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VITALITY AFFECTS IN DANIEL STERN'S THINKING—A PSYCHOLOGICAL AND NEUROBIOLOGICAL PERSPECTIVE

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Abstract

The goal of the present article is to deepen the theme of vitality, the topic of Daniel N. Stern's last book, *Forms of Vitality*, published in 2010, which further conceptualized the vitality affects originally proposed in his book *The Interpersonal World of the Infant*, published in 1985. Vitality forms characterize personal feelings as well dynamics of movements. They are therefore related to feelings of agency and efficacy, and may be shaped and influenced by early interactions between caregivers and infants. In this ambit, infants experience a sense of personal efficacy and a hedonic pleasure when they are recognized and confirmed by their caregivers. The interactional perspective is further discussed considering psychoanalytical contributions and recent infant research. However, vitality, as Stern (2010) highlighted, is grounded in the body and more specifically in the brain. From a neurobiological perspective, we discuss the role of mirror neurons by considering inter subjective exchanges and infantile matching experiences, which influence the sense of vitality.

In his last book, published in 2010, *Forms of Vitality*, Daniel Stern deepened the topic of vitality, defined as "a whole. … It is a Gestalt that emerges from the theoretically separate experiences of movement, force, time, space and intention" (p. 5), which represents a constant and underlying lived experience in the personal life as well in the relationship with others. However, vitality is mirrored also in artistic work; a special example is the Greek statue "The Dancing Satyr," loved by Stern, because it transmits to the spectator a sense of vitality through the movement of the body.

In psychoanalytic theory, the theme of vitality emerges frequently without a satisfying conceptualization. An interesting exception is a chapter by George Klein (1976) on "vital pleasures" in his book *Psychoanalytic Theory: An Exploration of Essentials*. Adopting a developmental perspective, Klein connected the feeling of vitality to pleasure and distress that the infant experiences. This is a topic of remarkable interest, considering the subsequent contribution of Stern. In fact, according to Klein, vitality is "the sensual pleasure which originates in bodily induced sensations … vital in affirming a sense of physical and psychological identity" (1976, p. 220). But particularly relevant is the reference to pleasure

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in functioning, which infants exhibit in front of parental eyes when they reach some goal such as grasping a ball in a glass. Connected with this personal feeling is the "pleasure in experiencing the self as effective agent of change (which) resides in the perception that through one's own interference one has changed and can change the course of events once set in motion" (p. 224). Stern (1985) further developed Klein's description of this personal experience through the concept of "self-agency, in the sense of authorship of one's own actions" (p. 71).

A further distinction between the concept of agency and that of efficacy is illustrated in an interesting article by Rustin (1997), based on Sander's biological perspective (1985) which highlights an infant's inherent state, an organizing competence which has a special role in the process of mutual regulation. Rustin (1997) proposed that while agency is based on the innate capacities that enable infants to organize experience and engage in the process of exchange, efficacy is the capacity to reliably produce desired effects. Repeated experiences of efficacy of having one's agency confirmed contribute to the experience of a felt sense of agency. In addition, Lichtenberg (1989) considered efficacy to be a central motivation in the exploratory assertive system and a dimension of experience in all other systems. When an infant is able to have his or her needs met (e.g., the needs for physiological regulation or attachment), he or she experiences both a sense of efficacy and achieves satisfaction of the original need and an intrinsic pleasurable feeling.

From a self-psychological framework, Kohut (1978) described how the fulfillment of the self evokes "triumph and the glow of joy" (p. 757). Drawing upon Stern's (1985) infant-research-grounded theory of "vitality affects," Lichtenberg (1991) emphasized the vitalizing function of self-object experience, which contributes to the cohesion and vitality of the self. Finally, within the context of object relations theory, Winnicott (1971) repeatedly underlined the capacity for play and the engagement with transitional phenomena as central to that unfolding of freedom necessary for vital and creative living.

