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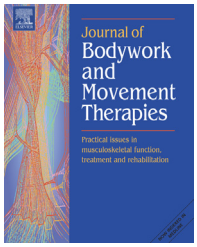

FASCIA SCIENCE AND CLINICAL APPLICATIONS: EDITORIAL

Does fascia hold memories?

KEYWORDS
Tissue memory;
Fascial mechanisms;
Fascial contraction;
Fascial treatment;
Bodywork;
Fascial release

Summary The idea that tissues may possess some sort of memory is a controversial topic in manual medicine, calling for research and clinical exploration. Many bodyworkers, at some point in their practice, have experienced phenomena that may be interpreted as representing a release of memory traces when working on dysfunctional tissues. This feeling may have been accompanied by some type of sensory experience, for the therapist and/or the patient. In some cases, early traumatic experiences may be recalled. When this happens, the potency of the memory may be erased or eased, along with restoration of tissue function. Hence the questions: can memories be held in the fascia? And: are these memories accessible during manual fascial work?

Modern research has proposed a variety of different interpretations as to how memory might be stored in soft tissues, possibly involving other forms of information storage not exclusively processed neurologically (Box 1).

Neuro-fascial memory

Early investigations of fascia showed that it is well innervated (Stilwell, 1957), especially by afferent free nerve endings, including nociceptive ones (Yahia et al., 1992). Irritation of these primary afferent nociceptive fibres can initiate the release of neuropeptides, which in turn may alter the normal tissue texture of the surrounding connective tissue, through their interaction with fibroblasts, mast cells, and immune cells (Levine et al., 1993). This process may trigger a number of both local and global responses: connective tissue remodelling, inflammation, nervous system sensitisation (Langevin and Sherman, 2007), pain – possibly evolving into persistent pain (Melzack et al., 2001), eventually followed by an adaptive response of the whole organism (Willard, 1995). Thus, under certain dysfunctional conditions, a neuro-fascial interaction may be responsible for the setting of a local tissue "memory" (peripheral sensitisation – Nickel et al., 2012), followed by a corresponding spinal facilitation (Baranauskas and Nistri, 1998). This may lead to a possible global effect through the involvement of higher centres (Nijs and Van Houdenhove, 2009) and of autonomic and endocrine pathways (Cortelli et al., 2013). Changes not only of neural pain-signaling mechanisms might follow, involving the function of somatosensory and cognitive/affective areas in the brain (Staud et al., 2007).

Fascial treatment may access such memories and obtain therapeutic effects. For instance, in indirect types of fascial techniques, the unloading of the tissues may cause a consequent decrease of neural input and mechanical load through the fascial structures, possibly unloading muscle spindles while loading Golgi tendon organs (Van Buskirk, 2006). This may change the pattern of sensory input to the facilitated spinal cord area, quieting the nociceptors (Kakigi and Watanabe, 1996). Local and spinal cord level autonomic reflexes would be stilled, particularly the sympathetic drive which may have encouraged vasoconstriction and diminished lymphatic flow. This may encourage more normal pumping action of the muscles and improved fascial sliding motion (Tozzi et al., 2011).

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Word box 1. **Neural memory and morphic fields: a theoretical model**
Initially, memory traces were thought to be stored as patterns in specific areas of the brain: so that electrical stimulation of these areas could activate sequential records of 'memories' (Penfield, 1975). However, the same recollections could also be evoked by stimulating the brain at different sites, as well as different recollection being produced by repeatedly stimulating the brain at one site. Therefore, it seemed that rather than being confined to a specific location, memories are diffused throughout the brain. A new interpretation was then advanced suggesting the possibility that the brain may store memories as interference patterns, in a holographic-like manner (Pribram, 1969). According to this theory, memory, including that of pain (Ray et al., 2013), is to be found not in the patterns of neural activity of a specific brain region, but in the interference patterns of nerve impulses that crisscross the entire brain in the same way that laser light interferences crisscross the entire area of a film containing a holographic image. It is suggested that this phenomenon may be extended throughout the organism, via the neuro-fascial interactive function, involving a process of encoding memories in the connective tissues in a holographic-like manner. The brain (and maybe all connective tissues?) may then be able to compare stored holographic patterns with newly acquired ones, directly through "adaptive resonance", allowing rapid processing of recognition and learning (Marcer, 1992).

Along this line of thought, Sheldrake's theory goes further. He basically proposes that memory is maintained in morphic fields: potential organizing patterns of influence, extending in space and continuing in time. "Memory is inherent in all organisms in two related ways. First, all organisms inherit a collective memory of their species by morphic resonance from previous organisms of the same kind. Second, individual organisms are subject to morphic resonance from themselves in the past, and this self-resonance provides the basis for their own individual memories and habits" (Sheldrake, 1988). In this way, a sort of "phylogenetic memory" is constructed. Obviously, this theory represents a radical alternative to the conventional idea that memories are encoded as material traces within the nervous system, or in body tissues in general. The idea has even been advanced that such collective memory field can be holographically stored in the surrounding environment, accessible by the brain (and possibly by the rest of the body) just as a radio tunes in to music from surrounding electro-magnetic fields (Laszlo, 1995).

Fascial memory

Memories in the body may be also encoded into the structure of fascia itself. Collagen is deposited along the lines of tension imposed or expressed in connective tissues at both molecular (Gautieri et al., 2011) and macroscopic level (Sasaki and Odajima, 1996). Mechanical forces acting upon the internal and/or external environment, such as in postures, movements and strains, dictate the sites where collagen is deposited. Thus, a "tensional memory" is created in a particular connective tissue architecture formed by oriented collagen fibres. This architecture changes accordingly to modification of habitual lines of tension, providing a possible "medium term memory" of the forces imposed on the organism. However, this type of signalling may be altered in pathological conditions, such as locally decreased mobility due to injury or pain (Langevin, 2006). In cases of functional strain or mechanical stress through collagen bundles, known physiological responses involve fibroblast mechano-chemical transduction, and modulation of gene expression patterns (Chiquet, 1999), together with inflammatory and tissue remodelling processes of the collagenous matrix (Swartz et al., 2001). Furthermore, the release of substance P from nerve endings, particularly driven by the hypothalamus following emotional trauma, may alter the collagen structure into a specific hexagonal shape, referred as "emotional scar" (Heine, 1990). The entirety of this phenomenon may be interpreted as a highly structurally and functionally specific process of encoding memory traces in fascia.

Extracellular matrix and tissue memory

In addition, this ability seems to be present not only in the collagen network but also in elastin fibres and in various cells throughout the connective tissue: fibroblasts, mast cells, plasma cells, fat cells. Since these are relatively durable and long-lasting cells, they may represent a kind of "long-term memory" of the ground substance. "The existence of a cellular network of fibroblasts within loose connective tissue may have considerable significance as it may support yet unknown body-wide cellular signaling systems." (Langevin et al., 2004). The ground substance, in turn, provides a non-genetic memory complementary to the genetic one by ensuring a consistent set of signals to the cells. In fact, while genes may provide information to the ground substance on "how to", the ground substance may define for the cell "what to", shaping individual patterns of metabolism, development, growth, repair and behaviour (Lu et al., 2011). This microenvironmental memory, underlying most pathobiochemical events, has been indicated to be dependent on matrix turnover and, as such, to be erasable via fibroblast induction and maintenance (Tan et al., 2013). The extracellular matrix may play a crucial role in sensing, integrating and responding to the "physical and chemical environmental information either by directly connecting with the local adhesion sites or by regulating global cellular processes through growth factor receptor signalling pathways, leading to the integration of both external and internal signals in space and time" (Kim et al., 2011).