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Origins of Subjective Experience

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It is a commonplace that evolution proceeds by selection of the fittest with elimination of organisms less well adapted to the environment. Along with this, the appearance of novel form arises from preliminary stages in growth, not as additions to the endpoints of prior specialization. The mechanisms of evolutionary change, from earlier form-building layers and specification by elimination, have been described in morphogenesis as prolongation of pre-terminal stages in development and winnowing of redundancy to achieve specificity. In earlier writings, these trends in evolutionary and developmental growth were the basis of an account of the nature of the symptom (error) with focal brain lesion. This paper extends the argument from pathology to subjective experience, namely that patterns in evolutionary and fetal growth that are carried over into adult cognition can explain the emergence of intrapersonal phenomena in human mind conceived as a kind of organism, with activity in the mental (mind/brain) state interpreted as a dynamic process of growth.

Keywords: microgenesis, epigenesis, neoteny, parcellation

This paper describes processes involved in the evolution of subjective experience and the shift from animal to human mind. The question is, how can one explain the appearance of mental phenomena, such as the self, thought and imagery, and consciousness of inner events and objects in relation to a theory of the mind/brain state, as well as evolutionary and developmental processes that are responsible for this enormous leap in mental capacity. A description of the mental state has appeared elsewhere (most recently, Brown, 2015, 2019), while processes that account for cognitive advance have been discussed in relation to a theory of symptoms or errors with focal brain lesions (Brown, 1994), though the theory has not addressed, except by inference, the relation of pathology to normal cognition. It turns out that the same processes that account for pathology also account for further development. The theory has focused on two epigenetic mechanisms, parcellation (Changeux, 1985; Ebbeson, 1984) and heterochrony (Goodwin, 1982),

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with particular attention to neoteny (Gould, 1982). The one accounts for pattern, the other timing. First, an account of errors in language, then an account of the relation of error to mental process.

The Nature of the Error

Since neuropsychology shifted from a qualitative description of symptoms to a quantitative measure of performance, the error has been viewed as anecdotal, non-repeatable and without scientific value, displaced by an interpretation of scores on various tests or probes while the error, which was of primary interest in the past, has fallen into disregard. This is partly because of the effort to turn psychology into a science, and partly for lack of an interpretation of the error as something other than a guess. Take a common language error, misnaming as an example, say a patient with aphasia and left posterior brain damage who names a chair as a table. Clearly, the error points to a category of furniture in which a word related in the category is selected. It should be noted that such within-category errors are the rule in pathological cases. Patients will name red as blue, not as a chair, or identify a face as another person, not a table. Prior accounts of error, none successful, have proposed an equalization of associative strength (Pavlov), a reversion to an earlier stage (regression hypothesis), a shift from abstract to concrete attitude (Goldstein), and inhibition, dis-inhibition, release or compensation by neighboring or contralateral regions in the brain (e. g., diaschisis; von Monakow, 1914).

My interpretation many years ago was that focal brain injury exposed normal preliminary phases in a recurring process in the realization of an act of language or cognition (Brown, 1988), but a more precise formulation was not forthcoming at the time. This situation changed with the publication of studies on epigenetic mechanisms that conformed to microgenetic theory, and opened the door to an account of errors from an ontogenetic standpoint. The problem with an ontogenetic correlation is that the brain develops more or less as a whole over a span of years, unlike phylogeny which has millions of years to lay down formative structure. The finding of a relation of growth to dynamic process in brain was in stark contrast to the still-dominant view of encapsulated or modular functions in a brain conceived as a static circuit board. These studies were evidence that fetal and post-natal growth (morphogenesis) appeared to be of great relevance to understanding the nature of the error. Specifically, while prior accounts of ontogeny in relation to symptoms of brain pathology emphasized a regression back through stages in acquisition — an unpeeling of the onion-skin of development — epigenetic studies led to the idea of a continuation of brain-developmental process into later life. This suggests that pathology is not related to stages in acquisition but uncovers processes in early growth that account for normal mentation. The implication is that the *timing* and *pattern* of brain process in development plays a role in mental process in the adult, uniting microgenesis and ontogenesis.

The concept of a regression is replaced by the observation, through the effect of focal disruption, that pathology uncovers processes relating to growth trends in development. In a word, the underlying process is exposed, not the behavior that the process lays down.

