AN ANALYSIS AND EVALUATION OF THE INTROSPECTIVE OBSERVATIONS OF WILLIAM JAMES

1. Introspection

William James declared introspection to be a basic tool of discovery: "Introspective Observation is what we have to rely on first and foremost and always. The word introspection...means...looking into our own minds and reporting what we there discover" (James 1890, 1:185). Although not explicitly stated here, muscular behaviors were as integral to introspection as mental and sensory ones. Both James and Fechner frequently reported on muscular behaviors, as when on the association of eye movements with mental phenomena James wrote: "In myself the 'backward retraction' which is felt during attention to ideas of memory, etc., seems to be...an actual rolling outwards and upwards of the eyeballs, such as occurs in sleep..." (James 1890, 2:436).

As for the scientific validity of introspection, Bertrand Russell stated that "introspection is valid as a source of data, and is to a considerable extent amenable to a scientifc controls" (Russell 1948, 51), and that "a fundamental objection is raised by a certain school of psychologists, who maintain that ‘introspection’ is not a valid scientific method...This view seem to me so absurd that...I shall state my reasons for rejecting it" (45).

Nevertheless, lacking a rigorous methodology introspection never gained sufficient importance. The reasons for this were: (a) falling short of effective **neutralization** of global body actions which normally mask underlying subfunctions: neutralization is necessary to isolate regions under study, (b) not considering that muscular respiration is a constant rhythmic **variable** factor in body mechanics, and (c) not providing **artificially** designed demonstrations, experiments and control experiments. A methodology that does employ these operations can yield consistent and instrumentally or statistically verifiable data. Such potentials form the basis of current research, as by Glenberg (2010) and others, in demonstrating the grounding of mental functions in body mechanics.

The following is a brief outline of an updated technical analysis of behaviors James had analyzed. Evidently he had correctly noted characteristics of a structure in the body that is composed of **frameworks of forces** integrated with both perceptions and cognitions. It will be shown that he also observed, although in different terms, that (a) the mechanics of this system involve force configurations governed by hierarchically organized anchors (nodes) of intersecting forces acting within physical envelopes and that (b) frames interact and transfer between each other through mergers and sequential superimpositions.

2. Monadism

A principle recognized in the East, in holistic disciplines in the West, and to an extent in science, that the mind and body is a single **monadically** working entity, is fundamental in the present analysis. James, Fechner and Bain were psychologists who espoused this notion. James wrote:

> *...we might say that every possible feeling produces a movement, and that the movement is a movement of the entire organism, and of each and all its parts*. What happens patently when an explosion or a flash of lightning startles us, or when we are tickled, happens latently with every sensation which we receive. The only reason why we do not feel the startle or tickle in the case of insignificant sensations is partly its very small amount, partly our obtuseness. Professor Bain...expressed it thus: "According as an impression is accompanied with Feeling, the aroused currents diffuse themselves over the brain, leading to a general agitation of the moving organs, as well as affecting the viscera. (James 1890, 2:372)

In discussing movement, James distinctly spoke of monadism, calling it “diffusion”:

> ...it is hard to doubt the truth of the law of diffusion, even where verification is beyond reach. *A process set up anywhere in the centres reverberates everywhere, and in some way or other affects the organism throughout, making its activities either greater or less*. We are brought again to the assimilation which was expressed on a previous page of the

> nerve-central mass to a good conductor charged with electricity, of which the tension cannot be changed anywhere without changing it everywhere. (James 1890, 2:372)

Monism, defined by James (1909, 778) as an entity in which "all things interpenetrate and telescope together in the great total conflux", is a universal generalization that necessarily includes body monadism.

2a. Monadism and the senses

The muscular frame map and the sensory frame map of a perception are two aspects of a single phenomenon. In simultaneous coactivity by several senses, several aspects are superimposed. James, in discussing various modes of imagery cited Binet's description of merged sensory functioning:

> ...the complex impression of a ball...in our hand, is the resultant of optical impressions of touch, of muscular adjustments of the eye, of the movements of our fingers, and of the muscular sensations which these yield. When we imagine the ball, its idea must include the images of these muscular sensations, just as it includes those of the retinal and epidermal sensations. They form so many motor images. (James 1890, 2:61)

James added a footnote about his own recognition of the same in the use of blackboards to teach children (2:62).

2b. The significance of monadism

The significance of body monadism is that any action by a single component of the body will in a particular way uniquely relate to and influence the workings of the entire system. A simple mechanical example is the pantograph, the classic duplicating machine: a design traced with the stylus attached at one vertex is exactly replicated (and proportionally resized) by the movements of a pen at another vertex (fig. 1). In a variant utilization, (the "4-bar link", in fig. 2), this geometrical device is employed in mechanical and biological engineering, e.g., in the

complex jaw movements of higher fishes (Westneat 2004). Figure 3 depicts a model where movement by any node in a complex assembly is reflected by proportional translocation by other parts.

