson, 1972; 1994). For example, Watson (1972) has shown that two-month-olds increase their rate of leg kicking when it results in a contingent stimulus event (the movement of a mobile), but not when they experience a similar, but noncontingent event. Furthermore, after experiencing their contingent control over the mobile's movements, these infants exhibited social smiling and cooing when the mobile was presented. These results indicate not only that very young infants are able to detect contingent response-stimulus relations, but also that the ensuing experience of causal control over an external event is generally positively arousing for them.

How do young infants perceive response-stimulus contingencies so efficiently? Based on Watson's extensive studies (1979, 1985, 1994), we have recently proposed (Gergely and Watson, 1999) the existence of an innate contingency detection module (CDM) that analyses the conditional probability structure of the contingent relations between responses and stimulus events. Briefly, this analytic device applies two independent mechanisms: one (called the sufficiency index) is looking forward in time registering the conditional probability of an upcoming stimulus event as a function of an emitted response, while the other (called the necessity index) is testing backwards in time, monitoring the relative likelihood that a given stimulus event was preceded by a given response. The two separate indices estimate two aspects of the contingency relation that can vary independently of each other providing a scale

of different magnitudes of contingent relatedness. However, whenever the two indices provide different estimates of contingency, it is possible that this difference may signal the fact that the actual contingency is higher than the average of the two estimates. This is so because the device may be monitoring either a too narrow or a too broad class of responses. There is some evidence, however, that the CDM can discover the maximal degree of contingency (contingency maximizing, see Watson, 1979) by either reducing or expanding the sampled set of responses, eventually zeroing in on the correct response set and identifying the actual degree of contingent control (for details, see Gergely & Watson, 1996, pp. 1191-2).

Though much of the evidence has come from studying purely temporal contingency relations, there are, in fact, three separate and independent bases of contingency: temporal, sensory relational (relative intensity), and spatial (similarity of spatial distribution or pattern) (Watson, 1984). We have argued (Gergely and Watson, 1999) that the CDM is an analytic device that at its input end monitors for and registers all the three parameters of response-stimulus contingencies in parallel and computes as its output an overall value indicating the estimated degree of causal relatedness between responses and stimuli. There is converging evidence that infants use all the three informational bases in detecting contingency (see Gergely and Watson, 1999, pp. 103-107).

1. 2. Developmental functions of the contingency detection module: Differentiation of the self and orientation towards the social world

By differentiating among varying degrees of contingencies, the CDM can identify those stimulus events that are the necessary sensory consequences of the infant's motor responses (and as such belong to the self) vs those stimuli that emanate from external sources (Bahrick & Watson, 1985, Watson, 1994). For example, Bahrick and Watson (1985) (see also

Rochat and Morgan, 1995, and Schmuckler 1996) seated young infants on a high-chair in front of two monitors so that they could freely move their legs. One monitor presented the video recorded live image on the subject's moving legs providing a stimulus that was perfectly contingent with the infant's responses. The other monitor presented a previously recorded image of the infant's legs which was, therefore, not contingent on the baby's present leg movements. It was found that in 3-month-olds the distribution of preference was significantly bimodal: one subgroup showing preference for the perfectly contingent image, while the other preferring the non-contingent image.

Note that one's motor actions produce stimuli that are necessarily perfectly response-contingent (as in the case of double-touch, or watching one's hands as one is moving them), while the perception of stimuli emanating from the external world typically show degraded levels of response-contingency. Therefore, the detection of contingency between efferent (motor) activation patterns and consequently perceived stimuli may serve as the original criterion for distinguishing the self from the external world (Bahrick & Watson, 1985).

Interestingly, however, in contrast to 3-month-olds, Bahrick and Watson (1985) found that 5-month-olds showed a strong preference for looking at the non-contingent image. This aversion to looking at the perfectly contingent display raises the question of what levels of contingency might be preferred over non-contingency after 3 months. Watson (1979, 1985) examined infants' reactions to different magnitudes of response-stimulus temporal contingencies varying between less than 1 but greater than zero (in terms of conditional probability). He found that between 4 and 6 months infants have great difficulty with contingency magnitudes that are less than .5. At the same time, they also failed to engage contingencies that approached a magnitude of 1 on both indices (i.e. on both necessity and sufficiency). Therefore, Bahrick and Watson proposed that their sample of 3-month-olds was

in developmental transition from a preference for perfect contingency to a preference for high-but-imperfect contingency. Thus, after 3 months, infants seem more motivated to explore high but imperfect degrees of response-stimulus contingencies than they are to explore perfect contingencies.

Based on such data, Watson (1994) proposed that during the first 2-3 months the initial target of the CDM is genetically set to seek out and explore perfectly response-contingent stimulation. The hypothesized evolutionary function of this initial attention bias is to develop a primary representation of the bodily self as a distinct object in the environment by identifying those stimuli that are the necessary sensory consequences of the body's motor actions and over which the infant exercises perfect control.

Furthermore, it is hypothesized that around three months the target value of the contingency analyzer in normal infants is 'switched' to a preference for high-but-imperfect contingencies which are characteristic of the infant-directed reactive behaviors of well-attuned social objects. This maturational change functions to orient the infant towards the exploration and representation of the social world as presented by the (necessarily less-than-perfectly response-contingent) parental environment.

2. 1. Contingency detection and parental affect-mirroring

So far it has been argued that the CDM serves such central functions in development as self-other differentiation and orientation towards the social environment. Below we summarize our recent proposal (Gergely & Watson, 1996, 1999) concerning a further significant function that we believe is mediated by the CDM: namely, the development of emotional self-awareness and control in infancy. Our model is based on two central assumptions: a) that in its initial state the human organism has no differential awareness of

his/her basic categorical emotion states, and b) that affect-reflective parental "mirroring" interactions play a vital role in the development of perceptual sensitivity to the infant's internal affect states. It is argued that this sensitization process (similar to that of adult biofeedback training) is mediated by the mechanism of contingency detection and maximizing (Gergely & Watson, 1996). In terms of our model, apart from sensitization, affect mirroring serves a number of further developmental functions as well such as: 1) It contributes directly to the regulation of the infant's affective states; 2) It leads to the establishment of secondary representations that become associated with the infant's primary procedural emotion states providing the cognitive means for accessing and attributing emotions to the self; and 3) It results in the development of a generalized communicative code of 'marked' expressions characterized by the representational functions of referential decoupling, anchoring, and suspension of realistic consequences.

2. 2. Initial sensitivity to internal versus external stimuli

Most classical and current approaches to infancy tend to adhere to the basic assumption that infants have conscious access to their internal basic emotion states from the beginning. For example, Meltzoff and Gopnik (1993) propose that there are innate mechanisms that allow the infant to attribute emotions to other minds starting from birth. Based on evidence on neonatal imitation (Meltzoff & Moore, 1977, 1989) and on the innate basis for primary emotions (Ekman, Friesen, & Ellsworth, 1972; Izard, 1977), they propose that by imitating the parent's facial emotion expression the infant activates through prewired connections (see Ekman, Levenson, & Friesen, 1983) the corresponding physiological emotion state in herself. The imitation-generated internal emotion is then introspectively accessed and the felt affect is attributed to the other's mind (but see Gergely & Watson, 1996,

pp. 1183-5, for a critical evaluation of this view). Similarly, differential emotions theory (Izard, 1977; Izard & Malatesta, 1987) also holds that "there is an innate expression-to-feeling concordance in the young infant" (Malatesta et al., 1989, p. 6.). Stern (1985) also enumerates "categorical affects" as belonging to "the basic elements of early subjective experience" (p. 67).

In assuming that the infant's initial state is characterized by direct introspective access to internal emotion states, these authors follow the tradition of a long line of developmental theorists. For example, Freud and his followers (e. g., Mahler, Bergman, and Pine, 1975; cf. Gergely, 2000) have long held the view that the infant is initially more sensitive to internal than to external stimuli. Bruner, Olver, and Greenfield (1966) also proposed that the infant moves from an initial reliance on internal, proprioceptive cues to a reliance on exteroceptive cues (see also Rovee-Collier, 1987).

However, according to Colombo et al., (1990), there are no empirical data to directly support this view. In contrast, in experiments designed to test this assumption, they demonstrated that 3-month-olds show discrimination learning on the basis of exteroceptive as well as interoceptive cues. Moreover, in 6- and 9-month-olds they actually found dominance of the exteroceptive over the interoceptive cues in learning.

