A Multiscaled Approach to Privacy [1, 2]

Kenneth W. Jacobs [3]
University of Nevada, Reno

Robert W. Isenhower
Rutgers, The State University of New Jersey

Linda J. Hayes
University of Nevada, Reno

Abstract

There are bodily processes and events to which the behaving organism is sensitive. A self-descriptive response, taken as indicating such sensitivity, is not specific to a localized source of stimulation posturing as a private stimulus, but is specific to the coordinative efforts of the body as an integrative whole. The skin does not bound private stimuli or stimulation because stimulatory processes span the organism and environment and cut across the private-public distinction. Private events are not inaccessible; they are multiply scaled. We endeavor to characterize this scaling and lay the foundation for an empirically driven account of privacy. With the multiscaled view as our theoretical guide for inquiry, we propose a characterization of the body from nanoscale to macroscale. This characterization enlightens, as we come to find that the organism is sensitive and responsive to bodily events, processes, and states that take form under certain circumstances. Research on haptic perception and its biological bases provides an example according to which the historically deemed private event can be brought under investigative control.

Keywords: *bodily states, dynamic touch, ecological psychology, multiscaled view, privacy, and tensegrity*

Resumen

Hay procesos y eventos corporales a los que el organismo que se comporta es sensible. La respuesta auto-descriptiva tomada como una indicación de tal sensibilidad no es específica a una fuente localizada de estimulación que pueda ser señalada como un estímulo privado, sino que es específica de los esfuerzos de coordinación del cuerpo como un todo integrado. La piel no delimita los estímulos privados o la estimulación ya que los procesos estimulantes abarcan al organismo y al medio ambiente y sobrepasan la distinción 'público-privado'. Los eventos privados no son inaccesibles; son de escala múltiple. Intentamos caracterizar este escalamiento y sentar las bases para una consideración empírica de la privacidad. Con la perspectiva de multiescala como nuestra guía teórica para la investigación, proponemos una caracterización del cuerpo de una nano escala a una macro escala. Esta caracterización ilumina, en la medida en que encontramos que el organismo es sensible y responsivo a los eventos, procesos y estados corporales que ocurren bajo ciertas circunstancias. La investigación sobre la percepción háptica y sus bases biológicas proporciona un ejemplo según el cual el históricamente considerado evento privado puede ser traído bajo control en la investigación.

[1] Reference to this article on the web is: http://conductual.com/content/multiscaled-approach-privacy
[2] A reply to this article by Andrés García-Penagos can be found on this reference: http://conductual.com/content/psychology-not-science-organism-and-physiology-will-not-solve-problem-privacy. Jacobs, Isenhower, and Hayes declined the opportunity to reply to Reviewer A's (i.e., Andrés García-Penagos) response.
[3] Corresponding Author: Department of Psychology/296 University of Nevada, Reno, Reno NV 89557 Email: kjacobs789@gmail.com.

Palabras clave: *estados corporales, sensibilidad al tacto, psicología ecológica, perspectiva multiescala, privacidad y tensegridad*

> A science of behavior must consider the place of private stimuli as physical things, and in doing so it provides an alternative account of mental life.
>
> —Skinner, *About Behaviorism*

Privy to you, and only you, is a phenomenal experience. Despite the development of technologies that probe, prod, and extend our investigative reach, we have been unable to capture that experience. As such, sensings and imaginings are a presumed subjectivity yet to be conquered; a subjectivity ripe for the Cartesian construal that humans are unlike animals. That last stronghold of a bastion, or last line of defense for the mentalistic philosopher and cognitive psychologist alike, is the *skin* and the supposed residings within it (Bentley, 1941). Behavior analysts characterize these residings—sensings, imaginings, percepts, and feelings—on the basis of their *privacy,* and hence their *inaccessibility*.

Skinner (1945) provided a means by which one can analyze behavior in relation to private events, but he did not succeed in fully specifying those private events. He considered private stimuli to be physical in nature, while posing a resounding question: "What is inside the skin and how do we know about it" (Skinner, 1974, p. 233)? Rather than attempting to specify the physical goings on within the organism's body, Skinner asked: Under what *conditions* does a person *say,* "I feel" or "It hurts"? Answering such a question is telling of why an organism might emit a particular response, but it is not telling of the actual goings on within the skin. While a bruised leg and hand-to-jaw are markers useful to our inferring private events, they do not make for a comprehensive account of behavior and its controlling relations. If what is felt or introspectively observed *is* the observer's own body (Skinner, 1974), then the body is deserving of specification.

Over seventy years gone and Skinner's (1945) anti-mentalistic contentions have yet to foster a coherent system within which to analyze and interpret private events (Fryling & Hayes, 2015). Skinner (1945) founded some of the most basic assumptions pertinent to a radical behavioral account of mental life, but no theoretical guide for future inquiry was, nor has been, framed for an empirically driven account of privacy (see Dennett, 1984). Behavior analysts can infer that private feelings are subject to modification and specific to an organism's surrounds, but have yet to fully understand the origins, controlling relations, and predictive utility of private events across contexts and beyond individual instances. Pragmatically, behavior analysts are effective in their endeavors to change behavior—as any behavioral therapist would attest—but that behavior analysts can change behavior does not mean they understand it and its operative mechanisms (Marr, 2009).

Owing much to Skinner's (1945) discussion of private events we offer an alternative, while still anti-mentalistic, account of events occurring within the skin. It is an account grounded in biology and research on motor behavior (Rosenbaum, 2005) with an eye towards the environment (see Oyama, Griffiths, & Gray, 2001 for an appreciation of niches and their construction). With this grounding we provide a conceptualization of the body consistent with the basic assumption that we are dealing with a whole behaving organism (Skinner, 1956). We propose that a multiscaled view, as a conceptual guide for inquiry, paves the way for an empirically driven account of private events. The aims of this view are neither organism-based (Mendelian-based) nor environment-based (Darwinian-based), for it is our attempt to characterize organismic, environmental, and behavioral variables as they coalesce on differing yet equally important spatiotemporal scales of analysis (Field & Hineline, 2008; Hineline, 1990; Lewontin, 1983). By discerning exactly what behavior analysts are referring to when speaking of private events and by explicating the tenets of the multiscaled view, we attempt to foster a systematic approach to the investigation of that which has traditionally been deemed private (by radical behaviorists) or mental (by cognitivists).

Does the Privacy Notion Present a Problem?