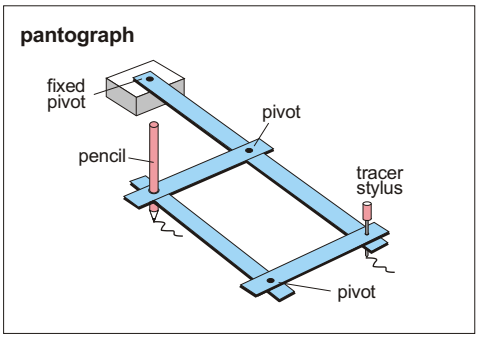


fig. 1

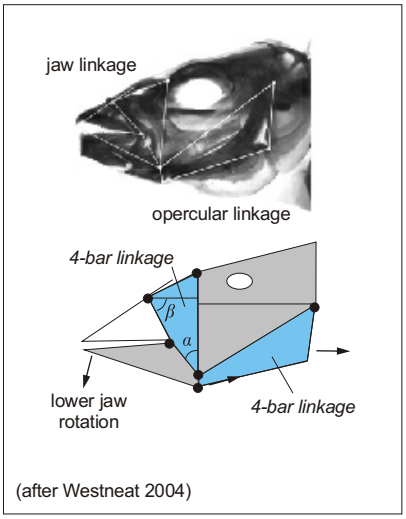


fig. 2

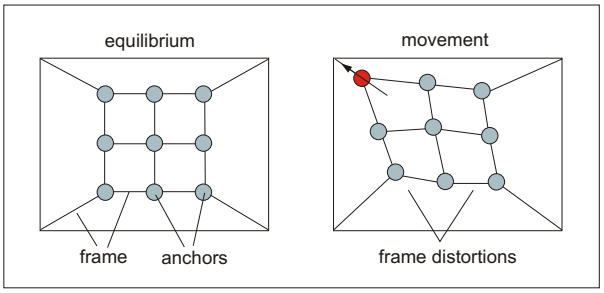


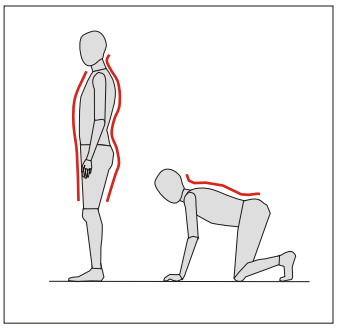
fig. 3

Monadic mind-body coacitivity is currently under study by one school of neuroscientists. David Wolpert (2009), who considers that the brain has essentially evolved to organize body action, has stated during the PBS symposium "The Brain", that thinking originates in movement. In his 2009 lecture at the Kavli Foundation he expressed that "to understand movement is to understand the whole brain". This is, of course, exactly what James had concluded: "All consciousness is motor" (James 1892, 237). Ongoing research on thought manipulation of prosthetic limbs supports this view (Scherberger 2009).

Discrepancies in observations by James and other workers, especially between speakers on different languages are attributable in part to monadism: their map of body mechanics during experiments were not necessarily identical. The position or tension of any body region affects the movement of all other parts, so, for instance, with differently positioned arms observers might discern different force patterns in their eyes. The bases of articulation of each language, their

characteristic muscular frames of pronunciation also factor into movement, cf. gesticulation. Head rotation in agreement, front-and-back among most ethnicities is lateral in India, where hand greetings are also expressed in the Christian prayer position. Holding arms to indicate surrender lowers aggressive intent, whereas the same configuration but with hands held by the shoulders, as practiced by priests in the Catholic mass generate a feeling of religious surrender. The similar position but with arms and hands relaxed typifies the sleeping infant: this is a setting of repose.

fig. 4



A demonstration of monadism as a factor in the rise of human **bipedality** may be found when one reverts to a quadrupedal body configuration. Supported on all fours, with palms down, if one properly tenses dorsal muscles and relaxes ventral ones, including the laryngeal complex (which then axially retracts), the mentality of the quadrupedal stance appears—we cease normal thinking and instead become highly attentive to the environment. But when we stand up the ventral musculature activates, balancing the dorsals to maintain the upright position, the larynx rises and normal thinking returns along with associated tightening of respiration and noticeable loss of tranquillity (fig. 4).

2c. Monadism and quantitative measurements

Importantly, monadism permits detection and measurement by external instrumentation of internal muscular movements. Since all parts of the musculoskeletal apparatus, including the muscles of the sensory organs move in concert, the actions of inaccessible regions are also represented, in exact correlation, in accessible regions.

An obvious example of this is occurs when in a happy or a sad state the internally felt muscular actions, in the head, respiratory tract, thorax, etc. are simultaneously manifested by the muscles of facial expression. Were movements of eyebrows not recognized to signal internal feelings, they could be "discovered" as the indicators of such. Documenting all external muscle activities simultaneous with smiling offers a surface map of the neuromuscular image of the same actions in the interior body and the brain.

For instance, it can proprioceptively be sensed that smiling or frowning is also accompanied by tensions at contrasting regions in the neck and upper chest (platysma muscle) and upper back (trapezius muscle). See fig. 5. Concentration and thinking are likewise tied to certain facial and eye behaviors.

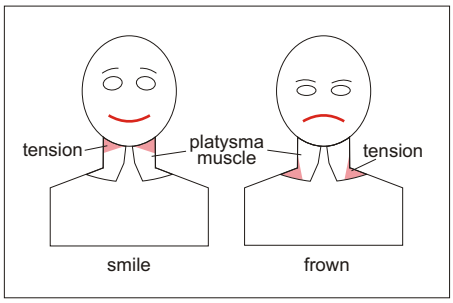


fig. 5.

Going further, thinking of the past, present or future is also reflected in muscular behavior, both of the eyes and of the entire body, cf. James's " 'backward retraction' ...felt during attention to ideas of memory, etc." (James 1890, 1:436). A subsequent paper will describe how conceiving of the three times can be quantifiably related to backward, central and forward bias of regions of musculature, and it will clarify why these time periods are cognized as spatial directions.

Monadism is particularly adapted to studying both the physiology and the bodily grounding of language because the **speech mechanism** is relatively accessible to introspection. Noam Chomsky's neurally hardwired grammar is built on syntax, an entity still within the realm of language. We can go outside language and demonstrate that, once again, since the brain emerged as a tool for body control in face of the external world, the innate roots of grammar are primarily not matters of syntax, but of cognitions built into survival: movement (verbs), static objects (nouns), etc., i.e., they are mental representations of external action, non-action, qualities etc.

Gesticulation manifests linguistic, emotional and mental settings in monadic bodily movement. A subsequent paper will show how hand, arm and finger movements are grounded in these settings. Work by psychologists such as Glenberg (2010) and others have documented the embodiment of linguistic and mental cognitions in body movement.

Monadism is active behind the phenomenon in which viewing an action generates movement in the viewer's body-mind, as in empathizing in stories, movies or watching physical action by others. James wrote, first quoting Lotze:

> "The spectator accompanies the throwing of a billiard-ball, or the thrust of the swordsman, with slight movements of his arm; the untaught narrator tells his story with

> many gesticulations; the reader while absorbed in the perusal of a battle-scene feels a slight tension run through his muscular system, keeping time as it were with the actions he is reading of. These results become the more marked the more we are absorbed in thinking of the movements which suggest them..."
>
> We may then lay it down for certain that every representation of a movement awakens in some degree the actual movement which is the object; and awakens it in a maximum degree whenever it is not kept from so doing by an antagonistic representation present simultaneously to the mind. (James 1890, 2:525-526)

This spontaneous imitative behavior, or **mirroring**, has been neurologically documented regarding the way young monkeys learn behaviors by simply watching others (Rizzolatti and Craighero 2004). Mirroring is part of human behavior and carries important ramifications.