The first "mechanism" to consider is neoteny, a selective slowing or retardation of a juvenile stage in development and its prolongation into later structure or function. Gould (1982) illustrated the effect by citing older work comparing the human form to a "fetal ape," indicating that a prolongation of a fetal stage could account for evolutionary advance (Somel, 2009). Neoteny can lead to birth anomalies or to greater development. One example is the prolonged period of childhood dependency and delayed sexual maturity in humans compared to apes. However, the most striking example is the prolongation of a fetal stage of rapid brain growth well into the post-natal period that accounts for the great increase in brain size. Along with this, another neotenous feature, postponement in the closure of the cranial sutures, allows for expansion of the skull after birth to accommodate a larger brain which, at birth, would not pass through the pelvic canal.

If we consider that a focal lesion does not, as is widely assumed, degrade or destroy a brain area or a function but disrupts the flow in a wave-front (Figure 1), with the effect of a delay in the process mediated by the damaged area, the significance of the symptom takes on a new light. We can assume from studies of a variety of aphasic errors that the process of word-finding proceeds from fields of wide to narrow semantic distance, with a progressive zeroing in on the target category and word. This is also true for phonology, with some errors reflecting a distance of several phonological features and others only one. This would mean that the specification of a lexical item is delayed at a phase prior to elicitation, namely, as in the above example, the category of furniture, such that either the word chair or table could individuate. In fact, if the correct word *chair* is produced, it has more expansive (holophrastic) semantic boundaries than in the normal individual, and can be used for stool, bench and so on, much as the word daddy in infants applies to all men, or doggy to animals. Overinclusion of semantic boundaries has been shown in aphasics with posterior brain damage (Grober, Kellar, Perecman, and Brown, 1980).

The interpretation is that retardation, or neoteny, prolongs the phase of specification in a semantic category, at times leading to a correct response or to one of related meaning. If neotenous prolongation affects the substrates of phonology, the required word *table*, might be pronounced as a word like *dabel*, a phonemic error close to the target, or a neologism such as *catal*, where the distance from target is more pronounced. The error reflects the degree of individuation within the phonemic category, but the specification-effect is the same, zeroing down on the final phoneme. These principles apply to all domains of cognition (Somel, Tang, and Khaitovich, 2012), not just language, for example, the appearance of illusion or hallucination as a pre-perceptual phase with damage to visual cortex.

A last point is that neoteny is not a block or ceiling on the process which, though delayed, continues on to the ensuing phase. Thus an incorrect word still undergoes normal phonological realization at a subsequent phase. In the same way, brain size eventually reaches equilibrium and the cranial sutures close.

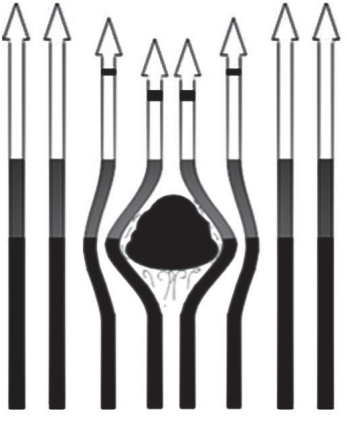

Figure 1: The effect of a focal brain lesion is like a rock in a stream that retards the flow. The delay results in an error, which is a normally concealed phase in the mental state. Eddy currents also occur and have been compared to Hopfield simulations as another source of error. The slowing leads to incomplete specification of the target word, so that a more preliminary phase in category-selection occurs. Unlike a river that flows on, the mental state recurs, and the disruption is repeated, though not in the same way. This accounts for the within-category nature of errors as well as the variability. In this way, neoteny, or focal prolongation, and parcellation, or specification, can explain cognitive symptoms.

Epigenesis and Cognitive Process

The concept of neoteny applied to process in a momentary act of cognition — the mind/brain state — and the revival of the effect over successive states, allows us to reconstruct from errors the normal sequence of events underlying word-production and, by implication, all other mental functions. It also has the advantage of understanding the brain, not as a fixed circuitry and storehouse of specific functions, but as an organic system in dynamic flux in which patterns of growth, of mental process and disruptions in normal flow all have a common basis. This epigenetic mechanism is also to be considered in relation to arguments by Goodwin (1982), that morphogenesis, conceived as a 4-D process in time, can be viewed as first laying down form in the form of structure, and then, with a more or less completed morphology, laying down form in the form of process. In other words, a more or less complete morphology does not output functions; rather, a process of growth lays down morphology and continues as a mental process that

underlies cognition. Specifically, mind/brain process develops as a prolongation of morphogenetic growth trends. From this it is evident that neoteny, at least in part, is responsible for the advance from animal mind to human mind. The errors in language and cognition are explained be neotenous delay of process in the mental state, and that mental process is a continuation of epigenetic trends in fetal growth.