When Skinner (1945) stated, "my toothache is just as physical as my typewriter" (p. 552), he asserted that private events are *not* functionally different than public events. Thus, private and public are distinguishable along a single physical dimension instead of a mental-physical dimension (Hackenberg, 1988). This was an ingenious way of dispensing with the mentalistic, but left behavior analysts with the remnants of a dichotomy. That is, *no* phenomena can be accessible while inaccessible. If an event is public, it is not necessarily inaccessible, but if an event is private, it is necessarily inaccessible. As such, the dimensions according to which we deem something private or public are mutually exclusive. Skinner implied such a dichotomy when referring to "a small but important private world of stimuli" (Skinner, 1945, p. 548), "the world within the skin" (Skinner, 1974, p. 20), and "the line between public and private" (Skinner, 1953, p. 282). Dichotomies pose both ontological and epistemological problems for coherent and parsimonious theoretical accounts of behavior. They can also stifle progress in areas of scientific investigation. For example, the remnants of Descartes' dichotomy between mind and body are still apparent in cognitivist formulations that rely on mental representations for understanding behavior.

Thompson (2007) pointed out the problematic nature of the private versus. public distinction when he stated, "These distinctions are contrary to the epistemology of a functional analysis of behavior, which attempts to identify the *functions of variables in relation to observable behavior,* not their physical locus or ease of accessibility to public scrutiny" (p. 423). In other words, preordaining variables on the basis of physical locus and accessibility is incongruent with the science of behavior's characterization of organism-environment relations via investigative operations (Hineline, 1984). Preordained variables are variables decided on or determined before investigation. The researcher's course of action is also decided on beforehand, or at the very least is restricted. Therefore, preordaining variables prior to investigation is not only incongruent with the epistemology of functional analyses but also incongruent with Skinner's operationism. Skinner's toothache was just as physical as his typewriter, but inaccessibility alone should not impede analysis (see Schnaitter, 1978 on interpretation as an alternative to analysis).

Analysis impeded by physical locus is a problem of grammatical rather than investigative operation. Privacy is a *prescriptive description* which asserts the precluding notion of inaccessibility onto phenomena. Solving the presumed problem of inaccessibility, then, is an attempt at solving a false problem. The problem is not with the nature of phenomena as either inaccessible or accessible, but with our descriptions that impose a restrictive dichotomy upon them. Again, no phenomenon can be accessible while inaccessible, so no measure of an event privy to an organism can be taken or inferred. Privacy as a precluding notion is supported by the observation that "the literature on private events since Skinner's time amounts to a reiteration of Skinner's contentions concerning them, including the insurmountable problem of their inaccessibility to observers" (Hayes & Fryling, 2009, p. 44). In alignment with Hayes and Fryling (2009), we take this "insurmountable problem"—the attempt at solving a false problem—to be a pseudo-problem.

Minimizing and eventually obviating the pseudo-problem of the private-public distinction will require an observational language that encompasses rather than precludes analysis on the basis of inaccessibility. In our view, this new observational language must dispense with the pseudo-problem of privacy and admit, for the sake of progress in the natural sciences, that nothing is, in principle, inaccessible. Therefore, events typically deemed inaccessible are events observable at scales amenable to recently developed methodologies and technologies (Thompson, 2007). Events are not private, but are multiple in scale. Figure 1 helps exemplify this point, as you can never see the opposing protrusions of a Necker cube at once. Face *a* protrudes in a direction different than face *b*. The different protrusions of faces *a* and *b* are observed on different occasions following different modes of action (the saccades of each eye) or investigation. Observed in this case, are "two different facts as one" (Watts, 1961, p. 88). Similarly, private and public are two different facts as one, or two different facts of the same nature. By substituting faces *a* and *b* with private and public, the illusion of the pseudo-problem of privacy becomes even more apparent. Private events might appear inaccessible, but provided a multiscaled analysis they are not. Although more difficult to assess, multiscaled phenomena are observed within a single matrix—a matrix amenable to the rigorous investigative operations of the natural sciences.

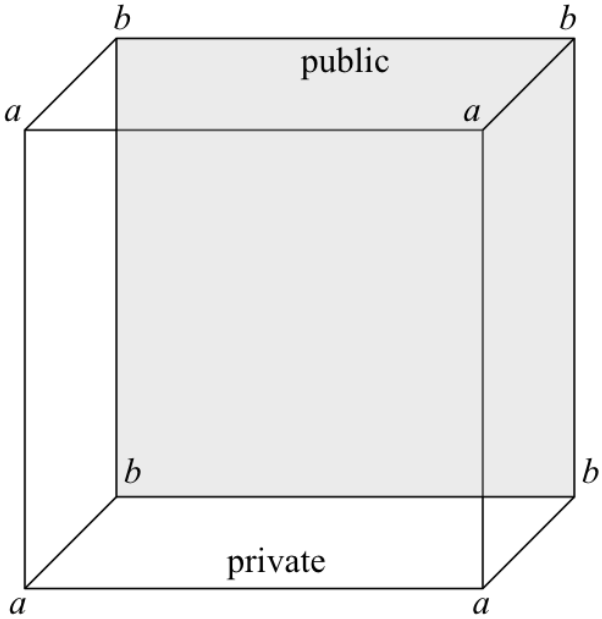

Figure 1: Three-dimensional cube portraying two different facts as one. Faces *a* and *b* present as different protrusions, but are not mutually exclusive. Similarly, private and public present as two different facts, but are one. The gray face of the cube (the *b* face) is designated as public while the *a* face of the cube is designated as private. See primary text for details.

What are Scaled Analyses?

Discussion of scaled processes and events is by no means new to behavior analysis. Hineline (1995, 2001, 2006, 2011) has proposed this very orientation, which he terms the multiscaled view. According to this view, processes—physical, biological, psychological, or cultural—occur naturally at multiply organized spatiotemporal scales. This view is prevalent among the study of physical systems, dynamical systems, and homeokinetics (Hineline, 2001; Kelso, 1995; Soodak & Iberall, 1978). As such, the multiscaled view may be exemplified by its shared affinities with field theoretic perspectives and the notion of nested processes in ecological psychology's animal-environment system (Turvey & Shaw, 1999).

From a field theoretic perspective, multiple factors within a field are deemed mutual and reciprocal in their relations. As Kantor (1950) stated, "Causal changes or fields are functions of mutual and reciprocal changes in every aspect of a factorial system" (p. 157). In this statement, mutuality implies "sameness" whereas reciprocity implies "complementarity" (Turvey & Shaw, 1999, p. 99). Therefore, field or event factors are mutual in the sense that they are equivalent in their participation and reciprocal in the sense that they would not exist as they are observed, one without the other. Take for example, the seeds of a eucalyptus species that germinate only when exposed to bushfire (Giffiths & Gray, 2001). The tree, seed, resinous litter, and bushfire are all factors within this field. Other factors may include wind, temperature, season, or gravity. All factors are mutual in that no factor in isolation is causal. All factors are reciprocal in that no tree distinct from a bushfire would exist as it is observed, one factor without the other. Additionally, note that almost all of these factors are occurring on multiple and varying spatiotemporal scales. No matter the duration or physical locus of such processes, whether mere units of much longer time-scale events (e.g., time of season or gravitational attraction) or processes varying in locale (e.g., small-scale activity internal to the organism), these processes are mutual and reciprocal in their relations. Ecological psychologists speak of these multiscaled processes in terms of nesting (Michaels & Carello, 1981).

