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E. Z. Tronick

Why do infants, indeed all people, so strongly seek states of interpersonal connectedness and why does the failure to achieve connectedness wreak such damage on their emotional, mental and physical health? When the break in connection is chronic, as occurs in some orphanages, infants and children become distressed, depressed, listless, and fail to develop. In less extreme situations where caregivers are withdrawn and emotionally unavailable infants go into sad withdrawn mood states. Even in experimental manipulations that briefly break the interactive connection between infants or children and others, such as the Face-to-Face Still-Face Paradigm or the Strange Situation Procedure, infants and children become angry, distressed, frustrated, and/or withdrawn and apathetic. No less dramatic are the exuberant smiles and giggles of infants and children when they are connected to others, a phenomenon which also needs explanation. Further, the contrast between the subjective experience of connection and disconnection is vivid. When connection is made with another person there is an experience of growth and exuberance, a sense of continuity and a feeling of being in synch along with a sense of knowing the other’s sense of the world. With

1 I would like to acknowledge the invaluable work on this paper by Jacob Ham and my discussion with my colleagues Marilyn Davillier, George Downing, and Alexandre Harrison.
disconnection there is an experience of shrinking, a loss of continuity, a senselessness of the other. Feeling disconnected is painful and in the extreme there may be terrifying feelings of annihilation. But what makes this emotional contrast between connection and disconnection so objectively and phenomenologically powerful? Why does connection have such a profound effect on the body, brain, behavior, and experience in the moment and over time? Indeed what do we mean by connection? What is being connected, and how is connection made?

DYADIC STATES OF CONSCIOUSNESS MODEL (DSCM)

The hypothesis I want to explore is the Dyadic States of Consciousness Model (DSCM). The DSCM assumes that humans are complex and open psychobiological systems. As open systems humans must garner energy from the environment to maintain and increase their organization and complexity—that is, to reduce their entropy. At the top of the human hierarchy of a complexly assembled multitude of psychobiological subsystems for making meaning such as emotional, action, unconscious and cognitive systems are emergent psychobiological states of consciousness (SOCs). The content of an SOC is the individual’s age-possible implicit and explicit sense of the world and his or her relation to it. As such, SOC is also an anticipation of how to move into the future. SOCs are linked and dependent on all the psychobiological levels below it (e.g., physiologic, neuronal, neuronal group, emotional, cognitive, dynamically unconscious, whole brain processes) and in a circular (downward) causal manner SOCs affect the lower levels. SOCs are generated with the purpose of making as coherent, and complex but paradoxically simpler and more integrated sense of the world as possible at every moment by garnering meaning from the world. Nonetheless, as we shall see the sense made of the world is at best messily coherent and continuously changing.

Though SOCs are private and ‘of’ and “in the individual” and the individual has self-organizing meaning making capacities for creating
them, these capacities are limited compared to dyadic meaning making regulatory processes. Thus, as with many other psychobiological states (e.g., states of hunger, sleep, moods, temperature, metabolism), SOCs are elaborated and created by a dyadic regulatory system that operates to make meaning within and between individuals. The successful process of a mutually elaborated ‘good fit’ of meanings between individuals leads to the emergence of a mutually induced dyadic state of meaning, what I call dyadic state of consciousness (DSC). When a DSC is formed new meanings are created and these meanings are incorporated into the SOCs of both (or more) individuals. As a consequence, the coherence and complexity of each individual’s sense of the world increases, a process I refer to as the dyadic expansion of consciousness model (DECM). Thus the successful creation of SOCs fulfills the open system principle to garner energy and increase complexity.

Connection then is the dyadic regulation meaning to form a DSC and the creation and incorporation of meaning with its consequent increase in the coherence and complexity of the individual’s SOC. An unfortunate implication of the DECM derived from open systems theory is that when individuals chronically fail to create DSCs there is a dissipation (loss) of their coherence and complexity; they move closer to entropy (i.e., death). Disconnection is the failure of the dyadic meaning-making system. Meaning is not created, exchanged and incorporated, and consequentially the coherence of an individual’s SOC incrementally dissipates.

At the outset, I want to acknowledge that this paper draws heavily on the work of Bruner (J. Bruner, 1990; J. S. Bruner, 1970, 1972) on meaning making and my discussions with him on co-creative processes, Freeman (W. Freeman, 1994; W. J. Freeman, 2000) for his ideas on the purposive functioning of the brain, Prigogine (Stengers & Prigogine, 1997) and Per Bak (Bak, 1996) for their descriptions of open and complex systems, Edelman (1987) his ideas on neuronal selection, and my collaborator Brazelton (Brazelton, 1992; Brazelton, Koslowski, & Main, 1974) for his

WHAT IS A STATE OF CONSCIOUSNESS (SOC)?

What is an SOC? The literature is filled with varying definitions and meanings about consciousness and it is foolhardy to try and make coherent sense of them. As used here, an SOC is seen as a psychobiological state which is derived from the medical and developmental literature and not from the typical dictionary definition that often equates consciousness with the sole characteristic of awareness. The dictionary definition is somewhat all-or-none, and once consciousness is attained it is seen as much the same even with development. In fact, though there may be different levels or kinds of consciousness, this unchanging a-developmental quality permeates much of neuroscience models of consciousness. By contrast, a psychobiological definition encourages the examination of components and elements of states, their coherence and complexity, their linkage and organization, and importantly their development. Thus an SOC is a psychobiological state with a distinct complex organization of body, brain, behavior and experience. It is a distinct assemblage of implicit and explicit meanings, intentions and procedures. SOCs are individuals’ private continuously changing knowing of the world and their relation to it.

