2

The mature organism model

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Introduction

The Mature Organism Model (MOM) (see also Gifford 1998) has been developed as a teaching tool to help clinicians and patients reach a broader understanding of pain, appreciate it in a biological context, and ultimately manage it better. A fundamental feature of the model is the placement of pain into the discipline of stress biology. Stress biology is concerned with the physiological mechanisms and behavioural strategies that enable organisms to survive, or to maintain their homeostasis (Weiner 1991). Thus, pain can be viewed as a single perceptual component of the stress response whose prime adaptive purpose is to powerfully motivate the organism to alter behaviour in order to aid recovery and survive.

The perspective and principles proposed in the MOM are essentially Darwinian in nature (for example, see Nesse & Williams 1994, Williams 1996) in that it views the human body (or any living organism's 'body') as a very sophisticated vehicle that carries and looks after our genes. Hence our bodies can be viewed as survival machines in which the genetic material that enables us to replicate lives (Dawkins 1989). The animal and plant kingdoms contain a remarkable variety of replicating survival machines (for example, see Dawkins 1996).

In a simple single celled animal, like an amoeba, it is fairly plain that in order for it to survive it must have some mechanism of sampling its immediate environment, assessing or 'scrutinising' what it finds, and then reacting/responding in accordance with whether it finds the environment advantageous or threatening. Thus, it may move towards an area which contains food or a possible mate or move away from areas that contain toxins or predators. For many organisms the physiological essence of this sample—scrutinise—respond pathway is chemical; chemicals are sampled from the environment via chemical receptors which then initiate cascades of internal biochemical processes whose end result is an appropriate survival reaction or behaviour—a 'motor' response. Note that higher animals have evolved sophisticated sense organs that are capable of conveying remarkably detailed environmental information via the medium of light sound and smell. Even so, the information received is still converted into meaningful information for 'scrutiny' via chemical activity.

Survival of an organism also involves the capacity to sample itself. There is a need for a system that is able to monitor the health of the organism's own body and provide an appropriate recovery response should damage occur. For a single celled animal, this may mean the activation and conveyance of chemical messengers from the damaged area to the nucleus, the activation of appropriate genes in nuclear DNA and hence the production of new protein products for transport back to the damaged area to complete the repair process. In higher, larger and more complex animals the underlying mechanisms are fundamentally the same. It is just that more sophisticated communicating and coordinating systems have evolved that are capable of producing far more complex responses. The vertebrate central nervous system/brain is a prime example.

In thinking about ourselves, our own bodies and brains, as sophisticated machines bent on survival and maintaining homeostasis, it helps if the CNS/brain is viewed as a central scrutinising centre, or stress response coordination centre, that continually samples (consciously and 'unconsciously') the outside environment, its own body and relevant past experiences (the brain samples 'itself'), and then 'acts', or outputs, on what it finds, to the best advantage for its body and the vital genes it contains (Fig. 2.1).

'Actions' can be broadly divided into:

1. **Overt behavioural responses.** For example, when injured we demonstrate subsets of 'illness' behaviours (Fordyce 1984, Pilowsky 1986, Waddell et al 1993, Pilowsky 1995a, 1995b), which may be useful—hence adaptive, or of no use whatsoever—hence maladaptive. Other examples of behavioural 'actions' that maintain homeostasis include food seeking when levels of vital energy diminish and activities like shivering, putting an extra jumper on and switching on the heating when the temperature drops. It should be evident that our behaviour contains elements of conscious decision as well as being driven by robust unconscious reflex mechanisms and drives (see Plotkin 1994). What must be accepted is that these unconscious reflexes are keenly influenced by the decisions and thoughts produced in the conscious brain. The fact that I may have a pain and appropriate muscle spasm preventing movement of my neck is quickly overridden if for some reason movement is essential to survival or I strongly desire to move it normally.
2. **The less obvious but highly complex physiological processes that are a necessary response to environmental and bodily changes.** These also allow a chosen behaviour to occur, or are a homeostatic response to the behaviour.