3. The two bodies

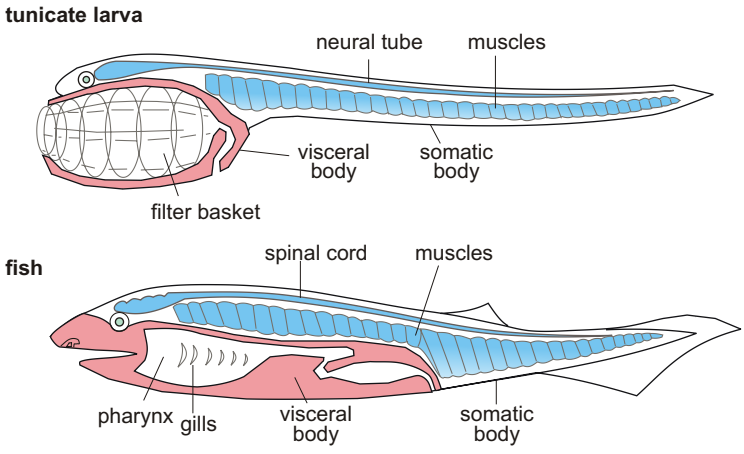
> James expressly wrote that the feeling of "self" appears to be located in the head region: *the 'Self of selves,' when carefully examined, is found to consist mainly of the collection of these peculiar motions in the head or between the head and throat*. I do not for a moment say that this is all it consists of, for I fully realize how desperately hard is introspection in this field. But I feel quite sure that these cephalic motions are the portions of my innermost activity... If the dim portions which I cannot yet define should prove to be like unto these distinct portions in me...it would follow that our entire feeling of spiritual activity...is really a feeling of bodily activities whose exact nature is by most men overlooked. (James 1890, 1:301)

Perception of the world chiefly enters at the level of the head, through the eyes and ears, but is the presence of a "self" a matter of sensory perspectives? And how is the "self" connected with the body as a whole? Evolutionary derivation of the neurological connections between body and mind is effectively clarified by the **two-bodies** principle that was advanced by the noted vertebrate anatomist Alfred S. Romer. Observing the development of the tunicate sea-squirt he stated in Romer (1972) that there are two distinct, incompletely integrated bodies in vertebrates: (a) the

ancestral **visceral** feeding tract to which (b) the later evolving **somatic** musculoskeleton became fused:

> "In many regards the vertebrate organism, whether fish or mammal, is a well-knit unit structure. But in other respects there seems to be a somewhat imperfect welding, functionally and structurally, of two somewhat distinct beings:
>
> (1) an external, "somatic", animal, including most of the flesh and bone of our body, with a well organized nervous system and sense organs, in charge, so to speak, of external affairs, and
>
> (2) an internal, "visceral", animal, basically consisting of the digestive tract and it's appendages, which, to a considerable degree, conducts it's own affairs, and over which the somatic animal exerts but incomplete control."

fig. 6.



The tunicate model is theoretical: it combines the extant tunicate (sea-squirt) larva, which has somatic muscles and notocord with the sessile adult which only has feeding organs (diagram after Romer, Alfred Sherwood. 1970. The Vertebrate Body. 4th ed. Philadelphia: W. B. Saunders, 29).

Remarkably, James recognized this, writing: "The whole neural organism...is, physiologically considered, but a machine for converting stimuli into reactions; and the intellectual part of our life is knit up with but the middle or 'central' part of the machine's operations" (James 1890, 2:372). Commonly, "visceral" refers to the digestive tract, but in the evolutionary perspective of terrestrial vertebrates, the term denotes the entire feeding-respiratory tract, starting at the mouth. The significant region, in our analysis extends from the mouth to the diaphragm, and is best termed the

"**upper visceral body** or **tract**". Through evolution the visceral branchiomeric (gill-derived) and somatic hypobronchial muscles (under the gills) of our fish ancestors developed in terrestrials into structures and muscles within and covering the head. Since the hypobranchials, like the facial muscular sheet belong to both the somatic and visceral bodies, they constitute an interface between the two (figs. 7 and 8).

This is important in mind-body interrelation because whereas the somatic body neurally communicates only with the spinal cord, the **upper visceral body** consisting of the muscles of respiration, feeding, hearing, smell, and sound production, directly connects with the brain through the twelve **cranial nerves** (fig. 8a). These nerves serve vision, eye movement, respiratory tact, mastication, taste, olfaction, ear, larynx, esophagus, diaphragm, stomach, etc. The eye muscles are somatic, but are mechanically joined to the facial sheet, and through that to the visceral regions, by the *levator palpebrae superioris* eye muscles which raise the eyelids.

fig. 7.

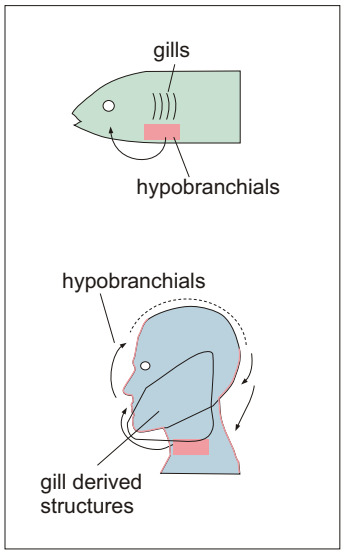


fig. 8.