SOCs are purposive and organize internal and external actions toward some end. Freeman (2000) sees individuals as operating with intentionality but what the individual intends and does is only sensible in the context of the individual's SOC – sense of the world at that moment. There is no necessity for awareness in an SOC as demonstrated by the fact that most daily activities are purposive and carried out without awareness.
With or without awareness, SOCs have an *impelling certitude* about the way the world *is* (Harrison, personal communication 2003). What is meant by an impelling certitude? Freeman refers to our “brains and bodies [as being] committed to the action of projecting ourselves corporeally into the world” (Freeman, 2000, p.18). Impelling certitude is that sort of commitment, an empowering of intentions and actions. Like the air we breathe it is likely to be out of awareness, but it is always present with greater or lesser intensity. However, when an impelling certitude is violated it comes into awareness. Think of the impelling certitude about the *reality of wholeness* that is violated when a magician makes a body separate from a head, or a New Englander's *discomfort* when confronted by a Californian’s desire for sharing personal stories, or an adolescent’s *insistence* that it is realistic to achieve peace by everyone just agreeing to it. Thus SOCs might be thought of as unique gestalts of meaning that have an impelling certitude about the way things are for the individual. They are the meaning the individual has for being in and acting on the world in the present as he/she moves into the future.

**AGE-POSSIBLE SOCs**

A critical feature of SOCs is that they can only be “age-possible,” though as we shall see age-possible is hardly the only constraint on SOCs. The concept of “age-possible” SOCs is needed to take into account the developmentally possible sense individuals are capable of making given their meaning-making processes. For example, the sense of the world that is in a baseball player's muscles (sometimes referred to as muscle memory) when he catches a ball is qualitatively different than the knowing that is in a toddler’s body when she catches a ball. Yet, both of their SOCs make coherent sense of what they are doing. Further, the concept of age-possible makes explicit that the interpersonal connection, the DSC made between an infant and adult versus a child and adult will be qualitatively different. Thus SOCs and connectedness are not fixed but dynamically changing with development.
Young infants’ SOCs are psychobiological assemblages of emotions, actions and experience. The meaning is in what their body and brain do and their subjective experience. It is of and in the moment, though the moment soon integrates personal experience and lengthens with development. For example, the alert newborn has an SOC that might be something like there are things to look at. This SOC of the world is an integration of the circadian rhythms of their bodily (i.e., the biorhythmic flow of sleep and awake states), emotional and brain processes (i.e., occipital processing of visual input), and their perceptual activity (e.g., visually exploration of the world) and actions on the world for gaining meaning. Of course a look-for-things SOC is difficult for the young infant to maintain given their self-organizing capacities (e.g., head movements go in a different direction than eye movements, their intention switches, their bowels act up) and it deteriorates into distress and crying, a rather different SOC.

For older infants, Piaget (Piaget, 1954) described how the meaning of an object is what infants can do with it – an object is graspable or ‘bangable’ – and their action and intention of repetitive banging make sense once we appreciate their SOC. The Piagetian infant’s SOC is qualitatively different if she can reach and grasp an object with one hand and explore it with the other hand while sitting than the SOC of infant who has to hold objects with two hands while lying on his back because the meaning is in the action. Take another example: Infants’ SOC about a (virtual) looming object is that it is “dangerous” and ducking out of its way makes sense given their meaning making. And if this ascription of meaning to the infant’s actions seems over the top, realize that the infant could apprehend the looming event in other ways – it might be interesting, novel or make no sense at all. Moving into the domain of social interactions but still holding to Piaget’s ideas, infants smiling back at a smiling adult apprehend that there is a general affordance for emotional connection but infants have more specific and different SOCs for different
people. Forgive the grammar, but for the infant the SOC of one “liked-familiar-person” is very much emotion and action laden and simultaneously huggable, communicable-with, synchronizable-with, happy-and cryable-with, and sing-songable-with, whereas a different liked-familiar person is exciting, not-to-be irritable with, too-arousing-with, bouncable-with, and peek-a-boo-able-with.

Infant SOCs also have an impelling certitude. Observe the young infant who fails to search for a hidden object to see that she is “absolutely certain” that it is gone. Another example is the total distress of the infant separated from the mother – the certitude that not only is she gone forever, but the certitude that he will be annihilated. Or, the absolute thrill an infant experiences being tossed into the air by a parent (and the other parent’s impelling certitude that the infant will be dropped). Of course I recognize that we are inferring infants’ SOCs about the world, and we can’t truly know them. However, in different contexts we can see what infants do, as well as what they don’t do, which gives our inference power. But our inference does not tell us if they are conscious or not, self-aware or self-reflective, which is a different problem than our inferring their SOCs. And if this still seems difficult, we must realize that if infants did not have age-possible SOCs about themselves in the world they could not function in it. Their actions would be incoherent and unpredictable, a veritable Jamesian “bloomin buzzin confusion,” a view that is no longer tenable given the past 50 years of research on infant competencies.

The toddler and young child have qualitatively different SOCs from those of the infant. Their meaning-making tools include language and symbols, and complex body skills (e.g., finger movements to running) and body micro-practices (e.g., false coyness). In pretend play toddlers assemble fantasy, reality and their age-possible memories into new SOCs. They hardly are only in the moment, but their meanings are disjunctive and assemblages of illogical narratives. The SOCs of toddlers are complex and have an “and ____, and ____,” organization of apprehension that
places no demand for the possible or the logical. Think only of a toddler’s impelling certitude when he loudly demands to have the identical berries that fell from a branch back on the tree the way they were, and his utter distress when he says a different branch is bad and he does not want it ever! (A. Bergman, personal communication).

There is little need to further elaborate the idea that SOCs are different for older children, adolescents and adults. Nonetheless it is worth noting, because developmental and neuro-scientists tend not to attend to it, that at some point in development SOCs assemble meanings from psychodynamic processes including a psycho-dynamic unconscious. These dynamic processes are not equivalent to the passionless non-conscious or implicit processes invoked by developmental psychologists, cognitive neuroscientists or even some psychoanalytic writers. I believe that unconscious dynamic processes are inherent to the SOCs of children and adults. Dynamic unconscious processes make one person’s knowing what is in another person’s SOC cryptic as problematic as knowing the SOC of an infant, yet somehow we do come to apprehend the functional meaning of another’s SOC. How we come to have that apprehension is based on understanding how SOCs are formed and what principles govern their formation.