VITALITY IN INFANT–MOTHER RELATIONSHIP

In his last book, Stern (2010) raised issues regarding the topic of vitality, which characterized his previous research on infant–mother relationships. Outlining human relationships and interactions from birth, including the interactive rhythm and the synchrony, Stern created a real lexicon which describes the world of human relationships. However, the most relevant experience in the first months of life, at the base of the theoretical construct of vitality, is the concept of vitality affects, to which Stern (1985) dedicated some dense and complex pages in his book *The Interpersonal World of the Infant*. Stern (1985) was conscious of the complexity of the concept of vitality affects, so he tried to define the meaning as "elusive qualities (which) are better captured by dynamic, kinetic terms" (p. 54). While humans are accustomed to experiencing everyday categorical and discrete affects, from joy to distress and disgust to wonder, widely explored by psychological research, infants' vital feelings have a specific status—in fact, they appear very early in life when infants begin to experience pleasure and displeasure, fundamentally connected to somatic states. What is typical of vitality affects is the close connection with the vital processes of the body, such as breathing, sleeping, and rising and declining of

emotions, which represent a real impingement of the organism in the personal experience. Infants, in their early stages of development, integrate all these aspects and begin to recognize, define, and give meanings to these processes. A typical aspect of vitality affects is the contour of emotional activation as “they are experienced as dynamic shifts or patterned changes within ourselves” (Stern, 1985, p. 57).

In his book *Forms of Vitality*, Stern (2010) further developed these concepts about vitality, widening its theoretical framework: “The vitality forms of interpersonal happenings are part of implicit relational knowing” (p. 111), which is a non conscious and nonverbal knowing specific of the first year of life. In this regard, the early experience of infants assumes a special multisensory dynamic flow because the specific modalities are not yet adequately discriminated. Stern’s (2010) statement that “It is not clear when one can speak of the beginning of vitality forms” (p. 104) is still without an answer; however, the origin of these vital feelings takes place within infants’ psychobiological rhythms of the body, and vital feelings also can arise from relationships with others, particularly with the mother. The early mother–infant interaction can be considered a biobehavioral system that is regulated, at the brain level, through complex neurochemical systems and circuits that are involved in reward and in motivation. For example, during mother–infant interactions, there is brainstem dopaminergic fiber activation, which triggers high levels of endogenous opiates when the infant watches the mother’s joyful expression. These endorphins are biochemically involved in the pleasurable aspects of social interaction and affective exchange, and are related to attachment (Schore, 1996).

When infants’ needs are satisfied, for example with the caring intervention of the parent, infants experience a feeling of vitality, which confirms a personal integration of the self. During infants’ development, maternal availability and constancy represent examples of expected-experience environment (Greenough & Black, 1992), which supplies the biologically determined "environment of evolutionary adaptedness" of a secure base (Bowlby, 1969, p. 59). In fact, experience-expectant plasticity occurs during critical or sensitive periods of early development and takes place especially in the sensorial system, as the brain, in these sensitive periods, is primed to receive particular classes of information from the environment. The infant’s earliest social abilities, including discrimination and imitation of adult communicative expressions, are indicative of the brain’s precocious capacity to be attuned to social stimuli and to support the complex regulatory nature of infant affective states, based on self–other relationships. Infants form expectations of predictable events from birth and even before (see Beebe & Lachmann, 1994), which reflect infants’ biological preparedness to detect regularity and generate expectancies (Emde, 1988), providing the scaffolding for the maturation of neural organization. According to the regulatory system perspective (Beebe et al., 1994), the dynamic action exchange (including perceptions, affects, and proprioceptions) between infants and caregivers, as each influences the other, creates a variety of mutual regulatory patterns. If the caregiver, interacting with the developing infant’s capacity, responds sensitively to the infant, she or he simultaneously contributes to the regulation of the infant’s affects, states of arousal, and behavior. As Beebe and Lachmann (1994) highlighted, “The principle of ongoing regulations refers to those characteristic, predictable, and expected ways in which an interaction unfolds. A shared

system of rules for the regulation of the actions of the two partners develops" (p. 133). The sensitive caregiver's role is to modulate the infant's arousal, which also could follow intense displeasure, fear, or frustration, by calming the infant and restoring a tolerable emotional state (van der Kolk &Fisler, 1994). In animal studies, Hofer (1994) described the interactions between pups and their mothers in the first days of life, and showed that maternal regulation includes both physiological and behavioral modulation of the pups.

