# Gestures as embodied cognition

## A neurodevelopmental interpretation

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Fundamental dimensions of behavior include approach, withdrawal, domination, submission, indicating and dearousing maneuvers. Generically, approach involves flexion at many joints, withdrawal involves extension. Dominating involves moving upwards, submitting involves moving downwards. Indicating involves pointing. Repetitive meaningless motions control anxiety. These movement patterns are found in behaviorally simple animals, and in young infants, except for pointing, which emerges in babies at about 9 to 11 months of age. When human adults express thoughts that have directional attributes in fact or in metaphor, co-occurring gestures are likely to have corresponding characteristics that are observed early in neuromotor development.

**Keywords:** gestures, gesticulations, synergisms, approach, withdrawal, domination, submission, embodiment, brain

### 1. Introduction: The challenge of gesture diversity

Some gestures have discrete conventional meanings (emblems), whereas others arise in the course of thought and speech, and contribute to generating and signaling the meanings as they are being developed (gesticulations). Emblems are held to be socially constructed, and differ extensively between cultures. Gesticulations depend on thought processes and to an extent embody them. This discussion proposes that some gestures exhibit properties of the neural underpinnings of the meanings they embody. Even emblems are not totally arbitrary in construction but are compatible in their form with the embodiment of the meanings they express.

Many gestures are "phrases, discrete movements that express equally discrete meanings" (Kendon, 1986). These "emblems" return to the postural

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background from which they arose. They are generally assumed to be artifacts of social construction. Even so, that leaves it unclear why any given gesture was chosen to assume a particular form, and not one of many other possible forms. I argue that even if details of the gesture are culturally idiosyncratic, its overall form is likely to be subject to biologically based constraints.

Other gestures are seen as independent domains, but intertwined with speech acts, both speech and "gesticulation" are enactments of the current meaning. The speech sound combinations are acknowledged to be largely arbitrary, accounting for the spectacular number of different languages that exist across cultures. But no such extensive cultural influence has been demonstrated on the forms of gesticulations. Are there prior constraints on form?

I will describe some categories of gesture whose form is constrained by the type of thought that they express (automatically or with communicative intent). The constraints arise in infancy, when thinking and moving have not yet dissociated. Infants' bodily actions are the result of brain activations which themselves represent what the infant is thinking. The infant's thought processes are all embodied. Embodiment of mental activity is not a sporadic event (Johnson & Lakoff, 1999). Rather, it is how thinking began, and the embodiments that are observed in adults are residua of their infant origins.

## 2. Neuromotor development and gestures

Unlike adults, who draw upon a vast repertoire of actions, infants draw upon only a limited repertoire of actions. These are largely compounded of innately preformed stereotypic movement combinations. Movements at individual joints are innately interconnected in specific ways to express adaptively relevant meanings and attain adaptive goals. The newborn children can move every one of their somatic muscles, but not one at a time. The innately "prewired" movements are "synergisms". Each synergism serves a distinct adaptive role, such as orienting and approach, withdrawal in fear or disgust, startle to a loud sound or sudden loss of equilibrium, grasp, and nuzzling ("rooting") for the nipple. For example, when looking to one side, infants manifest the "asymmetrical tonic neck reflex". They point with extended arm, swivel their gaze and turn their head toward the indicated location. The opposite arm flexes. The leg extends on the side of the target, and flexes on the opposite side. The mouth opens, as if to ingest. When the infant undertakes any one of these component movements, the other components of the synergism automatically co-occur (Kinsbourne, 1986). For an infant, to consider a movement is to perform it. To

activate the movement pattern in the nervous system (for consideration) and yet not perform it requires inhibitory ability that has not yet emerged.

As the nervous system matures, its higher levels gradually become functional, and yet basic underlying synergisms continue to be represented. However, later maturing higher levels of motor organization exert inhibitory control on the synergisms, which become suppressed. The individual becomes able to decompose the synergisms, and undertake any single component movement while holding the rest in check. Or, he can intend or consider an action, but hold its outward manifestation in abeyance by inhibition. He can combine elements of unrelated or even incompatible synergisms by dint of effortful learning and sustained practice (Kinsbourne, 1993). Once learned, the learned activity is no longer effortful. However, if practice is suspended, effortful relearning is again required; the nervous system's organization reasserts itself when practice lets up.