**DYADIC REGULATION: OPEN SYSTEMS AND COMPLEXITY**

The coherence of an individual’s sense of the world is both regulated and increased by internal self-organizing and dyadic regulatory processes. Prigogine states that a primary principle governing the activities of open biological systems is that they must acquire energy from the environment to maintain and increase their coherence, complexity and distance from entropy. The energy for a biological system must have a particular form to be useful (i.e., have meaning or what Sander (1983) calls fittedness for the organism). For example though the food that prey eat has plenty of energy, if predators eat what prey eat, they cannot utilize the energy – it has no ‘meaning’ for them. Complexity refers to a hierarchical system exhibiting
emergent systems’ properties. These properties are neither fixed nor chaotic. A complex system is information rich with local contextual interactions. Self-organizing processes that increase complexity have limits that put a ceiling on a systems’ maximum complexity. These limitations of self-organization are an inherent characteristic of all open systems. Humans have developed an exceptional (though hardly unique) way to overcome these limits by forming synergistic relations with others, what I refer to as a dyadic regulatory system. Though dyadic regulation also has limits, this dyadic system is able to garner more resources than each individual’s self-organizing processes could on its own. As a consequence the complexity of each individual as a complex psychobiological system is increased.

DYADIC REGULATION: PSYCHOBIOLOGICAL STATES

To understand mutual regulation I want to start with an example far from the regulation of SOCs -- infant temperature regulation. I choose this example because it illustrates the dyadic regulatory process for a psychobiological state that is most typically seen as a self-organized process. Temperature regulation is a complex system with a singular purpose: maintain homoeothermic status. This regulatory system is hierarchically organized with a multitude of subsystems from metabolic processes to behavioral systems. It is a system that operates to maintain equilibrium, and though it changes with development (e.g., the loss of brown fat) and is influenced by environmental factors (e.g., the increase in capillary networks in the hand in cold environments) its change and development is limited compared to other psychobiological systems (e.g., respiratory systems or motor systems or SOCs). Infants have self-organizing capacities to regulate below normal temperature, such as increasing their activity level, preferentially metabolizing high energy brown fat or moving into less energetic behavioral states. But these self-organized capacities are limited and immature, and will eventually fail, an especially quick event for infants with their high surface to volume ratio.
However, though Claude Bernard saw temperature regulation as a within individual process, it is not. It is a dyadic process.

Infants’ self-organized regulatory capacities for operating on temperature control are supplemented by external regulatory input by caregivers that is specifically fitted to overcome the infant’s limitations (Hofer, 1984). For example, caregivers place infants against their chests, share their body heat with their infants which, in turn reduces their infants’ surface heat loss. This dyadic regulatory process itself is guided by communicative signals from the infant. These communicative signals induce the implicit purpose and intentions of the infant into the caregiver’s sense of what is going on with the infant. “I’m cold, help me.” Adult, “Got it!” When done successfully the input provided is fitted (meaningful) to the infant’s temperature regulatory system and the system becomes more coherently organized than the infant would be on his/her own.

Additionally, the capacities for self-regulation actually grow with the acquisition of meaningful input from the caregiver, such that later in development the infant will be able to self-regulate temperature without as much external regulatory scaffolding, an idea not unlike Vygotsky’s (1978) concept of the zone of proximal development. Alternatively, were the formation of a dyadic state to fail the infant would lose control of his temperature, and his homeostatic state would dissipate. When the failure is chronic the infant’s self-regulatory capacities might maintain themselves at a cost to other systems but eventually they would not grow. Further note that even this equilibrium system is not fully predictable. The infant actions that induced the infant’s intent into the caregiver may have one form one day and another form another day. The caregiver’s apprehension of it and the caregiver’s input to the infant might also vary. Moreover, the infant signal that worked one time may not work the next time, and the same is true for the caregiver’s response, as most parents have experienced. Nonetheless, it is likely that the activities that work more
often will become more and more a part of the workings of the dyadic regulatory process.

**DYADIC REGULATION: SOC\(s\) AND ACTIONS IN THE WORLD**

Dyadic processes more effectively regulate the infants' SOC\(s\) than the infant can do on his or her own, even when the infant is doing something that seems to be an individual task. Take, for example, a not-yet-independently-reaching infant who nonetheless tries to reach an object. The infant has an intent that is beyond his own self-regulatory capacities. At first his SOC is organized and his looking and intent are coherently organized. However, once he attempts to get his hands to the object he is unable to coherently organize his actions, looking and intent. The organization of his SOC is decreased. He becomes distressed, loses what motor control he had, but he does not necessarily give up the intent. In a way, the infant can no longer make sense of the world and his relation to it. His SOC loses some coherence and complexity. By contrast as part of a dyadic system with a caregiver who by apprehending the infant's intent provides postural support and a little cheating with the object the infant is able to free up his arms, control his posture and bat at the object. The infant engages in a more complex action than he would be capable of on his own.

**DYADIC REGULATION: INDIVIDUAL SOC\(s\) AND THE EMERGENCE OF DSC\(s\)**

Bullowa (1979) described this phenomenon when she documented the greater complexity of the infant's behavior in the presence of others compared to the infant alone. In the example had the mother's apprehension of the infant's SOC been that the infant intended to reach for the object when in fact he intended to stroke her face, the infant and mother would remain separate and uncoordinated. Then again when there is a successful mutual mapping of (some of) the constituent meanings in their individual SOC\(s\) into the other's SOC there is the emergence of a dyadic state of shared meaning, a DSC. This DSC is more complex and
information rich than individual SOCs. It is more complex because it is made up of more systems, the infant and the mother and their hierarchically arranged subsystems; and, it is information rich because it contains meanings from both the infant's and the mother's SOCs. Critically, the effect of being subcomponents of a DSC is that the infant and the mother can appropriate information from it into their own SOCs. A critical consequence of this appropriation is the expansion of their individual SOCs. Namely by being connected their sense of themselves in the world expands and becomes more coherent and complex.