From these aforementioned studies, we suggest that in humans, the origin and stabilization of vitality affects are in close connection to early regulatory exchanges. The correspondence between infants' experience-expectancies and caregivers' responses forges infants' affective experience and self-functioning (Emde, 1983). Several communicative modes are coordinated between parents and infants, such as emotion, vision, and other sensorimotor pathways. Affective sharing is central in the inter subjective relatedness and catches the sense of parental mirroring or the empathic responsiveness, which have been regarded by several psychoanalytic theorists such as Lacan, Bion, Loewald, Mahler, Jacobson, Kohut, and Winnicott. For example, the mother imitates the facial expressions and gestures of the baby, demonstrating that she is able to read the infant's feeling state from the infant's overt behavior. To accomplish these transactions, the mother must go beyond the strict imitation of mirroring, as Gergely and Watson (1996, 1999) showed. According to Gergely (Gergely & Watson, 1999), the mother not only produces empathic imitative emotion displays corresponding to the infant's affect expressions but also performs a transformed, perceptually marked (i.e., exaggerated) version of the realistic facial expression of the baby. The resonating caregiver does more than reflect back the infant's state; rather, she or he creates a context of inter subjective resonance, assuming the role of a "biological mirror" (Papousek & Papousek, 1979) or of an "amplifying mirror" (Schore, 1994). This special maternal mirroring plays an important role in the development of the baby, as Winnicott (1967) suggested. In fact, Winnicott suggested that the infant, when looking at the mother, who is looking at the infant, sees her- or himself in the mother's eyes: "The mother is looking at the baby. … What she [the mother] looks at is related to what she sees there" (p. 26).

It has been well-established that the face-to-face interactions of parents and infants occur quite early and are bidirectional. Facial mirroring illustrates that there are interactions organized by ongoing regulations and experiences of mutually attuned interactions, which are fundamental to the developing sense of the "we." A high-intensity mirroring exchange creates in the infant a "merger" experience, defined also by the neurobiologists Singer and Hein (2012) as emotional contagion in which there is not the awareness that these emotions originate from another person. The context of a specifically fitted interaction between infant and mother has been described as a resonance between two systems attuned to each other (Sander, 1991).

A further perspective on vitality forms underlines their rooting not only in the body but also in the brain, especially the "right side of the neonate's brain … known … for holistic, synthetic, and multisensory tasks" (Stern, 2010, p. 113). In fact, affectionate contact between the infant and caregiver activates the limbic and mesofrontal regions, which undergo developmental changes for years after birth, starting with an early maturation phase

which is lateralized to the right hemisphere (Joseph, 1996; Schore, 1996, 2003). Interconnections between the amygdala, orbitofrontal cortex, and cingulated provide the necessary integration between feelings, impulses to act, and experiences of the world, including experiences of individuals and their actions and emotions. Several neuroscientific researchers also confirmed that the right hemisphere is significantly involved in maternal nurturing behaviors (Swain & Lorberbaum, 2008).

It is thus clear that early inter subjective experiences are mapped into an individual's cerebral functioning. This mapping also can be illustrated by referring to the recent discovery of the mirror neurons system (Ferrari, Gallese, Rizzolatti, & Fogassi, 2003; Gallese, 2001; Gallese, Fadiga, Fogassi,&Rizzolatti, 1996), as it we will be illustrated in the following sections. In this context, recent research (Ammaniti & Trentini, 2009; Lenzi et al., 2008) has explored the mothers' mirror neuron system while imitating and empathizing with their own and with unknown infants' images. Results have shown that during these interactions, there is a significant activation of mirror neuron areas and the limbic system, particularly in the right hemisphere. These data (Lenzi et al., 2008) have suggested that mirror neurons could represent the neurobiological substrate of maternal responsivity, playing a significant role during the first year of life (Ammaniti & Trentini, 2009).