The biological systems that may be involved in producing the behavioural or physiological 'response' to any given threat to our homeostasis include: the somatic motor system, the autonomic nervous system, the neuroendocrine system, and the immune system. Thus, physical injury may alter the activity of all these systems. A key facet of the CNS/brain is that it provides the essential

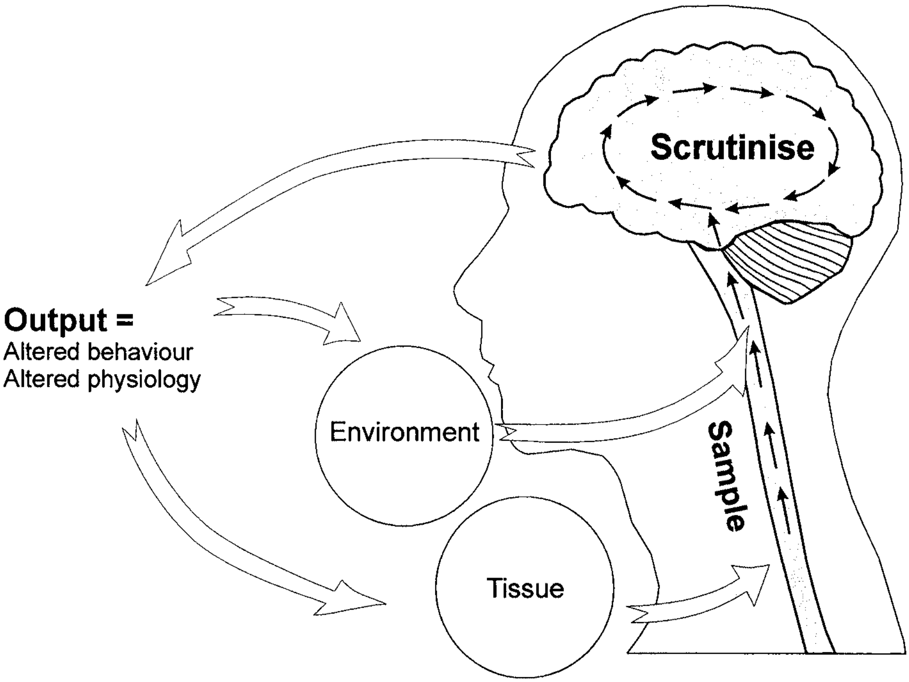

Fig. 2.1 Staying alive—homeostasis and the mature organism model. This figure represents the fundamental pathways into and out of the brain/CNS that are required for bodily survival. (From Gifford L S 1998 Pain, the tissues and the nervous system: a conceptual model. Physiotherapy 84(1):27-36, with permission)

co-ordinating role. Note that these systems will also be activated to produce positive responses to favourable situations and environments.

The biological systems involved in 'sampling' largely involve afferent sensory neural pathways but the slower and more primitive circulatory communicating systems should not be forgotten. Interestingly, the immune system is now being viewed not only as an effector system—for example in fighting off invading pathogens or by facilitating repair of damaged and worn tissues—but also as a sensory afferent system that receives information from the environment and other parts of the body. Thus, the immune system has similar capability as the CNS/brain, in that it samples—scrutinises—acts. What is also interesting is that strong afferent and efferent links exist between the brain and the immune system and so one system's activities can powerfully effect the other, even up to, or from, the psychological/behavioural level (see Sternberg & Gold 1997).

The young organism is naive, it has a relatively 'empty' brain and central nervous system in terms of environmental and physiological experiences (but see Mithen 1996). As the organism ages it matures and its CNS/brain 'fills-up' with mindful and physiological experiences on which it can draw to aid in its quest for survival and reproductive success. The naive human organism is strongly dependent on its parents for survival. As it matures it becomes progressively more independent, until it is capable of reproducing and having offspring which are in turn dependent on it. In these terms, maturity is all about getting to know the environment and learning how to act within it to one's bodily and genetic advantage. The process of maturation is also about the brain getting to know its own survival machine and how to use it. Simply, this can be regarded as a progression from naiveté, where the CNS/brain houses only a few innate but vital sample—scrutinise—action pathways, to maturity, where layers of sample—scrutinise—action experiences are imprinted into the system and which can be drawn upon if needed later. Thus, as the system matures it slowly gets 'filled' with meaningful new interconnections and pathways that can be considered the biological representations of past experience (Kandel et al 1995). Physiological and environmental experiences are thus stored as 'memories' during 'learning' and are capable of being 'recalled or remembered' when needed (Rose 1992, Gross 1996, LeDoux 1998). Along with physical maturation, learning, memory and recall, in the broadest sense, are the fundamental neurobiological processes that take the naive organism from being grossly dependent on its parents, to being fully independent and capable of rearing children.