DYADIC REGULATION: SOCs, DSCs AND SOCIAL INTERACTIONS

Infant-adult interaction, or for that matter any dyadic human interaction is perhaps the quintessential example of dyadic regulation of meaning making (Fogel, 1993). In interaction each individual attempts to increase the coherence of his/her sense of the other and what they are doing together. When an interaction is dyadically well regulated there as an emergence of a more coherent and complex sense of the world. For example, in infant-mother interaction each individual communicates their affective evaluation of the state of what is going on in the interaction: relational affects (e.g., feeling apart from, feeling in synch with, Foscha, 2000), and their relational intention (e.g., continue, stop, change, Weinberg & Tronick, 1994) These communications simultaneously express what they are experiencing in the moment and what they intend to do. In response to the induction of meaning in the other, infants and mothers attempt to adjust their behavior to maintain a coordinated dyadic state. When the mutual induction is successful a DSC is formed, meanings from the other's SOC are incorporated and their individual SOCs gain coherence and complexity.

Figure 1 illustrates the process of mutual regulation and formation and breaking of dyadic DSCs. A 6 month old infant and his mother are playing a game and the mother leans in to nuzzle the baby. The infant takes hold of the mother's hair and they are both joyful. The infant's age-
possible SOC is in his actions and his affect. He has yet to make sense of the game as a game, echoing Piaget's argument that objects are not yet objects for infants but only what they do to them. He has an impelling certitude something like “This is the greatest thing I have ever done!” The mother's more complex SOC includes a similar age-possible feeling (i.e., the joy of him!), as well as her more knowing of the game, how to make it work, their other games, and many implicit and unconscious things. Collaborating together they create a DSC by inducing some of these meanings into the SOC of the other person.

FIGURE 1 ABOUT HERE

When she pulls away he does not let go. In pain, the mother responds with a bare-toothed angry facial express and angry vocalizations – Ouch, ouch!!. The infant immediately sobers and brings his hand up to his face in a defensive move. His SOC changes to something like “this is threatening” and he defensively ducks behind his hands. The meaning is in the ducking and the feeling of threat. The mother almost immediately pulls back from him. Her mentalization (Fonagy & Target, 1998) of her action (an age-possible knowing the infant is not able to do) and the infant’s induction of meaning into her SOC change her SOC. They disconnect, the hair-pulling DSC is broken and each is left to self-organize their SOCs. The infant’s SOC is now in his sober wary face and his looking away from behind his hands. Its impelling certitude perhaps is something like “I’m confused, this doesn’t happen!” Likely the mother is feeling something like “concern” or “apology” and age-possible meanings such as “I scared him. I messed up our good time,” and maybe meanings out of her own past or current conflict (“I always felt apologetic to my mother.”) The mother pauses and then slowly approaches the infant again. The infant drops his hands with a number of coy moves that convey his intent to cautiously reengage. The mother too makes a slow approach and they reconnect with joyful smiles. A DSC is restored: “Whew!” They again induce meaningful elements of each of their SOCs in the other. Specifically,
the infant’s emotional reaction is determined by his own meaning making capacities, his capacities for affectively apprehending his mother’s affective displays and reactions.

HUMAN CONNECTION: DSCs AND THE EXPANSION OF SOCs

We can now return to the opening question: “Why do infants, indeed all people, so strongly seek states of connectedness and why does the failure to achieve connectedness wreak such damage on their mental and physical health?” Connection is the formation of a DSC and it is critical because it expands the coherence and complexity of individuals’ SOCs. Normal interactions are examples of the creation of DSCs. The mutual smiling and cooing of mother and infant in face-to-face interactions is an example of a DSC made up of emotional and action. So too is the pretend play of the toddler with another person and the all night conversations of adolescents. Social referencing by infants, children and adults is a way to gain meaning about ambiguous events that leads to a new impelling certitude about its meaning (Campos & Lucariello, 2000). The 12 month-old who backs away from the visual cliff in apprehension of the mother’s expression of fear has used her meaning to form his sense of the event. Similarly, the 2-year-old’s laughing at the mother who makes a fear face in the visual cliff reflects his certitude about the situation and her actions – this is pretend! By being in a DSC individuals experience a growth in the coherence and complexity of their SOC. Thus forming DSCs is not an exotic state or an exceptional moment in time, but very much the chronic experience of normal development (but see below as regards their “intensity”).

HUMAN CONNECTION: THE (SF) AS A BREAKING OF CONNECTION

The still-face (SF) is an example of a failure to create a DSC and dissipation of the individuals’ SOC (Adamson & Frick, in press; Tronick, Als, Adamson, Wise, & Brazelton, 1978; Vygotsky, 1978). The still-faced mother precludes the formation of a DSC because there is no exchange or creation of meaning. The recipient of the SF has to make meaning with
his/her own self-organizing abilities. Infants in response to the SF act to acquire and re-instate their exchange of meaning but with the mother’s continued lack of response they engage in self-organized regulatory behaviors to maintain their coherence and complexity, to avoid the dissipation of their SOC. Figure 2 shows how an infant during the SF literally loses postural control, turns away, has a sad facial expression and is self-comforting with his hands in his mouth. The age-possible impelling certitude of the infant’s SOC is something like, “[this is] threatening.” This certitude is both in and expressed by his posture and actions. As the SF continues the infant’s SOC is likely to change to something like “I must try to hold myself together.” This certitude is similar to the earlier examples the infants’ apprehension of the looming object or the mother’s anger expression as dangerous. If one doubts these or similar interpretations, simply consider that the infant could apprehend the SF mother in other ways -- as boring, playful, or novel – all of which would result in different behaviors by infants, and none of which happen in the SF.