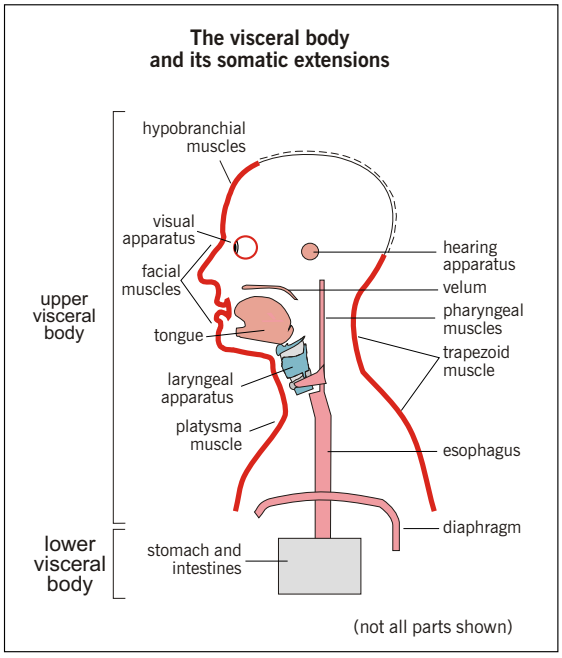
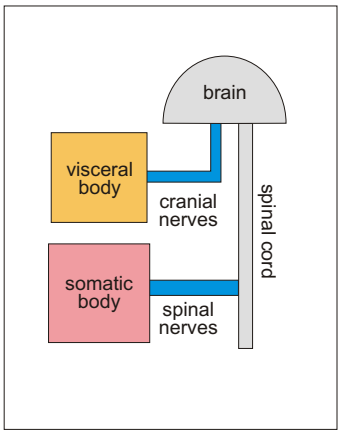


fig. 8a



Thus, since the somatic muscles of the eyes, as well as the hypobranchials, (the facial, some superficial neck, shoulder muscles, etc.) have become integrated with the gill-derived (branchial)

musculatures of the upper visceral system, their combined behavior is directly tied to mental states. Musculo-neural unity exists between the respiratory-feeding tract and ocular, facial and other movements and we apparently sense our worldly presence in the visceral body, in the head or even in the abdomen (fig. 8). Introspection by James and colleagues have consistently focused on cephalic activity, and it is precisely such relation of mental functions and the gill-derived system that James observed speaking of the consciousness of the self:

> In consenting and negating, and in making a mental effort, the movements seem more complex, and I find them harder to describe. The opening and closing of the glottis play a great part in these operations, and, less distinctly, the movements of the soft palate, etc., shutting off the posterior nares of the mouth. (James 1890, 1:301)

The immediate connections of mental content with the upper and lower visceral system is underscored by the associations between verbal expressions of feelings and of taste, and functions involving the tongue, olfactory region and digestive tract. As James phrased it:

> There is a whole vocabulary of descriptive adjectives common to impressions belonging to different sensible spheres -- experiences off all classes are sweet, impressions of all classes *rich or solid*, sensations of all classes *sharp*. Wundt and Piderit accordingly explain many...expressive reactions...as symbolic gustatory movements. As...experience arises which has an affinity with the feeling of sweet, or bitter, or sour, the same movements are executed which would result from the taste in point." All the states of mind which language designates by the metaphors bitter, harsh, sweet, combine themselves, therefore, with the corresponding mimetic movements of the mouth." Certainly the emotions of disgust and satisfaction do express themselves in this mimetic way. (James 1890, 2:481-482))

The two-bodies system solves an old puzzle: why do we **yawn**? Texts explain it as increase of oxygen intake, but cannot go further. However, if muscle stretching is an innate behavior of the somatic body, then the somatic striated muscle portions of the upper visceral system may also need to perform this function. Yawning is precisely a stretching of the facial-head sheet, jaw, external

and internal ears, oral, laryngeal and diaphragmatic regions, and air intake is a necessary by-product. Furthermore, body stretching is typically coupled with yawning and both functions are involuntary.

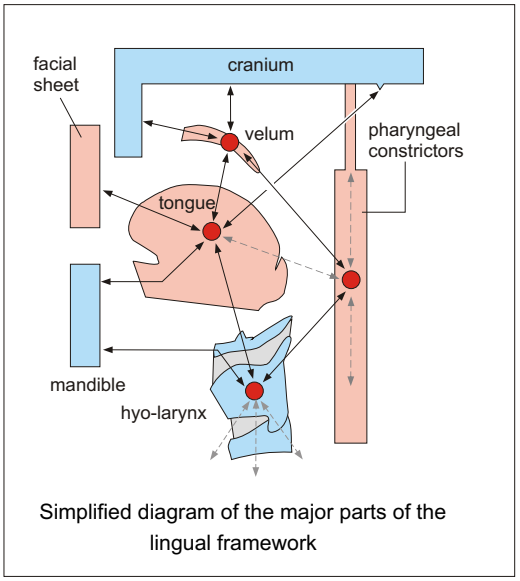
4. Frames

James correctly envisaged a unifying mechanism needed to organize body-mind behavior:

> Now for the next step in our construction of real space: How are the various sense-spaces added together into a consolidated and unitary continuum? For they are, in man at all events, incoherent at the start. (James 1890, 2:181)

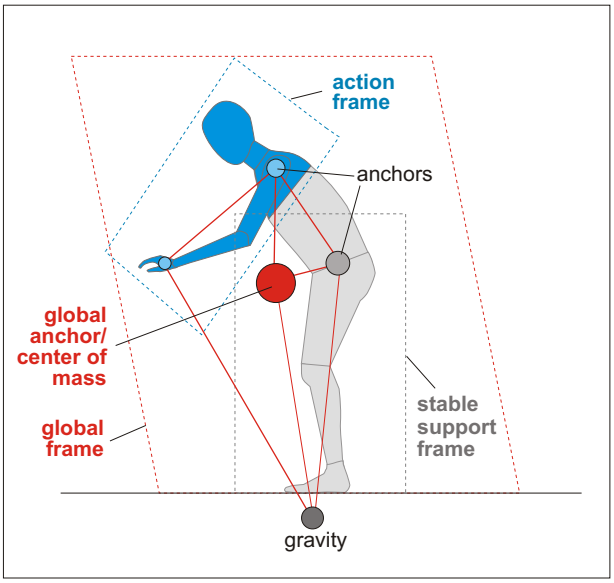
The unifying structure of body monadism can be modeled as a **dynamic framework of concurrent muscular forces**, or briefly as a global **frame** and its subframes (fig. 9). The frame concept, a sine qua non in introspective analysis defines the forces generating a particular action as a purely geometrical configuration such as employed in engineering or kinesiology. The configuration defines what muscles are employed, at what energy level, and which are prime movers or antagonists. In complex mechanisms, whether machines or bodies, various main frames and subframes must harmonize governed by a hierarchically ordered system to produce monadically coherent action. Bending at the waist utilizes both a high ranked primary base frame to stabilize the lower body plus legs and a lower ranked secondary action frame to manipulate the upper body and arms (fig. 10).