Figure 2.1 schematically illustrates the mature organism, its connections to the environment via the sense organs and to its own body. Inputs produce outputs which can alter the environment and the body, they are sampled again and so on in a perpetual manner. All life, from the minutest single celled organisms right up to the complexities of the multicellular human-being depend on this continuous sample—scrutinise—response—re-sample capability in order to survive.

Injury and pain in the context of the MOM

Consider a situation in which someone is innocently sitting in their car waiting to pull out of a junction when a large truck hits them from behind. The impact is so heavy that the recipient is jerked violently forward and back. The situation takes on a dramatic turn physiologically and behaviourally. Figure 2.2 includes a representation of just this—the perceived events in the environment and the damage to the tissues. The brain receives information about it all, scrutinises it and reacts accordingly. In turn, physiological responses in the body go into red alert to produce stress response subsets appropriate to the situation the brain finds itself in (Cannon 1929, Selye 1978, Gray 1987, Sapolsky 1994, Gifford 1997). This may or may not involve the perception of pain.

Part of the CNS/brain response/output may be to actually prevent nociceptive messages from impinging on consciousness (Fields & Basbaum 1989, Fields & Basbaum 1994). For instance, if the injured persons' life was under severe threat they would be unlikely to feel any pain. The issues of bodily survival (classically involve freeze, fight or flight) take priority over the perception of pain and its concomitant illness behaviour (Gray 1987). Thus, whether we

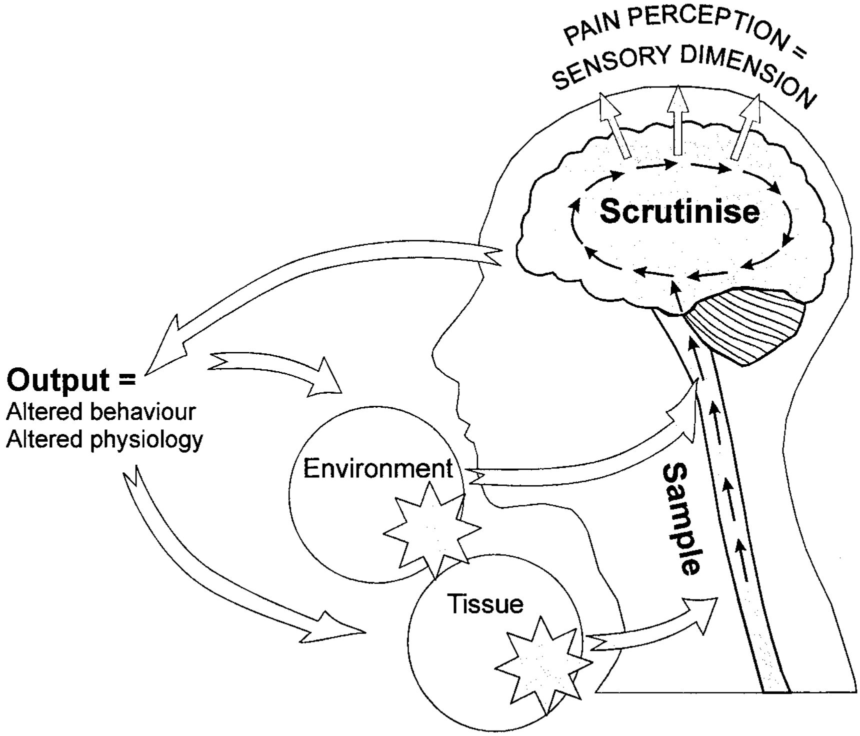

Fig. 2.2 Injury and the mature organism model: a possible initial stage. (From Gifford L S 1998 Pain the tissues and the nervous system: a conceptual model. Physiotherapy 84(1):27-36, with permission)

feel pain at the time of injury is very variable and largely a product of the circumstances as assessed by our brain (for example, see Beecher 1946, Melzack et al 1982, Blank 1994).

Perhaps we should not forget that pain, like the appreciation of colour, is ultimately a perceptual quality whose neuronal correlates are somewhere in the CNS/brain (Edelman 1992, Crick 1994, Adolphs & Damasio 1995, Backonja 1996, Wall 1996, Koch 1997).

The sensation of acute pain is the conscious signal of a physical threat whose major purpose, in parallel with producing the biologically linked emotional reaction of fear and/or anger, is to motivate and bring about an alteration in our behaviour in order to further our chances of recovery and survival (Wall 1979, MacLean 1990). Thus, acute pain from injury and the classic instantaneous behaviour patterns that are found across all cultures may be viewed as being 'adaptive' biologically well ingrained in our systems, and hence difficult to consciously modify. Later on, pain helps us to become physically vigilant and avoid use of the injured part, our whimpering and distress attract support from others and our general demeanor demands care and respect from anyone venturing too close without undue care (Walters 1994). Seen in this way, pain adaptively drives recuperative behaviour (Wall 1979).