The hedonic pleasure experienced by the infant when he or she is being fed, spoken to with a gentle rhythm, or caressed creates intense expectancies in the baby, who later will expect or try to re-experience the same or similar pleasant affects/states. Heightened affective moments (Beebe et al., 1994), positive or negative, not only give interactional experiences a chromatic salience but also intervene in organizing them. With regard to this organization, Panksepp (2001) considered "positive emotional systems … as attractors that capture cognitive spaces, leading to their broadening, cultivation, and development" (p. 132). The emotional environment experienced by the infant has lifelong consequences such as creating emotional strengths and vulnerabilities.

The quality of early social interactions therefore is central for infant cognitive and social development. Thus, if elements of the infant's biologically "expectable" normal social environment are either lacking or altered, then the immature nervous system, which seeks out specific environmental/social input, is likely to be profoundly affected. This may lead to significant disturbances and miswiring of several brain networks (Leppanen & Nelson, 2009). In absence of these sensitive interactions and of external modulation of affect between the parent and the infant, the mind and the brain are unable to learn self-regulation of affects, such as when infants are raised by depressed mothers who are either withdrawn and disengaged in their interactions with their infants or are insensitive, intrusive, and sometimes angry (Cohn & Tronick, 1989; Murray & Cooper, 1999). Several studies have demonstrated that depressed mothers have impoverished sympathetic engagements, imitation, and mirroring of their infants, thus showing a general decrease in their capacity to understand their infants' emotional states and to read their infants' social signals (e.g., vocalizations, smiles, body gestures). Such misattuned maternal responses may have several consequences on infant social and cognitive development, and under certain circumstances may induce infant distress, avoidance, and disorganized behavior (Murray, Fiori-Cowley, Hooper, & Cooper, 1996). In the case of such dysregulated states of the basic infantile

psychobiological rhythms, the infants feel a somatic uneasiness characterized by tension and by coenesthetic distress, which can be translated into a lack of vitality and a failure to integrate the self. Winnicott (1974), referring to these early states, used the word *agonies*, "as anxiety is not a strong enough word here, which implies a return to an unintegrated state" (p. 104).

Amodal Perception and Attunement

Considering the particular characteristics of vitality affects, which do not have a specific emotional content but an activation contour, Stern theorized (1985) that they are not perceived through a specific modality because vitality affects can be abstracted in an a modal coding and can be transferred to different behaviors through intermodal correspondences. There is evidence that infants have an innate general capacity—amodal perception—to receive information derived from one sensory modality and translate it into another sensory modality. This particular information is probably not experienced as belonging to any particular sensory modality and tends to transcend mode or channel probably assuming some not yet known supramodal form, which could involve "an encoding into a still mysterious a modal representation, which can then be recognized in any of the sensory modes" (Stern, 1985, p. 51).

In this perspective, synchrony has a special role in a modal perception because it implies the regulation of the caregiver–infant interaction along a temporal dimension, which has been described in a series of articles about kinesic rhythm (Beebe, Stern & Jaffe, 1979), coactive and alternating vocal exchanges (Stern, Jaffe, Beebe, & Bennett, 1975), vocal congruence (Beebe & Lachmann, 1988b), and the interpersonal timing of vocal interaction (Beebe & Jaffe, 1992). These studies have documented a remarkable temporal sensitivity—on the part of both partners—to the ongoing durations of their own and their partner's behavior. Synchrony is relevant for a modal perception because the temporal aspects of the interactive flow such as the rhythmic repetitions, the ongoing match of affective states, and the sequential mirroring of the infant's communicative signals (Feldman, 2007) can be transformed by the parent into a variety of sensory and behavioral modalities that preserve the intensity, shape, and rhythms of the original message, marking in this way the essence of the synchrony experience (Beebe & Lachmann, 1988a; Brazelton, Koslowski, & Main, 1974; Papousek, 1996; Stern, 1974, 1999). As Feldman (2007) highlighted,

> In its focus on the temporal and organizational features of the dyadic system, rather than on specific behaviors, synchrony describes a time-bound, coregulatory lived experience within attachment relationships that provides the foundation for the child's later capacity for intimacy, symbol use, empathy, and the ability to read the intentions of others. (pp. 329–330)

Note that synchrony not only forges interactions but also biological systems and body functioning, as it has been evidenced by the "entrainment" of heart rhythms between mother and baby with the alignment of the two heart rhythms into a coordinated beat (Feldman, 2007).