Thinking about an action is representing it in the brain by patterned discharges of brain cell assemblies, while the output instructions that would realize the contemplated action in movement are held in check. This inhibition tends to be imperfect, however, so that fragments of the envisaged movement actually do inadvertently leak through — for instance, an isolated gaze shift or a slight head turn, which betray that approach is under consideration, or a gaze and head turning away, indicating withdrawal. The agent sometimes deliberately releases the same action pattern, so as to signal the corresponding intention without immediately committing to overt and irrevocable action. In both cases, body language that communicates is the result; for instance the observer learns by body language that her company is desired, or rejected, as the case may be, without a word spoken. Even higher order thought that is not immediately tied to action or communication is attended by gestures, particularly in children. The infant gestures even when no one else is present (Bates, 1976). Not only sighted but also blind children gesture when they work out a route, or accomplish a Piagetian conservation task (Iverson & Goldin-Meadow, 1997). People gesture when speaking on the telephone.

## 3. Thought embodied in gesture

The intimate connection between a movement and its neural substrate is illustrated by laterality of the gesture depending on whether it is associated with speech or not. When people gesticulate while speaking, they mostly use their right hand, because speech is almost always left lateralized (Kimura, 1973). Apparently the activation of the word representations spreads to the closely

adjacent right hand control area of the motor cortex and activates it as well, so that overt movement of the right, not left, upper extremity accompanies the speaking. According to the functional cerebral distance model (Kinsbourne & Hicks, 1978), when adjacent, interconnected areas of brain accommodate two independent activities; they will be advantaged in the performance of the dual task if the actions are congruent, and disadvantaged if they are incongruent. If gestures independently express the same meaning as co-occurring speech, then the two activities lend themselves to conjoint realization. If a meaning is being represented or expressed in one of these modes, expression in the other is automatically facilitated.

When gestures are driven by emotion they become less discrete, and may occur in concert with postural shifts and facial expressions that incidentally emphasize and clarify the meaning that is being communicated. Beyond the information being conveyed, they can turn up the volume, so to speak, by enhanced amplitude of movement, more abrupt onset and offset and faster pace, and thus act as a more forceful signal, analogous to shouting rather than speaking. Such amplification may serve a purpose that is rooted deeply in biology. Across a multitude of species, high intensity signals can be used to induce their recipient to withdraw from confrontation (Schneirla, 1959). Human infants respond to stimuli of moderate intensity, but not to stimuli of high intensity (Lewkowicz & Turkewitz, 1981). In human interaction, the recipient may physically leave the scene, or at least leave it symbolically, by abandoning his/her argument. Gestures that symbolize approach or withdrawal are shaped by the manner in which these movements are represented in the developing brain.

Even in adults, the embodiment in gesture approximates to a varying degree the neurodevelopmentally specified action rudiment. The tendency to embody never vanishes. In the course of neural maturation, it is increasingly held in check by the inhibition of the synergism in question, or its parcellation by selective inhibition into components that are actualized in movement and components that are suppressed. Thus, for a thought that has an approach motive, be it physically moving closer, or more covertly contemplating or desiring closeness, the accompanying gesture will have an overall flexion pattern. Conversely, assuming a posture in flexion or in extension induces the corresponding approach-related or withdrawal-related emotion, positive and negative respectively (Caccioppo, Priester, & Berntson, 1993). If the motive is to withdraw, physically or mentally, its embodiment in gesture will feature extension. If the person conceives herself to be superior, or wishes to indicate superiority, her gestures will loom above the other. If she feels or wishes to appear submissive, the gestures will trend downward.

In contrast to the above widely distributed patterns of behavior, pointing to a target is a typically human behavior. Though not in phylogeny, it appears relatively early in ontogeny. When the target is in sight, the infant aged nine months and over will point to it. If an adult is expounding a point of logic, he may embody it in a finger pointing movement, even if there is nothing relevant to point to.

Differentiated index finger–thumb opposition becomes available at about one year of age. The child has become able to grasp precisely. When an adult makes a point that he believes precisely captures his meaning, he occasionally gestures with precise thumb–finger opposition.