More recent work on the SF with young children and adults makes it even clearer how the SF is failure to form DSCs. Katherine Weinberg in my laboratory has developed a procedure for using the SF with children 18 to 54 months of age. (Weinberg, M. K., Beeghly, M., Olson, K. L., & Tronick, E. Z., 2002) In the first episode of this procedure the child and the adult engage in floor-play with toys. This episode is followed by a SF episode in which the mother “freezes” and does not respond to the infant. In a third episode the mother resumes her normal play. The findings are as striking as our original SF findings with infants. Young children respond to the maternal SF with heightened negative affect and expressions of confusion and demands for change. The toddlers ask “Why don’t you talk to me?” or command, “Talk to me!”, while soliciting the mother’s interactive behavior (e.g., pointing at her eyes, tapping or almost hitting the mother, making repeated louder and louder requests), and then distancing themselves from
her. Importantly and in keeping with their greater age possible meaning making capacities, preschoolers attribute states of mind to the mother (e.g., “Are you sleeping? Wake up!” or “Don’t be afraid of the alligator [toy]!”). Thus there is meaning in their affect and actions (similar to the age-possible meanings of the infant), but also in their age-possible capacities for pretend play, cognitions, language, mentalization, and complex affects. Their impelling certitude is one of confusion and fearfulness at the break in connection. And during the play or when play is resumed some children ask questions to attempt to make coherent sense of what happened (e.g., “Why didn’t you talk to me?”) even though it brings back the painfulness of the experience.

In further extension of the SF to adults, a research assistant Lisa Bohne, interviewed college sophomores after they participated in an experimental role-play of an adult version of the SF. One student role played an unresponsive mother and the other simulated being “in the mind of an infant.” The infant-persons who experienced the SF had strong emotional reactions. They reported feeling anxious and vulnerable, angry, frustrated, sad, afraid, confused, even “panicky.” The students who acted out the SF mother reported feeling guilty, distressed, anxious, depressed, shamed, vulnerable, and confused. One reported, “It felt terrible to be so closed off from the infant. It made me feel depressed and I’m sure the infant did too after our interaction.” Preventing an exchange of meanings and the formation of a DSC disorganized each adult’s own SOC and generated a fearful and confused emotional states and a less coherent sense of the world. Importantly, these adults did not try to step away from their negative experience, but in more sophisticated ways than the toddlers, continued to try to make coherent sense of what they had experienced after the procedure was terminated. Some of them actually apologized for what they had done. It is unfortunate that we cannot know what sense the infant makes of the SF some time after it is terminated.
HUMAN CONNECTION: THE CHRONIC BREAKING OF CONNECTION AND DOWNWARD CAUSATION

An extreme example of the failure to form DSCs is the chronic deprivation of infants in orphanages described by Spitz (Spitz & Coblener, 1965). For these infants I believe that the complexity of their SOCs actually dissipated. Perhaps still more compromising, their self-organizing organizing and dyadic capacities were stunted such that they could hardly make coherent sense of their place in the world. Of note is the general finding of their emotional apathy, an extremely pathological state in which there is a reduction of attempts to acquire meaningful input from others or the environment to expand their SOC. Nonetheless, the apathy may be a protective state in which the infants self-organized themselves to maintain whatever remnant of a coherent sense of the world they have. However, I believe the compromise is so great that there was an ongoing dissipation of their SOCs and further diminishment of their self-organizing abilities.

It is easy to think that how compromising the food intake of the Spitz’s infants would lead to their a kind of “malnourished” body, brain, and SOC. But in many cases we know that the nutrition and other ‘necessities’ were adequate and that the necessity that was unavailable was connection with others, namely the establishment and maintenance of DSCs. These infants were not able to exchange meanings with others. This deprivation of meaning led not only to the failure to maintain and expand their SOCs it also led to the disorganization of many of the lower level psychobiological states, such as metabolic systems and the immune system. This “downward causation,” what Freeman (2000) calls “circular causality”, is a characteristic of complex systems.

Downward causation occurs when the operation the emergent properties at higher levels (e.g., SOCs) in the hierarchical assembling of sub-systems constrain and impact the actions of the lower level systems (e.g., motor systems). For Spitz’s infants the downward causal effect of being unable to form DSCs was to downwardly cause systems such as
their immune system to dissipate resulting for many in death by opportunistic infections. In the infants who were physiologic-survivors of the deprivation of meaning their capacity for acquiring resources was so damaged that they failed to grow and develop. We also see damaged self-organizing capacities for acquiring resources in the reports on the Romanian orphans who as older children are not able to engage in forms of normal exchange. Thus Spitz’s infants are an example of a failing open system – a human system that deprived of connection could not maintain or increase the complexity of their SOCs. In a sense these infants viewed as systems lost much of their capacity to generate the most human of characteristics.

HUMAN CONNECTION: THE DISTORTION OF CONNECTION

Distortion of DSCs can help us understand the effects of parental affective disorders on infants and children in two ways. First, a mother with an affective disorder (e.g., a depressed mother) is often an inadequate external regulator of the infant. Her responsiveness and her apprehension of communications are limited, her communications are harder for the infant to apprehend, and her responses are less likely to fit to the infant’s regulatory needs. Forming a DSC with her is difficult and the difficulty is self-amplifying – initial difficulties impact by increasing the dysregulatory effects of later exchanges. Second, despite these dyadic regulatory problems the mothers’ and the infants’ capacities are not so compromised that they cannot form a DSC, but the formation of a DSC insidiously compromises the infant.

The DSC between a depressed mother and her infant contains sad and angry affect, melancholic feelings and gloomy meanings. Were this depressed DSC restricted to the connection between the children and their mothers its toxicity might be restricted as well but lamentably it is not. Field (Field et al., 1988) found that the interactions of infants of depressed mothers with others was sadder.
My hypothesis is that the impelling certitude children of depressed mothers is that connection can only be made in sadness and their self-organizing capacities for creating DSCs aim to create or re-instate this kind of DSC with others. For example, in our laboratory infants of depressed mothers have more dysregulated interactions with our experienced research assistants who are blind to the depressive status. The RAs feel that the infant induces an experience of “stay away, don’t connect” and the RAs touch the infant less and maintain a greater distance from the infant. In the interactions with their mothers there is a growth of complexity and coherence of these infants’ SOC, but their impelling certitude limits the child’s acquiring of resources from non-depressed others.