In the context of synchrony and rhythmicity, musicality plays “a vital role in the nurturing of the Self with their progressions from regularity and predictability to novelty and surprise and back again” (Malloch & Trevarthen, 2009, p. 6). In recent years, the origin of musicality has been studied in infancy and especially in infants’ interactions with their parents (Papousek, 1996). Mothers’ lullabies, musical intonations, rhythmic gestures, and dancing are shared with infants before the acquisition of language.

Research has highlighted mothers’ melodious expressions when talking to their infants, known as *motherese*. After birth, infants manifest an intense interest in the prosodic intonation of maternal talk, and they try to synchronize their expressions with those of the mother (Marwick & Murray, 2009). Maternal playful songs may increase infants’ arousal, which stimulates sustained infant attention or interest, while soothing forms of maternal singing may reduce arousal level and induce sleep. However, the communicative musicality between mothers and infants can fail in depressed mothers who lack the typical mother rhythmic organization, and thus infants fail to correspond with their mothers in a predictable way, thus interfering with the exchange (Marwick et al., 2009).

Stern (2010) noted the key role of a modal perception in maternal affect attunement due to the fact that the characteristics of shape, time, and intensity can all be perceived by the child and caregiver on an underground sphere (a modally) and evoke an intersubjective reciprocally related reaction from both partners. Maternal attunement is “a partial and ‘purposely’ selective kind of imitation” (Stern, 2010, p. 113) which aids in matching the vitality form of the infant. The fundamental difference between attunement and imitation is based on the fact that in the former, mothers match and focus the dynamic features of inner state of infants. This has been confirmed in a study by Markova and Legerstee (2006), who found evidence that maternal attunement produces in infants more gazing to the mother, more smiles, and more positive vocalizations, as compared with maternal imitation.

At around 9 months of age, Stern (1985) observed that mothers tend to inherently sense and react to their infants’ actions and behaviors with affect-laden responses. More than simple reciprocated verbal or behavioral reactions, mothers tend to attune their responses expressing praise, joy, excitement, disappointment, and so on, and pair these affect attunements with a primary verbal response. In turn, infants learn these affective attunements and their meaning based on a system of a modal perception in which they come to understand emotion through the mother’s recasting and restating of subjective states. The a modal qualities of intensity and time relate to another key aspect of affect attunement: vitality affects. Vitality affects refer not to which behavior a child exhibits but rather how the behavior is performed. All behaviors incorporate vitality affects and hence provide evidence for how subjective inner states relate to persistent changes within affect attunement.

Stern (1985) posited that the infant’s capacity for a modal perception initially favors the infant’s development of a differentiated core self, which allows infants to relate to others through the process of being attuned to others’ nonverbal and verbal interactions. With the acquisition of language, new experiences and exchanges are made available to the infant, and the a modal form of perception which had a primary role now becomes secondary,

although remaining a key element, inscribed in implicit functioning, in the relationship and perception of others and particularly the primary caregivers.

VITALITY FORMS FROM A NEUROBIOLOGICAL PERSPECTIVE

Stern's (2010) concept of forms of vitality is certainly elusive; nonetheless, the attempt to connect it to the underlying neurobiological processes is central in his theoretical view. By emphasizing the primary role of movement in creating forms of vitality, it is clear that the physical aspects and mechanics of the movements in time are the building blocks for the creation of a mind that is shaped to capture the dynamics of forces and sensations linked to movement, either self-generated or produced by others.

In the emerging mind of the fetus and of the newborn, movement becomes increasingly complex and coordinated, expressing, since in the womb, forms of intentionality and of goal-directedness. In this process, there are several problems that the brain needs to solve. For example, how are the different pieces of information, derived from the different sensory modalities, integrated? How do infants at birth perceive the world and how does sensorimotor experience determine the capacity to perceive and appreciate the different contours of early dynamic interactions with the mother/caregiver?