In light of such evidence we (Gergely & Watson, 1996, 1999; Gergely, 2000) have proposed to explore the consequences of abandoning the classical assumption concerning the presumed dominance of internal stimuli in the initial state of the infant. In contrast, we hypothesize that at the beginning of life the perceptual system is set with a bias to attend to and explore the external world and builds representations primarily on the basis of exteroceptive stimuli. In this view, then, the set of internal (visceral as well as proprioceptive) cues that are activated when being in and expressing an emotion state are, at first, not

perceived consciously by the infant, or, at least, are not grouped together categorically in such a manner that they could be perceptually accessed as a distinctive emotion state.

2. 3. Levels of representations of self-states: Automatic versus controlled processes

There are a number of dichotomies such as the procedural/declarative, implicit/explicit, unconscious/conscious, or automatic/controlled distinctions (Shiffrin & Schneider, 1977; Karmiloff-Smith, 1992) that refer to qualitatively different levels of information representation. Automatized processes refer to prewired or over- learned structures of behavioral organization in which information is represented implicitly, embedded in procedures, and is unavailable to other representational systems of the mind. Such automatisms are inflexible, perceptually driven, and operate outside of consciousness. In contrast, deliberative or controlled processes refer to voluntary and conscious operations which are flexible and modifiable, can be governed by higher-order cognitive goals, and can usually override automatisms.

In this framework, the infant's primary emotions can be conceived of as prewired, stimulus driven, dynamic behavioral automatisms over which the baby has no control at first. Affect-regulation is carried out mainly by the caregiver who, reading the infant's automatic emotion expressions, reacts to them with appropriate affect-modulating interactions. In this view, emotional self-control becomes possible only with the establishment of secondary control structures which (a) monitor, detect, and evaluate the primary level dynamic affective state changes of the organism, and (b) can inhibit or modify the emotional reaction if the anticipated automatic affective response would jeopardize higher-order cognitive plans.

Therefore, a precondition for the voluntary control and self-regulation of primary affective states is that the level of deliberative processes be informed about the on-going

dispositional state changes of the organism that take place at the level of automatized processes. Within this framework, consciously felt emotions can be conceived of as signals that inform the level of deliberative processes about the automatic affective state changes of the organism.

This leads then to the question of how the infant develops awareness of and comes to represent the sets of internal state cues as indicating categorically distinct emotion states? We propose that the species-specific human propensity for the facial and vocal reflection of the infant's emotion-expressive displays during affect-regulative interactions plays a crucial role in this developmental process.

2. 4. Affect-reflective "mirroring" interactions in early socio-emotional development

Historically, there are two traditions which emphasize the formative importance of the role of the caregiver's inclination to „mirror" the emotional and intentional states that she attributes to her infant. One is the social constructivist tradition (Hegel, Baldwin, Cooley, G. H. Mead, and Bruner), which emphasizes the social origins of the development of the self. In this view, the inferential basis for constructing the representation of the self is provided by the social reflections of the child's states and properties. The second tradition is that of psychoanalytic object relations theories which have long identified the maternal mirroring function as an important causal factor in early emotional and personality development (e. g., Bion, 1962; Fonagy & Target, 1996; Fonagy, Target, and Gergely, 2000; Kohut, 1971; Mahler et al., 1975; Jacobson, 1964; Kernberg, 1984; Stern, 1985; Winnicott, 1967).

Recent studies have confirmed the traditional view that facial and vocal mirroring of affective behavior is a central feature of parental affect-regulative interactions during the first year (Beebe and Lachmann, 1988; Kaye, 1982; Murray & Trevarthen, 1985; Muir and Hans,

1999; Nadel et al., 1999; Papousek & Papousek, 1987; Sroufe, 1996; Stern, 1985; Trevarthen, 1979; Tronick, 1989). Mother and infant form an affective communication system from the beginning (Brazelton, Koslowski, and Main, 1974; Beebe, Jaffe, and Lachmann, 1992; Bowlby, 1969; Hobson, 1993; Sander, 1970; Stern, 1985; Trevarthen, 1979; Tronick, 1989) in which the mother plays a vital interactive role in modulating the infant's affective states.

Studies using the still-face procedure (Tronick et al., 1978; Muir and Hains, 1999) or delayed feedback techniques (Murray and Trevarthen, 1985; Nadel et al., 1999, see, however, Rochat, Neisser, & Marian, 1998) indicate that young infants are sensitive to the contingency structure of face-to-face interaction and are actively searching to reestablish such a pattern of communication when being abruptly deprived of it. There is evidence for the early existence of bi-directional influence of behavior and mutual regulation of affective communication between mothers and infants (Beebe and Lachmann, 1988; Cohn and Tronick, 1988; Tronick, 1989). Imitative matching is frequent during mother-infant interactions (Uzgiris et al., 1989) and mother-infant pairs increase their degree of coordination in terms of matching and synchrony with infant age (Tronick and Cohn, 1989). Maternal imitative behavior evokes more smiling and vocalization in three and a half months old babies than nonimitative responses (Field, Guy, and Umbel, 1985). Infants' expressions of sadness and anger produce affective responses of sadness and anger in their mothers (Tronick, 1989) and maternal reactions to negative affect include mock expressions of negative affect (Malatesta and Izard, 1984).

Research on facial and vocal interaction between depressed mothers and their infants (Cohn et al., 1986; Bettes, 1988; Murray et al., 1996; Tronick and Field, 1986; Tronick, 1989) have shown that there is a decrease in the amount of contingent affective interactions as well as more intrusiveness and more negative affect expression on the part of the mother. Such infants' affective and regulatory reactions as well as their later security of attachment are

related to the affect and behavior of their depressed mothers (Field, 1994; Murray, 1992; Murray et al., 1996; Pickens and Field, 1993; Tronick, 1989).

In sum: while theoretical, clinical, and empirical approaches converge on the view that parental affect-reflective interactions play a central role in early emotional and self development, the exact nature of the causal mechanisms mediating such effects has, nevertheless, not yet been identified.

2. 5. The social biofeedback model of parental affect-mirroring

Recently, we have proposed such a specific model in our 'social biofeedback theory of parental affect mirroring' (Gergely & Watson, 1996, 1999; Gergely, 1998). The model applies contingency detection theory to the special case of affect-reflective stimulus displays and identifies several important functions that affect-mirroring may serve in early development:

(i).The state-regulative effect of empathic emotion-reflective interactions

Imagine a frustrated, angry or fearful infant and his/her empathic caregiver who attempts to console the baby. Apart from providing gentle physical contact, a sensitive and attuned parent will tend to display short bouts of empathic facial and vocal mirroring expressions that match the infant's negative emotion displays. It may seem paradoxical that such affect-mirroring expressions actually contribute to emotion regulation instead of leading to the escalation of the infant's negative state: after all, the sight of a fearful or angry mother is normally highly stress-inducing for an infant (Bowlby, 1969; Main & Hesse, 1990). However, there are three distinguishing features of affect-mirroring displays that we believe result in (a)

blocking the attribution of the expressed negative emotion to the parent, and that (b) generate positive arousal in the infant thereby contributing directly to the soothing effect.

(a) Markedness. First, empathic affect-mirroring displays tend to be perceptually saliently 'marked' as being distinct from the parent's realistic emotion expressions. Marking is typically achieved through producing an exaggerated version of the parent's realistic emotion display (similarly to the marked 'as if' manner of emotion displays produced in pretend play) (cf. Fónagy & Fonagy, 1995). It is hypothesised that the salient marking of the mirroring display blocks the attribution of the perceived emotion to the parent by signalling to the infant that 'this is not for real', mother is not really angry or fearful.

(b) Nonconsequentiality. This interpretation is also reinforced by the fact that marked affect-mirroring expressions are nonconsequential: i.e., the normally expectable behavioral outcomes associated with a realistic negative emotion display (e.g., she is going to shout at me, put me down, leave me alone) do not follow the marked affect-mirroring version of the same expression. Thus, due to the markedness and nonconsequentiality of empathic affect-mirroring displays, even though the expressed emotion will be recognised by the infant, its attribution to the parent will be inhibited: it will be 'decoupled' from the parent (Gergely, 1995).

