

How Brain Organization Supports and Constrains Memory for Gestures and Rituals across Generations and across Cultures: An Outline.

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Symposium: Gestures, Rituals and Memory

Toronto May 6-8, 2004

1. Relevance of Neurobiology to the Form and Function of Signs and Gestures

The rich inventory of gestures, signs and rituals that has accumulated across the ages and cultures conveys a treasury of implicit meaning. Though their form and their prevalence are subject to development and change, it is more remarkable how stable they are, both in time and geographical space. Is that because they are valued, well remembered, and carefully passed down from generation to generation? Possibly they are, but not necessarily. Beyond any transmission by narration, imitation and direct instruction, a family resemblance in the form of their signs and gestures generated by far distant cultures could well arise in quite another way. While the forms of signs and gestures may be arbitrarily socially constructed with respect to refinements, their basic design may be supplied by the organization of the nervous system. Since we carry our nervous systems around with us, this information is always at hand, and may not call for much specific memorizing.

People approach each other, withdraw from each other, reciprocally engage and disengage. However, when they hesitate to commit themselves to one of these acts, they can indicate their intention or inclination with corresponding gestures or signs. They use fragments, rudiments and simplifications of the overt patterns of movement as stand-ins for the activity in question. These fragmentary movements and shifts in posture assume a semiotic role, as do corresponding inscriptions and other recordings. Since the neurological organization of motor control is the same in people everywhere, it is to be

expected that beyond culture-specific minor details, similar meanings will be non-verbally represented by similar movement patterns, even when the cultures that use them have not been in contact at all. Such functional convergence from disparate origins would make it unnecessary to invoke spread by information transmission. Rather, the nervous system constrains the motor expression of the major categories of meaning, regardless of epoch and culture.

2. Organization of Motor Control

A newborn child can move every muscle in his body, but not singly, in isolation. Rather, her movements are compulsorily conjoint into patterns that are called “synergisms”. Each synergism is adapted to a particular adaptive reaction, such as orienting and approach, withdrawal in fear or disgust, startle to a loud sound or loss of equilibrium, grasp, and nuzzling for the breast. When orienting, the infant produces the “asymmetrical tonic neck reflex”. She points with extended arm and swivels gaze and turns her head toward the indicated location. Her opposite arm flexes. Her leg extends on the same side, and flexes on the opposite side. Her 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.

As the nervous system matures, basic underlying synergisms continue to be represented, but become latent on account of additional inhibitory control. The synergisms gradually differentiate, such that the individual can undertake one component movement while restraining the rest, by the exercise of an inhibitory capability that was not available at birth. Or, he can intend or consider a movement pattern, but hold its outward manifestation in abeyance. He can even combine elements of unrelated or incompatible synergisms by dint of effortful learning, and maintain that skill by incessant practice.

When people think about an action that they might or would have liked to perform, they have the action in question in mind, which means that they represent it in their brains, but they inhibit the output instruction that would otherwise realize it in movement. This

inhibition tends to be imperfect, so that fragments of the envisaged movement actually occur. A component of basic synergisms, such as for approach or withdrawal, may inadvertently seep through, and betray the underlying thought. Or it will deliberately be released, to indicate the thought without committing the person to the complete action. In both cases, gestures are the result, and for instance the observer learns by body language that her company is desired, or rejected, as the case may be, without a word spoken.

3. Learning of Gestures, Signs and Rituals

Whatever their form, individuals have to acquire facility in the movements involved. In the cases of most gestures, simple spontaneous imitation would seem to suffice. However, specific learning is required for skilled sequences such as dance, and this will be effortful to the extent that the requisite movements violate the prewired organization of the nervous system. Yet gymnasts show that even the most adventurous and improbable revisions of one's neural organization are feasible when the individual exerts disproportionate effort over a disproportionate period of time. The acquired knowledge is classified as "procedural". It is nonverbal, ultimately fluent and automatic, and relies on the function of the basal ganglia more than the cerebrum. Sign learning may involve semantic as much or more than procedural memory, in that though the sign may not be complex in motor execution, it might have been deliberately made arbitrary in design. Semantic learning is attributed to the cerebral cortex.