**HUMAN CONNECTION: THE BLIND SELECTIVE OPERATION OF COHERENCE ON MESSY MEANING SYSTEMS**

The SOCs of infants of depressed mothers clearly are not growth promoting in the long run, but the alternative would be to not form a DSC at all. From the perspective of open systems what the infant does is to choose the lesser of two evils: either grow complexity now, or dissipate now. As a consequence the child’s experience of expansion becomes focused on the sharing “depressed” states. Thus the more general question is: How is an individual’s sense of the world put together? My proposal is that SOCs emerge from selective processes operating to increase the coherence and complexity of the individual’s age-possible sense of the world. However, we must first understand that selection has to repetitively operate SOCs and DSCs – meanings as well as meaning making processes -- that are messy.

This argument is analogous to the argument made by neuroscientists that initially disordered arrays of neurons are selected to form Hebbian circuits or cell groups because of repetitive co-occurring activation. Edelman (Edelman, 1987) sees selection operating on neurons to form neuronal groups. Cells that fire together in relation to sensory input, motor output, and all the other forms of input and output in the brain
and its subsystems (e.g., reafferent signals) come to form coherent cell groups. More specifically, selection operates to maximize the coherence of the relations among brain and bodily processes and structures from the level of neurons, to neuronal groups, to activation patterns in different areas of the brain, to the autonomic nervous system, to homeostatic physiologic systems, to endocrine systems, to metabolic processes, to bodily movements and behavior into a functioning whole in an environmental context. Coherence means that there is a growth of relations (correlations) among previously unrelated internal and external variables. These new relations can be thought of as a pattern in space and/or time (e.g., unrelated neurons become a cell group by having a pattern of firing) which may have greater complexity and emergent properties.

LEARNING PEEK-A-BOO: SELECTIVE COHERENCE AND MESSY SYSTEMS

Let me begin with an example of selection from messiness: The infant learning to play peek-a-boo. The learning of peek-a-boo emerges through the repetitive operation of coherence on the messiness of the infant’s actions, intentions, and apprehensions in an incremental bit-by-bit and moment-by-moment manner. Initially the infant makes a large number and variety of behaviors and has lots of varying intentions and apprehension of what is going on. Most of these actions are unrelated to each other or to the adult’s game playing actions. The infant looks away when he should be looking at the adult, or he raises his shoe, or he wants a light source and reaches for it. What he is doing is messy – variable, unstable, disorganized. There is no coherence in what he is doing in relation to the game, though of course he is making some sort of sense of what is going. Nonetheless, over time and with repetition some of the infant’s behaviors, intentions, and apprehensions of the adult’s actions and intentions come to be related to one another. The infant looks at the same time as the adult places her hands over her eyes or looks back at the adult after she says “boo.” Further, the adult makes adjustments (e.g., holding
positions longer) in what she does in relation to the infant’s actions and her apprehension of his intent increases the likelihood and maintenance of the coordination.

The selective assembling of these co-occurrences of the infant’s self-organized actions and intentions and his apprehension of the adult’s intentions and actions is becomes incrementally more coherent than what was assembled in prior moments. There still is a lot of messiness to the actions and intentions of his sense making, but without belaboring the process. With an enormous number of repetitions the messiness is pared away over weeks and months and finally the ‘game’ is put together. The infant’s SOC and his DSC of the game become more coherent (see Thelen, 1995, for a similar reaching example).

The example can help us to understand that selection of new meanings about the world cannot increase the coherence of SOCs with too little or too much messiness. A low coherence state of meanings is unpredictable and constantly randomly changing and self-organizing and external processes are unable to generate order. The peek-a-boo infant’s actions are messy but not random. By contrast, a highly coherent organization of meanings is predictable and static but the infant’s initial actions are hardly fixed. Perhaps when the game is learned they do become fixed and unchanging (do we all play peek-a-boo the way we did when we were 15 months old?), but by then the infant will have new intentions.

THE UBIQUITOUSNESS OF MESSINESS

Fortunately, Messiness is ubiquitous in development. The expression of meaning and intent does not have fixed forms. Infants have sets of affective configurations for expressing emotional meanings but they are expressed by a variable assembling of expressive modalities. “Stop” is expressed by turning away one time or pushing away another time or with cries and flailing arms another time. For toddlers, the same word can express different intents. “Ball” means “there is the ball” or
“give me the ball” or “you have the ball” or “ball?” Older children and adults seem to express meaning more clearly but there is much that is cryptic. Also, whatever the age of the individuals, meanings are missed or misread, responses are inappropriate, don’t fit to the expressed meaning, or are mistimed. Importantly, meanings and intentions are not fully formed, they change from one moment to the next, and of course there are differences in the intent of the two individuals and intention often exceeds capacities to fulfill it. Even were there not these difficulties that create messiness, the expression of meaning operates at tenths of seconds or faster, a rate that cannot be maintained for sustained periods. Further, because SOCs are age-appropriate and are assemblages of implicit, nonconscious and dynamically unconscious meanings, the individuals have a problem of fathoming intent across age- and ‘explicitness’ gaps. Indeed one can wonder how can infants induce meaning in adults when their meaning making systems are dramatically qualitatively different and years of development different? And this accounting leaves out the meanings that are purely personal and individually historical. Messiness, indeed!

For SOCs when an individual is engaged with things there is a selective assembling of intentions, information garnered by exploratory behaviors and from the effects of instrumental behaviors on the environment that enhances their coherence. When the individual is with another person there is more stuff to work on and more relations to bring together for incrementing coherence. In a dyad coherence comes with the apprehension of mutual intentions and the coordination of their behaviors and their mutual effects on each other. When one of the individuals is an infant or child and the other individual an adult, coordination can be easier because the adult adjusts his/her activities to better fit to the child’s SOCs. With mutual apprehension the SOCs of each individual become increasingly well-fitted together. When the coherence of their intentionalizing, talking, looking, touching, and moving is increased sufficiently a DSC is formed. In this DSC age-possible meanings which are
expressed with their bodies, movements, and intentions, can be appropriated by the two individuals to increase the coherence of their own SOC.