(c) Contingent relatedness. Since the marked affect-mirroring display shows a high degree of contingent relatedness to the infant's emotion expressive facial and vocal responses (being temporarily contingent as well as similar in spatial pattern and relative intensity), the infant's CDM will automatically indicate a high level of causal control by the infant over the mirroring expression. There is evidence (Watson, 1972, 1994) that the detection of

contingent control induces positive arousal in infants. Therefore, it is hypothesised that due to the perception of causal control over the parent's affect-reflective display, the initially helpless infant will start to experience a sense of efficacy and instrumentality. The positive arousal thus generated will counteract and inhibit the infant's negative affect state contributing to the overall soothing effect of parental interventions.

(ii) The representation building function of parental affect-mirroring

We assume (Gergely & Watson, 1996, 1999) that the infant's prewired basic emotions (Ekman et al., 1972; Izard, 1977) are nonconscious stimulus-driven automatisms that are at first not under voluntary control. Conscious awareness of and deliberate control over the primary affect states becomes possible only via accessing those secondary representations that during early development become associated with the primary emotion states. We suggest that repeated experience with parental affect-reflective displays may form the original basis for the construction of such secondary representations (Fonagy, Gergely, Jurist, & Target, 2002).

Briefly, due to the three features (markedness, nonconsequentiality, and high contingent relatedness) that differentiate affect-reflective expressions from realistic emotion displays, the infant will set up separate representations for such mirroring expressions. As argued above, due to their 'markedness' the affect-mirroring expressions will be referentially 'decoupled'[1] from the parent who is displaying them: in other words, they will be represented

[1] The terms 'referential decoupling' and 'referential anchoring' have originally been introduced by Alan Leslie (1987, 1994) to characterize the representational properties of communicative expressions produced in pretend play. We apply these terms in the current context to suggest a potential developmental and functional relationship between the markedness of affect-reflective expressions, on the one hand, and the markedness of expressions in

as ‘not being about’ the parent’s actual emotion states. Nevertheless, the infant will need to referentially ‘anchor’ the representation of the marked affect-display as expressing or ‘being about’ somebody’s emotion. The basis for this ‘anchoring’ process will be the experience of the high contingent control that the infant’s emotional reactions exert over the affect-mirroring display. As a result, the representations of the marked affect-mirroring expressions will become associated with the infant’s primary emotion states and so they will form (cognitively accessible) secondary representations that express or are ‘about’ those primary affective states.

(iii) Affect-mirroring and the emergence of the sense of self as self-regulating agent

According to our contingency-based account, the infant will experience the regulation of his/her negative emotional state that is brought about by parental affect-mirroring interactions as an active causal agent. Apart from feeling causal efficacy in bringing about an externalised version of his/her internal emotion state in the form of the adult's affect-reflective displays, the infant will simultaneously register the ensuing positive modification of his/her negative affect state as well. In this way infants can learn from affect-regulative mirroring interactions that by externalising their internal emotion states they can achieve successful homeostatic regulation over their affective impulses (Gergely, 1995, 2000; Gergely and Watson, 1996).

At the early stages the affect-mirroring parent is vitally instrumental in this process as the medium of externalisation. Later, however, when the infant has already established the secondary representations of his/her primary emotion states by internalising the marked

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the 'pretend' mode of communication, on the other (see Gergely, 1995; Gergely & Watson, 1996).

affect-mirroring expressions of the caregiver, s/he will become able to self-regulate his/her negative state by externalising his/her affective impulses without parental mediation. This can be observed during the adaptive use of pretend play for affect-regulative purposes (cf. Freud, 1920), where the young child (as if mirroring him/herself) produces marked expressions of his/her own emotional conflicts and painful affective impulses by projecting them onto protagonists participating in imaginary 'as if' scenarios.

(iv) Affect-mirroring as an early proto-form of pretense

The representations of the 'marked' affect-mirroring displays of the caregiver will form the initial basis for the establishment of a generalized communicative code of marked expressive displays associated with (a) referential decoupling of the expressed content from the agent producing the display, (b) with referentially anchoring the expressed content in an agent other than the one displaying the emotion,[2] and (c) with the suspension of the dispositional consequences of the realistic version of the expressed content. Note that these features will become the central characteristics of the 'as if' mode of communication as it first emerges in the ability to comprehend and produce pretend play during the second year of life (see Leslie, 1987; Fonagy and Target, 1996; Fonagy, Target, and Gergely, 2000; Fonagy, et al., 2002; Gergely, Fonagy, & Target, 2002; Gergely, 1995; Gergely & Watson, 1996).

[2] While in affect-regulative interactions the marked emotion is anchored in the infant as a result of the experience of contingent control, later, when using the marked code in pretend play, the expressed content may be anchored in another (possibly imaginary) agent with whom the person producing the marked behavior identifies (see Leslie, 1987).

(v) Affect-mirroring as a means to sensitise infants to their primary emotion-states: The social biofeedback hypothesis

We have seen that the classical assumption of an initial stage of heightened sensitivity to internal physiological and visceral stimulation, including affect states, has been called into question (e.g. Colombo et al., 1990). Therefore, we (Gergely & Watson, 1996, 1999) proposed to examine the opposite hypothesis according to which initially the perceptual system is set with a bias to attend to and explore the external world and builds representations primarily on the basis of exteroceptive stimuli.

In this view, the infant initially lacks differential introspective awareness of his/her basic emotion states, just as adults are unaware of certain internal physiological states they are in (such as their blood pressure). However, as we argued, being able to recognise the dynamic changes of one's internal affective states seems a necessary precondition for exerting self-control over such emotional impulses. So what facilitates then the development of self-awareness of emotional states during infancy?

We hypothesise (Gergely & Watson 1996, 1999) that the infant becomes aware of his/her own differential emotion states only gradually as a result of a social sensitisation training provided by the parent's emotion-reflective displays. This sensitisation process is similar to adult biofeedback procedures (Miller, 1969; 1978) and is thought to be mediated by the same perceptual mechanisms (contingency detection and maximising). In biofeedback training subjects are repeatedly presented with some external stimulus (say, a beep) that appears contingently with the onset of an (automatically registered) change in an internal target state that subjects are not consciously aware of at first (such as their blood pressure). Repeated exposure to such a contingent externalised representation of the internal state

eventually results in sensitisation to, and in certain cases subsequent control over the internal bodily state.

In a similar manner, by repeatedly presenting a contingent external version of the infant's automatic emotional reactions, parental affect-mirroring provides a kind of natural social biofeedback training for the infant that results in the gradual sensitisation to his/her internal differential affect states. The ensuing perceptual awareness of his/her own emotion states is a precondition for the development of affective self-control and as such plays a crucial role in emotional development (see Gergely & Watson, 1996, for more details).

In sum: according to the social biofeedback model the instinctual parental inclination to empathically reflect back in a marked form the infant's affect expressions during emotion-regulative interactions, on the one hand, together with the infant's sophisticated contingency detection and secondary representation building mechanisms, on the other, result in the gradual internalisation of the originally symbiotic emotion-regulative function of the biosocial mother-infant interactive system (cf. Gergely, 2000).

3. The obscure (social) object of desire: 'Just like me' or 'Nearly, but clearly not, like me'?

Meltzoff and Gopnik (Meltzoff, 1990; Meltzoff and Gopnik, 1993) proposed that early imitative interactions may provide the basis that leads babies to pay special attention to conspecifics. This arises when the caregivers imitate their infants as opposed to when the babies imitate the caregivers. Meltzoff and Gopnik propose that an infant may use his/her innate cross-modal capacity to map the caregiver's visual movements onto the proprioceptive feelings of his/her own movements that the parent is imitating thereby generating a „just like me" experience. They suggest that the caregiver's movements become attractive (attention

capturing) precisely because they are perceived (via the mapping) to be very much like the baby's own. In this view, the more „like me" the infant experiences an object's behavior through cross-modal mapping, the more attracted s/he will be to that object.

To test this hypothesis, Meltzoff (1990) applied a preferential interaction paradigm in which 14-month-olds were faced with two adult models, one of whom imitated as best as she could the child's object-related behaviors, while the other always performed a temporally contingent, but dissimilar (spatially noncontingent) action. Meltzoff found that the infants looked and smiled more at the adult who mimicked them than at the one whose actions were only temporally contingent with theirs.