Morris (2009) described the notion of nested processes within an animal-environment system when he stated:

> "In this view, 'natural processes' are lawful at their respective levels of analysis and not reducible to processes at other levels, even as the products of the processes at one level participate in and influence those at another level, that is, sustain and constrain them" (p. 287).

In concordance with field theoretic approaches and the multiscaled view endorsed in this paper, nested processes at varying scales or levels are not reducible, one to the other, for they are mutual. These multi-level processes are also reciprocal in that they sustain and constrain one another. This is to say that lower-level activity internal or external to the organism may coordinate higher-level activity and vice versa. In Hineline's (2006) words, "...emergent relations may both affect and be affected by what happens both at smaller and at larger scales..." (p. 226). No scale or level of process—small, large, low, high, micro, macro, molecular, or molar—is causally privileged (Hineline, 2006; Kelso, 1995). This aligns with the ecological psychologist's operational strategy according to which "the full complement of field factors" is specified rather than being considered a mere *locus* or *thing* (e.g., private as locus; stimulus as thing, Turvey & Shaw, 1999, p. 99). This theoretical and methodological strategy emphasizes the notion of an animal-environment system in which the animal is continuous with, and therefore, not separable from the environment (Järvilehto, 1998). The animal and environment, as well as events considered private or public, are two aspects of the same system or field in which processes are nested "just as words must be understood in the context of sentences, paragraphs, chapters, books, libraries, and ... life itself" (Watts, 1966, p. 97).

In this view, the locus of privacy or inaccessibility is a pseudo-problem. The multiscaled view eschews this pseudo-problem because it treats processes as neither *discrete* instantaneous time-slices of "now" nor *discrete* in locale (Hineline, 1995, 2006; Michaels & Carello, 1981). The full complement of field factors, or multiscaled processes, is emphasized. The events nominated as private and public by radical behaviorists are what Kelso and Engstrøm (2006) call a *complementary nature*. The question, however, is how the complementary nature of these events span the organism and environment, not as inaccessible or accessible, but as *one* regardless of physical locus.

Making Sense of Private Stimuli and Stimulation

According to Skinner (1945), a toothache is a private stimulus. What that private stimulus entails, though, is uncertain. If a private stimulus is a localized source of stimulation, it must be asked how private stimulation (restricted to receptive sites) coordinates whole organism behavior (see Gibson, 1960). Gibson

(1966) answered this question by making a useful distinction between mere stimulation—optical, mechanical, and chemical—and stimulus information. Mere stimulation occurs when a stimulus (optical, mechanical, or chemical) impinges on passive receptors. In contrast, stimulus information is a higher-order variable that coordinates whole organism behavior when it is detected. For example, the ambient optic array is the structured arrangement of light reflected from the various substantial surfaces of the environment as characterized from a single point of observation. The forward movement of an organism generates a form of stimulus information termed global optic outflow (i.e., all points of the array expand from a single point of focus at the eye-height of the organism), which specifies (i.e., is invariant across conditions) that the organism is moving forward relative to the environment. This perception-action cycle is a circularly causal system distributed over the organism and the environment. More generally, whole body action generates an invariant pattern of stimulus information that is specific to the whole body action.

In accordance with Gibson (1966), the psychophysics of receptor cell thresholds and mere stimulation do not adequately account for the behavior of the whole organism. Additionally, simply referencing that which is private as being a source of stimulation is not an adequate account of events privy to a particular organism (Tourinho, 2006). So as not to attribute the functioning of the whole to a part, we must better discern those instances of stimulation nominated as private.

Following Gibson (1966), a more modern account of stimulation acknowledges the responsive architecture of the body constituted by components of adjustment and components of reception (Turvey & Fonseca, 2014). This comprises an adjustive-receptive system. The adjustive components of this system constitute the mechanosensitive architecture of the organism (e.g., musculature, connective tissue, and the skeletal system), which alters the effectiveness of receptive sites in relation to changes in stimulation (Turvey & Fonseca, 2014). The concerted responding of the olfactory system embedded in a head attached to a mobile body provides an example. Receptive components include the nose situated in facial bones while adjustive components manifest as sniffing and breathing thanks to chest muscles (Gibson, 1966). On this account, smelling is an achievement of not only receptive components, but also adjustive components that enhance or stifle changes in stimulation originating in the environment. Stimulation, then, is equally a fact of the organism and fact of the environment. By this account, stimulation cuts across the private-public distinction, as it spans the organism and environment. This is to say that stimulation extends beyond the skin. In Järvilehto's (1998) words, "All organismic processes include processes both inside and outside the body, in the nervous system and in other necessary parts and in the environment" (p. 330).

That ecological psychology views meaningful (i.e., relevant for coordinating whole body action) stimulation (i.e., stimulus information) as spanning across organism and environment raises a question: What is the locus of the behavior analytically deemed "private stimulus" or "private stimulation"? Given what we know about the adjustive-receptive nature of the body, this question appears to not be viable. The spatially distal yet concerted responding of adjustive and receptive components undermines the notions of private stimuli and private stimulation. The chest muscles (adjustive) and nose (receptive), for instance, are not localized in the same region of the body (Turvey & Fonseca, 2014). Provided these facts, we propose that there are no private stimuli analogous to public stimuli such as a light, tone, or food in an operant chamber. This is to say that there are no private stimuli as spatially localized and temporally discrete as a light, tone, or food.

Smelling, touching, seeing, hearing, and tasting are not under the control of a private stimulus or the stimulation at receptor cell sites alone. The mechanoreceptors in the hand, for example, do not readily detect length (Chemero, 2009). Instead, it is by way of effortful touching that organisms come to detect the length of objects via higher-order relational variables. Research on what ecological psychologists call *dynamic touch* is an exemplar of a multiscaled analysis that overcomes the pseudo-problem of privacy. Such research incorporates the full complement of field factors, as perception and action are accounted for with respect to bodily events (e.g., adjustive and receptive), stimulus object properties (e.g., the resistance of an object to being rotated: its inertial properties), and their interaction within an environment.

Dynamic Touch: Macroscale Findings for a Multiply Scaled Analysis

Dynamic touch is a perceptual subsystem of the haptic system used to detect meaningful properties of objects through wielding and hefting (Carello & Turvey, 2004; Gibson, 1966; Turvey, 1996). Object properties are detected thanks to the simultaneous contribution of adjustive components realized as muscular effort and receptive components found in the skin and joints (Gibson, 1966). Within the field of ecological psychology, dynamic touch has been one of the most successful research programs in uncovering the informational bases for perception, primarily because the candidate variables are relatively few and the physics of inertia is well understood.