fig. 9



Simplified diagram of the major parts of the lingual framework

fig. 10



Fechner, here cited by James, speaking of associations of mental actions with specific muscular setting interpreted frames as “differently localized tensions” managed as whole structures:

> When we transfer the attention from objects of one sense to those of another we have an indescribable feeling (though at the same time one perfectly determinate and reproducible at pleasure) of altered direction, or differently localized tension (Spannung). (James 1890, 2:137)

Regarding mental-muscular structural settings to be "determinate and reproducible" emphasizes that frames are well-defined dynamic configurations. James himself spoke of such organizational devices, although without clarifying their nature. Dealing with organization of summed sensory and associative perceptions he mentioned a " 'solidification' or 'integration' ...with absent and merely representative sensations", (James 1890, 2:79), describing a coherent structure containing conscious and subconscious parts of a perception. He and his colleagues regarded this integration as a cerebral function, however, and not a muscular one. Still, elsewhere he explicitly connected cerebral and muscular actions, as when writing that the "'backward retraction' which is felt during attention to ideas of memory, etc., seems to be...an actual rolling outwards and upwards of the eyeballs" (James 1890, 1:436). Indeed, if monadism is a fact, then James's cerebrally placed phenomena must have muscular correlations.

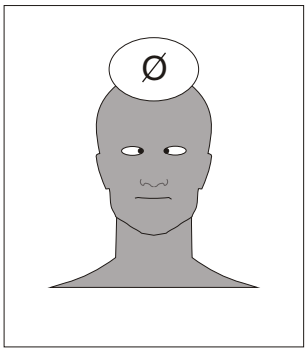
Elsewhere, James once more implied the existence of frames:

> ...we have, whenever we perform a movement...[a] set of impressions...which come up from the parts that are actually moved. These *kinæsthetic* impressions, as Dr. Bastian has called them, are so many *resident* effects of the motion...[which] give us as many distinctive feelings as there are movements possible to perform. (James, 1890, 2:488)

Frame structuring stored in memory offers a mode of organization in the physical body; the brain need not affect individual muscles, but rather, can deal with a frame, which has at the neuro-muscular level already arranged the details. It is organized muscle input that is received and manipulated by the brain, so the frame system is, at one level, an image of brain organization.

Visible behaviors exhibit specific frames: smiling in a happy mental state differs from a frown and its mental state. The articulatory basis of a language is a rigid "resident" frame that accounts for the difficulty for foreigners to reproduce the pronunciation, and even for the difference in direction of handwriting among cultures.

fig. 11



The monadic relationship between mental action and body frames is intimate. Outward attention or inner reflection require different muscular configurations, cf. Rodin's Thinker. A simple experiment proves this: maintaining a grimace or crossing the eyes disables effective cogitation. That the brain, the senses and musculature work move together as gears in a clockwork was emphasized by James:

> ...the raising of the eyebrows in outward attention, the opening of the mouth in astonishment, come, [according to Darwin], from the utility of these movements in extreme cases. The raising of the eyebrows goes with the opening of the eye for better vision; the opening of the mouth with the intensest listening...(James 1890, 2: 479)

The action of the eyebrows and the mouth are facial sub-framework behaviors of the upper visceral body integrated with various mental states and together they form a single composite framework. The note, again, by James on the "'backward retraction' which is felt during attention to ideas of memory" (James 1890, 1:436) illustrates coaction between cognition and eye movements, as does Fechner's comment quoted by James:

> If I wish, for example, to recall a place or person, it will arise before me with vividness, not according as I strain my attention forwards, but rather in proportion as I, so to speak, retract it backwards. (James 1890, 2:138)

There are numerous specimens of coactive mind-body frames. Standing at ease, crossing the legs while sitting has a pacifying effect. Reading while eating is not an uncommon habit, which suggests that the frames of each can be efficiently combined. This has biological ramifications. Reading incorporates visual attention, a natural part of animal feeding behavior because during

feeding great heed is paid to approach of predators or competitors. Feeding is similarly mergeable with speech in humans, as it is with vocalization in animals. Normal respiration operates a frame that merges both thoracic and abdominal musculature, while purely thoracic or abdominal breathing are distinct frames. The walking frame includes the subframes of alternating left right side strides. The well-known ambiguity in a passenger's perception, mentioned by James (1890, 2:90) of whether the train or the station is moving is a matter of **dominance** (i.e., primary mover role) in the complex interaction of frames of vision and of motion sensing. The ambiguous figure illusion is similarly based on alternate visual frames.

4a. Frame structure - a summary

A **frame** configuration consists of (a) lines of force, (b) envelope, (c) anchor, or center of mass, and (d) manifold. As figure 12 illustrates, the resultants of concurrent interacting forces pass through a shared **center of mass** that the *Columbia Encyclopedia* defines as "the point at which all the mass of a body may be considered to be concentrated in analyzing its motion". The center of mass of connected ropes pulled by persons is at the intersection, where opposing forces cancel each other and approach zero (fig. 13).

fig. 12

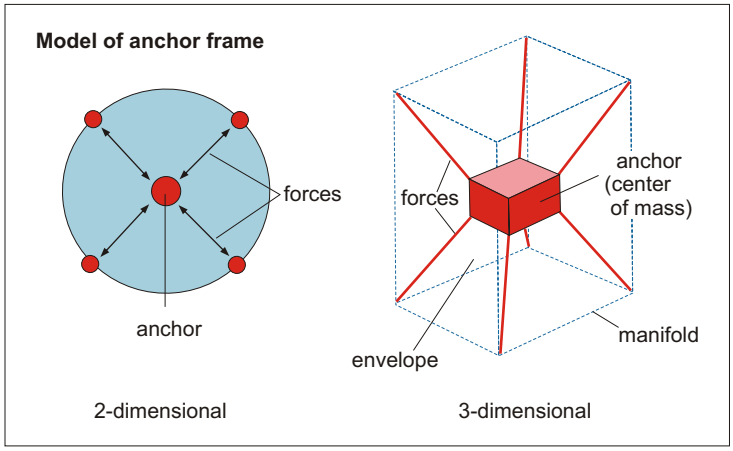
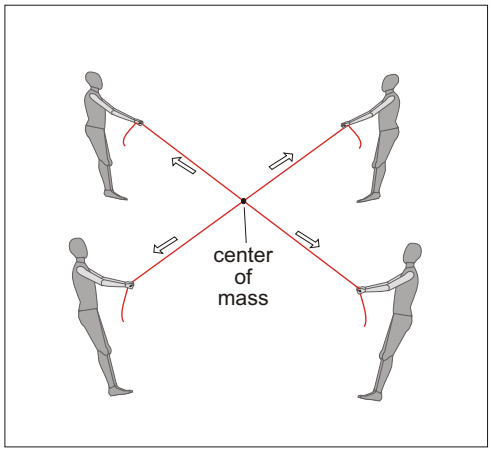


