CHAPTER 16

Sensation, movement, and emotion

Explicit procedures for implicit memories

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Though cognitive neuroscience locates all memory systems in the brain and has gone to great lengths to understand the issues involved in the various forms that memory takes, where these forms are stored, and how they interact, it may be 'neurocentric' to think of memory as only occurring in and mediated by the brain. Undoubtedly, neural networks for memory abound in many different areas of the brain, and are absolutely essential hubs for the encoding, storage, and retrieval of human experience. Yet emerging work in neuroscience also confirms the crucial role of sensorimotor and affective processing in the shaping and reshaping of human memory. A case for 'body memory' can be made, and the role of the moving, sensing, feeling, and emoting body can now be seen as fundamental to the developmental structuring of and subsequent neurogenetic changing of memory, particularly implicit memory. This understanding of the phenomenological body's centrality in the navigation of non-verbal and affect-laden learning and remembering has profound impacts for our understanding of attachment, enactment, the therapeutic relationship, and psychotherapeutic procedures.

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As much as some scientists and academics would like it to be so, our bodies do not exist in the discrete categories that our minds (our left hemispheres, to be exact) tend to create for purposes of clarity and organization. The brain is not separate from the rest of the body, and the body's systems are not isolated from each other. All parts of the body form a network of mutual influence and interdependence, and together they produce the mind. This 'interbeing' is at no place more evident than in the structure and function of memory systems. For instance, as far as the body is concerned, learning and memory are the same thing: something that you remember is something you have learned. In order to demonstrate what you have learned, you 'recall' it.
Memory tends to be seen almost exclusively as a function of brain processes, and memories are generally accepted as being located in neural networks inside the brain (Squire & Schacter 2002). While the evidence for this is overwhelming, these networks in the central nervous system (brain and spinal cord) cannot be divorced from the operations of the peripheral nervous system (the networks in the rest of the body). By beginning with this fundamental assumption, we can better understand the phenomenon known as 'body memory.'

The term body memory has been in popular use for some time, and has been used to describe the fact that once you learn how to ride a bike you never again have to think consciously about how to do it — your body just does it — and you never forget how to do it. Dancers speak of it when they perform complex choreographed steps they have worked hard to learn but now can enact without cognitive effort. These body phenomena might be partially understood as sensory 'engrams' (Julian 1987). More recently, the term body memory has been used by mental health professionals to explain why a client's postures, gestures, movements, and states of arousal change when they remember instances of trauma or other intense events (Elzinga & Bremner 2002). It is as if the body is remembering (re-membering) the past, just as much as the mind does, and is even re-experiencing the event in the present moment.

This chapter, along with other chapters in this volume, attempts the tricky task of articulating the concept of body memory neuroscientifically, but without resorting to reductionistic neurocentrism. It also endeavors to use an interdependence perspective to inform various methods of psychotherapy, with the hope that working directly with body memories can facilitate more effective healing.

Conceptual overview of body memory

Many different types of memory exist, and are distributed throughout the brain as well as being networked with the rest of the body. "Human memory is not a unitary faculty, but rather an ensemble of various forms of learning that differ in their uses, their operating characteristics, and the neural networks that mediate their processing" (Gabrieli et al. 1995: 76). Different types of memory tend to be stored in the parts of the brain where the information they are based on is processed (Gabrieli 1998; Gabrieli et al. 1995; Garrett 2009; Squire 1992). Thus, visual memories are located at visual processing areas, etc.

Most all memories originate as sensory impressions, an observation that is fraught with somatic significance that will be discussed later. They form as a result of a three-stage process that begins with encoding sensory events into meaningful schemas, consolidating them into storage, then retrieving them when we want to remember them. Different types of memory have been identified because of observed differences in how events are encoded, consolidated, and retrieved.

The two main divisions of memory are named because they involve separate systems and operations (Squire 1992). Declarative memory, or recall of facts and events,
is conscious and explicit. In this system I remember that I rode my bike to work yesterday. Nondeclarative memory involves implicit, or nonconscious activities such as how to perform actions (like riding a bike), habit formation, and classical conditioning. Declarative memories tend to be located in time, whether something happened yesterday or a decade ago. They begin to form somewhere in our second or third year of life, when we have mastered the rudiments of language and our hippocampi have matured enough to store our personal historical narratives (Cozolino 2002; Lambert & Kinsley 2005).