Since our contingency-based social biofeedback theory also generates specific predictions for the infant's attraction to parental "mirroring" acts, we would like to make explicit two important differences between our position and that of Meltzoff and Gopnik. First, Meltzoff and Gopnik assume that the infant has direct introspective access to his/her internal "feeling states" from the start. By contrast, we assume that initially much of infants' internal state transitions (including the visceral and physiological state cues that accompany basic emotion states) are outside of their perceptual awareness. Indeed, a central aspect of our model is that such internal state cues only become liminal after a period of biofeedback sensitization brought about as a result of parental mirroring interactions. This difference in assumption about what is and what is not "felt" by the infant is not likely to be resolvable empirically, however, as it is unclear how one could measure such a distinction in relation to the subjective experience of an infant.

The second difference between our model and Meltzoff and Gopnik's "like me" hypothesis about the attractiveness of social mirroring is far more assessable empirically. The "like me" hypothesis would seem to clearly predict that the more the mirroring reproduces the infant's behavior, the more attractive it will be for the baby. By contrast, the contingency-

based model assumes (see Bahrick and Watson, 1985; Watson, 1994) that after about 3 months, the target setting of the CDM of the normal human infant is switched toward seeking out high-but-imperfect degrees of contingency. This predicts a preference for highly-but-imperfectly contingent mirroring displays over perfectly contingent ones, while the opposite prediction follows from the "just like me" hypothesis.

Note that according to our model (Gergely and Watson, 1999) the CDM computes the overall degree of contingent relatedness on the basis of the registered values of the three independent sources of contingency (temporal, spatial, and relative intensity, Watson, 1984). Therefore, the nonimitative (only temporally contingent) model will receive a lower contingency value than the imitative model. The latter, while clearly showing a rather high degree of contingency, will nevertheless be still lower than perfectly contingent as it is the result of the variably successful imitative efforts of a real-life human imitator. Therefore, our explanation for the looking pattern in Meltzoff's (1990) study is that the mimicking model provides a high but nevertheless only imperfectly contingent action that is preferred as such over the simply temporally contingent model that produces a much lower degree of contingency. Thus, we propose that the preference for the temporal plus spatial and sensory relational (the mimicking adult) over the just temporal (the nonimitative alternative model) contingency simply indicates that the imitating model provided a contingency magnitude that was closer to the target criterion of best (high-but-not-perfect) contingency of the CDM than was the alternative model.

In contrast to Meltzoff and Gopnik's "just like me" hypothesis, however, we would predict that if given a choice between a perfectly contingent versus the highly but only imperfectly contingent imitative display used by Meltzoff, the infant (after 3 months) would preferentially attend to the latter. In other words, we predict that infants would be attracted to the "nearly, but clearly not, like me" versus the "just like me" display. They would do so

because, rather than preferentially orienting towards a self-like (perfect) contingency, they are committed to engage contingencies that are specifically not self-based (i. e., are not perfect).

To test this prediction, we contrasted the effect on young children's behavior of the availability of perfect versus imitative feedback of their manual activity (see Magyar and Gergely, 1998; Gergely et al., 1999). We tested 32 normal subjects (between 18 and 36 months of age) who sat in front of two TV monitors each displaying the moving image of a schematic hand. The subjects moved a small

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Insert Figure 1 here

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metal bowl (with a computer mouse hidden inside) freely on the surface of the table in front of them (Figure 1). On one of the screens they saw the perfectly response-contingent movements of a schematic hand generated by a computer program controlled by the subjects' manual manipulation of the bowl. The second screen displayed a highly but imperfectly response-contingent image of the schematic hand generated by the imitative efforts of an experimenter. This person attempted to faithfully copy the subject's manual behavior by moving a mouse under the visual guidance of the perfect feedback display viewed on a separate monitor in another room. This procedure provided the normal lag and imperfection of a human act of direct imitation. We found (see Figure 2, Panel B) that normal children attended more to the imitation-based (highly but imperfectly) contingent image than to the perfectly contingent one ($p < .05$). This preliminary study seems therefore to provide support for our hypothesis that normal children are selectively attracted to response-contingent stimuli that are "nearly, but clearly not, like them" rather than being "just like them".

Insert Figure 2 here

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4. Implications for developmental psychopathology

4. 1. Contingency perception and childhood autism: The 'faulty switch' hypothesis

In recent years, a number of new hypotheses have been offered concerning the primary causes of autism. These have ranged from global deficits like "a missing drive for global coherence" (Frith, 1989) to specialized modular deficits like a missing "Theory of Mind module" (Baron-Cohen, Leslie, and Frith, 1985; Baron-Cohen, 1995), a deficient "eye tracking module" (Leekam et al., 1997), a deficient "attention switching mechanism" (Courchesne et al, 1994), an "executive function deficit" (Ozonoff, Pennington, & Rogers, 1991; Russell, 1997) or a deficient "imitation mechanism" (Meltzoff & Gopnik, 1993) each concentrating on some subset of the complex symptom cluster of this pervasive developmental disorder. Recently, Watson (1994; Gergely and Watson, 1999) added to the list of these intriguing theories a conceptually different approach which proposes that the etiology of childhood autism may be related to a genetically based dysfunction of the CDM.

Above, it was argued based on a set of studies (Bahrick & Watson, 1985; Field, 1979; Papousek & Papousek, 1974; Rochat & Morgan, 1995; Schmuckler, 1996; Watson, 1979, 1985) that there is a biologically based transition around 3 months in the preferred target setting of the CDM. During the first 2-3 months infants are preferentially engaging perfect response-stimulus contingencies typically provided by cyclic repetitions of body-centered

activities (see Piaget's (1936/1952) primary circular reactions). It was hypothesized that the self-generated perfect contingencies provide an important source of self-calibrating information (Watson, 1994) leading to the progressive differentiation of the self and the construction of the primary representation of the body-schema. In the long run, however, selective evolutionary pressure is for adaptation to the external environment and so the infant must shift orientation from self-based perfect contingencies to environment-based contingencies. This shift is accomplished by resetting the target magnitude of the CDM from perfect to something discriminably less than perfect at about 3 months of age. By doing that, the infant's preference shifts from engaging self-stimulation to engaging stimulus consequences of action on the environment that typically provides less than perfectly contingent effects. As a result, in normal infants after 3 months the preferential engagement in primary circular reactions is progressively replaced by producing and attending to secondary circular reactions, i. e., by exploring the external stimulus consequences of acts on the environment. Furthermore, as argued above, the infant-induced reactions of responsive social objects such as affect-reflective mirroring interactions (Gergely and Watson, 1996, 1999) or repetitive game-like interactions (Watson, 1972) provide optimal, highly but imperfectly response contingent stimulation that approximates best the preferential target value of the contingency detection device after 3 months. This functions as the basis for the infant's emerging orientation towards and exploration of the social environment and forms the basis for the establishment of the representations of relationships with primary attachment figures.

Our proposal concerning the aetiology of childhood autism is a simple one: we hypothesize that in autistic individuals the normal shift at around 3 months (as triggered by maturation or experience) in the genetically based target value of the CDM does not take place (or not by enough) and, as a result, children with autism continue to invest in perfect

contingencies throughout their life. This tragic devotion to life-long perfection-seeking can be seen as underlying a wide range of the symptoms characteristic of childhood autism:

1. Stereotypies. Children with autism often exhibit characteristic behavioral rhythmicities, and stereotypic motor activities as well as an intolerance of variation in routines. These central features of the disorder can be seen as a direct consequence of the fact that the target setting of the CDM remains in its original position of seeking out perfect contingencies. The preference for invariance and the repetitive engagement in primary circular reactions generate close to perfect response-stimulus contingencies, whereas the high but imperfect contingencies provided by responsive social interactions remain too low in contingency value to engage the autistic child's attention.

2. Executive function problems. Perseveration with habitual routines and a difficulty in inhibiting circular reactions may contribute to the difficulties that children with autism show in carrying out complex, planned goal-directed activities. They can also be expected to be less motivated and efficient in engaging in planning action outcomes involving conditional (less than perfect) contingencies especially when competing habitual action alternatives with clearly predictable perfectly contingent outcomes are available.

3. Aversion to social objects. To be able to predict the behavior of social objects one needs to learn about the significance of dispositional behavioral cues which, however, are displayed in a contingency matrix that is by necessity lower than perfect. By hypothesis, children with autism will show a deficit in attending to and processing the facial and gestural dispositional cues produced by their social environment. This will render the behavioral variation of social partners largely unpredictable to children with autism which will be anxiety provoking and will lead to aversion to and avoidance of social interaction.