fig. 13



Forces in a body frame can be analyzed through their **center of mass**. It is convenient to call this point, easily found in body functions through a specific method of introspection, the **anchor**

of the **concurrent** forces. An **envelope** surrounding the anchor is the spatial region in which the forces operate. The **manifold** is the surrounding stable ground from which forces originate. Although bodily frames are three-dimensional, we can represent them here as two-dimensional. The anchor in a frame at equilibrium is centered, but it is repositioned when forces are unequal.

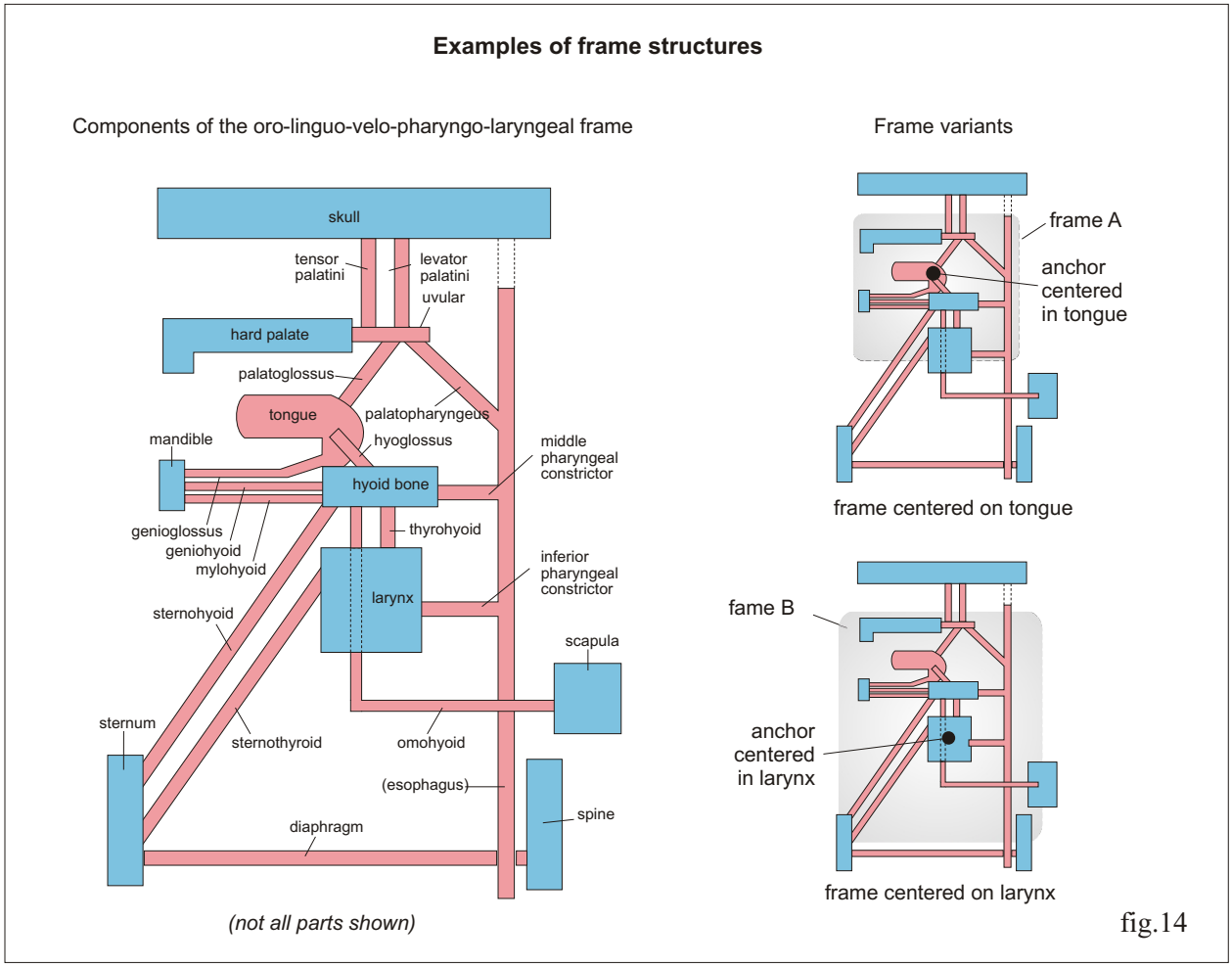


fig.14

James (1890, 1:300) virtually described **anchors** in a geometric **frame**, writing of a "vaguely localized *diagram* in my mind, with the various fractional objects of the thought disposed at particular *points* thereof." [italics mine]

4b. Projected frames

The perception of lines or points of force in space is commonly experienced, whether with magnets or when touching something with a stick and vividly feeling the point touch the object,

although the fingers never contact it. Seeing an object at a distance is analogous: we sense outside the body. James and others have described physical sensations perceived outside the body: "the draughtsman's immediate perception seems to be the point of his pencil, the surgeon's of the end of his knife..." (James 1890, 2:37-38). Perceiving the oral cavity is perception of space, although we feel only the muscular forces encompassing it.

Experiments on this phenomenon were discussed in Talbot (1991, 25):

> [Georg von Bekesy, who]...in the late 1960's...demonstrated [that]...by attaching vibrators to [subjects'] knees...[he] was able to alter subject's perceptions of the location of the vibrators so they believed that they were experiencing sensations in the space between their knees. This artificially created phenomena is similar to the phantom limb pain experienced by amputees.

Projection is fundamental in survival. Man's jumping or stone throwing or the archer fish's jet of water use trajectory projections. Vision is another case: the retino-neuromuscular agency of seeing is within the head, yet we sense things at a distance—in the virtual space of the mind. But projection is not a secondary function applied to a primary non-spatial sensation; the sensations themselves—images, thoughts, etc.—are projections in mental space, whether appearing inside or outside the head.