Figure 2.3 adds another component to the MOM that introduces the possibility of a degree of flexibility of response. The brain samples itself before creating a behaviour. For example, it samples relevant past experience, knowledge and beliefs and mixes this in with its appraisal of the current situation. This sampling includes knowledge of past successful behaviours in similar situations, as well as successful behaviours related to us or observed in others. Adventure stories and the rather sickening attraction many of us have to investigate accidents or read about other people's mishaps may well have great survival advantages! What any one individual has stored in their brain's filing cabinets of experience is a reflection of the culture and society they were brought up in, their relative age, and the life experiences they have had. In comparison to the naive organism the mature organism has a large number of behavioural strategies to choose from. It is worth reflecting that as a result of the great variety of options provided by modern complex societies (should I go to the doctor? to the chiropractor? to the casualty department? to my aromatherapist? etc.) the more difficult it becomes for the individual to make a secure choice—and that doubt promotes anxiety.

The message is that along with the powerful effects resulting from the inputs being sampled and reflexly scrutinised from the damaged tissues, our current thoughts and feelings about the situation that we find ourselves in, as well as the thoughts and attitudes of those around us, will all have a marked influence on the degree of pain, our illness behaviour and the level of suffering (see Fordyce

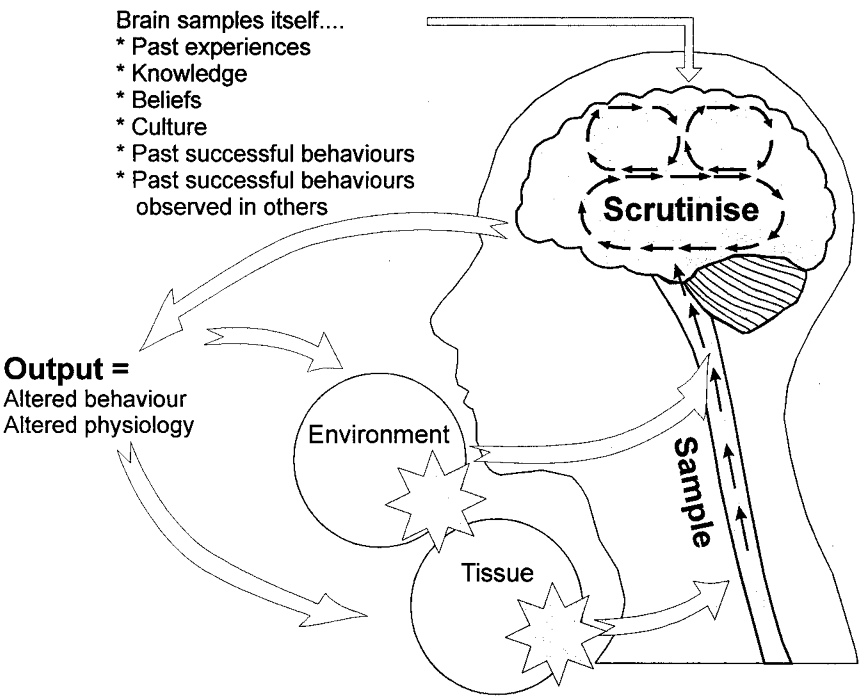

Fig. 2.3 Injury and the mature organism model, showing the brain sampling itself and how the contents of our brains that represent such attributes as experience, beliefs and culture will influence the output system activity. (From Gifford L S 1998 Pain the tissues and the nervous system: a conceptual model. Physiotherapy 84(1):27-36, with permission)

1986, Jensen et al 1991, Skevington 1995, Turk 1996).

Figure 2.4 highlights the importance that the current thoughts and feelings a person suffering pain may have on the outputs of the brain. Most therapeutic approaches usually consider pain in a single **sensory dimension** (Fig. 2.2): i.e., the perception of where the pain is located, the quality and type of pain, its intensity and the way it behaves over time. However, pain has been considered in terms of three dimensions for quite along time (see Melzack & Casey 1968, Melzack 1986): i.e., the **sensory dimension** as described; the **cognitive dimension**, which recognises that pain alters our thoughts; and the **affective dimension** recognising that for every pain we have there is some kind of emotional reaction.