4. Inattention to faces and lack of social responsivity. There is evidence that the power of faces to attract attention and elicit smiling increases markedly at around 3 to 4 months in

normal development. Watson (1972) proposed that the face acquired special ethological potency for eliciting smiling and drawing attention by virtue of its association with high-but-not-perfect contingency as exemplified in repetitive game-like face-to-face interactions. By this view, the failure of an infant with autism to modify contingency seeking from a target of perfect to high-but-not-perfect undermines the infant's capacity to engage the early interactional games that normally would generate the special social potency of the face to capture attention and elicit smiling.

5. Lack of social understanding. Inferring actions of others based on attributed dispositional and intentional mental states imply a sensitivity to the behavioral cues (such as facial expressions or gaze direction) that indicate such internal states in others. Note that such discriminative cues enter into conditional probability relations with consequent actions that are typically less than perfect and may therefore be missed by children with autism. This fact, together with the inattention to facial cues, may help explain the profound difficulties that children with autism have in reading other peoples' minds.

6. Emotional impulsivity and abnormal sensitivity to internal stimuli. Autistic children have serious problems in impulse control showing uncontrollable tantrums and irritability. This may be related to the fact that parental affect-reflective mirroring interactions, that, as we have argued, play a central causal role in the development of emotional self-awareness and control, are by necessity lower than perfect in contingency. Therefore, due to the setting of the target value of the CDM to seek out only perfect contingencies, children with autism may simply fail to attend to and process the less than perfectly contingent mirroring displays of the parents. As a result, they will not anchor the representations of marked affect-reflective displays to their own internal self states and so they will not establish secondary representations for their dispositional emotion states. This predicts a consequent deficiency in being perceptually aware of internal affect states as well

as an inability to anticipate and control emotional impulses. Furthermore, due to their deficient processing of the lower than perfect contingencies the hypothesized sensitization to internal state cues that results from the social biofeedback effects of affect mirroring is also likely to be impaired. This may explain the characteristically abnormal thresholds to internal stimuli (such as pain) found in children with autism (Ornitz and Ritvo, 1968; Sahley and Panksepp, 1987).

7. Lack of pretense. If the availability of secondary representations and an understanding of 'markedness' as a generalized communicative code associated with decoupling (see above and Gergely, 1995; Gergely and Watson, 1996, 1999) are cognitive prerequisites for understanding and producing pretense (Leslie, 1987), the inability to process marked affect-mirroring displays may contribute to the autistic child's deficient ability to comprehend and produce pretend play. This could be so in so far as the repeated encounters with marked forms of emotion displays during affect-regulative mirroring interactions contribute to the acquisition of markedness as a cue of decoupling and suspension of dispositional outcomes (Gergely, 1995; Gergely & Watson, 1996). Since marked affect-reflective displays are characterized by less-than-perfect degrees of contingency, infants with autism, due to their dysfunctional obsession with only perfectly contingent stimulation, are likely to show a deficiency in processing and producing marked forms of behavioral expressions and will lack understanding of the representational implications of such expressions.

The above account of childhood autism as relative 'blindness' to less-than-perfect contingencies is admittedly highly speculative. Up until now we had no direct evidence to indicate that children with autism remain seekers of perfect contingencies. A recent extension of our preferential looking study described above (Magyar and Gergely, 1998; Gergely et al, 1999) to include autistic subjects has, however, provided new evidence that children with

autism react to response-stimulus contingencies significantly differently than normals. Recall that our study showed that normal children preferentially orient towards a highly but imperfectly contingent (imitative) feedback of their manual actions when compared to a perfectly contingent computer-generated feedback (Figure 2, Panel B). We have also tested 16 children with autism on the same task and found the opposite effect: the autistic subjects spent significantly more time ($p < .02$) looking at the perfectly contingent computer-generated feedback than the imitative, human-generated feedback display (see Figure 2, Panel A).

This preliminary result suggests, therefore, that, unlike normal children, children with autism are drawn to preferentially engage perfectly response contingent stimulation in a situation in which a competing highly but imperfectly response contingent imitative social stimulus is equally available.

4. 2. The aetiology of 'Disorganized/Disoriented' (D) attachment: The 'flickering switch' hypothesis

In this final section we present some new ideas and preliminary supporting data (Koós, Gergely, Gervai, and Tóth, in preparation) concerning the potential role that the dysfunctional resetting of the target value of the CDM may play in an other area of developmental psychopathology, namely, in the etiology of 'disorganized/disoriented' (D) attachment in infancy (Lyons-Ruth and Jacobvitz, 1999; Main and Solomon, 1986).

(i) Disorganized/Disoriented (D) attachment and family risk factors

Infants classified as Disorganized/Disoriented at 12 months exhibit a variety of atypical behaviors in relation to an attachment figure in the Strange Situation test (Ainsworth et al.,

1978) which involves brief separations from the caregiver. Such infants proved to be ‘unclassifiable’ within the standard categories of ‘secure’ (B), ‘insecure-avoidant’ (A), and ‘insecure-resistant’ (C) attachment. According to Main and Solomon (1986), unlike the other three attachment groups, ‘disorganized’ infants lack a coherent, organized behavioral strategy to cope with separation induced stress. They developed a new coding system for ‘disorganized/disoriented’ attachment based on the ethological model of „conflict behaviors” (which result from simultaneous activation of incompatible response systems).

The frequency of disorganized/disoriented infants in middle-class, nonclinical groups in North America is about 15%, while in low-SES samples it is 24% (van IJzendoorn, Schungel, and Bakermans-Kranenburg, 1999). Notably, disorganization is especially frequent (over 80%) in maltreated infants and in infants of parents who experience unresolved loss or trauma (George, Kaplan, and Main, 1985). In contrast, infant temperamental variables were found to be unrelated to disorganized attachment (see van IJzendoorn et al., 1999). Several studies demonstrated a link between infant disorganization and later dissociative disorders (Carlson, 1998) as well as controlling, externalizing, and aggressive behavior (see Lyons-Ruth and Jacobvitz, 1999; van IJzendoorn et al., 1999).

Disorganized/disoriented infants exhibit a variety of behaviors which imply a temporary collapse of the organized adaptive behavioral strategies characteristic of the other attachment types (Main and Solomon, 1986; Main and Hesse, 1990). These include sequential or simultaneous displays of contradictory behavior involving both approach and avoidance, un- or misdirected, incomplete or interrupted movements, temporal freezing, stilling, or slowed down movements or expressions, displays of apprehension regarding the parent, and disorganized or disoriented activities such as wandering, confused or dazed expressions, or multiple rapid changes of affect. These behavioral episodes are characterized by a temporary disruption of attentional and behavioral organization, often involving minor dissociative states

and the production of repetitive, stereotypic body movements (such as rocking, ear pulling or hair twisting) (Main and Solomon,1986).

(ii) The possible role of frightened and/or frightening parental behavior in the etiology of disorganized/disoriented infant attachment.

Main and Hesse (1990) hypothesized that disorganized attachment arises from the infant's experiencing the attachment figure as frightening. This represents an inherent conflict for the infant: the experience of fear activates the attachment system compelling the baby to seek proximity, but the ensuing proximity to the parent, who is, in fact, the source of fear, leads to increased alarm which activates avoidance tendencies. This inherent paradox results in the collapse of the infant's behavioral and attentional strategies.

Furthermore, Main and Hesse (1990) hypothesized that due to unresolved loss or trauma, the parent experiences dissociative periods of painful, loss-related thought intrusions during which s/he may display unmodulated frightening or frightened behaviors that are unpredictable to their infant. Similarly to being abused, such inexplicable frightening parental displays are also seriously alarming to the infant and result in the simultaneous activation of approach/avoidance tendencies. This, then, suggests a unifying explanation for why disorganization is associated both with parental abuse and with unresolved loss or trauma in the parent.

However, the few studies that tested the hypothesis that the association between unresolved loss and disorganized attachment is mediated by frightening parental behavior provided only weak and somewhat equivocal support for the theory (for a review, see Lyons-Ruth and Jacobvitz, 1999). In fact, several studies (see Lyons-Ruth and Jacobvitz, 1999, pp. 350-351) found additional maternal behavioral categories (such as affective communication

errors, role confusion, negative/intrusive behaviors, disorientation, and withdrawal) which, while not involving explicitly frightening and/or frightened behaviors, predicted infant disorganization equally well or even more strongly.