## 4. The basic forms of gestures

The human and animal brain innately programs behavior along major dichotomies of attention and action. Most ancient and ubiquitous in phylogeny is the dichotomy: approach versus withdrawal. An orthogonal domain is looking up and away versus down to nearby. A ventral fronto-temporal system of the cerebrum directs gaze up and into the distance, whereas a posterior parietal system directs orientation down to the body and its immediate surround (Previc, 1990).

Gestures have direction, form, involve specific body parts, are differently paced, and may repeat. The dichotomies of interest in this discussion involve direction and location. They are represented in the brain by opponent processors positioned along each of the three cardinal coordinates: laterally between the hemispheres, front and back between frontal and parietal areas of the two hemispheres, or superior and inferior, (upper and lower) in the form of dorsal stream (the "where" system) versus ventral stream (the "what" system).

Normal adults exhibit fragments only of the synergisms that are so prominent in infants. And yet, the synergisms remain hardwired into the nerve net. They are uncovered in their original primitive form in athetosis, a variant of cerebral palsy. In this movement disorder both the limb muscles and the muscles of the neck and trunk are ceaselessly in motion. The involuntary movements are alternations between approach and withdrawal synergisms, involving head, trunk and limbs, as they do in infants.

Approach and withdrawal are basic behaviors found in all motile species (Schneirla, 1959). Human brains represent approach concretely or at numerous levels of abstraction. At the greatest level of generality, approach engages flexion and withdrawal involves extension. Consider the flexed position of the predator

ready to pounce, or of the short distance runner crouched in starting position. Even a mere button press is a minimal act in the approach domain, whereas button release is a withdrawal (Schiff & Bassel, 1996). Consider the extended position of limbs and trunk and averted head and eyes of the one who rejects and withdraws from temptation in Renaissance paintings (*Noli me tangere*). In dyadic interaction, eye contact, pointing for joint regard, joint symmetrical actions such as high-fives, face-to-face imitation and conversation generally are approach behaviors. They all serve to orient two people to a shared perspective or state of mind. Alternating actions, words or gestures interpersonally or in a group, discussed below, serves to consolidate mutual approach, toward a common purpose. In the human brain, approach is implemented by left hemisphere activity (Kinsbourne, 1978). Withdrawal, also represented at various levels of abstraction, is the prerequisite of the right cerebral hemisphere.

The beginning movements of approach and of withdrawal have signaling value. Interpersonally people, before they commit themselves to approach, or conversely, disengagement, may signal or betray their intention or inclination with corresponding gestures or signs. They do this by emitting motor fragments, components and simplifications of the overt patterns of the action they are contemplating, as stand-ins for the activity in question. Since people everywhere have much the same neurological organization of motor control, the nervous system constrains the motor expression of the major categories of meaning, regardless of epoch and culture, leaving the details and refinements of execution to cultural choice.

Gestures of advance and of retreat accompany metaphors of motion, which spatialize both concrete and abstract concepts. One moves forward, pushes on, puts one's best foot forward, acts in a forward fashion, advances an idea, while putting things behind one, or backs away from the problem. Foresight is favorably contrasted with hindsight. One can be mentally advanced, or alternatively mentally backward. The speaker's postures and gestures embody the spatial metaphor.

Among gestures that are characterized by the directional thrust of their movement sequence are those that move along the vertical axis. The upward dynamic of a "high-five" is integral to the triumphant feeling and message. In contrast to engaged eye-to-eye confrontation, reciprocal domination and submission are signaled along the vertical axis. Level eye contact is not made, and an upward and backward extension of the head by the dominant person complements the head lowering and bowing, if not the kneeling, of the submissive person. Further elaborations along the vertical axis are raising one's hat up in the air or otherwise expansively gesturing in an upward sweep, in contrast to