In the last few decades, there have been important advances in the field of social and cognitive neuroscience, and we believe that these fields might provide important insights for understanding the dynamics of the interactions between infants and caregivers, and more generally, the decoding of elements within a unified perspective, in which time, space, force, and directions are cross-modally processed in the brain.

ACTION, PERCEPTION, AND MULTIMODAL PROCESSING IN THE BRAIN ARE CENTRAL FOR THE EMERGENCE OF AN INTERSUBJECTIVE MIND

For years, cognitive psychology and neuroscience have taught us that action and perception are separated entities. According to the classical cognitive paradigm, our mind is organized in modules, hierarchically organized and each endowed with a specific function. According to this model, sensory information is coded in brain areas that allow the elaboration of an abstract representation of the world. This information is then sent to areas that elaborate a response and a motor plan to be executed. Such a cognitive model posits a clear-cut separation between sensory and motor processes. However, studies in the neurosciences have provided us with a new perspective of the mind in which the clear-cut separation between motor functions and perception can no longer be maintained. The theoretical perspective that movement is not involved in the coding of sensory information but confined only to execution is no longer valid (Gallese et al., 1996). In particular cortical motor areas, which traditionally were believed to possess functions purely related to movement, are now known to be actively involved in processing sensory information as well (Rizzolatti&Craighero, 2004). In fact, several investigations have demonstrated, for example, that cortical areas involved in motor control of the hand during grasping also are activated during the observation of graspable objects or, as anticipated previously, in the

case of mirror neurons, during the observation of an action performed by another individual (Gallese et al., 1996; Ferrari et al., 2003; Fogassi et al., 2005).

The implications of these discoveries have been fundamental in developmental psychology and child research. Work by Stern and other scholars (Stern, 1985) has supported the idea that very early during development, the infant is endowed with an innate capacity of subject–subject engagements, in a game of bidirectional communication that enables the infant to possess direct “alteroception” or as Bråten (1992) defined it, of “alter-centred participation”. This capacity is highly adaptive and seems to rely on ancient evolutionary mechanisms shared with other nonhuman primates (Ferrari et al., 2006). This new perspective in developmental psychology represents a breaking point with the Freudian and Piagetian legacy anchored to auto- and egocentric assumptions (Ferrari & Gallese, 2007).

These findings on the infant–mother relationship clearly indicate that our nervous system has been constructed in such a way to be attuned to others’ living experiences, as also recently demonstrated in an electroencephalographic study in newborn monkeys (Ferrari et al., 2012). Despite their immature brains and limited cognitive skills, infants demonstrate active interest in their social world, and are motivated to respond to these social stimuli. From birth, they are capable of discriminating adult communicative expressions and can imitate, which is indicative of the brain’s precocious capacity to be tuned to social stimuli and to support the complex regulatory nature of infant affective states, based on the self–other relationship.

The discovery of mirror neurons has been a breakthrough not only in the neurosciences but also in child psychology because it is in contrast to the idea that to understand others and feel their emotions, we need to infer others’ mental states and read minds through cognitive processes involving mental state attribution. The fact that the mirror neurons in the motor cortex and posterior parietal cortex activate during both action execution and observation demonstrates that others’ behaviors, emotions, and sensations are mapped into our internal motor representation, thus creating a direct connection between self and others. Further studies in monkeys and humans have shown that during the observation of facial emotions, a mirror mechanism is activated that involves not only the premotor cortex (Ferrari et al., 2003) but also the anterior cingulate cortex and the anterior insula (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Singer et al., 2004; Wicker et al., 2003). In other words, through a mirror mechanism we are capable of simulating within ourselves the same emotional and somatosensory experiences that we observe in others. This direct, interpersonal route of knowledge allows individuals to resonate in synchrony with others and make it possible to share dimensions of experience at a subconscious level, at the same level of implicit inter corporeality.