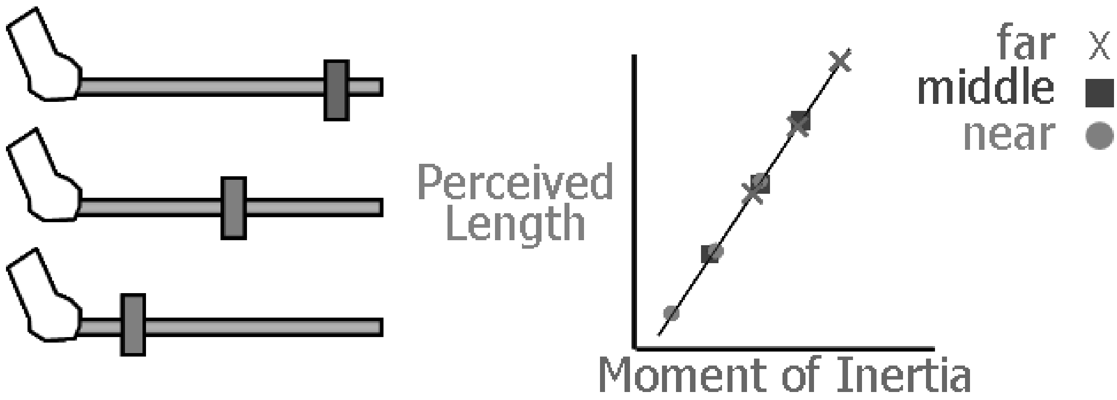

Figure 2: Left: Depiction of a person wielding a rod (out of view) with an attached cylindrical weight. Altering the position of the weight systematically changes aspects of the inertia tensor but keeps the mass of the object constant. Right: Graphical representation of the single-valued function between perceived length of a cylindrical object and the inertia tensor. Adapted with permission from Claudia Carello in personal communication to Isenhower.

Many studies using *occluded* (i.e., out of sight) hand-held objects have demonstrated that the perceived length of cylindrical objects (Solomon & Turvey, 1988), of various-shaped objects (Fitzpatrick, Carello, & Turvey, 1994), and perceived object width (Turvey, Burton, Amazeen, Butwill, & Carello, 1998), are all functions of what is called the inertia tensor. The inertia tensor quantifies the magnitudes of the resistance to rotational acceleration that occurs when wielding objects (see Turvey, 1996, for an overview the inertia tensor and dynamic touch research more generally). When a person wields an everyday object such as a pencil, a hammer, or a fork, it primarily involves rotations about the point at which the object is held. Objects can be rotated up and down, side to side, or twisted. Resistance to this rotational acceleration is predictive of verbal and nonverbal reports on length, shape, and width and is quantified by the inertia tensor. The precision of the haptic perceptual system is represented in Figure 2, a schematized version of the covariation between verbal or non-verbal object length judgments and inertial variables. On the left is a depiction of the hand-held objects that are wielded out of sight. On the right is a graphical representation of the single-valued function between perceived length of a cylindrical object and the inertia tensor. The presence of a single-valued function indicates a one-to-one mapping between a given (length) percept and the corresponding value of the inertia tensor.

In the case of detecting and making judgments about object shape, participants hold a rod to which an object is attached at the end. Without being able to probe the object directly, participants are capable of selecting objects that match the occluded objects at the end of a given rod. The inertia tensor is stimulus information that makes this non-visual match-to-sample task possible. Not all objects, however, are easily discriminable. Burton, Turvey, and Solomon (1990) found that people can only discriminate *crude* shape through dynamic touch. Errors in shape judgments correspond to aspects of the inertia tensor that do not have a unique characterization (e.g., round and square objects).

The precision with which participants can report on length, shape, and width is not a matter of happenstance, guesswork, or covert hypothesizing. In other words, this ability is not by means of some private event. That participants can reliably report on object properties via dynamic touching is evidence that there are bodily processes and events to which the organism is sensitive. This is to say that participant behavior is not only under the control of the inertia tensor, but is also under the control of bodily events. Muscular deformation—thanks to the *action* of touching—appears to be specific to particular inertia tensors, and therefore, muscular deformation is meaningful information about object properties. Put simply, muscular deformation is discriminative for particular participant reports on certain object properties.

The focus of dynamic touch research is not the organism's phenomenal experience; but instead, its focus is whether or not bodily processes are *lawfully constrained* and specific to certain circumstances (Turvey & Fonseca, 2014). Lawful constraining refers to the reliable coordination of the body under certain circumstances (e.g., when wielding objects). In other words, lawful constraining is the case in which the many parts of the body coordinate and take on a unique pattern that is *specific to* certain circumstances. If a unique pattern is discriminable—thanks to a context or task-specific lawful constraining—it might play an important role in accounting for the self-descriptive response. Dynamic touch research provides evidence that people are sensitive to themselves relative to an object (proexteroception), and to an object relative to themselves (exproprioception). Given this evidence we hypothesize that humans self-describe and speak of "feelings" in the presence of bodily states that are lawfully constrained under certain circumstances. As such, it must be discerned how these bodily states—cutting across private and public as action oriented adjustive-receptive systems—are lawfully constrained.

From Nanoscale to Macroscale: A Multiscaled Exposition

Ecological psychologists, in their analysis of dynamic touch, have arrived at quantifiable functional relations descriptive and predictive of whole organism behavior (verbal and nonverbal) in relation to not only the environment, but also in relation to bodily processes and events. A thorough understanding of the precision of the haptic perceptual system at the whole organism-environment level has allowed ecological psychologists to assess the biological bases of these bodily processes that co-occur with behavior observed. As stated by Baum (2011), "...understanding function is propaedeutic to studying mechanism; one must know what one is trying to explain before one can explain it" (p. 186). The following is an attempt to discern and describe how these bodily processes and events are lawfully constrained in such a way that the organism is sensitive to itself. Such work exemplifies the beginnings of synthesis between the facts of the organism and behavior observed at the whole organism-environment level.

In their efforts to discern the ways in which bodily processes are lawfully constrained, Turvey and Fonseca (2014) provide us with a conception of the body derived from biological research and consistent with behavior analytic notions of the whole organism. The body, as proposed by Turvey and Fonseca (2014), is a *multifractal tensegrity system*. Generally, this is called the tensegrity hypothesis. The term fractal denotes a physical or mathematical object that is self-similar. In other words, fractals have a sameness at each spatial or temporal level of analysis (Mandelbrot, 1983). Examples include the Koch snowflake and the Sierpinski triangle. Fractals can be characterized as having a fractal dimension that serves as an index for how the fractal pattern changes across different scales. The fractal dimension of a monofractal can be described by a single exponent, which characterizes how the fractal pattern changes across scales. Multifractals, on the other hand, are more complicated, and are characterized by a family of exponents (see Kelty-Stephen, Palatinus, Saltzman, & Dixon, 2013, for a tutorial on multifractality). Turvey and Fonseca (2014) designate the body as multifractal due to the diversity of bodily components from nanoscale to macroscale. The upshot of this characterization is that it is also a form of analysis that might capture the interdependent and bidirectional effects of the components of the body across multiple scales. Although diverse, the organizations of the many components of the body (from cell to musculature) abide by similar mechanical principles at each scale of analysis. Those principles are discerned in what is called tensegrity.