Parcellation

While neoteny can account for the relation of symptom to focal brain damage in a dynamic model of brain activity, another mechanism is required to account for the process of progressive specification. For this we look again to morphogenesis and the process of sculpting or parcellation in fetal brain growth. The fundamental principle that underlies parcellation is an exuberant production of cells and connections in fetal brain, and an elimination of redundancy that gives specificity in connections (Schaefer, Kong, and Yeo, 2016). The implication is that growth and learning primarily accompany a loss of cells and connections. This can reach astonishing levels. It has been estimated that in macaque monkey at time of sexual maturity there is a loss of over two trillion synapses.

I have suggested that what begins in morphogenesis as elimination of cells and connections continues after a relatively stable morphology in the inhibition of alternate routes of cognitive process to arrive at a specificity of outcome. Put differently, elimination is replaced by inhibition as the vehicle of specification. Thus, visual potentials recorded over a wide distance in juveniles are gradually restricted to visual cortex. There is evidence of diffuse organization of the hemispheres early in life (Semmes, 1968) with specification of the left side for language processes. Cerebral dominance can be explained in this way as well (Brown, 1978). The most dramatic example is sculpting of endogenous gestalts by sensibility at the endpoint of the perceptual process (see below). The implication of these findings is that what begins as a competitive pruning of redundancy in early brain growth continues with inhibition as the basis of focality in the maturing brain to become the pattern of cognitive process. Content undergoes progressive individuation leading from generality to concision through a cascade of whole/part or category/member shifts in the passage over levels in the mental state.

To apply this to the prior discussion of aphasia, the process of zeroing in on a target reflects the suppression or falling aside of other potential alternatives. The progression is from wide to narrow category relations leading to the final word, act or object. Mental process is selection by inhibition of competing possibilities. Every thought or object represents that which is left after other potential options have been eliminated. The microgenetic parsing of configurations over phases in the mental state is analogous to sculpting in the development of morphology in ontogenesis. Moreover, the fractionation of mental content through elimination of alternatives conforms to evolutionary selection by the elimination of unfit

exemplars. There is continuation of a growth pattern from evolution (survival of the fittest), to morphogenesis (parcellation or sculpting) to a whole-to-part transition in the mental state (progressive individuation), confirming a common growth process over different time scales: millions of years in evolution, a lifespan in maturation and a fraction of a second in microgenesis.

Subjective Experience

The mental state consists of a rapid transit — 100 milliseconds or less — from a core of instinctual drive to an act or object. The object is the outcome of a transition from drive, experiential knowledge and egocentric space to an external space of object-relations, where the pre-object configuration is pruned by sensation to adapt to reality. Put differently, a model of the external world is shaped by a sculpting, through sensory input, of a pre-perceptual gestalt at a phase in endogenous process just prior to the final object. The transition over states (discussed in Brown, 2017) occurs in overlapping waves (James, 1890). In animal mind, the process leads from drive to objects of satisfaction. In human mind, an intermediate phase of mental content — a phase of introspection — arises not as an addition to animal mind but antecedent to the final object. This conforms to the evolutionary pattern in which new form emerges out of preliminary stages, not endpoints of specialization.

Mental content applies *inter alia* to self, consciousness, thought, reminiscence, agency and imagery. Verbal imagery refers to inner speech; visual imagery to the visual imagination, including spatial thought, symbolism and dreams. The common ingredient in all states is a self that is conscious of inner phenomena and outer events, and the distinction between them. There can be states of mental vacancy but, generally, objects are essential, in actuality or in memory, for a waking self to be conscious of inner content. In the absence of perception, consciousness is rudimentary, as in dream, and the self is passive to a stream of images. In animals, there is absolute objectivity. The mind of an animal is inseparable from the biosphere in which it lives. Animal mind fully objectifies without an interior portion, such that the organism is part of what it observes. The absence of subjective content deprives the organism of an interior life, so that it is perpetually glued to external happenings. Behavior is driven by non-conscious instinct and the changing environment without a self to anchor a state of awareness or an experience of "I see that" or "I feel this," The first hints of interior content occur in the higher mammals, especially primates, when the animal shows an interest or curiosity in objects that do not necessitate immediate action.