Nondeclarative memories, on the other hand, have no words and no time stamp — as with riding my bike, remembering is also doing — the memory is the action in the present moment, and past and present are therefore not different from one another. This functional sameness of action and remembering, past and present, emerges as highly significant for a nuanced understanding of many behaviors (Calvin 1998).

When I consciously observe and track my experience of riding the bike, the combination of moving and witnessing the sensory detail of my movements may lay down both declarative and nondeclarative memories. Both declarative and nondeclarative encoding relies on bodily sensations. In the former, the sensations and movement merge with my time stamped tracking of what occurred when, and would be recalled via words and images. In the latter, the sensations and movements become sensory engrams that can be recalled through enacting the same or similar activities. The explicit and implicit memory systems, though structurally separate, can be recalled either separately, or together. In the crucible of remembering a traumatic event, for instance, the scene might be recounted verbally while the body enacts the reactions that were encoded at the same time.

Enactment becomes highly relevant for a nuanced understanding of memory, because early experiences, especially interactions with caregivers, lay down largely unconscious ‘maps’ for making movements in both sides of the brain. These motor maps generate output signals to the muscles that produce complex movements and postures. Blakeslee and Blakeslee (2007) stress the significance of these motoric forms of memory, because our sense of meaning and our appraisal process is rooted in agency (the ability to act and choose), and agency, they noted, depends on embodiment.

Our motoric maps can be thought of as encoded body memories of how well we have moved through past experiences with a sense of agency. These movement memory maps then shape motoric responses (actions and choices) to current events. But because the recreated action patterns are mixed in with current embodied states, therapy that attends to our current embodied states may be able to influence and restructure these largely implicit maps via careful enactment sequencing.

Enactment relies on sensorimotor experiences. If we go back to Juhani’s concept of a sensory engram, for instance, we find that:

Each discrete sensory record of a particular movement is called a sensory engram and once the feeling of it is established as a clear, recallable memory, this engram is like a template. When we want to accomplish an act, we first recall the sensory
engram associated with past repetitions of that act – remembering how it felt to do it. Motor systems are then set into motion to reproduce the remembered sequence of sensations laid down in the engram. The sensory cortex has memorized the feel of a movement and each time it's recalled for the purpose of repeating the action. The proprioceptive feedback of all the body parts is compared against that memory for each step of the intended repetition, and cerebellar corrections are made automatically and unconsciously. Learning of a new motor skill is a process of establishing a new series of sensory engrams, and the ability to repeat skill depends on the preservation of an intact sensory engram. (Johan 1987: 265)

This memory for the feel of a movement, and the ability to replicate it in the present moment by blending the sensory engram with present bodily states may be the structural basis for what we are deeming body memory (Doyon & Ungerleider 2002). At the same time, we are building up to the idea that memories are not really representations of something that happened, but are schemas and engrams that form as a result of the mixing together of events with their social context, our physiological state, our mood and emotions, the environmental context, and our interactions with others.

In this way, we could say that most memory is inherently an associative process. Encoding, retention/consolidation, and retrieval all happen via association – if one sensory element of a memory is currently present, a whole network of associations will be called up along with it, and the new situation will be deemed a match to that memory. This can cause significant errors in our perceptions of the world and our current behavioral enactments in the context of those perceptions, as is often the case in unresolved trauma. This may also help us to understand why therapeutic modalities that involve the moving of memory, or bodily re-enactment, have such power to access the unresolved material that many therapy clients want to explore and resolve (Gabbard 2000).

It is within the framework of implicit, nonconscious enactment that we can understand body memory, because implicit memory contains stored patterns of bodily and emotional interaction with others, as well as personal experience. It begins to record our nonverbal body narratives, via the amygdalae, as early as our third trimester in utero. Implicit memories are often nonconsciously activated by nonverbal cues from others, as well as our own bodily sensations and explicit remembering (Cozolino 2002; Lambert & Kinsley 2005).