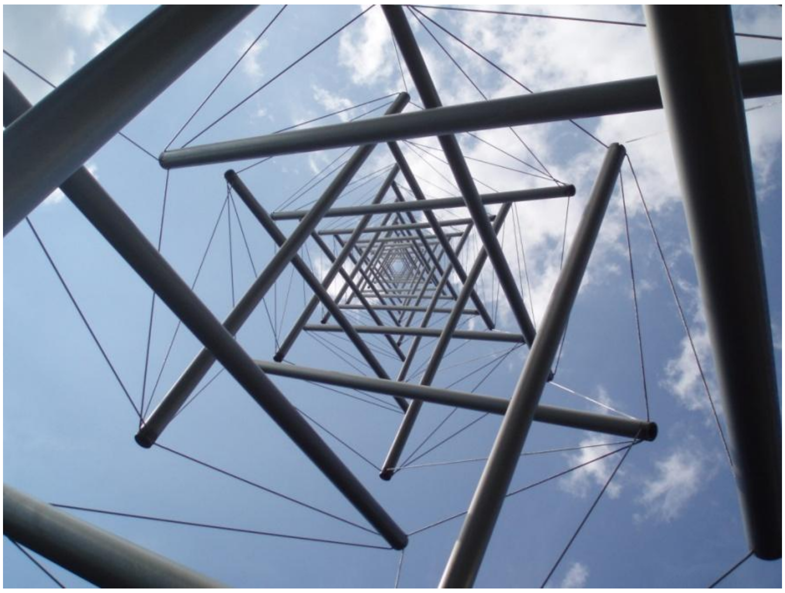

Figure 3: Snelson sculpture in which cables compress rigid-bodies, in this case rods, while the rods tension the cables. The force balance between compression and tension is such that the structure is self-stabilizing. This is the structure's equilibrium state. File labeled for reuse under the Creative Commons Attribution-Share Alike 2.5 Netherlands license. http://commons.wikimedia.org/wiki/File:Kenneth_Snelson_Needle_Tower.JPG

Tensegrity is an architectural notion that is a portmanteau of the words tension and integrity (see Skelton & de Oliveira, 2009, for a more in depth description of tensegrity and its mathematical basis). According to this notion, structures composed of rigid-bodies (e.g., compression-bearing struts) connected to tension-bearing elements (e.g., elastic cables) are self-stabilizing. Tensegrity structures are self-stabilizing in the sense that rigid-bodies compressed by cables, and cables tensioned by rigid-bodies, take a particular shape independent of external forces such as gravity. Compression-bearing rigid-bodies stretch or tense the cables while the tension-bearing cables compress the rigid-bodies (Ingber, 1998). Examples of tensegrity systems include Snelson sculptures (Figure 3) by Kenneth Snelson and Buckminster Fuller's tensegrity icosahedron (Figure 4).

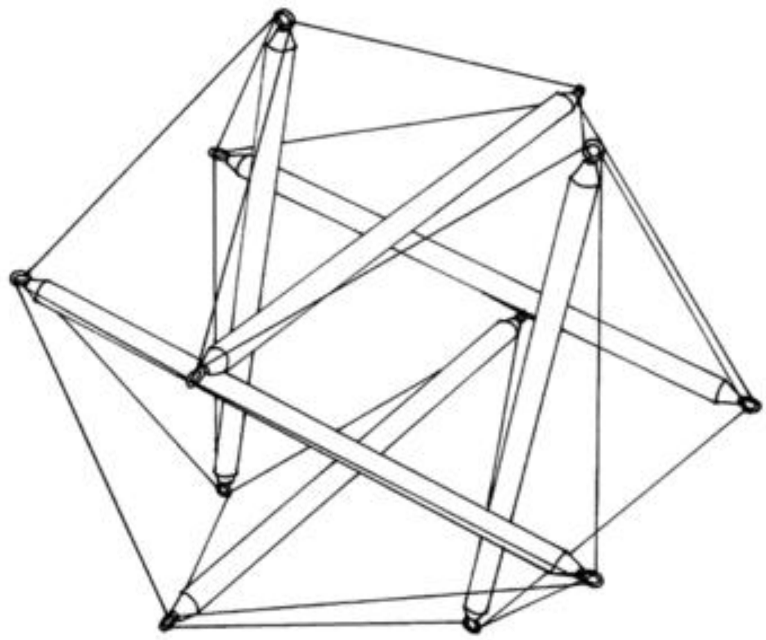

Figure 4: Tensegrity icosahedron in which cables compress rigid-bodies, in this case rods, while the rods tension the cables. The force balance between compression and tension is such that the structure is self-stabilizing. This is the structure's equilibrium state. File labeled for reuse under the Creative Commons Attribution 2.5 Generic license. http://commons.wikimedia.org/wiki/File:Tensegrity_Icosahedron.png

Figures 3 and 4 model how the body, with its many components, self-stabilizes so as to form a whole coordinated system. According to Ingber (1988), every one of our bodies is a complex tensegrity structure composed of bones, muscles, tendons, ligaments, etc. At different scales of analysis we find different structures functionally equivalent to compression-bearing struts and tension-bearing cables (Ingber, Wang, & Stamenović, 2014). Although different, as implied by multifractal, these structures are integrative in such way that we are not analyzing individual parts, but a unitary structure. In essence, we are observing many different facts as one (Figure 1).

As described by Turvey and Fonseca (2014), tensegrity is observed at scales above and below one another. This is to say that tensegrity is a *scale-invariant* characterization of the body. Scale-invariance refers to the observation that tensegrity ranges from the single cell to the whole organism, all the while maintaining its functional integrity. Tensegrity is observed at the level of cells (Ingber, 2003a; 2003b), musculature, connective tissue, and the skeletal system (MCS) in conjunction (Ingber, 1998; Ingber, 2006; Ingber et al. 2014; see Skelton & de Oliveira, 2009, on tensegrity classes related to joints and hinges), and even at the level of the brain (Turvey & Fonseca, 2014). Nested hierarchically, tensegrity systems—above, below, and within one another—sustain and constrain one another just as emergent relations can both affect and be affected at both smaller and at larger scales (Hineline, 2006; Morris, 2009). The body, then, is hierarchically organized and integrative (Ingber, 1998; Ingber, 2003a; Ingber et al., 2014). This is an example of whole *body concinnity* in line with the radical behavioral assumption that we are dealing with a whole behaving organism. Concinnity refers to the harmonious arrangement of parts and their coordinative or concerted nature (Turvey & Fonseca, 2014; see Tuller, Turvey, & Fitch, 1982, for illustrations and examples of coordinative structures). As such, local and even minute changes of a factor or factors within any one aspect of this system will result in global changes throughout the multifractal tensegrity system; that is, throughout the whole body. Not unlike a cascade, stresses at the level of the