doffing one's hat, curtsying, or performing the courtier's downward sweeping gesture, to indicate submission. The belle who drops her handkerchief elicits a groveling posture from the beau who retrieves it. The arm is raised for salute, and pumped upward to indicate triumph in a sporting event. The gestures are embodied metaphors. One is up-lifted, or downcast, jumps for joy, but hangs one's head in shame. The symbolism of upward versus downward orienting is not only exemplified nonverbally in direction of gaze and postural orientation, such as thumbs up versus thumbs down, but also by verbal surrogates, such as verbally indicating "thumbs up versus thumbs down" and such locutions as being "up-beat", having "lofty goals" and a "soaring intellect" when "things are looking up", versus having base "underhand" objectives. People are "upright" or alternatively, "crooked" or "bent". Metaphorically, we look submissively up to another, or domineeringly look down on him. We aspire "to the stars", "rise" to the challenge, place prophets on mountaintops, and envisage a "city on a hill", "look up to" the throne, in the "height" of joy. In contrast, we are "downcast", "dejected" and "downtrodden", are "going down", "going under" and "go downhill". A "downfall" is ominous, and "abysmal" plumbs the "depth" of despair. Indeed, one may "fall from grace". In short, higher is superior, a positive future orientation, and lower is inferior, a negative orientation to the present. The facial and bodily postures of joyful anticipation and sorrowful resignation embody the corresponding metaphors. They are oriented upward and downward on the vertical axis. One looks forward and upward, with open arms, or downward, wrapping one's arms around one's body, or covering one's face with one's hands ("I can't face this").

As indicated above, separate neural networks are associated with attending/acting upward versus downward. The upward directionality of ventral system activity is associated with looking ahead into the far distance (Previc, 1990) — being starry-eyed. The ventral system caters to movements, including gestures, which are directed to a goal in distant space, the location of an adversary, as well as to metaphors of height and distance, such as of heaven itself. Gestures directed upward implicate the ventral system, and gestures directed downward implicate the dorsal. So the opposite connotations of upward- and downward-directed metaphors spread a dimension of valence out into circumpersonal space (Johnson & Lakoff, 1999). Indeed, searching for items with positive valence is faster if they are in the upper part of the visual field, whereas items with negative valence are more quickly found in downward locations (Meier & Robinson, 2004). In turn, the metaphors are abstracted from physical gestures. These relationships lead again to the conclusion that the directionality of a gesture hints at its meanings even if the gesture itself is unfamiliar.

## 5. Conclusion: The constraints on gestures

Infants entrain with others in what has been termed interactional synchrony. Repetitive synchronized gesturing is an effective ingredient in ritual situations (as in Sieg Heil!). Rituals have a shared format. They consist of stereotyped sequences of gestures and postures that are usually repeated over relatively long periods of time. In social dyads approach and withdrawal may be alternated by turn taking between the partners, like the reciprocal steps of dancers in a Viennese Waltz. Dances and other rituals modify and manipulate mental/social state. Ritual serves gradually to moderate uncomfortable over-arousal/anxiety. Over and above the soothing effect of repetitive actions in unison, I have suggested that the affiliative effect is mediated primarily by the entrainment of the individual's actions with those of the group (Kinsbourne, 2005). The power of entrainment in fostering affiliation can be traced back in development to the "interactional synchrony" that obtains between infant and caretaker. This refers to the shared and alternating rhythms of motion and vocalization as adult and child face and engage each other, interact by word and by body language. The facility to entrain may be specifically developed in humans, in relation to sophisticated socialization.

A child may gestures repetitively with self-touching or rhythmic fine motor activity (tapping, flapping etc) in order to allay anxiety. So-called ritualistic behavior, termed "displacement behavior", also does so in animals (Kinsbourne, 1980). Electrophysiological evidence in animals and people demonstrates that repetitive high frequency actions are dearousing, and lessen anxiety. Some psychopathologies involve the repetitive use of gestures, postures, "mannerisms" and rituals, private, idiosyncratic and unrelated to the actions of others. For autistic individuals they may serve a dearousing function (Kinsbourne, 1980). They are not communicative in intent, in line with the general failure of people with autism to entrain with others. Some of these features are also found in the rituals of obsessive-compulsive disorder. In contrast, people with psychosis tend to fantasize and hallucinate in terms of upward located and distant events. Their "distal preference" betrays the aspiration to transcend mundane proximal concerns, such as food, shelter and survival (Previc, 1990), and their mannerisms seem outwardly directed. People with schizophrenia adopt recurrent non-conventional gestures and catatonic postures whose meaning is opaque to the observer. Perhaps these movements and postures express inner meanings that they maintain in private codes.

Many gestures are constrained in their formats by the organizational universals of the agent's nervous system. They embody emerging meanings,

meanings that may or may not concurrently be expressed in words. Gestures that reflect and reveal design characteristics of the universal organization of the nervous system afford an effective and natural way to express one's feelings and intentions, with reasonable assurance that they will be understood, even in cross-cultural encounters.

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