An interesting aspect of mirror neurons is that some of them fire not only during the observation of action but also while listening to the sound of that action, alone (Kohler et al., 2002). The responses of these neurons were specific for the type of action seen and heard. For example, they responded to a peanut breaking when the action was only observed, only heard, or both heard and observed, and did not respond to the vision and sound of another action or to unspecific sounds. Neurons responding selectively to specific action sounds

were termed *audio-visual* mirror neurons (Kohler et al., 2002). This finding exemplifies the idea that the matching can be generated not only through a mapping of a single sensory modality with the motor representation of the action but that the matching can be multimodal. This multisensorimotor integration binds together elements of dynamic experiences into a format that is not exclusively sensory or exclusively motor.

Kohler et al.'s (2002) study and other studies on mirror neurons have outlined an important property of mirror neurons: They do not code the biological aspects of the movement in terms of single movements or kinematics. Instead, these neurons code the goal of an action. Often these neurons code the goal of an action in an abstract form, regardless of the direction of the movement, space of the visual field in which the action is performed, type of object grasped, or type of effector (hand or mouth) used (Ferrari, Rozzi, & Fogassi, 2005). Interestingly, when this is occurring, multiple elements of an action are lost, or rather, fused together to provide a holistic description of an action, a sort of "gestaltic" description in which the details of the actions are not important but rather few core elements contribute to the holistic experience.

Together, these studies seem to echo Stern's (2010) proposition that the multimodality of sensorimotor experience is a cornerstone for the emergence of a vitality form. By opposing Damasio's (1999) view, Stern (2010) claimed, in fact, that "Instead this integration occurs in the sensorimotor system. This suggestion has similarities to the idea of vitality form arising as an emergent property of Gestalt from different sources, except that they suggest where this emergence may occur" (p. 49).

CAPTURING OTHERS' INTENTIONS AND INTERSUBJECTIVE EXPERIENCES OF VITALITY

The experience of vitality is expressed in movement by considering time, space, force, and intention. Decoding the intentionality of a movement, rather than simply the individual movements themselves, is advantageous because it allows the observer to filter out all the irrelevant observed movements. While interacting with someone, the observer attends to a very limited set of stimuli and only those that express intentionality are relevant to the observer. From a developmental perspective, recognizing the intentionality of the movement and the movement's relation to a goal marks a transition in infants' (and fetal) movement maturation from reflexive and guided by the external environmental changes to an internally generated drive. Infants enrich their own sensorimotor experience over the course of the first months of life, and by doing so, they become the leading actor of their own body. This process makes it possible for more sophisticated movements to control speed, force, and precision to develop, and in parallel, makes possible more elaborated forms of vitality.

The organization of the motor system and the property of the premotor cortex to code action goals, as described and defined in the present article and in others (Bonini et al., 2010; Fogassi et al., 2005; Rizzolatti & Craighero, 2004), offer an interesting model to understand how intentionality may emerge in evolution and in development, and why, in our everyday life, our capacity to understand others' intentions optimizes our social relations and allows the generation of intersubjective experiences of vitality.

In recent years, research carried out on the monkey ventral premotor cortex and IPL (inferior parietal lobule) has led to the discovery of an important property of mirror neurons: their capacity to decode not only the *what* of an action (e.g., grasping, smiling) but also the *why* of it (i.e., underlying intention). In fact, in a series of experiments in the macaque monkey, Bonini et al. (2010) and Fogassi et al. (2005) showed that during the observation of action sequences (e.g., grasping an object or a piece of food to place it into a container or to bring it into the mouth), mirror neurons are differentially activated during the observation of a grasping act depending on the final goal of the action (placing or eating). Thus, mirror neurons allow the monkey to *predict* the goal of the observed action and thus to "read" the intention of the acting individual. This process appears to be central in generating and sharing the same body experience not only in terms of objects of experience but also in terms of the same goals and intentions.

Using similar paradigms in humans, Iacoboni et al. (2005) explored how intention is decoded in the brain. In an fMRI study, participants observed a video of a grasping action performed in different contexts and with different patterns ("context" and "action" conditions), and in the "intention" condition, participants were instructed to infer the intention according to the context in which the grasping occurred (explicit task). The results showed that all conditions activate areas belonging to the mirror neuron system. Furthermore, compared to the action and context conditions, the intention condition elicited higher activation of the right inferior frontal gyrus, which is part of the mirror neuron system. Furthermore, activation of the mirror areas occurred without any explicit instruction to determine the intention of the observed actions. In other words, the ascription of intentions to others is automatic and effortless, and does not require any inferential process.