The available evidence, therefore, suggests that frightening and/or frightened parental behavior may not be the only, or, indeed, the most central aspect of the type of parental environment that leads to the development of disorganized attachment in infancy.

(iii) The possible role of deviant parental contingency environment in the development of disorganized/disoriented attachment: The 'flickering switch' hypothesis

Let us, therefore, consider an alternative approach (Koós, Gergely, and Watson, forthcoming) according to which the relevant common causal factor in parental maltreatment and unresolved loss or trauma leading to disorganized attachment is that both generate a 'deviant contingency environment' in which the infant repeatedly experiences periods of significant loss of contingent control over the caregiver's behavior. This occurs when the caregiver becomes abusive or due to intrusive loss-related ideation the parent dissociates and becomes unresponsive or noncontingent to the infant's communicative behaviors.

We propose that an important causal mediating mechanism leading to dissociative attentional and behavioral organization characteristic of disorganized attachment may be found in the effect that such deviant parental contingency environment exerts on the early development of the CDM. Earlier we discussed evidence (Bahrick and Watson, 1985; Watson, 1994) that around 3 months in normal development the target value of the CDM is 'switched' from a preference of perfectly response-contingent stimulation to high-but-imperfect social contingencies. We now hypothesize that while this resetting process is genetically driven, the

availability of controllable and predictable social contingencies may be necessary as triggering input for the new target setting at lower-than-perfect contingencies to become consolidated as the dominant steady state of the CDM. This process may involve the establishment of an active inhibition of the initial target setting of the CDM at perfect contingencies which results in an avoidance of self-stimulation when controllable levels of less-than-perfect social contingencies are also available.

What could be the impact on this developmental process if during the critical period of resetting the CDM 'switch' the infant were exposed to the type of deviant parental contingency environment that is associated with the aetiology of disorganized attachment? We hypothesize that: 1. During periods of normal (i. e., nondissociative and contingent) functioning of the abusive or unresolved caregiver, the infant will experience sufficient degrees of contingent control for the new target position of the CDM to become established at lower-than-perfect contingencies. 2. However, the infant will repeatedly experience periods of significant loss in the control power of the very same responses over the attachment figure's behavior during the times when the caregiver becomes abusive or dissociates. During these periods, the ensuing feelings of helplessness and anxiety may trigger a (defensive) 'switching back' of the CDM to its original target setting of exploring perfect contingencies. As a result, the attention system becomes disengaged from its social target and is turned towards self-generated perfect contingencies again which can provide affect-regulative experiences of causal control. 3. Such repeated experience with significant contingency loss in relation to an attachment figure may therefore result in an insufficient establishment of active inhibition of the initial target value of the CDM, and during such periods of helplessness the original self-oriented setting of the attention system becomes dominant again.

We hypothesize, therefore, that the deviant parental contingency environment provided by abusive or dissociating unresolved parents results in a fixation of a dysfunctional 'loose or

flickering switch' of the CDM with two dominant and competing target positions (one perfectly contingent, self-oriented and one less-than-perfectly contingent, other-oriented) leading to a dissociative style of attention organization. Distress and helplessness associated with the attachment figure with whom periods of significant contingency loss is repeatedly experienced become triggering stimuli for disengagement and dissociation leading to the temporary collapse of the other-oriented organization of the attention system. We predict that during such periods of disorganization sources of perfectly contingent stimulation will become attractive and may gain temporary dominance over the attention system because they provide affect-regulative control experience by 'throwing the CDM switch back' to its initial target position of seeking out perfect contingencies.

In fact, the observation that one of the indicative signs of disorganized attachment is the production of repetitive, stereotypic body movements in the presence of the caregiver (such as rocking, ear pulling or hair twisting) (Main and Solomon, 1986) seems to support the above prediction. Furthermore, the susceptibility to dissociation that is the result of the early fixation of a dysfunctional 'loose or flickering switch' of the CDM with two dominant and competing target positions may also help us explain the long-term association between disorganized attachment in infancy, on the one hand, and dissociative symptoms in adulthood, on the other (Carlson, 1998; Liotti, 1992).

(iv) A preliminary study of the 'flickering switch' hypothesis of disorganized attachment

Note that apart from providing a plausible account for several central characteristics of disorganized attachment, the 'flickering switch' hypothesis generates some testable novel predictions as well. For example, we hypothesized that as a result of distress evoked by the temporal loss of contingent control over the caregiver's behavior, disorganized infants will be

specifically attracted to stimulation that provide perfectly response contingent sensory consequences. Furthermore, this predicted effect should be demonstrable significantly earlier than 12 months (when disorganized attachment is diagnosed in the Strange Situation), because the 'flickering CDM switch' is hypothesized to be established during the early critical period (around 2-4 months) when the target value of the CDM is reset. Below we shall report preliminary results from an on-going study[3] which allowed us to test these predictions.

The three-phase Mirror Interaction Situation (MIS): Separation in front of a mirror involving a modified 'still-face' procedure

In the MIS paradigm (Koós, in preparation) the caregiver and the infant are seated 2 ms next to each other both facing a one-way mirror. They are separated by an occlusion screen which makes it impossible for them to touch or see each other directly, but they can interact by facial and vocal gestures through the mirror (Figure 3). Two video cameras placed facing (but invisible to) the subjects on the other side of the one-way mirror record their facial and vocal behaviours. These videorecords are fed into a mixer which creates a synchronised time-coded split-screen record of their interactive behaviour for off-line analysis.

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[3] This study is being carried out with 100 mothers and their first-born infants who participate in the longitudinal Budapest Infant-Parent Study conducted at the Institute for Psychology of the Hungarian Academy of Sciences by Judit Gervai, György Gergely, Júlia Frigyes, Orsolya Koós, Krisztina Lakatos, Krisztina Ney, and Ildikó Tóth. The MIS procedure has been developed by György Gergely and Orsolya Koós and the study forms part of Orsolya Koós's Ph. D. thesis (Koós, in prep.).

Insert Figure 3 here

The situation consists of 3 two-minute episodes: *Phase 1.*: 'Free interaction' in which the mother is instructed to freely interact with the baby, followed by *Phase 2.*: the 'Still-face period' in which (similarly to the standard still-face procedure, see Tronick et al., 1978) the parent is instructed to put on a motionless neutral 'still-face' while fixating the infant's image; and finally *Phase 3.:* the 'Recovery period' in which the parent is instructed to become 'alive' again and interact freely with the infant.

In relation to the present hypotheses the MIS procedure allows us (a) to observe mother-infant facial and vocal interactions and infant emotional and behavioral reactions in a situation which involves experimentally induced temporal loss of the infant's contingent control over the mother's behavior (during the still-face period), and (b) to examine preferential engagement of attention in a preferential choice situation where the infant can either engage the less-than-perfect maternal contingency or explore in the mirror the perfectly contingent sensory consequences of his/her own motor activity.

The preliminary result we are reporting here (Koós, Gergely, Gervai, and Tóth, in preparation) is based on a sample of 60 mothers and their first-born infants tested at 6.5 months in the MIS. Infant security of attachment was measured later in the Strange Situation at 12 months. There were 13 Disorganized and 31 Secure infants in this sample. We have developed a coding system for the MIS (Koós, in preparation) which codes a variety of maternal and infant behaviors and interactive categories including frequency and duration of affect, gaze-direction, infant- vs mother-initiated interactive episodes, contingent and mirroring reactions, different types of maternal vocalizations and verbalizations, and 'contingency testing in the mirror'(CTM). For the present purposes, we shall focus on this last

category which was defined as the relative frequency and duration of time that an infant spent looking at the (perfectly response contingent) visual consequences of his/her motor activity in the mirror. (Note that simply looking at the self-image without engaging in any visible motor activity was not included in this category. To fit the category, the infant needed to move in some way as well).

For secure infants both the relative frequency and duration of engaging in CTM changed significantly across the three phases of the MIS. During Phases 1 and 3, when the possibility of contingent interaction with mother was available, the secure babies engaged in relatively small amounts of CTM. In contrast, they showed a notable increase in CTM during the Still-face period (Phase 2) when the mother became noncontingent.