MCS produce changes in tension and compression at size scales all the way down to the cell (Ingber, 2006).[4]

This conception of the body places all of its various elements, from the nanoscale to macroscale, on equal footing. As described by Turvey and Fonseca (2014), the upshot of such a conception is similar to the tugging of a strut or cable of a Snelson structure (Figure 3). Necessarily following from such a tug is the rearrangement of all the components that functionally define the system: "The rearrangement is a new equilibrium" (Turvey & Fonseca, 2014, p. 163). This new equilibrium occurs at the level of the cell all the way up to states observed within the MCS. Nanoscale activity, then, is on par with the rest of the body including the brain. In the words of Kantor (1950), "Causal changes in any field constitute a rearrangement in the simultaneous coexistence of factors in a unique pattern" (p. 157).

A unique pattern or new equilibrium state is the lawful constraining of bodily processes under specific circumstances. Organisms, according to dynamic touch research, come to be sensitive to these unique patterns and their relation to stimulational changes originating in the environment. As observed in dynamic touch research, verbal and nonverbal behavior in relation to bodily events is reliably predicted and reliably controlled. A scale-invariant characterization of the body as a tensegrity system lends itself to an account in which there are not controlling things within the organism, but instead, nested tensegrity systems that make for the lawful constraining of bodily processes. In this account, notions of discrete and inert stimuli are replaced by a whole *mechanosensitive architecture* that envelops the full complements of field factors as they participate in psychological events. This conception of the body and its consequences with respect to accounting for whole organism behavior in relation to bodily processes is best described in the words of Turvey and Fonseca (2014):

> To construe haptic perception as a variant of inference making, hypothesis testing, and sophisticated guessing is to view its indefinitely many veridical achievements in the course of even a single act as good fortune or happenstance. The overwhelmingly self-evident precision of haptic proprioperception and exproprioperception manifest within life's ordinary circumstances suggests that the information available in the multifractal tensegrity is so specific to body states that an animal could be said to make only one inference, hypothesis, or educated guess—namely, the right one (Neisser, 1978). On this observation, putative mechanisms of inferring, hypothesizing, and guessing are superfluous (p. 168).

This statement encompasses the results of a research strategy that eschews the pseudo-problem of privacy. It provides a conception of whole organism behavior in relation to bodily events and the environment. It utilizes a conception of the body consistent with radical behaviorism and derived by way of multiscaled analyses. As a whole mechanosensitive structure, psychologists need not refer to parts alone, but to the lawfully constrained states to which the behaving organism is responsive. While the constituents of the body are important, the whole coordinated efforts of the body are most relevant to the science of behavior's characterizing organism-environment relations at an ecological scale. Understanding the coordinative workings of the body has bearing on our understanding the self-descriptive response.

The Unbounded Skin

According to dynamic touch research, self-descriptive talk about the body is hardly limited to the three nervous systems—interoceptive, proprioceptive, and exteroceptive nominated by Skinner (1974).

[4] Other examples include the long-range propagation of tension from the latissimus dorsi to the gluteus maximus (Carvalhais et al., 2013) and the nearly simultaneous adjustments in tension at the pectoralis major thanks to distal and minute perturbations at the thumb (Marsden, Merton, & Morton, 1983). See Turvey and Fonseca (2014) for a more extensive exposition of long-range anatomical activity.

Given the body's mechanosensitive structure, ecological psychologists have expanded upon the three nervous systems with the terms exproprioception and proexteroception (Turvey & Fonseca, 2014). Exproprioception refers to perceiving the environment relative to our own body (the horizon I see is not the horizon you see), whereas proexteroception refers to perceiving our own body relative to the environment (seeing the tip of my nose is indicative of distance from here). Conceiving the body as a mechanosensitive structure makes an analysis of bodily processes in relation to the whole behaving organism and environment possible (hence, the conceiving of exproprioception and proexteroception).

We contend that events historically deemed private are not neurogenic, receptor cell specific, or brain region determinant. The efforts of the many constituent aspects of the body—cells, joints, connective tissues, and muscles—are coordinative and context-dependent (Kelso, 2009). It is not only by means of retinal cells that you see, mechanoreceptors that you feel, and stereocilia that you hear. Not even the brain can be construed as the lone corpus through which we make sense of the world, for receptors do not simply convey a world for the brain to display. In the heads of a mechanosensitive architecture, the brain is but another cog nested within a hierarchy of adjustive-receptive systems. According to Turvey and Fonseca (2014), efferent pathways—projections descending away from the brain—constitute a neural variant of an adjustive-receptive system. As conditions of stimulation change, efferent pathways (adjustive components) descending away from the somatic sensory cortex dynamically alter the effectiveness of subcortical activity (receptive components, King, 1997).

In concert with retinal cells, mechanoreceptors, stereocilia, and the brain, the mechanosensitive architecture of the body is all at once adjustive and receptive devoid of an initiating agent besides its complement—the environment. Apparent when speaking of nested adjustive-receptive structures is the lack of a "private stimulus" analogous to stimuli construed within an independent-dependent, cause-effect, and agent-action model (Hineline, 1990). From this perspective, there are no private stimuli analogous to food as a reinforcer. As a hierarchically organized and integrative adjustive-receptive tensegrity system, the body and its many components differentially coordinate with respect to certain circumstances. The coordination dynamics of the auditory system provide an example with implications pertaining to a person's self-descriptive response.

Different hair cells (receptive components) in the inner ear sense different frequencies dependent upon the tensioning of structures (adjustive components) in not only the inner ear, but the middle and outer ear as well (Ingber, 2006). The isometric tensioning of these structures—a sort of tuning—makes it such that humans are immediately responsive to a whisper or a scream.

The coordination of the ear, concerted with the rest of the body, is a unique and lawfully constrained pattern that depends upon a person's presence at a library or concert. An identification of such lawfully constrained patterns might give new meaning to Skinner's (1974) behavioral translation of self-descriptive statements concerning "feelings." Skinner (1974) translated the statement, "I feel like playing cards" into "I feel as I often feel when about to play cards" (pp. 31-32). Statements concerning a particular sentiment are indicative of present contingencies, and therefore, potentially useful for the prediction of a person's future behavior.

We extend Skinner's (1974) interpretation by contending that statements concerning feelings are indicative of environmental contingencies *and* lawfully constrained bodily states. We propose that an identification of lawfully constrained bodily states might drive empirical investigations regarding the self-descriptive response. In accordance with this proposal, we might also fulfill Skinner's (1974) admonition that what is felt or introspectively observed is the observer's own body. The statement, "I feel like going to a concert" can be translated into empirically derived statements concerning the coordination of the whole body—from ear to cell—under circumstances related to concert-going.