Body memory and emotion

The amygdalae, located in the limbic area, evaluate the emotional meaning of incoming stimuli, and stamp sensory events with emotional associations (especially fearful ones) as an intrinsic part of the creation of implicit memory. Enacting an implicit memory, functionally the same as retrieving it, will call up the emotions that were encoded with it. The emotion will be experienced as a present moment event, but is equally an act of
emotional remembering (Feldman Barrett, Niedenthal & Winkielman 2005; LeDoux 1996). This point becomes critical in the depth of a psychotherapy session, when a client may confuse an emotional memory with what is happening right now. Sorting that out often hallmarks healing and recovery.

Thus, explicit systems stamp time as the relevant reference points for memory, and implicit systems stamp emotion as salient markers of an event. Emotions are central to implicit encoding, storage, and retrieval, and therefore are thought to shape perception via our selective attention to what our implicit schema have deemed emotionally significant. After assigning meaning to sensory information, the amygdala shapes emotional behavior by projections to the hypothalamus, hippocampus, and basal forebrain (Van der Kolk 1994). Van der Kolk has noted that in animals, strong stimulation of the amygdala interferes with hippocampal functioning, and that this implies that intense emotion may inhibit accurate evaluation and categorization of experience. It may also reflect the central nervous system's privileging of affect-based bodily experience over the verbal narratives we create, when in an intense situation. Again, this has strong implications for how psychotherapy might most effectively proceed.

LeDoux terms this process 'emotional memory' (1996, 2002). One of his most significant findings is that classical conditioning can cause fear to be permanently associated to a neutral event (such as a bell sound), causing a body memory to be enacted (such as shaking and cowering). Also via classical conditioning, one can train the bodily response to diminish (a process called extinction). But LeDoux asserts that this behavioral extinction is the result of the brain's controlling the fear response rather than the elimination of the emotional memory. The emotional memory does not extinguish; we can just manage not to re-enact it.

Body memory and attachment

In our first few years of life, memory is laid down via sensorimotor processes – the bodily interactions we have with our caregivers, our environment, and our body. These encoded interactions are implicit, and governed by affective states (Schore 2001). In the midst of our early bodily experiences of being held and put down, touched, gazed at, and played with, we form attachment bonds that can unconsciously drive most our future relational interactions. This attachment bond governs how our bodies come to know, trust, and care for the bodies of others. Mental models of who we are and who others are come later, and are constructed from the body models we have laid down earlier. Badenoch notes that:

Implicit memories of first year are encoded without conscious awareness – the memories contain behavioral impulses, affective experience, perceptions, sensations, and images. With repeated experience they cluster into mental models (generalized nonverbal conclusions about the way life works). The conclusions
create anticipations of how life will unfold and remain largely below consciousness, guiding ongoing perceptions and actions in ways that reinforce the foregone conclusions. We often experience these as "The Truth" or "The Way Things Are" and when we do find words for them they sound like axiomatic realities.

(2008: 16)

Schore (2001) pioneered this understanding of the role of bodily states in attachment when he reported that early emotional exchanges are encoded in the form of representations of the self interacting with caregivers. These representations are not verbal or even pictorial, but are stored as psychophysiological arousal and affective states. He concludes that our early sense of self is constructed bodily. Van der Kolk (1994) adds that these early representations of experience include procedural memories, which can be understood as motor skills and body memories of the felt sense of early experiences.

A type of implicit memory called imprinting is used by humans and other mammals from late fetal development through early childhood. It involves quick, strong, global associations that do not fade over time, and is the basis for an infant’s capacity to know and attach to its primary caregivers. These associations are experienced bodily, linking, for instance, a warm visceral feeling of pleasure with mother and with being fed and soothed. A tensing of muscles with repeatedly being startled by an aunt, and excitement tinged with a bit of fear with father and physical play.