Unlike secure babies, however, disorganized infants showed relatively high degrees of CTM throughout the three phases of the MIS. Furthermore, in Phase 3, following the loss of contingent control over their mother's behaviors during the preceding Still-face period, disorganized infants exhibited significantly more CTM than securely attached infants. (This pattern of CTM was unique to disorganized infants: the insecure-avoidant (n=10) and insecure-resistant (n=6) babies did not differ from secure infants in this regard.)

At the same time, secure and disorganized infants showed a similar emotional reaction to the sudden loss of contingent control during the Still-face period. In both groups there was a significant increase in negative affect from Phase 1 to Phase 2, while the relative amount of time they spent looking at their mother's image decreased significantly during the Still-face period. Thus, it seems that the secure and disorganized infants were equally frustrated and distressed by the Still-face intervention and avoided the mother's noncontingent image during Phase 2. Furthermore, in Phase 3, when the parent became reactive again, both groups significantly increased their looking at the mother and the two groups did not differ in this measure during Phase 3.

Interestingly, the secure and disorganized groups also showed a different pattern of change in affective state between Phase 2 and 3. Secure infants showed significantly more negative affect during Phase 3 (when the mother became reactive again) than during the Still-face. In contrast, disorganized infants expressed more positive affect in Phase 3 than in Phase 2. As a result, the relative amount of positive affect was significantly higher in disorganized infants when compared to secure babies during Phase 3.

We propose to interpret this intriguing pattern of results as follows. In line with the 'flickering switch' hypothesis, the fact that, unlike the other attachment groups, disorganized infants engaged in high degrees of CTM throughout the three periods indicates that sources of perfectly contingent stimulation are differentially attractive to them. Note that this finding is not a simple by-product of looking more at the self's image overall (i.e., including passive staring as well) or of looking less at the mother than the other attachment groups as disorganized infants did not differ in these measures from the other groups. It seems, therefore, that it is, indeed, their special attraction to sources of stimulation over which they exercise a perfect degree of contingent motor control that differentiated the disorganized infants from the other attachment groups at 6.5 months of age in the MIS.

The results are also in line with the hypothesis that the exploration of perfect contingencies is positively arousing for infants and as such can be used as a means of self-regulation. For example, secure infants reacted to the unavailability of the mother during the Still-face by increased exploration of self-generated perfect contingencies in the mirror, probably in an attempt to deal with their distress by generating positive arousal. Note, however, that the secure babies turned to this kind of self-regulatory activity only when they had no access to a reactive caregiver. During Phases 1 and 3, when the mother was available, they engaged in significantly less CTM than during the Still-face period. This is in line with our 'contingency switch' hypothesis according to which by six months in normal development

the dominant target position of the CDM switch is already set at lower-than-perfect (social) contingencies. This predicts that when a reactive attachment figure is available, secure infants will be less likely to preferentially engage their perfectly contingent self image. In fact, even though during Phase 3 they continued to experience frustration due to the preceding Still-face intervention (as evidenced by their increased negative affect), secure infants actually decreased their amount of CTM in this period.

In contrast, for disorganized infants the 'flickering switch' hypothesis predicts that after experiencing temporal loss of contingent control during the Still-face intervention, their attention will be more easily drawn to sources of perfectly response-contingent stimulation. This prediction was borne out as during Phase 3 disorganized infants engaged in significantly more CTM than secure babies.

Furthermore, since the experience of contingent control is positively arousing to infants (Watson, 1972), the fact that disorganized babies showed more positive affect during Phase 3 than secure infants may be attributed to the positive arousal generated by their higher amount of CTM during this phase. In other words, even though, similarly to secure babies, disorganized infants were distressed by the loss of maternal contingency during the Still-face period (as shown by the significant increase in negative affect during Phase 2), it seems that by engaging in more CTM during Phase 3 they managed to achieve some measure of successful self-regulation.

In sum: These findings provide preliminary support for the 'flickering switch' hypothesis of disorganized attachment. The MIS study has demonstrated a behavioral reaction that is specific to disorganized infants as early as 6.5 months of age that was predicted by the 'flickering switch' model: namely, that disorganized infants are differentially attracted to sources of perfectly contingent stimulation in a situation which induces stress as a result of loss of contingent control over the caregiver's behavior. This early differentiating feature

predicts attachment disorganization at 12 months and suggests that the formation of disorganized attachment is well on its way by the time the baby is six months old. This in turn is consistent with our hypothesis that at the heart of the aetiology of disorganized attachment lies the dysfunctional influence of a deviant parental contingency environment during the early critical period (around 2-4 months) when the genetically determined tendency for resetting the target value of the CDM switch towards social contingencies is activated.

6. Conclusions

In this paper we have explored the wide ranging role of contingency perception and parental contingent reactivity in early socio-emotional development focusing on issues of affect-regulation and control, the development of attachment relationships, and certain types of developmental psychopathology. In particular, we have concentrated on the central role that an innate information processing mechanism, the 'contingency detection module' (CDM) plays in the earliest phases of socio-emotional development. We argued that the CDM serves a number of crucial developmental functions such as the construction of the primary representation of the bodily self or the differentiation of and orientation towards social objects. The CDM was then proposed as the central mechanism for processing contingent and imitative parental reactions and for mediating their developmental effects through a process that we referred to as 'social biofeedback training'. We argued that this process is crucially involved in a number of developmental functions associated with contingent parental reactivity such as parental regulation of the infant's affective states, the establishment of secondary representations of primary emotion states, and the sensitization of the infant to his/her internal affect states leading to the development of emotional self-awareness and self-control.

Finally, we extended our model to two areas of developmental psychopathology: the etiology of childhood autism, on the one hand, and of disorganized/disoriented attachment, on the other. We proposed that both of these pathological developmental conditions can be understood as consequences of the early dysfunctional development of the CDM which comes about either as a result of a genetically based structural defect in this innate mechanism (as in the case of childhood autism) or due to the influence of a deviant parental contingency environment during a critical period of the maturational unfolding of this device (as in the case of disorganized attachment).

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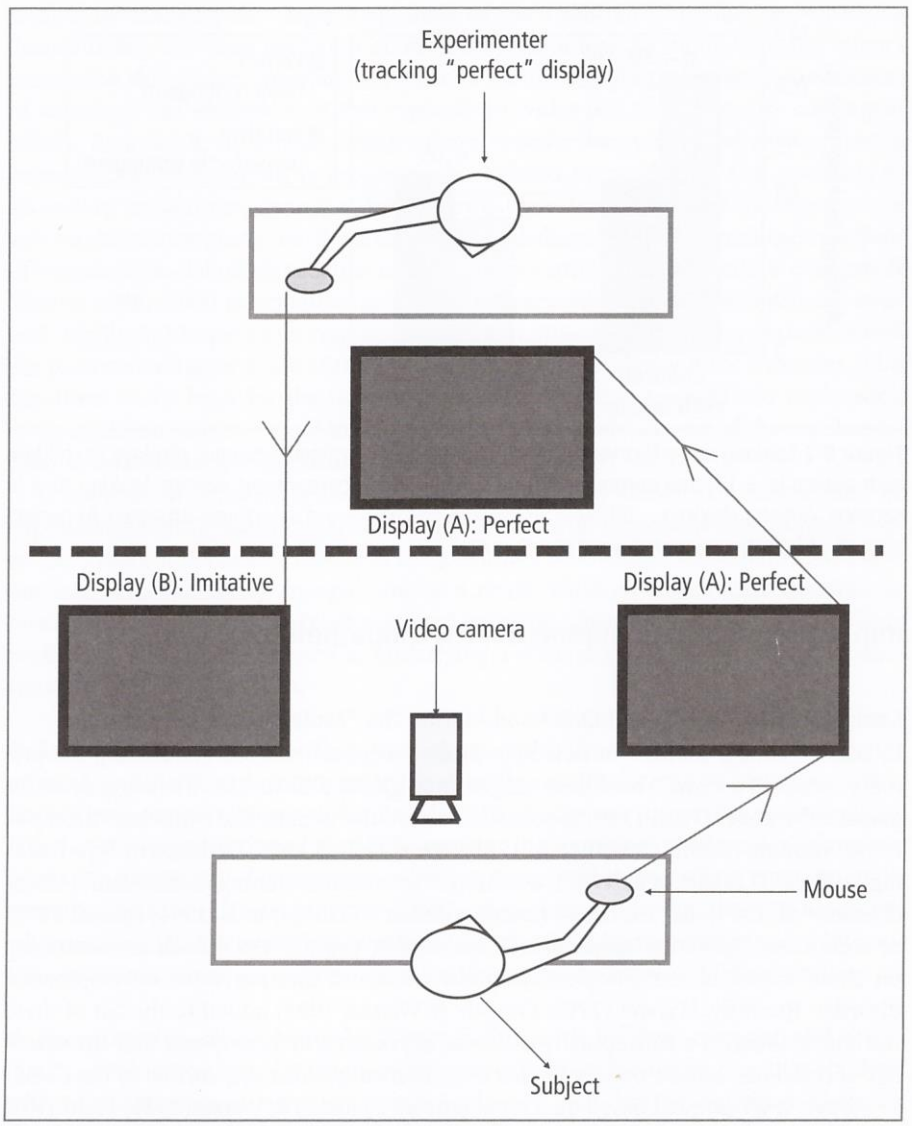