What is proposed here is that the appearance of mental events in the context of an object perception, or the completion of a state of object-formation, is explained by a neotenous delay of segments in the mental state that ordinarily undergo rapid transit and remain tacit or inchoate in the object. These segments, which are the substrates of self and imagery, are prolonged to give rise to mental

phenomena. Specifically, a focal delay in the transit of pre-perceptual substrates of potential imagery evokes imaginal content — verbal, visual, etc. — to emerge in the abeyance of external objects. In this respect, the partition of submerged potential to imagery resembles the lesion-induced prolongation of phases in language that reveal processes that are ordinarily concealed from observation. The categories that specify images correspond with those that specify words. The prolongation can be viewed as a focal neoteny within and over a series of states. The conceptual source of the image that was implicit in perception now comes to the fore as explicit content. Passage continues to objects but the world recedes to the background with the prominence of mental content. In thinking, an arousal of the experiential and world knowledge that are embedded in the object arise in the delayed termination of that phase. Along with this, the lack of complete specification to an object leads to an indefiniteness — the basis of uncertainty and choice in thinking — in the content that emerges. Indefiniteness is the conceptual analogue of parcellation in growth in that thought entails possibility prior to the final datum.

The arousal of a self at the liminal boundary of the mental state is fundamental and essential to the occurrence of all other contents. The self is aroused in relation to drive-based feeling prior to imagery. First, a proto-self is aware of objects; then, mental events arise for the self to be conscious of (Figure 2). Neoteny provides an explanation for the emergence of mental phenomena which, as in morphogenesis, accompany a lack of complete individuation. Sculpting of the final object achieves full specification. Pre-perceptual content is incompletely specified. This lack of specification is the basis of choice and decision-making, namely, that contents in mind do not fractionate to the same degree as objects. The indecision occasioned by lack of resolution can involve everyday choices or the most profound in life, from a decision on dinner or a film to the "to be or not to be" of life or death.

In directed thought there is a subjective aim toward a specific outcome. The outcome is shaped by pragmatic values. Thought is adaptive but, unlike the final perception, it lacks specificity and the process can be derailed. Imagery that arises still earlier, as in dream, is closer to meaning and past experience. The self lacks agency and is receptive to the flow of images. Goethe wrote of a descent to the pool of the creative unconscious. The greater the depth, the more pronounced the novelty and/or distortion. Conversely, the more superficial the image, as in rational thought or lucid dream, the closer to perceived reality. The elicitation of self and mental content depends on the dominant locus of delay in the mental state, closer to drive or closer to perception. In either case, novelty elicited in neoteny prevails over incompleteness in parcellation. What is most remarkable is the economy of these "mechanisms" that are instrumental in the growth of form. Essentially the same processes are involved in evolution as in development and the mind/brain state: process over millions of years, development over the lifespan, and actualization in a fraction of a second. In sum, the cognitive process is a process of growth.

Figure 2: In animal mind, the mental state proceeds from instinctual drive to objects. In apes and young children there is a proto-self in relation to awareness of drive and primitive feelings (Van Essen et al., 2019). Later, the self is conscious of images in the context of an object perception (see text).

Consciousness

The relation of self to mental events is linked to the emergence of consciousness, which is a relation of a self to objects, images and feelings. Initially, a proto-self early in the mental state, conscious of objects, feelings and needs. This stage gives way to a self in relation to waking mental phenomena such as thought and refined feeling or affect-idea. Neotenous change occurs early, evoking the proto-self as a coalescence of drive; then, at a later phase, the conscious self, the I, appears in relation to waking imagery. There is relative unity of the mental core in the specification of drive, but instinctual displacement occurs and the organism still has a conflict between aggression or defense. There may be hesitation in animals when the drive has not individuated to action. Indecision prior to selection in thought is comparable to the sculpting of redundancy in development. The later appearance of conscious imagery conforms to the description by Vygotsksy (1962) of the development of inner speech out of earlier egocentric speech in children, particularly when there is an obstruction or the child is uncertain. The shift from immediacy to indecision — incompleteness of individuation — is the beginning of conscious thought. Immediacy entails an absence of doubt. The uncertainty that accompanies pre-perceptual delay is an ingredient in deliberation and imagination. In a word, the arousal of thought through neotenous prolongation entails some degree of indecision that is analogous to parcellation and incomplete resolution.

This account has implications for our understanding of consciousness, which is not so much a thing to be explained or a problem to be solved as a relation across ingredients. Consciousness is not independent of self and object, which are sufficient for a state of consciousness. The awareness described in animals and young children (Piaget, 1969) is that of a proto-self in relation to objects and activity. Subsequently, a self (I) appears at a supra-liminal phase that self-consciously perceives objects and mental contents. In a state of introspection with inattention to the external, a prolongation of pre-perceptual phases expands the mental state with the effect of greater duration of the present, much as occurs in meditation. More generally, having a self means being conscious, being conscious means having a self to be conscious of something, and having mental experience is what the reflective self is conscious of. In a word, consciousness is the confrontation of a self with its own internal and external images.

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