Consider again the car accident described earlier. One minute the individual was happily minding their own business, the next minute they've been rudely shunted forwards by the vehicle behind. They have altered their feelings (shocked and anxious, perhaps increasingly angry—affective dimension), altered their thoughts ('What am I going to do now? I'd better ring my neighbour to take me to the casualty, and I'm not that keen on going there, they haven't a very good reputation according to the newspapers and some ex-patients I know'—

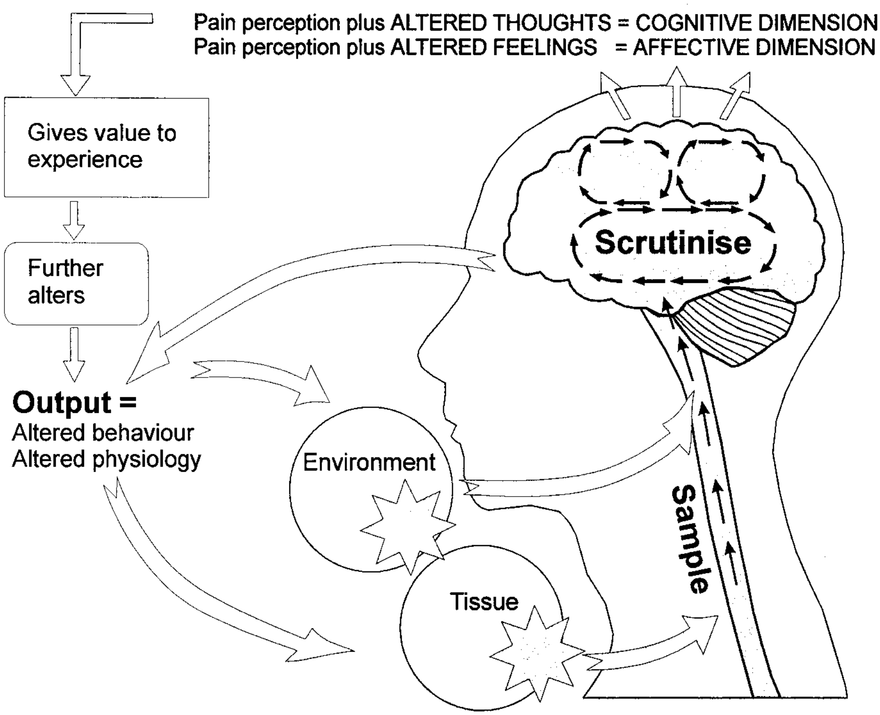

Fig. 2.4 Injury and the mature organism model. As a result of tissue sampling, environment sampling and self sampling, the brain/CNS produces appropriate thoughts and feelings. These perceptual outputs of the brain give value to the injury experience and hence further influence the activity of the physiological and behaviourally related output systems involved in survival and recovery. (From Gifford L S 1998 Pain the tissues and the nervous system: a conceptual model. Physiotherapy 84(1):27-36, with permission)

the cognitive dimension), and they feel a building throbbing pain in the neck, shoulder and back of head (sensory dimension).

These three dimensions represent three levels of integrated higher neural processing relating to consciousness that are largely responsible for an individual's behaviour pattern. Clearly, our thoughts and feelings about a given situation are the fundamental processes that give it value. Value means that if the individual sees the experience as very important, then something must be done, and the experience is worth giving attention to, focusing on (Wright 1994) and remembering for future use. Emotions are vital to providing experience with value and hence motivation to act (Melzack & Casey 1968, Damasio 1995) and are largely determined by our thoughts and beliefs as well as being reflexly triggered in novel and unexpected situations (LeDoux 1993,1994, 1998).

The classic emotional centres that reside in the more primitive limbic brain and associated areas are very powerfully linked to the areas of the major brain output systems—for example, the neuroendocrine system via the hypothalamus and pituitary glands; the sympathetic system via the hypothalamus and locus coeruleus in the brain stem and the somatic motor system via the motor cortex (Chrousos & Gold 1992, Brown 1994, Chapman 1995, Chrousos et al 1995). The powerful links between the neuroendocrine and sympathetic systems and the immune system are also well recognised (see below). The important clinical implication is that if we can change the way a person feels emotionally, by for instance changing their knowledge and beliefs about their problem or situation, we can beneficially change activity in the output systems (Bandura et al 1985, Bandura et al 1987, O'Leary et al 1988). This does not just mean bringing about changes in observable behaviour but also changes in autonomic, neuroendocrine and immune activity. The simple concept of 'mind influencing matter' is very much a scientific reality (for excellent overviews see Sapolsky 1994, Martin 1997, Sternberg & Gold 1997).