What types of distinctions are inherent in the design of the human brain, and prewired into it? The human and animal brain programs behavior along major dichotomies of attention and action. The most fundamental and ubiquitous is approach versus withdrawal. Many gestures constitute fragments or rudiments of physical approach behavior or of physical withdrawal. A socially important subset of this dichotomy is mutual social engagement versus disengagement, both for social interaction between equals, notably conversation, and between unequals, indicating domination versus submission. A second domain is looking up and away versus down to nearby. The dopaminergic ventral frontotemporal system of the cerebrum underlies upward

orientation, and posterior parietal circuits underlie orientation down to personal and peripersonal space (the body and its immediate surround). A subset of this brain-programmed behavior is externalized attention to the world versus internalized attention to self.

Actions that are consistent with the universal prewiring of the human brain, are both easier to execute and easier to remember or relearn. This large class of gestures/symbols is ideally suited for purposes of wide dissemination. An alternative is to formulate gestures, etc., in a deliberately arbitrary fashion, and even one that runs counter to the neurobiological prewiring. Insofar as these activities are harder to learn, and may require constant practice to maintain, they are less suitable for wide dissemination and more adapted to the effortful maintenance of elite status. Many art forms, types of dance, and sporting activities, conform to this category.

4. Brain Mechanisms

The brain is a continuous network of neurons, different parts of which are specialized for quite different forms of processing. Thus it is versatile in the range of information that it takes into account, and yet cohesive and unified in the action that it ultimately generates. Unitary action is implemented in part by an extensive system of opponent processors. Opponent processors mutually influence each other in either of two ways. The negative feedback variety establishes a balance between opposing tendencies so as to find a stable vector resultant on the lines of a thermostat or any homeostat. For instance, the direction of attention along the right-left plane is determined by the relative activation of mutually inhibiting opponent processors in the right and left hemisphere. The other type of opponent processing is based on positive feedback along the lines of “winner-takes-all”, as exemplified by a seesaw. A wide variety of responses are usually available to an individual with some basis for making any one of them. This response competition is resolved in such a way that the response which is most activated, even if only marginally more than other ones, gains in activation whereas the rest reciprocally weaken. As a result the animal’s behavior is unequivocal and definitive. Generally speaking, the

dichotomies of interest in this discussion are represented by opponent processors either laterally between the hemispheres, or anterior-posterior between frontal and parietal areas of the two hemispheres.

5. Approach/withdrawal

As a general rule, motile species are preprogrammed to approach soft stimuli (suggesting prey) and withdraw from strong stimuli (suggesting a predator). In humans, approach behavior is also represented at numerous levels of abstraction, and on its higher conceptual level is fueled by left hemisphere activity. Withdrawal, which is also represented at cumulative levels of abstraction, is more the prerequisite of the right cerebral hemisphere.

At the greatest level of generality, approach involves flexion movements and withdrawal involves extension. Consider the flexed position of the predator ready to pounce or of the runner in starting position. Consider the extended position of limbs, head and trunk of the one who rejects temptation in Renaissance painting (“Noli me tangere”). Thus eye contact, pointing for joint regard, joint symmetrical actions such as high-fives, face-to-face imitation and generally conversation are approach behaviors. They have in common that they orient two people to a shared perspective or state of mind.

In contrast, reciprocal domination and submission are signaled along the vertical axis, by failure to establish eye contact, an upward and backward extension of the head of the dominant person and conversely the head lowering and bowing, if not kneeling, of the submitter. Further elaborations along the vertical axis are raising one’s hat in the air or otherwise making an upward sweeping gesture as an aspiration/domination gesture, as opposed to taking one’s hat off to another, curtsying, or the courtier’s sweeping gesture downward to indicate submission. The symbolism of upward versus downward orienting is further exemplified both nonverbally in direction of gaze and verbally in such locutions as having lofty goals versus having base objectives. I will offer an example from phrenological mapping of how instinctively abstract properties of the personality are

related to the front and back, top and bottom, of a virtual spatial frame. In conversation, raising one's voice at the end of a sentence implies that one wants to hear from the listener, whereas dropping it implies that one does not. In accepting someone, one looks up to him or her; in rejecting, one looks down upon them. If two individuals accept one another as equals, the one's speech and body rhythms are entrained with those of the other. We aspire to the stars, place prophets on mountaintops, envisage a city on a hill, look up to the throne. In contrast, "abysmal" plumbs the depth of despair, and confirms the threat "You're going down". Sir Walter Raleigh left this message to Queen Elizabeth: "Fain would I rise, but that I fear to fall". She did not think he was going rock climbing.