**BLIND SELECTION AND COMPROMISES OF DEVELOPMENT**

In the moment-to-moment of the SF to the chronic failure to form DSC in Spitz’s orphans to the derailment of ‘normal’ SOCs in children of depressed mothers selection operates to make more coherent meaning of infants’ or children’s place in world. When the SF is done, children and adults struggle to find a coherent sense of what happened to them to overcome their confused and disjointed (i.e., in-coherent) SOC. In the depressed dyads, increasing the coherence of the meaning being made in the moment, selects an assemblage of meanings from those available that are the most coherent “We can be sad together (or not make sense of things at all).” These SOCs are more coherent now, but in the long run they will become increasingly problematic as they limit the resources available to the infant or child. But that is the rub of maximizing the coherence of meaning moment-by-moment. Selecting meanings to increase coherence is blind to the meaning assembled in an SOC and blind to its long-term impact. It simply operates to maximize what better fits together from what is available now. It operates even if the long run costs are extremely high because not only because the long run is unknowable, but in the moment the alternative is to dissipate, to lose coherence and complexity about the world, a loss that must be avoided by open systems.

**BLIND SELECTION AND THE CO-CREATION OF THE VARIETIES OF NORMAL DEVELOPMENT**

Blind as it is, selective coherence is not only the generator of pathology. It is ubiquitously “normal”. I have observed a surprising example of how coherence governed selection operating in the face-to-face interactions of Gusii mothers and their infants. This example also illustrates how what emerges from selective processes are a co-creation of the two individuals. It also shows how different age-possible SOCs, in this
example the a-cultural infant and the acculturated adult, as well as other constraints interplay with one another to affect development. The Gusii are agriculturalists in the Western highlands in Kenya (Robert A. LeVine & Leiderman, 1994). Though face-to-face play is a rare activity, when asked to engage in it the Gusii infants and mothers do it much like we observe in our Boston studies. But what was surprisingly in their interaction was that at the moment when the Gusii infants were getting most excited and about to express a big greeting with a smile and a hand wave, the mothers looked away. In response, the infant greeting dissolved mid-stream. The infant looked away and actually looked deflated. It was as if the mother made a SF. The infants’ SOC dissipated because his intent and actions were assembled to “greet” the mother, but the mother’s intention was to not engage in mutual excited affective greeting. There was a lack of coherence between the infant’s and the mother’s SOCs. But over time a coherent way of greeting emerged.

How does the infant come to know her intention and get his intention coordinated with hers? My sense is that in the next exchange as they move into play and the infant greets her again, the mother turns away and they remain disconnected. But bit-by-bit the infant no longer goes into a big gaping smile as well as doing a lot of other messy things (e.g., squirming, looking at his feet). At one point he may look at her briefly and soberly. The mother responds in a reciprocal manner – soberly. Their intentions and actions have relations that were not there previously. From this small increment in coherence they select mutual actions and intentions so that they develop a different way of how to greet – a kind of somber looking at each other that has greater coherence and complexity.

Making sense of this co-creation requires knowing that the mother’s SOC was constrained by a cultural rule about who can look at whom and with what affect. Women for example do not share heightened affect with others, and though this rule is relaxed with infants it still operates. The mother’s impelling certitude of what makes sense guides her actions. On
the infant side, over repetitions of the interaction he too comes to know in an age-possible way – perhaps with a body micro-practice – what gaze and affect to assemble to maximize the coherence he experiences with the mother. And this way of greeting, takes on an age-possible, and can we say age-possible cultural, impelling certitude.

This example is very surprising when we think of the mutually exuberant smiles that mothers and infants in Western communities assemble with one another into DSCs. To make sense of Western mothers and infants mutual gaping we need to know that the Western mother’s sense of her infant is that he is a social partner who needs to express emotions. Consequently, bit-by-bit with repetition of interactions, they assemble a heightened way of being together. On the Boston infants’ side, they come to know this meaning in an age-possible (cultural) form of affect, behavior and expectation. Despite these stunning differences both the Western shared exuberant dyadic greetings and the Gusii sober greetings, both are assembled through a reiterated selective process of increasing the coherence of the sense of what their shared greeting is. Thus despite claims to the contrary (Trevarthen, 1998), neither greeting is “natural” in the sense of innate, and neither pattern, or for that matter the thousands of other greeting patterns seen in other cultures are universal. They are co-created by individuals. The Gusii and Western greetings are distinct SOCs co-created by Gusii mothers and infants and Western mothers and infants. Neither infant came into the world armed with a Gusii or Western greeting. The greetings had to be co-created.

CO-CREATION AND PRIOR CONSTRAINTS

It is critical to note that the greetings created are not simply de novo creations. One of the powerful constraints is the adult’s cultural meaning. It affects what the mothers do and what will “feel natural” and be coherently assembled with their infants. As cultural forms they in fact an exemplar of Tomesello’s (2001) view that culture is created over historical time spans in a bit-by-bit bootstrapping process. Another constraint is are
long lasting emotional states or mood. The depressed mothers’ mood operates as a constraint on how the infant and the mother can form DSCs in the same manner as non-depressed mothers’ joyful mood acts as a constrain.