These imprinted, basic relational scenarios are important for us to figure out the rules of engagement in our primary relationships. Because of this, imprinting is most prominent at or around birth, and then tapers off as a learning/memory strategy. However, we remain capable of using imprinting under intense or stressful circumstances for the rest of our lives. In these circumstances it underlies the formation of post traumatic stress disorder, strongly linking all the different internal and external stimuli that are present during a traumatic event (called state bound learning), whether they are actually related to the trauma or not.

Whether attachment develops as secure or insecure rides on bodily experiences that are memorized below the level of conscious awareness, are stored as body maps, and retrieved as bodily actions. In order to positively influence attachment styles, therapists are likely to need to use their own bodies as vehicles for relational repair (Lyons-Ruth et al. 1998).

Body memory and trauma

Both chronic stress and unresolved trauma (PTSD) adversely affect memory systems. Declarative memory is particularly compromised. Van der Kolk (1994) explains that not only do chronic stress and PTSD interfere with hippocampal functioning (therefore declarative memories), but that they also cause deficits in the medial prefrontal cortex, a structure that exerts back pressure against the fears and panic generated by
the amygdala. This lack of a prefrontal braking mechanism may be the structural un-
derpinning of trauma survivors' experiences of the increasing frequency and intensity of overwhelming traumatic memories. Perversely, deficits in these brain areas can also result in strong emotional reactions occurring alongside a compromised ability to recall the emotional event.

Trauma memories are also encoded in body maps, and can be retrieved in bodily enactments. Our current physiological arousal can trigger traumatic memories, as well as those same memories precipitating bodily arousal. The stress hormones that are released in these arousal states may further imprint and strengthen unresolved traumatic memories. People with PTSD tend to over-interpret present moment sensory experiences as a recurrence of past trauma (Van der Kolk 1994), demonstrating the power of implicit memory, which is retrieved without any time stamp, to confuse and disrupt current perceptions of what is happening and how to deal with it.

It can be said that the goal of trauma therapy is to help clients live in the present moment, unencumbered by dictates from past events. It might also be said that trauma therapy seeks to unravel old sensory engrams and motoric maps that distort present experience and behaviors. However, the literature on trauma and memory also points to the fact that many trauma survivors experience their bodies as unregulated and untrustworthy, largely due to dysfunctional memory systems (Parson 1999). If my body shakes and sweats and cannot move every time I remember a past trauma, I am unlikely to want to pay attention to it. Paying attention to it might even make things worse.

Current trauma therapies that understand the body's role in healing and recovery tend to begin with facilitating a client's ability to stay within a physiological 'window of tolerance' (Ogden, Minton & Pain 2006; Rothschild 2000; Levine 1997), where arousal is kept to manageable levels, enabling the client to track her state in the present moment, and experientially distinguish between then and now. In this environment, the client can then gradually combine narrative recall with carefully enacted movement sequences that can re-pattern sensory engrams and motor plans so that a sense of agency, recovery, and embodiment is generated (Caldwell 2009, 2002).

Body memory and psychotherapy

Therapy that acknowledges and works with body memories may give therapists and their clients their best chance at facilitating change that lasts. This likely involves remembering or re-embodifying memory in new ways. Neuroscientist and clinician Dan Siegal has posited that every act of recall is potentially an act of modification (1999). When we remember, we bring the past into the context of the present, and as that past surfaces, it is exposed to the different experiential elements residing in the here and now. If these new elements are safe, calm, welcoming, and relationally secure (i.e., a therapeutic relationship), a painful memory can be consciously worked with on a body level, as a way to re-encode the past situation with new, more regulated associations.
The explicit memory of a difficult event is not forgotten, nor are the emotional and physiological states that occurred with them, but these remembered states can now be associated with a present that is more able to hold and care for the past with equanimity and perspective.