James aptly denied that sensations originate in the brain and are subsequently projectively localized. He held that the mental and spatial aspects formed a single entity:

> We often hear...that all our sensations at first appear to us as subjective or internal, and are afterwards and by a special act on our part 'extradited' or 'projected' so as to appear located in an outer world. Thus we read in Professor Ladd's...work that
>
> > “Sensations ... are psychical states whose place -- so far as they can be said to have one -- is the mind. The transference of these sensations from mere mental states to physical processes located in the periphery of the body, or to qualities of things projected in space external to the body, is a mental act..."
>
> It seems to me that there is not a vestige of evidence for this view. It hangs together with the

> opinion that our sensations are originally devoid of all spatial content....As I look at my bookshelf opposite I cannot frame to myself an idea, however imaginary, of any feeling which I could ever possibly have got from it except the feeling of the same big extended sort of outward fact which I now perceive. (James 1890, 2:31)

Another paper will discuss the basis of James's conclusion and will supply experiments to document that spatial projection is integral in the muscular mechanics of our senses and the two cannot be separated.

Frame structure helps to clarify the mechanism of projection. During intent viewing an object, the frame envelope extends in the space between the eyes and the target object, and the anchor lies at the object. In thinking, with body and head vertical, the envelop surrounds the head and the anchor lies within the head. With body and head tilted forward the anchor moves back, even partly or wholly outside the head. In simultaneous viewing and thinking the merged anchor lies between the head and the object. This is easily observed if one alternates between the actions (fig. 15).

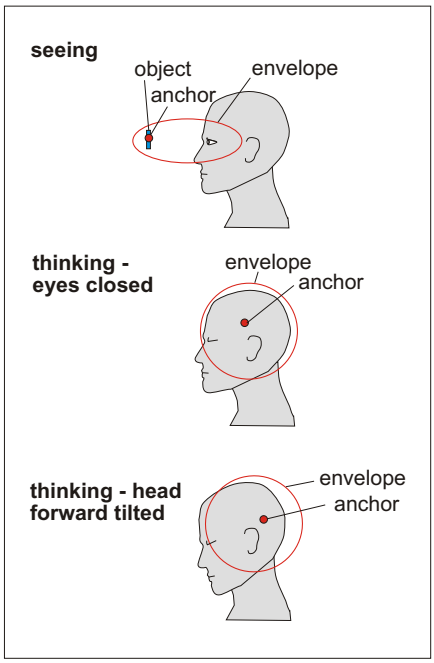


fig. 15

4c. Frame transformations

Frames change through **superimpositions** where the initial prime mover configuration of forces yields primacy to a new configuration, becoming its antagonist, therefore remaining **embedded** in the new frame. Being the stable ground for its active counterpart it also has higher **hierarchical** rank. James' term for superimposition was *superposition* (James 1890, 2:185).

The mode of frame transformation ranges between sudden ("**clutch** shifted") and gradual ("**gliding**") superimpositions. The former typically occurs when an accidental fall, an exclamation, a sudden event, etc. freezes the present frame which then abruptly changes its configuration. In the latter mode the transformation between frames is a fluid sequence.

As an example of "clutch" transformation: if the muscular frame of an /s/ or a /t/ articulation is continuously maintained, and although the tongue, bound to its central anchor can be extended in any direction in the envelope, the motion requires increased force when approaching the envelope edges. We must "break out from the envelope" by additional force to produce another sound. The further the anchor is pulled from the envelope center the more effort is needed to exit the envelope. In contrast, going from /h/ to /a/ is accomplished through a glide superimposition that requires far less effort.

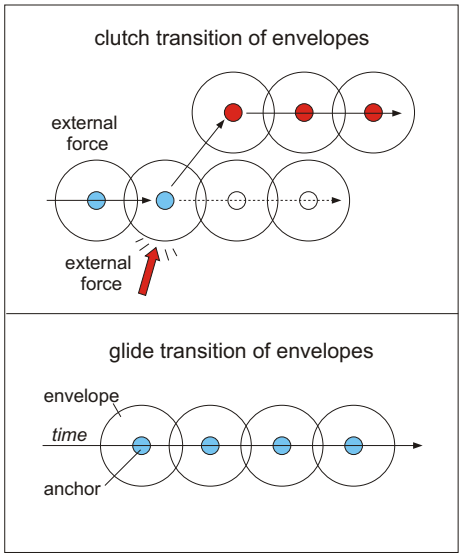


fig. 16

4d. Superimposition and merger

In a consecutive series of frames continuous translation occurs from one frame to the next through overlapping **superimposition**. James called this function "superposition", writing: "*The great agent in comparing the extent felt by one sensory surface with that felt by another, is superposition-superposition of one surface upon another, and superposition of one outer thing upon many surfaces*" (James 1890, 2:177).

In superimposition consecutive frames become **merged**, either in passing, as in movement, or in relative permanence, as in equipoise. The stereoscopic fusion of left and right eye images is an obvious instance of mergers.

5. The validity of James's analysis of introspective observations

It may be seen, with considerable certainty, that the **frame system** described in this paper is what James has observed and reported on. He recognized the presence of frame structure and its translations, including the function of embedding. Speaking about vision, he appears to be describing frame envelopes, anchors and their superimposition:

> Every single visual sensation or 'field of view' is limited. To get a new field of view for our object the old one must disappear. But the disappearance may be only partial. Let the first field of view be A B C. If we carry our attention to the limit C, it ceases to be the limit, and becomes the centre of the field, and beyond it appear fresh parts where there were none before: A B C changes, in short, to C D E. But although the parts A B are lost to sight, yet their image abides in the memory; and if we think of our first object A B C as having existed or as still existing at all, we must think of it as it was originally presented, namely, as spread out from C in one direction just as C D E is spread out in another. (James 1890, 2:185)

Clearly, "field of view" is the **envelope**, and “attention”, i.e., the **anchoring**, is B, which approaching the physical envelope's limits requires more energy to maintain movement. Saying that C "ceased to be the limit" and becomes "the center of the field" is equivalent to translation from one anchor-envelope to the next one, the process of **superimposition** by consecutive frames. As the central anchor of the initial envelope moves to an extreme position in the envelope, it can, with a reconfiguration of forces become the central anchor of forces in a new envelope. Since James did not define and label the anchor we must change his C D E to B' C' D. Otherwise the new anchor is not centered. James accurately stated that a (previous envelope's) "image abides in memory" and so remains retrievable: the "partial" **disappearance** refers to the **embedding** of the previous anchor-envelope (see figs. 17 and 18).