It is beyond the scope of this paper to elaborate on the issue of constraints. But there are numerous constraints including age-possible meanings, personal history and experience, temperament and personality. However, even with constraints coherence governed selection out of messiness and the co-creation of meaning emphasizes the dynamic and unpredictable changes of meaning making. Meaning making is always in process, taking form, and changing. It is not simply an exchange of pre-formed meanings from one brain into another brain, what I see as a common but false view in fields from linguistics to brain sciences. Instead, there is a mutual induction of not yet fully formed constituents of meaning from each individual’s SOC into the other’s SOC. These not-so-well-formed meanings are then selectively assembled to increase the coherence of the meaning being created. Elements that do not increase the coherent meaning are not selected (“neurons that don’t fire together don’t get linked together”). Further, co-creation also is not a process of co-construction of meaning. Co-construction implies a preexisting plan or more specifically preformed meanings that are put together to build a larger and shared meaning. Co-creation in contrast, emphasizes that the meaning made is a process in which each individual’s meaning is changed and created into a new meaning. The still-in-process eventual shared meaning is also new, that is created by both of them. However, the concept of co-creation does not question that meaning making is also private (Modell, 1993). Private meaning making is undeniable and when brought into dyadic processes affects the meanings that are co-created.

CONCLUSION

I would like to cautiously assert the possibility that many psychobiological states are SOCs because it may give us a more unified
way to think about development. It is easy to see SOCs as ways of making implicit sense of the world and for organizing action to gain meaning from the world when there is awareness or even when there is no awareness. Though perhaps more difficult to conceptualize, other psychobiological states such as sleep and hunger states may also be thought of as SOCs or at least as somewhat similar. These states are not regulating meaning, but they too organize brain, body, behavior and experience. Actions in these states are purposive and operate to maintain the organization of the state, change it, or change the world. Further, in these states individuals garner specific (“meaningful”) input from the world that leads to an increase in the coherence of the organization of the state. For example, when core body temperature drops infants adjust their posture to minimize surface heat loss, they switch to metabolizing brown fat, and they may fall asleep to minimize energy consumption. Thus even at the ‘mechanical’ psychobiological level states are purposive, have an implicit intended end state, organize behavior and experience, and require “meaningful” input to operate. This way of thinking about psychobiological states as SOCs is not unlike the ethnologists term *Umwelt*, the way the world is to an animal in its niche.

I make this suggestion because an advantage of even weakly accepting this argument is that development from infancy through adulthood can be viewed as the development of specific characteristics of SOCs and the specifics of their self- and dyadic regulatory processes. Moreover, regulatory processes, especially dyadic regulatory processes for these more ‘mechanical’ psychobiological states, can aid us in thinking about the dyadic regulation of SOCs. Nonetheless, a key difference between psychobiological SOCs and other psychobiological states is that SOCs are non-equilibrium states that are often in a state of criticality. They go through qualitative developmental changes, whereas many other psychobiological states are equilibrium states that tend not to qualitatively change.
Over the past 50 years of infancy research we have demonstrated the competencies of the infant. The implication is that the subjective experience of the infant was orderly as well. However, understanding that meaning is made out of messiness and that while coherence is increased it is never perfect, I would hypothesize that the infant’s experience of the world is messy as well. It is not a Jamesian confusion, but I think that it can be disjointed, contradictory, and confusing. For example, remembering that infant meanings are in their bodies, actions, intents and affects, what is the not-yet-reaching infant’s sense of the world when they fall over as they reach toward an object with both hands and throw their head back? “Where did it all go? What is happening?”

Simply put, I think we have overestimated the continuity and orderliness of experience and that the experience of states such as dissociation may be more common and ‘normal’ than we have thought as suggested by Fisher (Noam, 1996) But there can be abnormal effects as well. Incoherent SOCs will lack impelling certitude and because of their incoherence will be experienced as threatening to the integrity of the individual. Both of these experiential aspects will have profound effects including the sudden total distress of the infant or the toddler in a situation that to adults appears to be a “normal” event (e.g., the berries falling off the branch) to what we used to call nervous breakdowns, de-compensation and perhaps some kinds of psychoses.

Another point, and one that contrasts with some of the work I have done in the past which emphasized high experiential moments – Now Moments and Moments of Meeting – in this paper I have emphasized that the formation of DSCs is a common phenomenon (Tronick, 1998). I think the ordinariness of dyadic meaning making is obvious, but it is equally obvious that not all DSCs are experienced the same way; they do not have the same incremental effect on the coherence and complexity of SOCs. Rather it seems that DSCs and SOCs have an intensity and force. The emotion brought into an SOC may be one variable affecting intensity.
Another may be differences in the meanings being worked on. Based on the idea of coherence governed selection I would suggest that the DSCs with greater force and intensity are ones that assemble more private meanings from each individual into shared meanings. Such assemblages are most likely to lead to an increase in complexity of each individual's SOC, an emergence of something new and unexpected. For example, when an infant and a mother both engage in simultaneous huge gaping smiles “everything” about them and between them – actions, intentions, apprehensions – are coherently organized. They both experience expansion and connectedness. Another example of an intense and forceful DSC is a psychodynamic interpretation. Its effect is to bring together into a single coherent insight a vast variety of explicit and implicit and dynamically unconscious meanings in the patient’s SOC that will generate a powerful feeling of connection to the therapist (transference) and an experience of expansion.

Connection is the regulation and co-creation of the age-possible meanings individuals make of the world and their place in it. The making of meanings is dyadic and continuous. The meaning emerges out of the messiness of individual’s SOC and the DOC that is created. Neither SOC nor the DSC are perfectly coherent. At best in the moment and with development they become increasingly coherent and complex. Perhaps more important, experience itself has to be seen as messily coherent. Even more vital is the need to recognize that no connection between individuals ever is perfect but out of all this imperfection unique meanings and connections emerge. Such is the wonder of the human condition – the emergence of the new out of messiness.
References

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Figure 1: A 20 second sequence of infant responding to mother's anger facial expression. In the first image the infant is pulling on the mother's hair. She then takes his hands and disengages and then makes an angry face and vocalization. The infant brings his hands and arms up to his face in a defensive maneuver and then looks at her from under his arms. The mother backs away and then attempts to elicit his attention by touching his legs. In the last frame they have resumed their playful interaction.
Figure 2: An infant losing postural control and turning to self-comforting behaviors in response to the mother being still-faced.