Figure 2.5 illustrates that a new experience is put into memory in the CNS/brain for future reference (Rose 1992, Kandel & Hawkins 1993, Kandel et al 1995). Note that the Figure includes the possibility of a pain memory (see the discussion in Ch. 4), but will also include a 'memory' of the successful and not so successful behaviours, cognitions and emotions that were used and the concurrent physiological reactions required pertinent to the experience (Skevington 1995). In other words, if a similar experience happens later in life, our behaviour and physiological reactions to it may well be more efficient since the pathways responsible for it originally do not need to be newly established, merely rekindled. This is an example of how the organism gets 'cleverer' at survival as it matures and gains more experiences to add to its wisdom.

One would imagine the perfectly adapted organism to only 'record' events and experiences that were of significance or of great value to survival and replication (Sylwester 1995). However, it is also possible that many environmental and physiological events may be recorded detrimentally in some cases (Kandel et al 1995). Man's unique consciousness has the ability to think about the value he puts on events and experiences and may well consciously or unconsciously prejudice the maladaptive 'over' retention of many unhelpful experiences. Pain

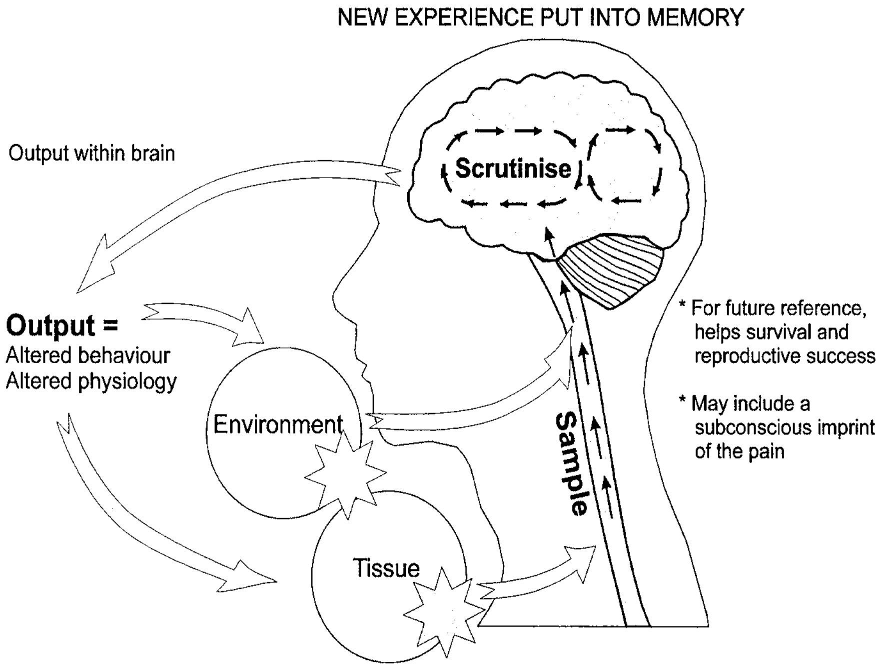

Fig. 2.5 The mature organism model. Illustrates the retention of the incident in memory and proposes that this may include a neural representation of the pain.

in all its dimensions is of course a prime example. The 'recording' of unhelpful experiences and related maladaptive physiological processes is perhaps the price we pay for being endowed with this rather remarkable recording capability (discussed at length in Butler & Gifford 1999). On the other hand, a cynical view could argue that given the present cultural climate, over-focusing and constantly attending to pain and adopting a disabled role may be relatively advantageous and hence biologically adaptive (see Ch. 15). Problems arise when the interface between malingering, and the present cultural norms that condition us to allocate blame and seek compensation are brought into the equation. It is very much a Darwinian notion that says 'get as much as you can for the least possible effort'. Perhaps before allocating blame, we should recognise that while overt selfishness is ethically offensive, it is biologically well ingrained and therefore very much a part of the makeup of the selfish gene and life's very success (see Wright 1994).

The MOM provides a biological perspective on which the effects of injury and pain can be more broadly rationalised. Chapters 3, 4 and 5 take a personal look at the science and clinical relevance of pain mechanisms and relates them back to the MOM (see also Gifford 1997, Gifford 1998).

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