Badenoch puts it this way:

> The very process of directing attention toward a particular memory adds, at a minimum, the energy and information of the present moment to that memory. This is one way that our comforting presence actually may alter our clients' painful past experiences. If we are able to stay in connection with one another, the feeling of comfort—often communicated through the sound of our voice, the position of our body, the look on our face as it reflects our inner experience of compassion—will initiate new neural firings in the neural nets of frightening & repeated childhood events. (2008: 8)

Other therapeutic strategies can develop for different memory systems. Neuroscience has shown us, for instance, that nonconsciously, motoric habits are not forgotten (they are like riding a bike!). Evidence that habituation is involved in the formation of addiction has been accumulating (Holloway 1991), to the point where not being able to stop taking one more drink or drug has been called a 'programmed reach.' We can also habituate to emotions, a factor likely involved in mood disorders.

Addiction hits the habit formation centers of the brain hard, and results in sensory and motor stereotypy, a state of not being able to feel or enact much that is outside of the addictive habit. In these situations 'unlearning' the programmed body memories has to be very deliberate, using a combination of conscious attention and novel sensory experiences and motoric behaviors in order to create a new option to the old body memory (Caldwell 1996).

Another consideration in psychotherapy involving body memory can be the possibility of false memories. False memories likely form via the interpreter mechanism of the left hemisphere in the brain, that half of our cortex that processes via logic, linearity, and literalness. Siegal (1999) has stated that the left hemisphere gets out into the world with words, and the right hemisphere gets out into the world with movement. The right hemisphere specializes in imagery, emotional processing, and stress regulation. It is thought that false memories arise when the left hemisphere makes up a logical (but potentially incorrect) explanation for what the nonverbal right hemisphere is doing. What this may point us to is the likelihood that by postponing the explanatory narratives of the left hemisphere, and engaging directly with conscious movements that can directly and accurately express the feelings welling up in the right hemisphere, we can avoid the trap of trying to figure out whether a recovered memory is true or not.

Because most processing of sensory input occurs outside of conscious awareness, and only new, important or threat-based information is selectively passed on to the conscious processing of the neocortex, psychotherapy must involve 'waking up to' current sensations and states. This initial therapeutic task could be called the
Awareness Phase of the session, and in this phase the therapist and client attend to the client's embodied experience. Holding current states in nonjudgmental and non-interpretive awareness, often called 'open attention' or body-centered mindfulness, helps to create a safe container for the rest of the session to emerge.

When new inputs are emergent, then a second phase (called Owning Phase) of direct physical engagement might follow, where the client can take empowered ownership of sensation, and allow complex motoric responses to develop in response to direct experiencing. Interestingly, most repetitive movement organizes at a subcortical level, in the basal ganglia or cerebellum. Novel movements, however, tend to depend on the premotor and prefrontal cortex. By enacting the authentic movements that want to emerge as a result of mindful attention to ones current state, the prefrontal functions so crucial to healthy emotional and psychological regulation may be strengthened.

A third stage (called Appreciation Phase) then might organize, one that integrates sensation and movement with viscera-based feelings of relational safety, comfort, and resolution, as well as self-empathy. This positive affective experience is crucial for the modification of body memory. It cannot be manufactured, but emerges as a natural by-product of the sense of agency that develops as a result of the previous two phases.

Lastly, a fourth stage (called Action Phase) could occur. At this point, because the body needs new actions to consolidate, replicate and remember therapeutic changes, the client might want to physically play with (and from within) new bodily memories. In this phase the client practices and rehearses the application of novel sensorimotor processes to his or her daily life, still within the experiential support of the therapeutic relationship.

Conclusion

Body memories form from sensory experiences, encoded and stored together with emotions, arousal states, relational contexts, and cognitive attitudes, into holistic schema that then organize motor maps. Those in turn plan and execute our bodily behavior. By working with the sensorimotor states of the body directly, we can consciously and carefully attend to, engage with, and hopefully resolve old and outdated body memories, memories that have shaped and driven our thoughts, attitudes, and actions. "At that point, these implicit mental models cease to exert so much covert influence over our relational choices and behaviors because they are no longer non-conscious determinants, but rather just other elements in a flexible decision-making process" (Badenoch 2008:26).

By seeing human beings as a coherent collection of interdependent systems, most of which share interconnected means of encoding, storing, and retrieving various kinds of information, we can appreciate body memory as a very real and relevant contributor to our self identity and behavior.
References