Figure 8-1 Experimental setup for preferential looking study.

mouse under the visual guidance of the perfect feedback display viewed on a separate monitor in another room. This procedure provided the normal lag and imperfection of a human act of direct imitation. We found (see Figure 8-2, right panel) that normal children attended more to the imitation-based (highly but imperfectly) contingent image than to the perfectly contingent one ($p < .05$). This preliminary study seems therefore to provide support for our hypothesis that normal children are selectively attracted to response-contingent stimuli that are "nearly, but clearly not, like them" rather than being "just like them".

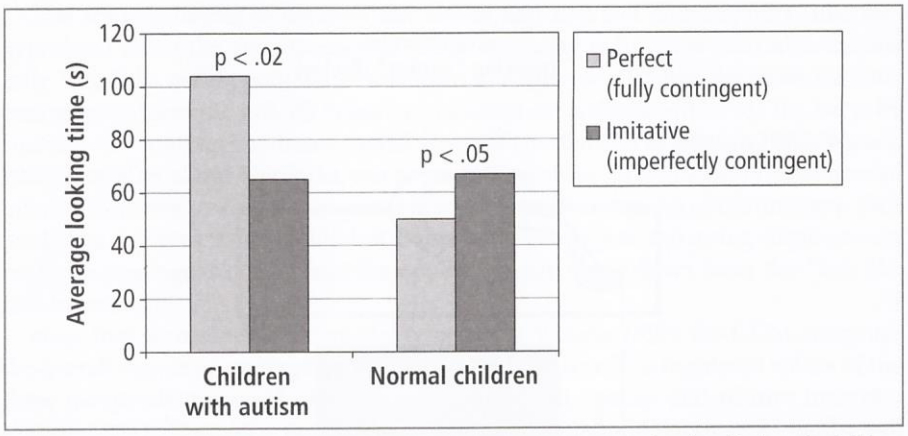

Figure 8-2 Looking at perfect versus imitative response-contigent stimulus displays in children with autism (n = 16) and normal children (n = 32). The bars represent average looking time in seconds. Autistic children – different as normal children – are selectively attracted to perfect instead of imitative response-contingent stimuli.

Implications for Developmental Psychopathology

Contingency Perception and Childhood Autism: The "Faulty Switch" Hypothesis

In recent years, a number of new hypotheses have been offered concerning the primary causes of autism. These have ranged from global deficits like "a missing drive for global coherence" (Frith 1989) to specialized modular deficits like a missing "theory of mind" module (Baron-Cohen et al. 1985; Baron-Cohen 1995), a deficient "eye tracking module" (Leekam et al. 1997), a deficient "attention switching mechanism" (Courchesne et al. 1994), an "executive function deficit" (Ozonoff et al. 1991; Russell 1997) or a deficient "imitation mechanism" (Meltzoff & Gopnik 1993) each concentrating on some subset of the complex symptom cluster of this pervasive developmental disorder. Recently, Watson (1994; Gergely & Watson 1999) added to the list of these intriguing theories a conceptually different approach which proposes that the a*etiology of childhood autism may be related to a genetically based dysfunction of the CDM.*

Above, it was argued based on a set of studies (Bahrick & Watson 1985; Field 1979; Papousek & Papousek 1974; Rochat & Morgan 1995; Schmuckler 1996; Watson 1979; 1985) that there is a biologically based transition around 3 months in the preferred target setting of the CDM. During the first 2–3 months infants are preferentially engaging perfect response-stimulus contingencies typically provided by cyclic repetitions of body-centered activities (see Piaget's [1936/1952] primary circular reactions). It was hypothesized that the self-generated perfect contingencies provide an important source of self-calibrating information (Watson 1994) leading to the progressive differentiation of the self and the construction of the primary representation of the body-schema. In the long run, however, selective evolutionary pressure is for adaptation to the external environment and so the infant must shift orientation from self based perfect contingencies to environment based contingencies. This shift is accom-

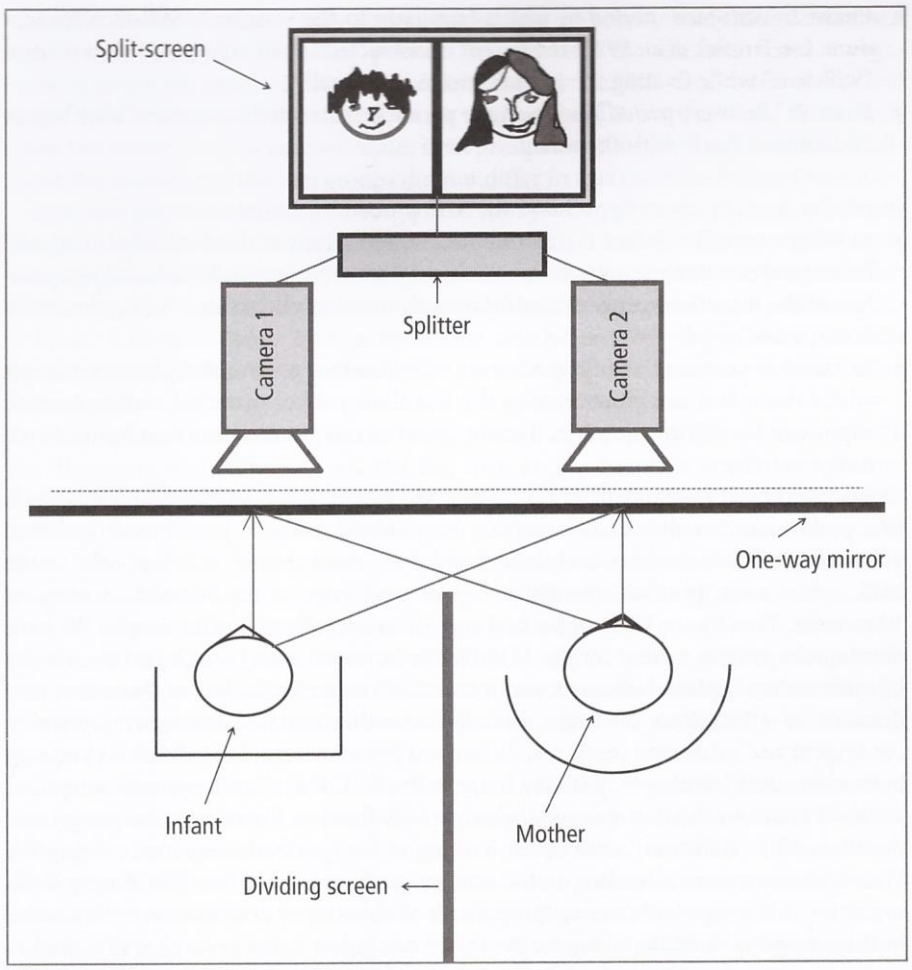

Figure 8-3 The mirror interaction situation.

The Three-Phase Mirror Interaction Situation (MIS)

In the MIS paradigm (Koós, in preparation) the caregiver and the infant are seated 2 ms next to each other both facing a one-way mirror. They are separated by an occlusion screen which makes it impossible for them to touch or see each other directly, but they can interact by facial and vocal gestures through the mirror (see Figure 8-3). Two video cameras placed facing (but invisible to) the subjects on the other side of the one-way mirror record their facial and vocal behaviours. These videorecords are fed into a mixer which creates a synchronised time-coded split-screen record of their interactive behaviour for off-line analysis.

The situation consists of 3 two-minute episodes:

- Phase 1: "*Free interaction*" in which the mother is instructed to freely interact with the baby, followed by