Conclusion

In this paper, we have presented dynamic touch research, the tensegrity hypothesis, and research on the context-dependent coordination of the body as empirically supported analogies that provide avenues for the empirical investigation of events historically deemed private. We do not suppose that there are feelings as noun-like or static things, but we do suggest that there is a context-dependent and almost simultaneous coordination of cells, MCS, and the brain. Again, such coordination takes on a unique pattern or new equilibrium to which the organism is sensitive when perturbed. Specification of these unique patterns is a serious possibility, for tensegrity-based quantitative models descriptive and predictive of cellular behavior are currently being developed (Ingber et al., 2014). Scaling-up these models to the level of MCS is a future to which we look forward, as it will likely inform the study of what is felt or introspectively observed; that is, the observer's own body.

The empirical examples from ecological methodology presented in this paper (specifically dynamic touch and tensegrity) serve as evidence to support our claims and demonstrate a methodological path toward eliminating privacy from behavior analysis. However, we should proceed with caution. Our approach may not eliminate all events conceptualized as private, although that is our ultimate goal. Additionally, while our empirical examples may be new to many students of the science of behavior, our approach to understanding mental life is not. In fact, it is entirely in keeping with the tenets of radical behaviorism.

Skinner called for an alternative account of mental life. In his own words, "An adequate science of behavior must consider events taking place within the skin of the organism, not as physiological mediators of behavior but as part of behavior itself" (Skinner, 1963, p. 953). Lawfully constrained bodily states are not mediators bound within the skin, but are a part of behavior. Bodily events are specific to certain circumstances and adjustive (action oriented) with respect to changes in stimulation that originate in the environment. On these grounds we contend that there is nothing private and no place for private stimuli inside the skin. As we expand and contract our scale of analysis we do not come into contact with more or less parts, but instead, varying patterns of relationship (Watts, 1961).

A methodological charge for the science of behavior will be the identification of lawfully constrained bodily states meaningful to the whole behaving organism. Such a charge will almost certainly necessitate interdisciplinary collaboration, but it is in the pursuit of a more comprehensive account of behavior that we propose this challenge. Extending concepts from ecological psychology (e.g., dynamic touch, tensegrity, and stimulus information) may provide an avenue toward this goal. The multiscaled view fosters this endeavor, as its tenets of mutuality and reciprocity emphasize the commensurable and complementary nature of organism and environment.

References

Baum, W.M. (2011). Behaviorism, private events, and the molar view of behavior. *The Behavior Analyst, 34*(2), 185-200.

Burton, G., Turvey, M. T., & Solomon, Y. S. (1990). Can shape be perceived by dynamic touch? *Perception and Psychophysics*, *48*(5) 477-487.

Bentley, A.F. (1941). The human skin: Philosophy's last line of defense. *Philosophy of Science, 8*(1), 1-19. doi: http://dx.doi.org/10.1086/286664

Carello, C. & Turvey, M. T. (2004). Physics and psychology of the muscle sense. *Current Directions in Psychological Science, 13,* 25-28. doi: http://dx.doi.org/10.1111/j.0963-7214.2004.01301007.x

Carvalhais, V. O., Ocarino, J. D., Araujo, V. L., Souza, T. R., Silva, P. L., & Fonseca, S. T. (2013). Myofascial force transmission between the latissimus dorsi and gluteus maximus muscles: An in vivo experiment. *Journal of Biomechanics*, *46*, 1003-1007. doi: http://dx.doi.org /10.1016/j.jbiomech.2012.11.044

Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, MA: The MIT Press.

Dennett, D. (1984). Wishful thinking. *The Behavioral and Brain Sciences, 7*(4), 556-557. doi: http://dx.doi.org/10.1017/S0140525X00027229

Field, D.P., & Hineline, P.N. (2008). Dispositioning and the obscured roles of time in psychological explanations. *Behavior and Philosophy, 36*, 5-69.

Fitzpatrick, P., Carello, C., & Turvey, M. T. (1994). Eigenvalues of the inertia tensor and exteroception by the "muscle sense." *Neuroscience, 60,* 551-568. doi: http://dx.doi.org/10.1016/0306-4522(94)90264-X

Fryling, M.J., & Hayes, L.J. (2015). Similarities and differences among alternatives to skinner's analysis of private events. *The Psychological Record, 65*, 579-587. doi: 10.1007/s40732-015-0130-7

Gibson, J. J. (1960). The concept of the stimulus in psychology. *American Psychologist*, *15*(11), 694-703. doi: 10.1037/h0047037

Gibson, J.J. (1966). *The senses considered as perceptual systems*. Boston, MA: Houghton Mifflin.

Gibson, J. J. (1979/1986). *The ecological approach to visual perception*. Boston: Houghton Mifflin. (Original work published in 1979).

Giffiths, P. E., & Gray, R.D. (2001). Darwinism and developmental systems. In S. Oyama, P. Griffiths & R. Gray (Eds.), *Cycles of contingency: Developmental systems and evolution* (pp. 195-218). Cambridge, MA: The MIT Press.

Hackenberg, T.D. (1988). Operationism, mechanism, and psychological reality: The second-coming of linguistic relativity. *The Psychological Record, 38,* 187-201.

Hayes, L.J., & Fryling, M.J. (2009). Overcoming the pseudo-problem of private events in the analysis of behavior. *Behavior and Philosophy, 37,* 39-57.

Hineline, P.N. (1984). What, then, is Skinner's operationism. *Behavioral and Brain Sciences*, *7*(4), 560. doi: http://dx.doi.org/10.1017/S0140525X00027266

Hineline, P.N. (1990). The origins of environment-based psychological theory. *Journal of the Experimental Analysis of Behavior, 53*(2), 305-320. doi: http://dx.doi.org/10.1901/jeab.1990.53-305

Hineline, P.N. (1995). The extended psychological present. *Behavioral and Brain Sciences*, *18*(1), 128-129. doi: http://dx.doi.org/10.1017/S0140525X00037687

Hineline, P.N. (2001). Beyond the molar-molecular distinction: We need multiscaled analyses. *Journal of the Experimental Analysis of Behavior, 75*(3), 342-347. doi: http://dx.doi.org/10.1901/jeab.2001.75-342

Hineline, P.N. (2006). Multiple scales of process and the principle of adduction. In E. Ribes-Inesta & J. Burgos (Eds.), *Knowledge, Cognition, and Behavior* (pp. 223-241). Guadalajara, Mexico: Universidad de Guadalajara Press.

Hineline, P.N. (2011). Private versus inner multiscaled interpretation. *The Behavior Analyst, 34*(2), 221-226.