fig. 17

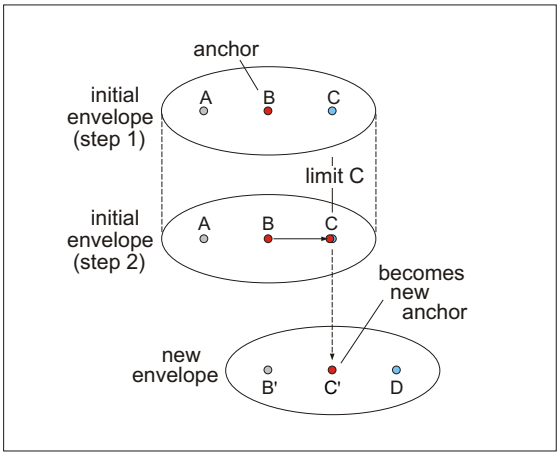
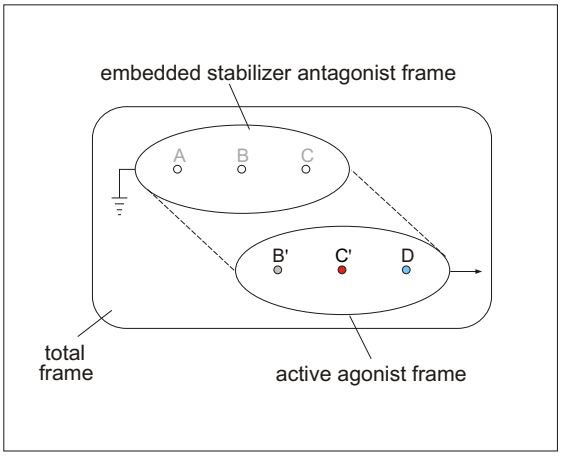


fig. 18



James's citation of Lange below contains descriptions of the superimposition of two frames (visual and manual) as well as eye and hand monadism, and mirroring (the function of a perceived shape generating imitative (hand) action).

> Thus Lange says that when he tries to imagine a certain colored circle, he finds himself first making with his eyes the movement to which the circle corresponds...
> "Let my reader...close his eyes and think of an extended object, for instance a pencil. He will easily notice that he first makes a slight movement [of the eyes] corresponding to the straight line, and that he often gets a weak feeling of innervation of the hand as if touching the pencil's surface. So, in thinking of a certain sound, we turn towards its direction or repeat muscularly its rhythm, or articulate an imitation of it." (James 1890, 1:444)

Here one larger composite motor frame incorporates the three subframes of visual memory, eye and hand movement. Action by any single function monadically generates the other two.

James also specifically noted **hierarchy** in a two-frame visual configuration where one is the **primary** higher ranked **embedded** grounding frame that stabilizes the eye muscles, preventing eye rotation by the **secondarily** applied peripherally targeted frame:

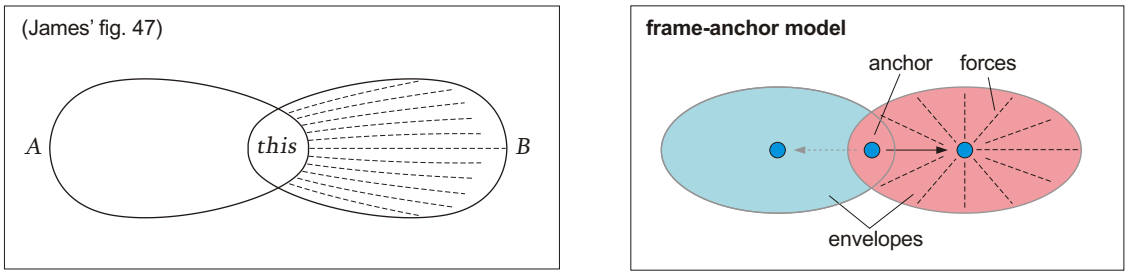
> ...no object lying in the marginal portions of the field of vision can catch our attention without at the same time 'catching our eye' - that is, fatally provoking such movements of rotation and accommodation as will focus its image on the fovea, or point of greatest sensibility. Practice, however, enables us, with effort, to attend to a marginal object whilst keeping the eyes immovable. The object under these circumstances never becomes perfectly distinct - the place of its image on the retina makes distinctness impossible - but (as anyone can satisfy himself by trying) we become more vividly conscious of it than we were before the effort was made. (James 1890, 1:437)

William James's sophistication in introspection is evident in his recognition of a mechanistically perceivable frame system. That he regarded it as cerebrally organized is

inconsequential for his analysis is sensory-muscular—not cerebral. With my substitution of terms and insertions (both in bold type and brackets) his text and his diagram can be interpreted as depicting the behavior of a frame-anchor structure:

> The two discrepant sets [**frames**] of associates do not neutralize each other or mix and make a blur...we more commonly get...first one object [**frame** or] in its completeness, and then the other in its completeness. In other words, all brain-processes are such as give rise to what we may call FIGURED [**frame structured**] consciousness. If paths are irradiated [**spatially** or **sequentially distributed**] at all, they are irradiated in consistent [**ordered**] systems, and occasion thoughts of definite objects, not mere hodge-podges of elements.
>
> ...These facts show how subtle is the associative link [**mode of frame change**]; how delicate yet how strong that connection among brain-paths which makes any number of them, once excited together, thereafter tend to vibrate as a systematic whole. A small group of elements, '*this*,' common [**anchor overlap in superimposition**] to two systems, A and B, may touch off A or B according as accident decides the next step (see Fig. 47). If it happen that a single point [**anchor**] leading from 'this' to B is momentarily a little more pervious [**of dominant/agonist role**) than any leading from 'this' to A, then that little advantage will upset the equilibrium in favor of the entire system B. The currents [**forces of the frame**] will sweep first through that point and thence into all the paths [**force lines in the envelope**] of B, each increment of advance making A more and more impossible. (James 1890, 2:82-83)

fig. 19



This concludes a brief outline of the frame system. The following section of experiments offers examples of some of the countless available demonstrations of frame behavior.

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