6. Rituals

In contrast to gestures and signs, the neural infrastructure of rituals does not consist of opponent systems. Rituals have specific contents that distinguish them from each other, but a shared format. They are stereotyped, long lasting and repetitive, and consist of components that are familiar. Rituals can be seen as manipulations of mental/social state. For the individual, they serve to moderate uncomfortable overarousal/anxiety in humans, and they also do so in animals, in which they are described as displacement behaviors. When undertaken in a group setting, gathered for religious or quasireligious military purposes, rituals serve as vehicles of affiliation to a common perspective or cause.

Physiological evidence demonstrates that repetitive high frequency behaviors are dearousing, and lessen anxiety. The dearousing effect of high frequency repetitive adaptively irrelevant behavior has been demonstrated in animals by means of electroencephalography. In groups, the ritual serves to consolidate and cement a shared perspective and shared purpose. Rituals are a vehicle for crowd control and manipulation. The individual permits his identity to merge with that of the group, and adopt the group purpose. Among the many instances are religious ceremonies and prayer meetings, military and political rallies, ritual dances, revivalist meetings and similar gatherings that are intended to persuade, cement loyalties, and relieve participants of their money. I have suggested that the affiliative effect is mediated primarily by the entrainment of the

individual's actions with those of the group. The power of entrainment in fostering affiliation can be traced back to the “interactional synchrony” that obtains between infant and caretaker, as they confront each other, interact by word, and, failing that, by deed. Susceptibility to entrainment may be a specifically human trait, which fosters our extremely sophisticated socialization.

7. Mirror Neurons

It has been suggested that so called “mirror neurons” activate in an observer, a mental state that corresponds to another person's mental state. In primates, these frontally located neurons fire in response to specific actions, whether by the individual himself or by another animal in the field of vision. Along the lines of “simulation theory”, mirror neurons supposedly implement an empathic experiencing by the observer of the observed individual's point of view and state of mind. It is implied that without those neurons we would be unable to determine and empathize with other people's states of mind, in other words, be autistic. The extent to which mirror neurons contribute specifically to modes of thinking that are limited to primates, awaits discovery as to whether and how widely they will ultimately be identified in nonprimate species. In terms of their implications for higher-level social behavior, I believe mirror neurons have been massively oversold. More conservatively, mirror neurons help represent an action, regardless of who performs it, and so fire indiscriminately when the action is perceived, and when an individual intends to perform it himself. Other brain areas identify the agent, self or other. Voluntary movement is initiated with a goal representation, which envisages the completed act, and is perceptual.

8. Rituals in Psychopathology

Some psychopathologies involve exaggerated and/or deviant use of gestures, postures and rituals. Autistic individuals are noted for their rituals and mannerisms, which I believe serve a dearousing function. Their failure to entrain with others, a lack of “interactional synchrony”, is a hallmark of their deficiency in social skills. Their

“proximal preference” for touching, feeling, and sniffing, rather than listening and looking into the distance, is a clue to the extreme internalization of their attention. Some of these features are also found in the rituals of obsessive-compulsive disorder. In contrast, psychotics tend to fantasize in terms of upward and distant events. Their distal preference tends to transcend mundane proximal concerns. Their gestures are opaque to the observer, and express inner meanings.

Concluding Comment

Gestures in their forms and rituals in their formats conform to the organization of the agent’s nervous system. Thus his mind is prepared to learn these gestures and rituals, and this lightens the load on his memory and learning. The recipient likewise has a prepared mind, and will recognize the meanings with little or no specific instruction. Gestures and rituals therefore are a highly efficient and thoroughly natural way to express one’s feelings and intentions with reasonable assurance that they will be understood.