Ingber, D.E. (1998). The architecture of life. *Scientific American,* 48-57. doi: http://dx.doi.org/10.1038/scientificamerican0198-48

Ingber, D. E. (2003a). Tensegrity I. Cell structure and hierarchical systems biology. *Journal of Cell Science*, *116*, 1157-1173. doi: http://dx.doi.org/10.1242/jcs.00359

Ingber, D. E. (2003b). Tensegrity II. How structural networks influence cellular information processing networks. *Journal of Cell Science*, *116*, 1397-1408. doi: http://dx.doi.org/10.1242/jcs.00360

Ingber, D. E. (2006). Cellular mechanotransduction: Putting all the pieces together again. *FASEB Journal*, *20*, 811-827. doi:10.1096/fj.05-5424rev

Ingber, D., Wang, N., & Stamenović, D. (2014). Tensegrity, cellular biophysics, and the mechanics of living systems. *Reports on Progress in Physics, 77*, 1-21. doi:10.1088/0034-4885/77/4/046603

Järvilehto, T. (1998) The theory of the organism-environment system: I. description of the theory. *Integrative Physiological and Behavioral Science, 33*(4), 321-334. doi: http://dx.doi.org/10.1007/BF02688700

Kelty-Stephen, D. G., Palatinus, Z., Saltzman, E., & Dixon, J. A. (2013). A tutorial on multifractality, cascades, and interactivity for empirical time series in ecological science. *Ecological Psychology*, *25*, 1–62. doi: http://dx.doi.org/10.1080/10407413.2013.753804

Kantor, J. R. (1950). *Psychology and logic* (Vol. II). Chicago: Principia.

Kelso, J.A.S (1995). *Dynamic patterns the self-organization of brain and behavior*. Cambridge, Mass.: MIT Press.

Kelso, J. A. S. (2009) Coordination dynamics. In: R. A. Meyers ed.). *Encyclopedia of complexity and system science*, , pp. 1537–64. Springer. doi: http://dx.doi.org/10.1007/978-0-387-30440-3_101

Kelso, J.A.S., & Engstrøm, D. A. (2006). *The complementary nature*: The MIT Press.

King, A. J. (1997). Sensory processing: Signal selection by cortical feedback. *Current Biology*, *7*, R85–R88. doi: http://dx.doi.org/10.1016/S0960-9822(06)00043-1

Lewontin, R.C. (1983). Gene, organism and environment. In D.S. Bendall (Ed.), *Evolution from molecules to men*. (pp. 273-285). Cambridge: Cambridge University Press.

Marr, M.J. (2009). The natural selection: Behavior analysis as a natural science. *European Journal of Behavior Analysis, 10*(2), 105-120.

Marsden, C. D., Merton, P. A., & Morton, H. B. (1983). Rapid postural reactions to mechanical displacement of the hand in man. *Advances in Neurology*, *39*, 645–659.

Michaels, C., & Carello, C. (1981). *Direct perception*. Englewood Cliffs, N.J.: Prentice-Hall.

Mandelbrot, B. B. (1983). *The fractal geometry of nature* (Vol. 173). Macmillan.

Morris, E. K. (2009). Behavior analysis and ecological psychology: Past, present, and future: A review of Harry Heft's ecological psychology in context. *Journal of the Experimental Analysis of Behavior*, *92*(2), 275-304. doi: http://dx.doi.org/10.1901/jeab.2009.92-275

Neisser, U. (1978). Memory: What are the important questions? In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 3-24). London, England: Academic Press.

Oyama, S., Griffiths, P. E., & Gray, R. D. (2001). *Cycles of contingency: Developmental systems and evolution*. Cambridge, MA: The MIT Press.

Rosenbaum, D. (2005). The Cinderella of Psychology: The Neglect of Motor Control in the Science of Mental Life and Behavior. *American Psychologist, 60*(4), 308-317. doi: http://dx.doi.org/10.1037/0003-066X.60.4.308

Schnaitter, R. (1978). Private causes. *Behaviorism, 6*(1), 1-12. doi: http://www.jstor.org/stable/27758902

Skelton, R. E., & de Oliveira, M. C. (2009). *Tensegrity systems*. London, England: Springer.

Skinner, B. F. (1945/1984). The operational analysis of psychological terms. *The Behavioral and Brain Sciences*, 7, 547–581. doi: http://dx.doi.org/10.1017/S0140525X00027187

Skinner, B.F. (1953). *Science and human behavior*. New York: Macmillan.

Skinner, B.F. (1956). A case history in scientific method. *American Psychologist*, *11*(5), 221-233. doi: http://dx.doi.org/10.1037/h0047662

Skinner, B. F. (1974). *About behaviorism*. New York, NY: Alfred A. Knopf, Inc.

Skinner, B.F. (1963). Behaviorism at Fifty. *Science, 140*(3570), 951-958. doi:10.1126/science.140.3570.951

Solomon, H., & Turvey, M.T. (1988). Haptically perceiving the distances reachable with hand-held objects. *Journal of the Experimental Psychology: Human Perception and Performance, 14*, 404-427.

Soodak, H., & Iberall, A. (1978). Homeokinetics: A physical science for complex systems. *Science*, *201*, 579–582. doi: http://dx.doi.org/10.1126/science.201.4356.579

Thompson, T. (2007). Relations among functional systems in behavior analysis. *The Journal of the Experimental Analysis of Behavior*, *87*(3), 423-440. doi: http://dx.doi.org/10.1901/jeab.2007.21-06

Tourinho, E. Z. (2006). Private stimuli, covert responses, and private events: Conceptual remarks. *The Behavior Analyst*, *29*(1), 13-31.

Tuller, B., Turvey, M.T., & Fitch, H.L. (1982). The Bernstein Perspective: II. The Concept of Muscle Linkage or Coordinative Structure. In J.A.S. Kelso (Ed.), *Human Motor Behavior: An Introduction*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Turvey, M.T. (1996). Dynamic Touch. *American Psychologist, 51,* 1134-1152. doi: http://dx.doi.org/10.1037/0003-066X.51.11.1134

Turvey, M. T., Burton, G., Amazeen, E. L., Butwill, M., & Carello, C. (1998). Perceiving the width and height of a hand-held object by dynamic touch. *Journal of Experimental Psychology: Human Perception and Performance, 24,* 35–48. doi: http://dx.doi.org/10.1037/0096-1523.24.1.35

Turvey, M. T., & Fonseca, S. T. (2014). The medium of haptic perception: A tensegrity hypothesis. *Journal of Motor Behavior*, *46*(3), 143-187. doi: http://dx.doi.org/10.1080/00222895.2013.798252

Turvey, M. T., & Shaw, R. E. (1999). Ecological foundations of cognition. i: Symmetry and specificity of animal-environment systems. *Journal of Consciousness Studies*, *6*(11-12), 95-110.

Watts, A. (1961). *Psychotherapy, East and West*. New York: Pantheon Books.

Watts, A. (1966). *The book on the taboo against knowing who you are.* New York: Pantheon Books.