In these aforementioned studies, what is mapped in the observer's motor representation is an intentional relation with the observed agent, regardless of whether this agent is real or potential. The ability of these neurons to encode actions through one's own sensorimotor experience indicates that while observing others, an individual is not detached from the potential interaction that might follow. Especially these latter studies, in fact, have revealed a prospective nature of mirror neurons. By decoding and predicting the possible outcome of an action and its intention, the observer is preparing the body to possibly interact with the other. Our body continuously creates expectations about others and the upcoming future. This generates a tension between bodies, and through this intentional attunement, it is possible to set the stage for regulating the inter subjective exchange of experience between two individuals. Mutual affective regulation between mother and infant is critically dependent on the capacity to understand the unfolding of behavior as well as the capacity to anticipate the changes and dynamical affective contours that occur as a consequence of their own behavior. While a mother is playing with her 1-year-old daughter with toy blocks, the mother might imitate her daughter's facial expression and vitality form when the daughter successfully puts one block over the other, expressing this with an explosion of joy and then turning to her mother. The sharing of the same emotion and vitality form might confirm to the daughter that this is a joyful experience. The mother, however, anticipating the fading of such an explosion of happiness, may add the expression "Oh yeah," make eye contact with the daughter in close proximity and with a more relaxed smile, and may therefore change the

momentary peak of joy, maintaining and continuing the affective communication exchange. This gives space to the possibility of smoothly shifting the dynamic of interaction to co-create again in the game of communication. In the absence of such synchronous experience and anticipation, the fading of the tension might result in temporary mismatch of the affective attunement and of the possibility to co-create. This typically would lead to a transition of the communication between mother and her infant in which the matching state should be repaired (Stern, 2010).

Stern's (2010) work on vitality forms has stimulated collaborative work with neuroscientists. The idea that the brain tracks the dynamic aspects of movements, in terms of vitality forms, is intuitive but hard to translate into an empirical investigation. The first attempts to explore this issue have been, however, recently pursued by means of an fMRI study in which participants watched short videos showing interactions between two actors performing different actions that were performed with different vitality forms (gentle and energetic). Participants were required to pay attention to *what* action was depicted (Task 1) or *how* it was performed (Task 2). Although there were large overlapping areas active in the two tasks, which coincided with the classical mirror areas (posterior parietal lobe, premotor cortex, and the inferior frontal gyrus), there also were differences. In particular, the right dorsocentral insula was activated more in the *how* as compared to the *what* condition (di Cesare et al., 2013). This sector of the insula has been proposed to have sensorimotor functions and, different from the anterior sector which might be involved in sociocognitive functions, it may play a role in evaluating some aspects of vitality forms. In support of this, Löken et al. (2009) showed that this sector receives information from a specific set of unmyelinated cutaneous fibers. Moreover, Morrison, Björnsdotter, and Olausson (2011) found that it is activated by pleasant stimuli such as caresses and also when the subject is observing someone else being caressed. It also has been proposed (di Cesare et al., 2013) that this area of the brain is receiving different sensory information (visual and somatosensory) and is involved in the cross-modal transfer of information.

CONCLUSIONS

As Stern (2010) highlighted in his last book, the issue of vitality is transverse and intersects several fields, from infant research to neuroscience. His book raised interest in various fields because it refers to phenomena that although difficult to describe, are phenomenologically tangible and evident in subjective experience. Note, however, that although his ideas are of high relevance from a clinical perspective, the issue of vitality forms did not stimulate adequate studies and research despite the conceptual contribution of the implicit relational knowing (Lyons-Ruth, 1998), which could constitute the natural theoretical platform.

In fact, implicit relational knowing forges intimate interactions, which are not language-based and are not translated into semantic form. In this context, vitality could represent an implicit barometer not only of the organization of the self but also has important implications for therapeutic relationships, such as in the case of autism, which are characterized by the emotional warmth and the rhythm of interaction.

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